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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; Part 4: Point-to-point functions

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**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;
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 and air-air Digital Link (VDL) Mode 4 radio equipment; Technical characteristics and methods of measurement for aeronautical mobile (airborne) equipment, as identified below:

- Part 1: "Physical layer";
- Part 2: "General description and data link layer";
- Part 3: "Additional broadcast aspects";
- Part 4: "Point-to-point functions";**
- Part 5: "VDL4 airborne equipment in compliance with the SES 552/2004 interoperability Regulation".

The present document is accompanied by an equivalent ground-based standard, EN 301 842 parts 1 to 6, covering the VHF air-ground Data Link (VDL) Mode 4 radio equipment; Technical characteristics and methods of measurement for ground-based equipment.

NOTE: Minimum Operational Performance Specifications (MOPS) are also being developed for VDL Mode 4. EUROCAE have previously published Interim MOPS for VDL Mode 4 (see bibliography) which are a sub set of EN 302 842-1 [5], 2 [6], 3 [7] and 4 (the present document). EN 302 842-1 [5], 2 [6], 3 [7] and 4 (the present document) comply with the requirements of CEC Mandate M/318.

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 states the technical specifications for Very High Frequency (VHF) Digital Link (VDL) Mode 4 aeronautical mobile (airborne) radio transmitters, transceivers and receivers for air-ground and air-air 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 VDL SARPs [2].

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 302 842-1 [5] and EN 302 842-2 [6].

The present document also indicates VDL Mode 4 compliance with the SES 552/2004 Regulation [9].

NOTE: The present document has been produced with a view to maintaining consistency of numbering with the equivalent standard for ground equipment (EN 301 842 [4]). Where requirements are the same, they have been given the same number. Some new airborne requirements have been inserted between requirements that were sequential in EN 301 842 [4]. This has led to a non-standard form of numbering for new requirements in some places.

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1 Scope

The present document applies to the following radio equipment types:

- Very High Frequency (VHF) Digital Link (VDL) Mode 4 aeronautical mobile (airborne) radio transmitters, transceivers and receivers for air-ground and air-air 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 VDL SARPs [2].

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 VDL SARPs [2] and ICAO VDL4 Technical Manual [1] and with the SES 552/2004 interoperability Regulation [9].

Manufacturers should note that in future the tuning range for the transmitter may also cover any 25 kHz channel from 112,000 MHz to 117,975 MHz and the receiver(s) may cover any 25 kHz channel from 108,000 MHz to 117,975 MHz.

The present document applies to "aeronautical mobile (airborne and as applicable also ground vehicles)" equipment which will hereinafter be referred to as "mobile" equipment.

The scope of the present document is limited to mobile stations. The equivalent specification for ground stations is EN 301 842 [4].

A description of the scope of the VDL Mode 4 system is provided in part 2 of EN 302 842-2 [6], clause 1.

EN 302 842-1 [5] deals with tests of the physical layer, EN 302 842-2 [6] deals with core link layer functionality and EN 302 842-3 [7] with additional broadcast functionality. The present document deals with tests of the datalink layer (DLS) and the link layer sufficient to support point-to-point functionality. Note that, as described in EN 302 842-2 [6], a system supporting point-to-point functionality is required to conform to EN 302 842-1 [5], EN 302 842-2 [6] and the specification in the present document.

The present document includes:

- clause 2 provides references to relevant documents;
- clause 3 provides general definitions, abbreviations and symbols used;
- clause 4 describes the VDL Mode 4 mobile station point-to-point functions;
- clause 5 provides performance specifications for the VDL Mode 4 mobile 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 ICAO VDL4 Technical Manual [1];
- annex B provides a description of compliance with the SES 552/2004 Regulation [9];
- annex C 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.

- [9] 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).

3 Definitions and abbreviations

3.1 Definitions

3.1.1 Basic reference model definitions

See EN 302 842-2 [6], clause 3.1.1.

3.1.2 Service conventions definitions

See EN 302 842-2 [6], clause 3.1.2.

3.1.3 General definitions

For the purposes of the present document, the terms and definitions given in EN 302 842-1 [5] clause 3.1.3, EN 302 842-2 [6] 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-Oriented 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 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.

3.2 Abbreviations

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

ACK	ACKnowledgement (burst)
ADM	ADMInistration identifier
ADS-B	Automatic Dependent Surveillance-Broadcast
ARS	Administration Region Selector
ATN	Aeronautical Telecommunication Network
CMD	CoMmanD
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)
erid	extended reservation ID
FRMR	FRaMe Reject (DLPDU)
GFSK	Gaussian Filtered Frequency Shift Keying
GSC	Global Signalling Channel
GSIF	Ground Station Information Frame
hex	hexadecimal
HO	Hand Off
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
LE	Link Establishment
lg	length
LME	Link Management Entity
M	More bit
MAC	Media Access Control
MOPS	Minimum Operational Performance Specification
neg	negotiation
NETs	Network Entity Titles
NM	Nautical Mile
NSCOP	Network Setup Connection Orientated Protocol
O	Optional
p	priority
PCO	Point of Control and Observation
PI	Parameter Identifier
pr	priority
QoS	Quality of Service
Res	Reserved header bits
RF	Radio Frequency
rid	reservation ID
RSP	ReSPonse
RTS	Request To Send (DLPDU)
SARPs	Standards And Recommended Practices
seq	sequence
SNDCF	SubNetwork Dependent 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-Oriented Protocol

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

4.1 General

A description of VDL Mode 4 is provided in EN 302 842-2 [6]. 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 mobile response to the establishment, termination and handover of links between ground stations. Decisions made by ground stations 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 mobile 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 ground stations. Requirements on ground stations are covered in EN 301 842 (all parts) [4].

The scope of the present document is for an mobile 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 mobile station, the ability to recognize the use by ground stations of these protocols and to respond in a consistent manner is an mobile 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 (see ICAO ATN SARPs [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.

- 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.

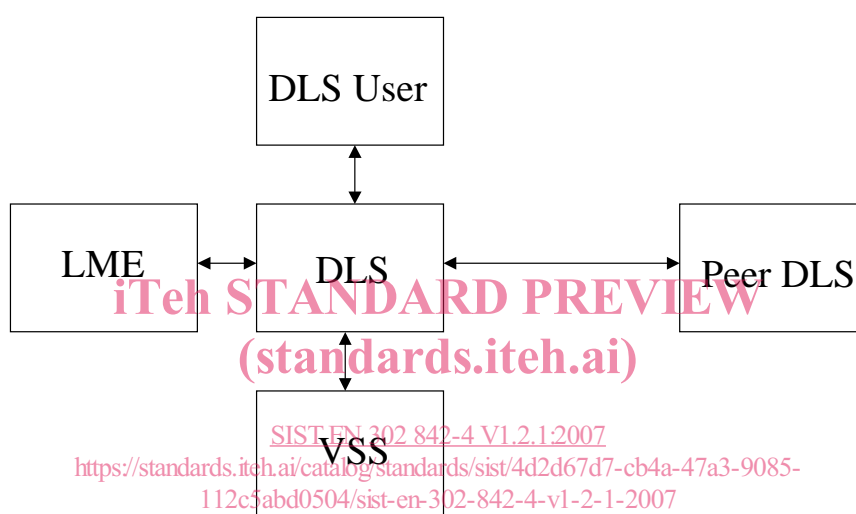


Figure 4.1: Functions of the DLS

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