



**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 (EN) has been produced by ETSI Technical Committee Aeronautics (AERO).

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: "Hamonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

The present document is accompanied by an equivalent airborne standard, ETSI EN 302 842 [i.1] Parts 1 to 4, 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:	6 April 2015
Date of latest announcement of this EN (doa):	31 July 2015
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 January 2016
Date of withdrawal of any conflicting National Standard (dow):	31 January 2017

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

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, 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 112,000 MHz to 136,975 MHz as defined in ICAO VHF Digital Link (VDL) Standards and Recommended Practices (SARPs) [7].

The present document may be used to produce tests for the assessment of the performance of the equipment.

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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 112,000 MHz to 136,975 MHz as defined in ICAO VHF Digital Link (VDL) Standards and Recommended Practices (SARPs) [7].

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) [7] and VDL Mode 4 Technical Manual (TM) [1].

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 111,975 MHz.

The scope of the present document is limited to ground stations. The equivalent specification for airborne stations is ETSI EN 302 842 [i.1].

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

ETSI EN 301 842-1 [4] deals with tests of the physical layer, ETSI EN 301 842-2 [5] deals with core link layer functionality and ETSI 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.

The present document is organized as follows:

- 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 provides 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.

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

2.1 Normative 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 referenced 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.

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

- [1] ICAO Doc 9816 AN/448 (First Edition 2004): "Manual on VHF Digital Link (VDL) Mode 4, Part 2: Detailed Technical Specifications".
- [2] Void.
- [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 (V1.4.1): "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 (V1.7.1): "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 (V1.4.1): "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] ICAO Annex 10 to the Convention on International Civil Aviation: "Aeronautical Telecommunications, Volume III: Communication Systems, Part I: Digital Data Communication Systems, chapter 6", including Amendment 88 (applicable 14/11/13).

2.2 Informative 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 referenced document (including any amendments) applies.

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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 EN 302 842 (all parts): "VHF air-ground and air-air Digital Link (VDL) Mode 4 radio equipment; Technical characteristics and methods of measurement for aeronautical mobile (airborne) equipment".

3 Definitions and abbreviations

3.1 Definitions

3.1.1 Basic reference model definitions

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

3.1.2 Service conventions definitions

See ETSI 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 ETSI EN 301 842-1 [4], clause 3.1.3, ETSI 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

NOTE: 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

3.1.4 Definition of bit order

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 is indicated by subscript numbers. Bit 1 indicates the least significant bit; and
- b) bits are transmitted octet by octet, starting with the first octet in each table, and within each octet the rightmost bit (as shown in the tables) is transmitted first.

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
LCR	Link Connection Refused
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
PI	Parameter Identifier
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

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 ETSI 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. The present document 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 ETSI EN 302 842 [i.1] Parts 1 to 4.

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:

- Explicit acknowledgement of each DATA packet.
- 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.
- Packet fragmentation, to allow long user data packets to be transferred across the link in fragments optimally matched to the link conditions.
- Duplicate detection and suppression via a simple toggle-bit mechanism.
- 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.

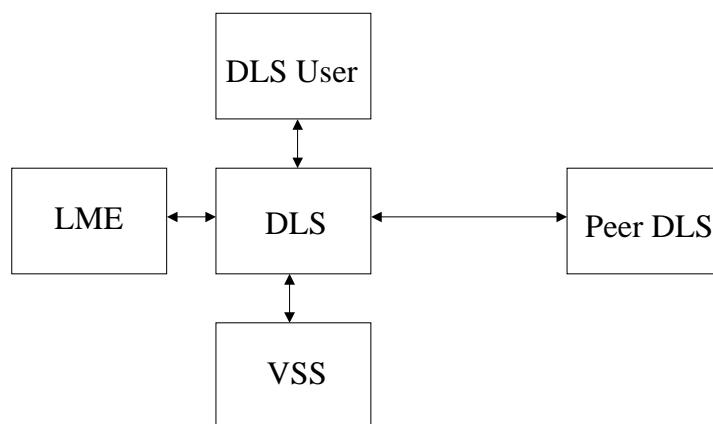


Figure 4.1: Functions of the DLS

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

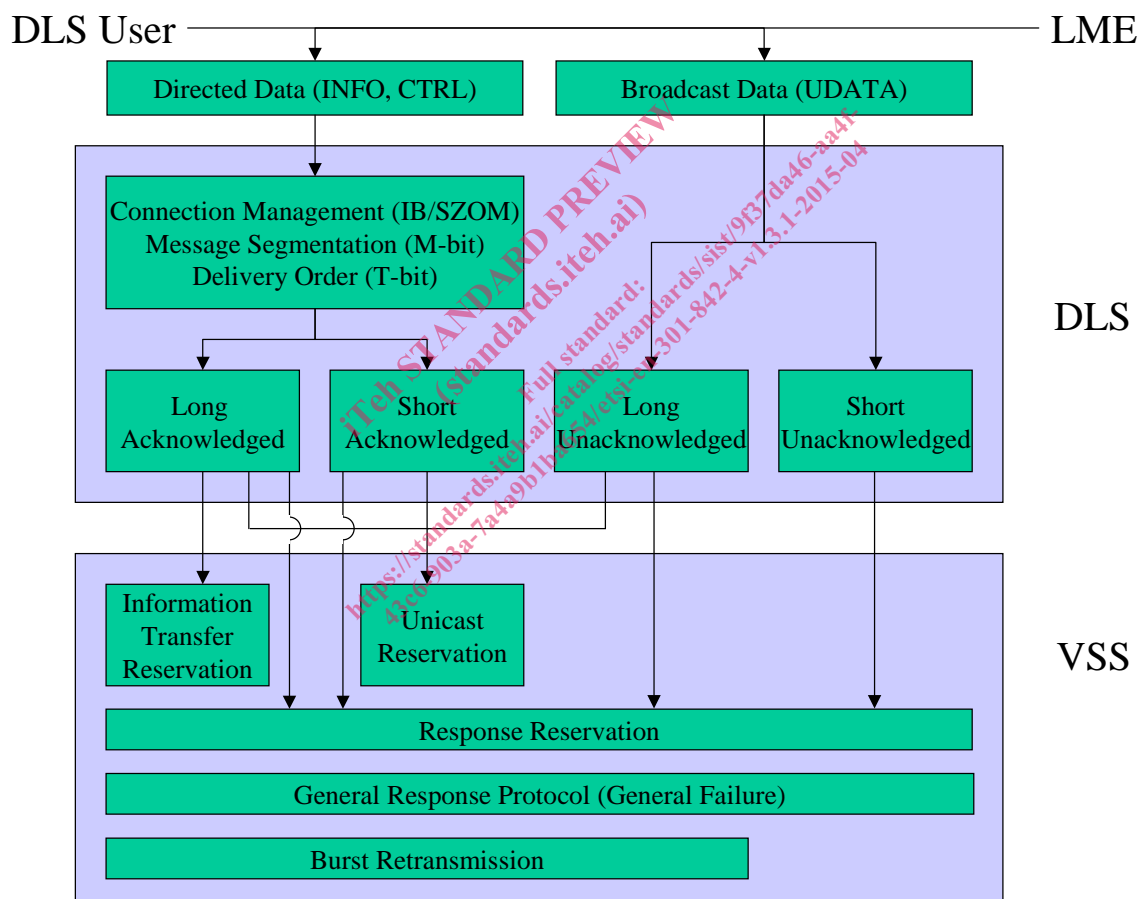


Figure 4.2: Services provided by the DLS and VSS in support of DLS User and LME

Protocols for short unacknowledged broadcast data have already been specified in the core link layer functionality (ETSI EN 301 842-2 [5]).

A DLS Burst consists of:

- Burst ID (fixed or variable).
- One or two DLPDUs.