SLOVENSKI STANDARD
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Elektromagnetna združljivost in zadeve v zvezi z radijskim spektrom (ERM) ï Radijska oprema za podatkovno povezavo VHF zrak-tla, 4. naļ in ï Tehniļ ne karakteristike in merilne metode za talno opremo ï 2. del: Plast podatkovnih povezav

Electromagnetic compatibility and Radio spectrum Matters (ERM); VHF air-ground Data Link (VDL) Mode 4 radio equipment; Technical characteristics and methods of measurement for ground-based equipment; Part 2: Data link layer

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

The present document is part 2 of a multi-part deliverable covering the VHF air-ground Data Link (VDL) Mode 4 radio equipment; Technical characteristics and methods of measurement for ground-based equipment, as identified below:

Part 1: "General description and physical layer";

Part 2: "Data link layer";

Part 3: "Additional broadcast aspects";

Part 4: "Point-to-point functions".

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Introduction

The present document states the technical specifications for Very High Frequency (VHF) Digital Link (VDL) Mode 4 ground-based radio transmitters, transceivers and receivers for air-ground communications operating in the VHF band (117,975 MHz to 136,975 MHz), using Gaussian-filtered Frequency Shift Keying (GFSK) Modulation with 25 kHz channel spacing. Optionally, the transmitters, transceivers and receivers may tune between 113 MHz to 117,975 MHz.

The present document may be used to produce tests for the assessment of the performance of the equipment. The performance of the equipment submitted for type testing should be representative of the performance of the corresponding production model.

The present document has been written on the assumption that:

- the type test measurements will be performed only once, in an accredited test laboratory and the measurements accepted by the various authorities in order to grant type approval;
- if equipment available on the market is required to be checked it will be tested in accordance with the methods of measurement specified in the present document or a documented alternative approved by the certifying authority;
- equipment complies with EN 301 489-22 [2].

1 Scope

The present document states the minimum performance requirements for radio transmitters, receivers and transceivers for ground-based VHF Datalink mode 4 (VDL mode 4) equipment intended to be used for air-ground data communications, operating in the VHF band (117,95 MHz to 137 MHz and optionally 113 MHz to 117,95 MHz) allocated to the aeronautical mobile service. It is designed to ensure that equipment certified to it will be compatible with the relevant ICAO VHF Digital Link (VDL) Standards and Recommended Practices (SARPs) and VDL Mode 4 Technical Manual (TM) [1].

Manufacturers should note that in the future, all or part of the frequency band 108,000 MHz to 117,975 MHz might become available for aeronautical communications.

The present document applies to Gaussian-filtered Frequency Shift Keying (GFSK) systems, with channel separations of 25 kHz intended for air-ground communications. The scope of the present document is limited to ground base stations.

The VDL system provides data communication exchanges between aircraft and ground based systems supporting surveillance applications. The supported modes of communication include:

- broadcast and point-to-point communication;
- air-air and ground-air;
- operation without ground infrastructure.

VDL Mode 4 is designed to be an Air/Ground subsystem of the Aeronautical Telecommunication Network (ATN) using the AM(R)S band and it is organized according to the Open Systems Interconnection (OSI) model (defined by ISO). It provides reliable sub network services to the ATN system.

The present document specifies functional specifications of radio transmitters, receivers and transceivers at ground-based VHF communication equipment intended to be used for air-ground and air-air data communications. The present document is derived from the specifications:

- Mode 4 standards produced under the auspices of the International Civil Aviation Organization (ICAO) [1].
- Other relevant standards as defined in clause 2.

EN 301 842-1 [4] deals with tests of the physical layer. The present document deals with tests of the link layer sufficient to support broadcast functionality. The present document also includes requirements and tests sufficient to recognize and respond to transmissions associated with point-to-point communication. Detailed requirements for point-to-point communication are beyond the scope of the present document.

The present document includes:

- references, definitions, abbreviations and symbols are provided in clauses 2 and 3;
- clause 4 describes the VDL Mode 4 ground station link layer;
- clause 5 performance specifications for the VDL Mode 4 ground station;
- clause 6 provides general design requirements;
- clause 7 provide protocol tests which emphasis the ADS-B functions of the system;
- a document history is contained in clause 8;
- clause A provides a detailed cross-reference to the relevant requirements contained in reference [1];
- annex B provides a description of the ISO/IEC 9646 [7] Test Methodology.

Note that the system can support a very wide range of functions. It is not practical to provide specific tests for all aspects of functionality. The approach used is to provide detailed tests for the core ADS-B functionality and to provide tests of those remaining requirements which, if wrongly implemented, could cause a deterioration in the service offered by other VDL Mode 4 stations. Therefore:

- a detailed set of protocol tests are provided for the broadcast functionality necessary to support ADS-B functions;
- a detailed test of position encoding and decoding is provided because of the importance of position in the management of the VDL Mode 4 link specifically and the need to support ADS-B applications in general.

Mandating and recommendation phrases

a) "Shall":

the use of the word "Shall" indicates a mandated criterion; i.e. compliance with the particular procedure or specification is mandatory and no alternative may be applied.

b) "Should":

the use of the word "Should" (and phrases such as "It is recommended that...", etc.) indicates that though the procedure or criterion is regarded as the preferred option, alternative procedures, specifications or criteria may be applied, provided that the manufacturer, installer or tester can provide information or data to adequately support and justify the alternative.

2 References

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 and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

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

[1] Annex 10 to the Convention on International Civil Aviation, International Civil Aviation Organization (VDL Mode 4 Technical Manual).

[2] ETSI EN 301 489-22: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 22: Specific conditions for ground based VHF aeronautical mobile and fixed radio equipment".

[3] ISO/IEC 3309 (1993): "Information technology - Telecommunications and information exchange between systems - High-level data link control (HDLC) procedures - Frame structure".

[4] ETSI EN 301 842-1 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); VHF air-ground Data Link (VDL) Mode 4 radio equipment; Technical characteristics and methods of measurement for ground-based equipment; Part 1: General description and physical layer".

[5] ISO/IEC 7498-1 (1994): "Information technology - Open Systems Interconnection - Basic Reference Model: The Basic Model".

[6] ISO/IEC 10731 (1994): "Information technology - Open Systems Interconnection - Basic Reference Model - Conventions for the definition of OSI services".

[7] ISO/IEC 9646 (all parts): "Information technology - Open Systems Interconnection - Conformance testing methodology and framework".

[8] ED-14D/DO-160D: "Environmental Conditions and Test Procedures for Airborne Equipment".

3 Definitions and abbreviations

3.1 Definitions

3.1.1 Basic reference model definitions

The present document is based on the concepts developed in the open systems interconnect basic reference model and makes use of the following terms defined in ISO/IEC 7498-1 [5]:

- layer;
- sublayer;
- entity;
- service;
- physical layer;
- data link layer.

3.1.2 Service conventions definitions

For the purposes of the present document, the terms and definitions given in ISO/IEC 10731 [6] apply:

- service provider;
- request;
- indication;
- confirm.

3.1.3 General definitions

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

aeronautical mobile service: mobile service between aeronautical stations and aircraft stations, or between aircraft stations, in which survival craft stations may participate

Aeronautical Telecommunications Network (ATN): internetwork architecture that allows ground, air/ground, and aircraft data sub networks to interoperate by adopting common interface services and protocols based on the International Organization for Standardization Open Systems Interconnection Reference Model

aircraft address: unique combination of 24 bits available for assignment to an aircraft for the purpose of air-ground communications, navigation and surveillance

NOTE: An aircraft may choose not to use this unique address and can use instead a non-unique address.

Automatic Dependent Surveillance-Broadcast (ADS-B): surveillance application transmitting parameters, such as position, track and ground speed, via a broadcast mode data link for use by any air and/or ground users requiring it

NOTE: ADS-B is a surveillance service based on aircraft self-determination of position/velocity/time and automatic, periodic or random, broadcast of this information along with auxiliary data such as aircraft identity (ID), communications control parameters, etc. ADS-B is intended to support multiple high-level applications and associated services such as cockpit display of traffic information, traffic alert and collision avoidance functionality, enhanced traffic management in the air and on the ground, search and rescue support and others.

autotune function: function, performed by the Link Management Entity, which allows a ground VDL Mode 4 station to command an aircraft to change the operating characteristics of synchronization burst transmissions

burst: VHF Digital Link (VDL) specific services burst is composed of a sequence of source address, burst ID, information, slot reservation, and Frame Check Sequence (FCS) fields, bracketed by opening and closing flag sequences.

NOTE: The start of a burst may occur only at quantized time intervals and this constraint allows the propagation delay between the transmission and reception to be derived.

burst length: number of slots across which the VDL Mode 4 burst is transmitted

current slot: slot in which a received transmission begins

delayed burst: VDL Mode 4 burst that begins sufficiently after the beginning of a slot so that the transmitting VDL Mode 4 station is confident that no other VDL Mode 4 station that it could receive from and is within the guard range is transmitting in the slot.

NOTE: The delayed VDL Mode 4 burst terminates by the end of the slot in which it began (its length is shortened to ensure completion by the nominal time).

Global Signalling Channel (GSC): channel available on a world wide basis which provides for communication control

ground base station: aeronautical station equipment, in the aeronautical mobile service, for use with an external antenna and intended for use at a fixed location

link: connects a mobile DLE and a ground DLE and is uniquely specified by the combination of mobile DLS address and the ground DLS address

NOTE: A different sub network entity resides above every link endpoint.

link layer: lies immediately above the physical layer in the Open Systems Interconnection protocol model

NOTE: The link layer provides for the reliable transfer of information across the physical media. It is subdivided into the data link sublayer and the media access control sublayer.

Link Management Entity (LME): protocol state machine capable of acquiring, establishing, and maintaining a connection to a single peer system

NOTE: A LME establishes data link and sub network connections, 'hands-off' those connections, and manages the media access control sublayer and physical layer. An aircraft LME tracks how well it can communicate with the ground stations of a single ground system. An aircraft VDL Management Entity (VME) instantiates a LME for each ground station that it monitors. Similarly, the ground VME instantiates a LME for each aircraft that it monitors. An LME is deleted when communication with the peer system is no longer viable.

Media Access Control (MAC): the sublayer that acquires the data path and controls the movement of bits over the data path

mobile: radio equipment designed for installation into vehicles

mode 4: data link using a Gaussian Filtered Frequency Shift Keying modulation scheme and self organizing time division multiple access

NOTE: Mode 4 has been validated for surveillance applications.

physical layer: lowest level layer in the Open Systems Interconnection protocol model

NOTE: The physical layer is concerned with only the transmission of binary information over the physical medium (e.g. VHF radio).

primary time source: normal operation timing mode in which a VDL Mode 4 station maintains time synchronization to Universal Time Coordinated (UTC) second

private parameters: contained in CTRL (CTRL) frames and that are unique to the VHF digital link environment

secondary time source: timing source used in a failure mode, which applies when the primary time source fails, in which a VDL Mode 4 station maintains time synchronization to UTC second

slot: In VDL Mode 4, time is divided into a series of time slots of equal period. Each VDL Mode 4 burst transmission starts at the beginning of a slot.

station: VDL Mode 4 Specific Services (VSS)-capable entity

NOTE: A station may be either a mobile station or a ground station. A station is a physical entity that transmits and receives bursts over the RF interface (either A/G or air-to-air (A/A)) and comprises, at a minimum: a physical layer, media access control sublayer, and a unique VSS address. A station which is also a DLS station has the same address.

superframe: group of slots that span a period of one minute

NOTE: The start of the current superframe is aligned with the start of the slot that is currently being used for transmission. The next superframe starts one minute after the current slot.

synchronization burst (or "sync" burst): VDL Mode 4 burst which announces, as a minimum, existence and position

NOTE: Ground stations announce existence, position, and the current time. Mobile stations lacking timing information can then derive the slot structure from ground synchronization bursts. Mobile stations lacking position information can derive position from both mobile and ground synchronization bursts. This periodic information is used in various ways including ADS-B, secondary navigation, and simplifying the LME algorithms.

tertiary time source: timing source used in a failure mode, which applies when the primary and secondary time sources fail, in which a VDL Mode 4 station maintains time synchronization to an estimate of the mean slot start times of a set of VDL Mode 4 stations

VDL Mode 4 Burst: VHF Digital Link (VDL) Mode 4 burst is composed of a sequence of source address, burst ID, information, slot reservation, and Frame Check Sequence (FCS) fields, bracketed by opening and closing flag sequences

NOTE: The start of a burst may occur only at quantized time intervals and this constraint allows the propagation delay between the transmission and reception to be derived.

VDL Mode 4 Specific Services (VSS) sublayer: resides above the MAC sublayer and provides VDL Mode 4 specific access protocols including reserved, random and fixed protocols

VSS user: user of the VDL Mode 4 Specific Services

NOTE: The VSS user could be higher layers in the VDL Mode 4 TM or an external application using VDL Mode 4.

VDL Management Entity (VME): VDL-specific entity that provides the quality of service requested by the ATN-defined sub network system management entity

NOTE: A VME uses the LMEs (that it creates and destroys) to acquire the quality of service available from peer systems.

VDL Mode 4 station: physical entity that transmits and receives VDL Mode 4 bursts over the RF interface (either A/G or air-to-air (A/A)) and comprises, as a minimum: a physical layer, Media Access Control sublayer and a VSS sublayer

NOTE: A VDL Mode 4 station may either be a mobile VDL Mode 4 station or a ground VDL Mode 4 station.

VDL Mode 4 Station Address: 27-bit identifier used to uniquely identify a VDL Mode 4 station

VDL Station: VDL-capable entity

NOTE: A station may either be a mobile station or a ground station. A station is a physical entity that transmits and receives frames over the Air/Ground (A/G) interface and comprises, at a minimum: a physical layer, media access control sublayer, and a unique DLS address. The particular initiating process (i.e. DLE or LME) in the station cannot be determined by the source DLS address. The particular destination process cannot be determined by the destination DLS address. These can be determined only by the context of these frames as well as the current operational state of the DLEs.