
Elektromagnetna združljivost in zadeve v zvezi z radijskim spektrom (ERM) – Radijska oprema za digitalne povezave VHF zrak-tla, 4. način – Tehnične karakteristike in merilne metode za talno opremo – 3. del: Dodatni vidiki v zvezi z radiodifuzijo

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

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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 3: Additional broadcast aspects**

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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 3 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".

The present document is accompanied by an equivalent airborne standard, EN 302 842 [9] 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:	18 February 2005
Date of latest announcement of this EN (doa):	31 May 2005
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	30 November 2005
Date of withdrawal of any conflicting National Standard (dow):	30 November 2005

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 118,000 MHz to 136,975 MHz as defined in ICAO VHF Digital Link (VDL) Standards and Recommended Practices (SARPs) [10].

The present document considers the additional broadcast functionality required to support ADS-B, TIS-B, FIS-B, and GNS-B services.

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].

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1 Scope

The present document provides part 3 of the technical specifications for 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) [10].

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) [10] 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 117,975 MHz.

The scope of the present document is limited to ground stations. The equivalent specification for airborne stations is EN 302 842 [9].

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 tests of the link layer sufficient to support broadcast functionality including requirements and tests sufficient to recognize and respond to transmissions associated with point-to-point communication. The present document provides technical specifications for a VDL Mode 4 ground-based transceiver supporting a full Automatic Dependent Surveillance - Broadcast (ADS-B) capability and, optionally, the additional functionality of either, or a combination of, the following services:

- Traffic Information Service - Broadcast (TIS-B);
- Flight Information Service - Broadcast (FIS-B);
- GNSS Augmentation Service - Broadcast (GNS-B).

The TIS-B, FIS-B, or GNS-B functionality in the ground-based equipment is expected to be provided by a TIS-B, FIS-B or GNS-B processor, which could be contained within the VDL Mode 4 transceiver, but could also be housed in a separate physical unit. Therefore to support TIS-B, FIS-B or GNS-B, the minimum functionality demanded of a basic VDL Mode 4 ground-based transceiver unit (i.e. one that does not have a TIS-B, FIS-B or GNS-B processor housed within it) is to receive, from the TIS-B, FIS-B or GNS-B processor, all messages to be transmitted, and to transmit them. In the case of FIS-B there is an additional requirement to receive report request messages (from other VDL4 stations) and to pass those messages to the FIS-B processor.

It should be noted that the specifications for TIS-B, FIS-B and GNS-B in the present document represent a first step towards defining these applications, based on the work carried out as part of the NUP and MEDUP Programmes, and changes to the specifications for these services may therefore occur in the future.

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 functionality to support ADS-B, TIS-B, FIS-B and GNS-B;
- clause 5 provides performance specifications for the VDL Mode 4 ground station supporting ADS-B, TIS-B, FIS-B and GNS-B Services;
- clause 6 provides general design requirements;
- clause 7 provide protocol tests which emphasis the ADS-B, TIS-B, FIS-B and GNS-B functions of the system;
- clause A provides a detailed cross-reference to the relevant requirements contained in [1];
- clause 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 functionality to support ADS-B, FIS-B, TIS-B and GNS-B focusing on the system 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.

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

- [1] ICAO Doc 9816 (First Edition 2004): "Manual on VHF Digital Link (VDL) Mode 4, Part 2, Detailed Technical Specifications".
- [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] RTCA DO-242A: "Minimum Aviation System Performance Standards for Automatic Dependent Surveillance Broadcast (ADS-B)".
- [4] ETSI EN 301 842-1: "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: "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 301 842-4: "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".
- [7] Amendments 76 and 77 to Volume I of Annex 10 to the Convention on International Civil Aviation, International Civil Aviation Organization: Appendix B-B2, 3.6 Ground-based augmentation system (GBAS)".
- [8] Eurocae ED-114 (September 2003): "Minimum Operational Performance Specification for Global Navigation Satellite Ground Based Augmentation System Ground Equipment to Support Category I Operations".

- [9] 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".
- [10] ICAO Standards and Recommended Practices: "Annex 10 to the Convention of International Civil Aviation", Volume III, Part I, Chapter 6.

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:

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

NOTE: ADS-B is a surveillance service based on aircraft self-determination of position/velocity/time and automatic, periodic broadcast of this information along with auxiliary data such as aircraft identity (ID), intent information and 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.

Automatic Terminal Information Service (ATIS): report generated by a ground station that includes weather conditions, operating procedures, runways and approaches in use, and any other information that may affect the departure, runway, and landing phase of flight

Flight Information Service - Broadcast (FIS-B): uplink broadcast application providing local airborne traffic with information

GNSS Augmentation Service - Broadcast (GNS-B): uplink broadcast application providing aircraft with GNSS augmentation and integrity data

METeorological Aerodrome Report (METAR): report generated by a ground station that broadcasts meteorological conditions at aerodromes, officially recoded and communicated at regular intervals

SIGNificant METeorological Information (SIGMET): report generated by a ground station that broadcasts information about weather phenomena that may have an impact on aircraft at subsonic, transonic and supersonic cruising levels including thunderstorms, cyclones, turbulence and icing

SPECIAL observations and reports (SPECI): report generated by a ground station that is issued when meteorological conditions change sufficiently to affect aviation operations. The SPECI report contains the same information as a METAR

Traffic Information Service - Broadcast (TIS-B): uplink surveillance service that derives traffic information from one or more ground surveillance sources and broadcasts that information to suitably equipped aircraft or surface vehicles

Traffic Information Volume (TIV): volume of airspace for which surveillance information is provided for all targets

NOTE: Inside the TIV, a pilot knows he can rely on the surveillance picture presented to him; outside the TIV, ADS-B reports may be received but TIS-B reports may not be available.

3.2 Abbreviations

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

A/A	Air/Air communications
A/G	Air/Ground communications
ADS-B	Automatic Dependent Surveillance Broadcast
AM(R)S	Aeronautical Mobile (Route) Service
ATIS	Automatic Terminal Information Service
ATN	Aeronautical Telecommunication Network
CCI	Co-Channel Interference
CPR	Compact Position Reporting
CRC	Cyclic Redundancy Code
dB	deciBel
DLE	Data Link Entity
DLPDU	Data Link Protocol Data Unit
DLS	Data Link Service
DOS	Directory Of Services
erid	Extended reservation ID
EUROCAE	EUROpean Organization for Civil Aviation Equipment
FAS	Final Approach Segment
FIS-B	Flight Information Service - Broadcast
FOM	Figure Of Merit
FPAP	Flight Path Alignment Point
FTP	Fictitious Threshold Point
GBAS	Ground-Based Augmentation System
GCID	GNS-B Continuity / Integrity Designator
GFSK	Gaussian filtered Frequency Shift Keying
GLONASS	GLObal NAVigation Satellite System (Russian system)
GNS-B	GNSS augmentation Service - Broadcast
GNSS	Global Navigation Satellite System
GPA	Glide Path Angle
GPS	Global Positioning System
GRAS	Ground-based Regional Augmentation System
GSC	Global Signalling Channel
hex	hexadecimal
IA-5	International Alphabet 5
ICAO	International Civil Aviation Organization
ID	IDentity
INFO	INFORmation (DLPDU)
ISO	International Organization for Standardization
LCI	Logical Channel Identifier
LME	Link Management Entity
LTP	Landing Threshold Point
MAC	Media Access Control
MASPS	Minimum Aviation System Performance Standards
MEDUP	MEDiterranean Update Programme
METAR	METEorological Aerodrome Report
MOPS	Minimum Operational Performance Specification
NEAN	North European ADS-B Network
NM	Nautical Mile
NUP	NEAN Update Programme
OSI	Open Systems Interconnection
PCO	Point of Control and Observation
PRN	Pseudo Random Noise
RCN	Runway Condition

RF	Radio Frequency
rid	reservation ID
SARPs	Standards And Recommended Practices
SBAS	Space-Based Augmentation System
SIGMET	SIGnificant METeorological event
SNR	Signal-to-Noise Ratio
SPECI	SPECIal observations and reports
TCH	Threshold Crossing Height
TCP	Trajectory Change Point
TIS-B	Traffic Information Service Broadcast
TIV	Traffic Information Volume
TTCN	Tree and Tabular Combined Notation
TV	Transmission Volume
UTC	Universal Time Coordinated
VDL	VHF Digital Link
VHF	Very High Frequency
VME	VDL Management Entity
VSS	VDL Mode 4 Specific Services
WGS 84	World Geodetic System 1984

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.

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4 General description of VDL Mode 4 ground station link layer

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4.1 General

A description of VDL Mode 4 is provided in EN 301 842-1 [4]. This clause provides a description of the assumptions made in the derivation of the requirements for the VDL Mode 4 ground station.

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 that apply explicitly only to airborne stations. A number of other requirements will also not apply because of the assumed services provided by the ground station. For example, it is assumed that the ground station will have no need to support net entry on a timescale shorter than one minute. The assumed services are provided by the ground station and the impact on the requirements is summarized in the rest of clause 4.

The scope of the present document is for a ground station supporting broadcast applications. Hence the ability to support point-to-point communication is not included in the present document. Those requirements are presented in EN 301 842-4 [6].

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 Automatic Dependant Surveillance - Broadcast

Automatic Dependent Surveillance - Broadcast (ADS-B) is a surveillance application in which aircraft, vehicles and ground stations broadcast their identity, position, velocity, time, intent and other information, enabling other aircraft, vehicles and ground stations to develop a surveillance picture. ADS-B relies on the regular and frequent transmission of position reports via a broadcast data link. The position reports are sent periodically by the aircraft with no intervention from the ground. Position reports may be received by any recipient in range of the transmitting aircraft. Recipients may be other aircraft, ground vehicles, or fixed ground sites.

ADS-B offers data delivery from aircraft-to-aircraft or from aircraft-to-ground. Transmitting data directly from air-to-air means that there is no need for a ground infrastructure to be present for airborne surveillance to be performed. By using position reports received from surrounding aircraft, a traffic surveillance picture can be generated in the cockpits of all aircraft. This potentially allows new applications or new manoeuvres to be performed by pilots.

The transmitting aircraft does not know which, if any, recipients are receiving and processing the position reports. Unlike a point-to-point link, position reports are not acknowledged. The concept with ADS-B is that position reports are transmitted so frequently that the loss of a small number of position reports is not operationally significant.

ADS-B messages are broadcast and received by appropriately equipped participant subsystems. ADS-B subsystems include aircraft, vehicle, and ground subsystems. The capabilities of participant subsystems will vary based upon class of equipment. The ADS-B aircraft subsystem may interact with other onboard systems such as flight management systems, pilot display equipment and the aircraft navigation system. The ADS-B ground subsystem may interact with other ground systems such as flight data processing systems, ATM applications and controller display processing equipment.

If received by a data acquisition unit, the position report will be processed with other surveillance data and may be forwarded to a controller/pilot display.

Ground stations play an active part in the ADS-B application by broadcasting their own position (the information is used by other stations in selecting transmission slots. In addition:

- Ground Stations receive and process ADS-B reports from aircraft and other vehicles passing the results to a surveillance server.
- Ground Stations may also transmit ADS-B requests in order to control the rate and content of ADS-B reports generated by aircraft and other vehicles.

Figure 4.1 illustrates the context for the ground station supporting ADS-B functions.

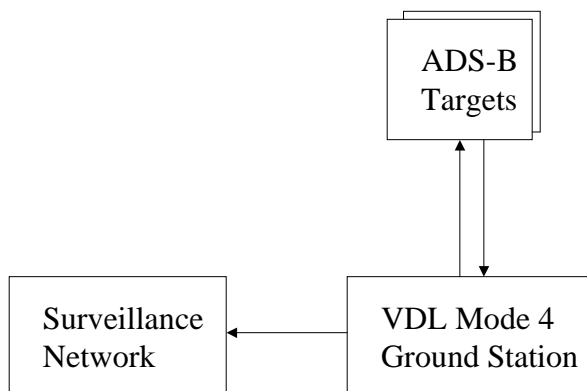


Figure 4.1: Ground station supporting ADS-B functions

The requirements for ADS-B are taken from the ICAO VDL Mode 4 Technical Manual [1].

4.3 Traffic Information Service - Broadcast

Traffic Information Service - Broadcast (TIS-B) is a surveillance service that derives traffic information from one or more ground surveillance sources and broadcasts that information to suitably equipped aircraft or surface vehicle.

The purpose of TIS-B is to complement the surveillance information provided from ADS-B aircraft to ensure that a full surveillance picture is available to airborne systems.

The TIS-B service is provided within an area known as the Traffic Information Volume (TIV), which is the volume of airspace for which surveillance information is provided for all targets. Inside the TIV, a pilot knows he can rely on the surveillance picture presented to him; outside the TIV, ADS-B reports may be received but TIS-B reports may not be available.

A TIS-B service either provides a "full surveillance picture" or a "gap filler service". For the full surveillance picture information is provided on all targets, the "gap filler service" information is only provided for targets which do not support ADS-B via VDL Mode 4.

TIS-B Ground Stations broadcast two main sorts of message:

- a) Management Messages: contain information about the TIS-B service and the TIV.
- b) Target Messages: contain information about aircraft or ground vehicle targets.

Figure 4.2 illustrates the context for the ground station supporting TIS-B functions.

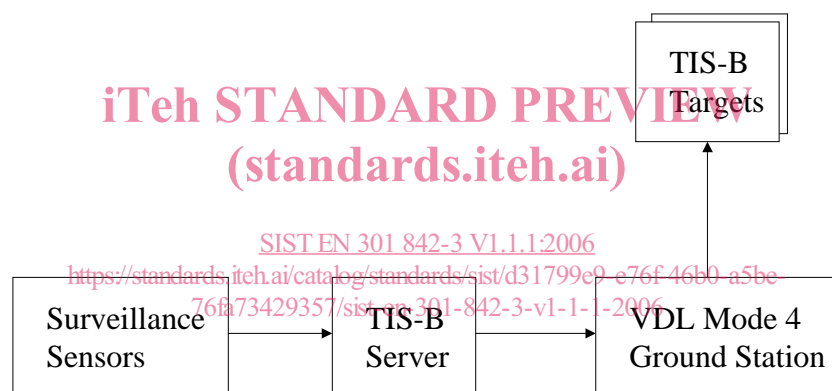


Figure 4.2: Ground station supporting TIS-B functions

The TIS-B server generates Target Messages from information provided by surveillance sensors and passes them on to the VDL Mode 4 ground station for onward broadcast transmission to targets.

The specifications for TIS-B as presented in the present document are derived from the TIS-B Service Description developed by the Nean Update Programme (NUP) and Mediterranean UpDate Programme (MEDUP). A reference to the NUP TIS-B Service Description is contained in the bibliography.

4.4 Flight Information Service - Broadcast

Flight Information Service - Broadcast (FIS-B) is an uplink broadcast application providing local traffic with information concerning

The following message types are supported:

- a) Meteorological Aerodrome Report (METAR): METAR reports are of meteorological conditions at aerodromes, officially recoded and communicated at regular intervals. Intermediate observations are also recorded and communicated when meteorological conditions change sufficiently to affect aviation operations (see SPECI).
- b) Automatic Terminal Information Service (ATIS): ATIS reports are broadcasts that include weather conditions, operating procedures, runways and approaches in use, and any other information that may affect the departure, runway and landing phase of flight.