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Electromagnetic compatibility and Radio spectrum Matters (ERM); VHF air-ground Digital Link (VDL) Mode 4 radio equipment; Technical characteristics and methods of measurement for ground-based equipment Part 4: Point-to-point functions

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European Standard (Telecommunications series)

**Electromagnetic compatibility
and Radio spectrum Matters (ERM);
VHF air-ground Digital Link (VDL) Mode 4 radio equipment;
Technical characteristics and methods of measurement
for ground-based equipment;
Part 4: Point-to-point functions**

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

- Part 1: "EN for ground equipment";
- Part 2: "General description and data link layer";
- Part 3: "Additional broadcast aspects";
- Part 4: "Point-to-point functions";**
- Part 5: "VDL 4 ground-based equipment compliance with the SES 552/2004 interoperability Regulation";
- Part 6: "Harmonized EN covering essential requirements of article 3.2 of the R&TTE Directive".

The present document is accompanied by an equivalent airborne standard, EN 302 842 [7] Parts 1 to 5, covering the VHF air-ground Digital Link (VDL) Mode 4 radio equipment; Technical characteristics and methods of measurement for airborne equipment.

National transposition dates

Date of adoption of this EN:	24 November 2006
Date of latest announcement of this EN (doa):	28 February 2007
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 August 2007
Date of withdrawal of any conflicting National Standard (dow):	31 August 2007

Introduction

The present document is part of a multi-part deliverable developed by ETSI and is designed to fit in a modular structure to cover all radio and telecommunications terminal equipment within the scope of the R&TTE Directive [9]. The modular structure is shown in EG 201 399 [11].

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, using Gaussian-filtered Frequency Shift Keying (GFSK) Modulation with 25 kHz channel spacing and capable of tuning to any of the 25 kHz channels from 118,000 MHz to 136,975 MHz as defined in ICAO VHF Digital Link (VDL) Standards and Recommended Practices (SARPs) [8].

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 comply with EN 301 489-22 [2], EN 301 842-1 [4] and EN 301 842-2 [5].

The present document also indicates VDL Mode 4 compliance with the SES 552/2004 interoperability Regulation [10].

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1 Scope

The present document applies to the following radio equipment types:

- 1) Very High Frequency (VHF) Digital Link (VDL) Mode 4 ground-based radio transmitters and receivers for air-ground communications operating in the VHF band, using Gaussian-filtered Frequency Shift Keying (GFSK) Modulation with 25 kHz channel spacing and capable of tuning to any of the 25 kHz channels from 118,000 MHz to 136,975 MHz as defined in ICAO VHF Digital Link (VDL) Standards and Recommended Practices (SARPs) [8].

The present document provides part 4 of the technical specifications.

The present document 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) [8] and VDL Mode 4 Technical Manual (TM) [1] and with the SES 552/2004 interoperability Regulation [10].

Manufacturers should note that in future the tuning range for the ground transceivers may also cover any 25 kHz channel from 108,000 MHz to 117,975 MHz.

The scope of the present document is limited to ground stations. The equivalent specification for airborne stations is EN 302 842 [7].

A description of the scope of the VDL Mode 4 system is provided in part 2 of these technical specifications (see EN 301 842-2 [5], clause 1).

EN 301 842-1 [4] deals with tests of the physical layer, EN 301 842-2 [5] deals with core link layer functionality and EN 301 842-3 [6] with additional broadcast functionality. The present document deals with tests of the datalink service (DLS) layer and the link layer sufficient to support point-to-point functionality. Note that, as described in EN 301 842-2 [5], a system supporting point-to-point functionality is required to conform to EN 301 489-22 [2], EN 301 842-1 [4], EN 301 842-2 [5] and the specification in the present document.

The present document is organized as follows:
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- clause 2 provides references to relevant documents;
- clause 3 provides general definitions, abbreviations and symbols used;
- clause 4 describes the VDL Mode 4 ground station point-to-point functions;
- clause 5 provides performance specifications for the VDL Mode 4 ground station;
- clause 6 provides general design requirements;
- clause 7 provide protocol tests for the point-to-point functions of the system;
- annex A provides a detailed cross-reference to the relevant requirements contained in [1];
- annex B provides a Bibliography;
- a document history.

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 point-to-point 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.

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.

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- SIST EN 301 842-4 V1.2.1:2007
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- [1] ICAO Doc 9816/AN/448 (First Edition 2004): "Manual on VHF Digital Link (VDL) Mode 4, Part 2: Detailed Technical Specifications"
 - [2] ETSI EN 301 489-22 (V1.3.1): "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] ICAO Doc 9705/AN-956 (Edition 3.0 - 2002): "Manual of Technical Provisions for Aeronautical Telecommunication Network (ATN)".
 - [4] ETSI EN 301 842-1 (V1.3.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); VHF air-ground Digital Link (VDL) Mode 4 radio equipment; Technical characteristics and methods of measurement for ground-based equipment; Part 1: EN for ground equipment".
 - [5] ETSI EN 301 842-2 (V1.5.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); VHF air-ground Digital Link (VDL) Mode 4 radio equipment; Technical characteristics and methods of measurement for ground-based equipment; Part 2: General description and data link layer".
 - [6] ETSI EN 301 842-3 (V1.2.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); VHF air-ground Digital Link (VDL) Mode 4 radio equipment; Technical characteristics and methods of measurement for ground-based equipment; Part 3: Additional broadcast aspects".
 - [7] ETSI EN 302 842 (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); VHF air-ground and air-air Digital Link (VDL) Mode 4 radio equipment; Technical characteristics and methods of measurement for aeronautical mobile (airborne) equipment".
 - [8] ICAO Annex 10 to the Convention on International Civil Aviation: "Aeronautical Telecommunications, Volume III: Communication Systems, Part I: Digital Data Communication Systems, chapter 6".

- [9] Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (R&TTE Directive).
- [10] Regulation (EC) No 552/2004 of the European Parliament and of the Council of 10 March 2004 on the interoperability of the European Air Traffic Management network (the interoperability Regulation).
- [11] ETSI EG 201 399: "Electromagnetic compatibility and Radio spectrum Matters (ERM); A guide to the production of candidate Harmonized Standards for application under the R&TTE Directive".

3 Definitions and abbreviations

3.1 Definitions

3.1.1 Basic reference model definitions

See EN 301 842-2 [5], clause 3.1.1.

3.1.2 Service conventions definitions

See EN 301 842-2 [5], clause 3.1.2.

3.1.3 General definitions

For the purposes of the present document, the terms and definitions given in EN 301 842-1 [4], clause 3.1.3, EN 301 842-2 [5], clause 3.1.3 and the following apply:

long transmission procedure: procedure that allows transfer of DATA packets in reserved slots, avoiding the loss rates and delays associated with random access.

NOTE: This includes the ability to link sequences of DATA packets, providing continuous transfer in reserved slots.

More bit (M): bit that controls message fragmentation and concatenation

NOTE: It is set to zero to indicate the end of a message. It is set to 1 to indicate that it is part of a fragmented message and that there are more fragments to follow.

Network Setup Connection Oriented Protocol (NSCOP): protocol that enables a ground-air link between mobiles

priority (pr): priority of a message, or, in the case of an RTS, the priority of the requested data

short transmission procedure: procedure for the sending of a single data packet. It contains a reservation for a subsequent acknowledgement

Toggle bit (T): bit that allows detection and rejection of duplicate DLPDUs

NOTE: The T bit is alternately set to 1 and 0 on each successive DATA transmission, except for retransmissions.

Zero-Overhead Connection-Orientated Protocol (ZOCOP): protocol that enables an air-air link between mobiles

3.2 Abbreviations

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

A/G	Air/Ground
ACK	ACKnowledgement (burst)
ADM	ADMInistration identifier

ADS-B	Automatic Dependent Surveillance-Broadcast
ARS	Administration Region Selector
ATN	Aeronautical Telecommunication Network
CPR	Compact Position Reporting
CRC	Cyclic Redundancy Code
CTRL	ConTRoL (DLPDU)
CTS	Clear To Send (burst)
DLE	Data Link Entity
DLPDU	Data Link Protocol Data Unit
DLS	Data Link Service
DM	Disconnected Mode (DLPDU)
FRMR	FRaMe Reject (DLPDU)
GFSK	Gaussian filtered Frequency Shift Keying
GSC	Global Signalling Channel
GSIF	Ground Station Information Frame
hex	hexadecimal
IA-5	International Alphabet 5
IB	Initialize Bit
ICAO	International Civil Aviation Organization
ID	IDentity
INFO	INFORmation (DLPDU)
ISO	International Organization for Standardization
IS-SME	Intermediate System - System Management Entity
lg	length
LME	Link Management Entity
M	More bit
MAC	Media Access Control
MOPS	Minimum Operational Performance Specification
NACK	Negative ACKnowledgment
NETs	Network Entity Titles
NM	Nautical Mile
NSCOP	Network Setup Connection Orientated Protocol
p	priority
PCO	Point of Control and Observation
R&TTE	Radio equipment and Telecommunications Terminal Equipment
RF	Radio Frequency
RTS	Request To Send (DLPDU)
SARPs	Standards And Recommended Practices
SNDCF	SubNetwork Dependant Convergence Function
SZOM	Start Zero Overhead Mode (DLPDU)
T	Toggle bit
UCTRL	Unacknowledged ConTRoL data broadcast (DLPDU)
UDATA	Unacknowledged DATA broadcast (DLPDU)
UINFO	Unacknowledged user INFORmation data broadcast (DLPDU)
VDL	VHF Digital Link
VHF	Very High Frequency
VME	VDL Management Entity
VSS	VDL Mode 4 Specific Services
ZOCOP	Zero Overhead Connection-Orientated Protocol

In the tables included in the present document to illustrate the format of bursts, the following order is implied:

- a) bit order in each burst subfield shall be indicated by subscript numbers. Bit 1 shall indicate the least significant bit; and
- b) bits shall be transmitted octet by octet, starting with the first octet in each table, and within each octet the rightmost bit (as shown in the tables) shall be transmitted first.

4 General description of VDL Mode 4 ground station point-to-point services

4.1 General

A description of VDL Mode 4 is provided in EN 301 842-2 [5]. This clause provides a description of the datalink layer and associated services of the VSS and LME required to support point-to-point communications.

The specifications in the present document provide air-to-ground and air-to-air point-to-point services based on the ICAO Technical Manual. Part 4 includes:

- Point-to-point data and control data transfer functions from the DLS.
- Point-to-point link control within the LME.

Note that the present document covers the establishment, termination and handover of links between ground stations. Decisions to establish, terminate or handover links between ground stations are local issues and beyond the scope of these specifications.

In most respects, the VDL Mode 4 ground station follows the provisions of the ICAO standards material for VDL Mode 4. Within the ICAO standard, there are some requirements which apply explicitly only to airborne stations. Requirements on airborne stations are covered in EN 302 842 [7] Parts 1 to 5.

The scope of the present document is for a ground station supporting point-to-point applications. Hence the ability to support broadcast communication is not included in the present document.

Note that, although certain protocols will not be used by the ground station, the ability to recognize the use by mobiles of these protocols and to respond in a consistent manner is a ground station requirement and is included in the present document.

4.2 Data Link Service (DLS) and Link Management Entity (LME)

4.2.1 General

The Data Link Service (DLS) provides a point-to-point protocol supporting both air-to-ground and air-to-air exchanges. For air-to-ground exchanges, connection management is handled by the LME, using a Negotiated Setup Connection-Orientated Protocol (NSCOP). For air-to-air exchanges, the DLS defines a ZOCOP protocol with link establishment and disestablishment controlled by timers, allowing rapid link negotiation between aircraft.

The specifications in the present document assume that VDL Mode 4 will be used with a network based on ATN protocols [3]. It should be noted that, in future, it could support other network protocols.

The DLS is a simple information exchange protocol which provides:

- a) Explicit acknowledgement of each DATA packet.
- b) Mechanisms to provide data transfer in reserved slots, avoiding loss rates and delays associated with random access. This includes the ability to link sequences of DATA packets, providing continuous transfer in reserved slots.
- c) Packet fragmentation, to allow long user data packets to be transferred across the link in fragments optimally matched to the link conditions.
- d) Duplicate detection and suppression via a simple toggle-bit mechanism.
- e) Explicit support for the 15 priority levels defined for the ATN, including the ability for high priority messages to be sent in the middle of a fragmented low priority message.

As illustrated in figure 4.1, the DLS:

- Provides services to external users in order to support point-to-point, multi-cast and broadcast communications.
- Provides services to the LME to support link management.
- Supports services between peer DLSs.
- Uses the services of the VSS in order to send and receive messages.

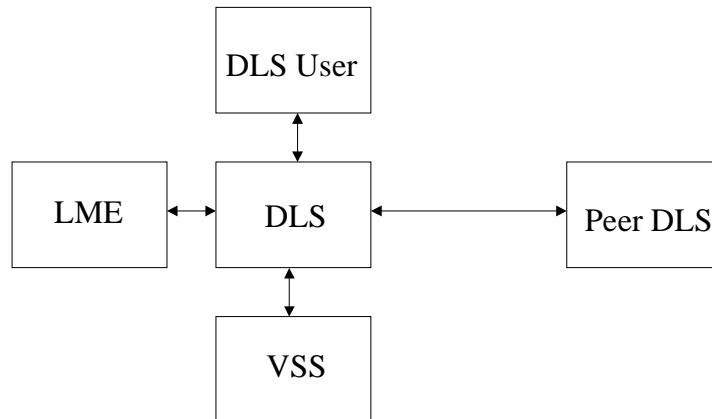


Figure 4.1: Functions of the DLS

Figure 4.2 illustrates the use of various services provided by the DLS and VSS in supporting the DLS User and the LME.

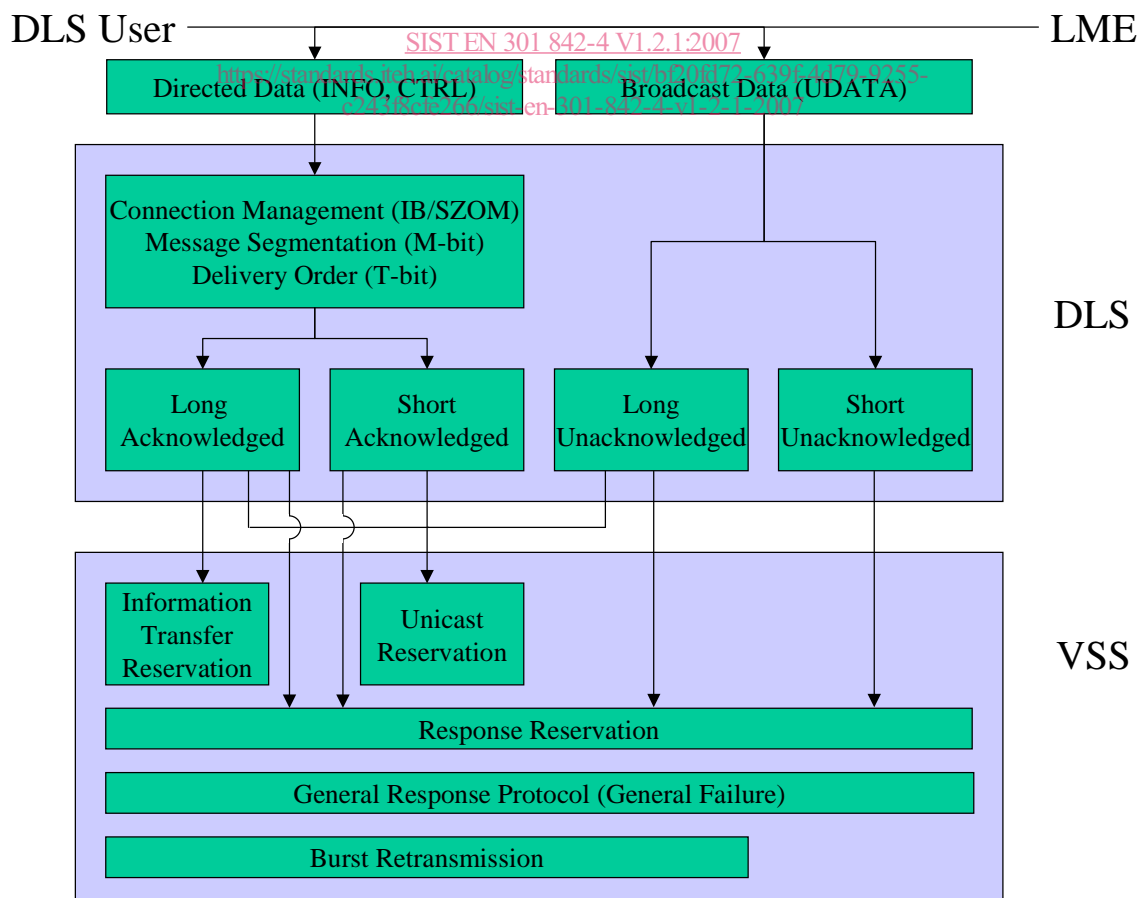


Figure 4.2: Services provided by the DLS and VSS in support of DLS User and LME