
**Intelligent transport systems —
Lower layer protocols for usage in the
European digital tachograph**

*Systèmes de transport intelligents - Protocoles de couche basse pour
utilisation dans le cadre du chrono tachygraphe numérique européen*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document is designed to encompass communication requirements in support of the Smart Digital Tachograph (SDT) as identified by Regulation 2016/799 of the European Union^[23].

This document specifies SDT Communications (SDTC). SDTC is the application of CEN Dedicated Short Range Communication (DSRC) for SDT. See the following:

- EN 12253, *Road transport and traffic telematics — Dedicated short-range communication — Physical layer using microwave at 5,8 GHz*^[1]
- EN 12795, *Road transport and traffic telematics — Dedicated Short Range Communication (DSRC) — DSRC data link layer: medium access and logical link control*^[2]
- EN 12834, *Road transport and traffic telematics — Dedicated Short Range Communication (DSRC) — DSRC application layer*^[3]
- EN 13372, *Road transport and traffic telematics — Dedicated short-range communication — Profiles for RTTT applications*^[4]

Complementing the standardized specifications and descriptions, several private documents describe this dedicated short range semi-passive communication technology in an informative manner, providing additional detailed explanations and implementation hints. See for example:

- DSRC tutorial published by ESF GmbH in July 2003 (publicly available)^[24];
- GSS industry specification published in August 2003^[25] (no longer available from the authors; essential content is now available in ISO 15509).

It is to be noted that the abovementioned private documents provide information that can be essential to easily achieving interoperability with existing DSRC equipment and optimum performance.

EN 12253^[1] deals with the physical layer of the DSRC protocol stack presented in [Figure 1](#); i.e. it comprises requirements for Open Systems Interconnection (OSI) Layer 1 at 5,8 GHz for DSRC.

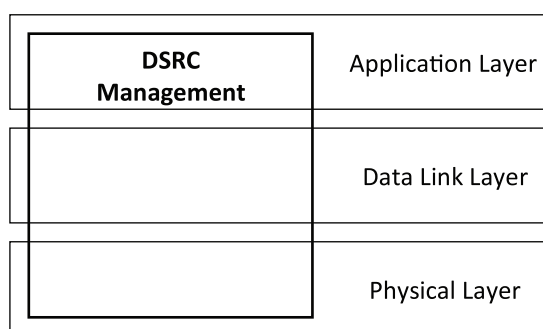


Figure 1 — DSRC protocol stack

EN 12253^[1] does not include associated measurement procedures for verification of the requirements. Test methods for conformity are provided in ETSI EN 300674-1^[12], ETSI EN 300674-2-1^[13] and ETSI EN 300674-2-2^[14].

EN 12253^[1] caters for on-board units based on transponder technologies. Furthermore, it allows for mixed time, frequency and space division multiple access approaches.

EN 12253^[1] is conceived for the 10 MHz part (i.e. 5,795 GHz to 5,805 GHz) of the ISM band at 5,8 GHz which is recommended by ECC/DEC(01)01^[10]. An additional sub-band (5,805 GHz - 5,815 GHz) may be

allocated on a national basis. National restrictions on the usage of these frequency bands can apply according to CEPT/ERC REC 70-03^[11].

EN 12795^[2] gives the architecture and services offered by the DSRC data link layer.

EN 12834^[3] and the almost identical ISO 15628 give the architecture and services offered by the DSRC application layer.

EN 13372^[4] deals with the interlayer management of the DSRC protocol stack.

Figure 2 illustrates the global data flow between the elements of the SDTC stack, (physical layer, data link layer and application layer) and the SDT application.

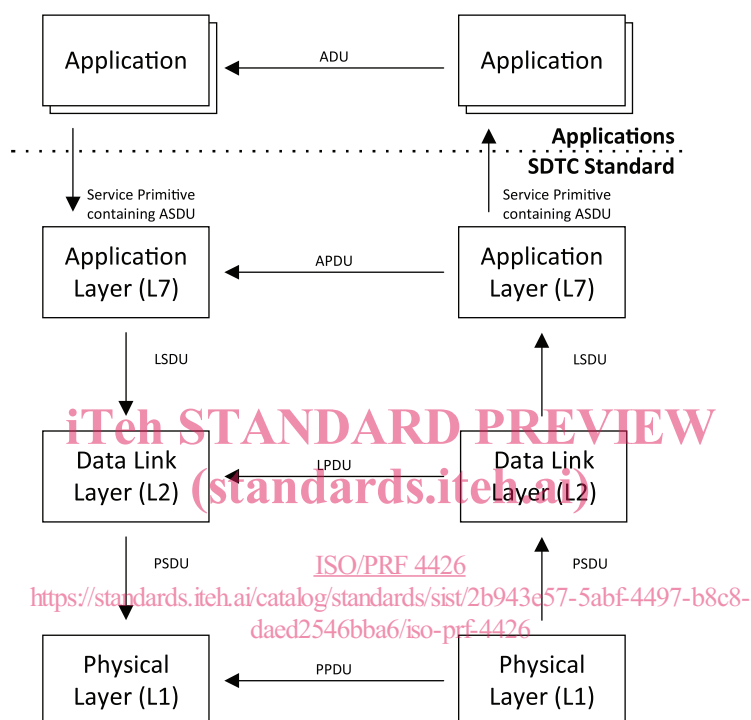


Figure 2 — Architecture and data flow of the SDTC stack

Intelligent transport systems — Lower layer protocols for usage in the European digital tachograph

1 Scope

This document specifies communication requirements in support of the Smart Digital Tachograph (SDT) as identified by Regulation 2016/799 of the European Union^[23].

The specification covers:

- the physical layer at 5,8 GHz for SDT communications (SDTC);
- the data link layer (DLL) of SDTC;
- the application layer of SDTC;
- SDTC profiles which provide coherent sets of communication tools for applications based on SDTC.

This document provides further information beneficial for the design and development of SDTC equipment.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 15628, *Intelligent transport systems — Dedicated short range communication (DSRC) — DSRC application layer*

ISO/IEC 13239, *Information technology — Telecommunications and information exchange between systems — High-level data link control (HDLC) procedures*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1

adjacent channel

neighbouring SDTC channel for use by two or more emissions

Note 1 to entry: It is possible that a SDTC channel has either one of two adjacent channels.

3.2

antenna bore sight direction

direction of maximum antenna gain

3.3

application

set of processes including related functions and structured data that uses the services offered by the SDTC communication stack

3.4

beacon service table

BST

data structure transmitted by the fixed equipment indicating available services

3.5

bit error ratio

averaged number of erroneous bits relative to the total number of transmitted bits

3.6

co-channel

refers to the use of the same SDTC channel by two or more emissions

3.7

communication initialization

procedure used to establish communication between an RSU and a newly arrived OBU

Note 1 to entry: Terms prefixed with D present downlink parameters; downlink parameters apply to transmission of data from RSU to OBU.

3.8

D1 — carrier frequencies

number and values of the downlink carrier frequencies, which are equal to the frequencies of the CW, transmitted by the RSU and used by transponder OBUs for uplink communication

Note 1 to entry: Each carrier frequency is the centre frequency of a downlink channel.

3.9

D1a — tolerance of carrier frequencies

maximum deviation of the carrier frequency resulting from any cause

Note 1 to entry: It is expressed in parts per million (ppm)

EXAMPLE ± 1 ppm of a 5,8 GHz carrier allows for the carrier frequency to be in the range of 5,8 GHz \pm 5,8 kHz.

3.10

D2 — RSU transmitter spectrum mask

maximum allowed power within a defined frequency band emitted by the RSU transmitter

3.11

D3 — OBU minimum frequency range

minimum range of frequencies that has to be received by the OBU receiver

3.12

D4 — maximum E.I.R.P.

maximum allowed value of E.I.R.P.

3.13

D4a — angular E.I.R.P. mask

E.I.R.P. as a function of the angle θ , where θ indicates the angle relative to a vector perpendicular to the road surface, pointing downwards

3.14**D5 — polarization**

locus of the tip of the vector of the electrical field strength in a plane perpendicular to the transmission vector

EXAMPLE Horizontal and vertical linear polarization and left- and right-hand circular polarization.

3.15**D5a — cross-polarization****ellipticity of polarization**

antenna designed to transmit left-hand circular waves, which can transmit some right-hand circular waves in addition

Note 1 to entry: Cross-polar discrimination (XPD) is defined as the ratio between left- and right-hand circular power, P_{LHC}/P_{RHC} , when the total power transmitted is $P_{LHC} + P_{RHC}$. XPD is related to the ellipticity of polarization.

3.16**D6 — modulation**

keying of the carrier wave by coded data

EXAMPLE Amplitude shift keying (ASK), phase shift keying (PSK), frequency shift keying (FSK) and linear amplitude modulation (AM).

3.17**D6a — modulation index**

ratio of the variation of the modulation parameter (frequency, amplitude, phase) caused by the modulation signal (data signal)

EXAMPLE Given the minimum and maximum values V_{\max} and V_{\min} of the envelope amplitude V of the modulated signal, the amplitude modulation index m is defined as:

$$m = \frac{V_{\max} - V_{\min}}{V_{\max} + V_{\min}}$$

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3.18**D7 — data coding**

downlink base band signal presentation, i.e. a mapping of logical bits to physical signals

EXAMPLE Bi-phase schemes (Manchester, FM0, FM1, differential Manchester), NRZ and NRZI. NRZI: No transition at beginning of "1" bit, transition at beginning of "0" bit, no transition within bit.

3.19**D8 — bit rate**

number of bits per second, independent of the data coding

3.20**D8a — tolerance of bit clock**

maximum downlink deviation of the bit clock resulting from any cause, expressed in ppm

EXAMPLE 100 ppm of 500 kbit/s allows for the bit clock to be in the range of 500 kHz \pm 50 Hz.

3.21**D9 — bit error ratio for communication**

maximum allowed bit error ratio valid within the dynamic range of the receiver as defined by D11a and D11b

3.22**D10 — wake-up trigger for OBU**

signal which:

- a) indicates to the OBU that it is within a communication zone, i.e. that it can now communicate with an RSU;

b) switches the OBU main circuitry from sleep mode to the active mode

Note 1 to entry: This is a feature to allow the OBU to save battery power. It is not mandatory for an OBU to use a wake-up process.

3.23

D10a — maximum start time

maximum time between the reception of the wake-up trigger and the time when the OBU has switched to the active mode

3.24

D11 — communication zone

spatial region within which the incident power of the OBU has a dynamic range as defined by D11a and D11b

3.25

D11a — power limit for communication (upper)

upper level of incident power referred to a lossless isotropic antenna (0 dB) in front of the OBU

Note 1 to entry: This is the level below which, subject to D11b, communication is guaranteed with a specified bit error ratio. Communication can take place above this limit, but is not guaranteed. Together with D11b it also specifies the minimum dynamic range of the OBU receiver. Power values are measured without any additional losses due to rain or misalignment.

3.26

D11b — power limit for communication (lower)

lower level of incident power referred to a lossless isotropic antenna (0 dB) in front of the OBU

Note 1 to entry: This is the level above which, subject to D11a, communication is guaranteed with a specified bit error ratio. Communication can take place below this limit, but is not guaranteed. Together with D11a it also specifies the minimum dynamic range of the OBU receiver. Power values are measured without any additional losses due to rain or misalignment

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3.27

D12 — cut-off power level of OBU

incident power that is lower than the specified cut-off power level that does not result in communication

3.28

D13 — preamble

specific downlink layer 1-bit pattern

Note 1 to entry: Preamble is the bit pattern transmitted immediately before a frame.

3.29

D13a — preamble length

length of the downlink preamble measured in number of bits

3.30

D13b — preamble wave form

signal shape of the preamble

3.31

D13c — trailing bits

sequence of bits transmitted after the end flag of the data link layer

3.32

downlink

communication channel on which the fixed equipment transmits its information

3.33

downlink communication

communication from the RSU to the OBU

3.34 equivalent isotropically radiated power E.I.R.P.

signal power fed into an ideal lossless antenna radiating equally in all directions that generates the same power flux at a reference distance as the one generated by a signal fed into the antenna under consideration in a predefined direction within its far field region

3.35 fixed equipment

fixed communication facility with one or more downlink channels and, optionally, one or more uplink channels

Note 1 to entry: Normally the fixed equipment is installed at a fixed location, but it may be installed on a mobile platform.

3.36 interlayer management

assembly of communication parameters of all protocol layers such that a consistent communication protocol is provided

3.37 link identifier LID

unique address used for addressing the mobile equipment

3.38 mobile equipment

mobile communication facility capable of receiving information from the fixed equipment on the downlink and, optionally, also capable of transmitting information to the fixed equipment on the uplink

Note 1 to entry: The mobile equipment normally corresponds to the vehicle's communication unit.

3.39 on-board unit OBU

physical assembly that is located and operated in or on the vehicle to transmit and/or receive SDTC signals

Note 1 to entry: An OBU may be in a form that is removable from the vehicle, or mountable in or on any part of the vehicle structure, or bonded to a part of the vehicle, or an integral part of a vehicle component, such as a windscreen, bumper or licence plate. In this document, parameters that refer to an OBU relate to the form that the OBU takes as it is supplied to the vehicle manufacturer or constructor.

Note 2 to entry: An OBU is an alternative descriptor to Mobile Equipment.

3.40 roadside unit RSU

SDTC equipment usually residing by the side of the road or overhead the road

Note 1 to entry: An RSU is an alternative descriptor to Fixed Equipment.

3.41 SDTC channel

frequency band for SDTC indicated by reference to the downlink centre frequency of one of up to four frequency bands with 5 MHz width each

3.42 SDTC profile

consistent and standardized set of cross layer parameters controlling the behaviour of the SDTC

3.43

service access point

SAP

interface point between data link layer and application layer, that has a unique link identifier and that allows layers to communicate

3.44

smart digital tachograph communication

SDTC

CEN DSRC applied for the Smart Digital Tachograph (SDT)

Note 1 to entry: This is as identified by Regulation 2016/799 of the European Union^[23].

3.45

termination

procedure used to terminate communication between an RSU and an OBU

3.46

U1 — sub-carrier frequencies

number and values of the uplink sub-carrier frequencies, i.e. the frequency separation from the centre of the uplink side band to the centre of the corresponding downlink band

3.47

U1a — tolerance of sub-carrier frequencies

maximum deviation of the sub-carrier frequency resulting from any cause

EXAMPLE 1 % of 1,5 MHz sub-carrier allows for the sub-carrier frequency to be in the range of 1,5 MHz \pm 15 kHz.

Note 1 to entry: Normally this is expressed in percentage (%) or in parts per million (ppm) of the sub-carrier frequency.

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Note 2 to entry: Terms prefixed with U present uplink parameters; uplink parameters apply to transmission of data from OBU to RSU.

3.48

U1b — use of side bands

specification of the use of the uplink side bands

Note 1 to entry: Data can be modulated on the upper side band only, or the lower side band only, or on both side bands. In principle, different data can be modulated on the two side bands.

3.49

U2 — OBU transmitter spectrum mask

maximum allowed power emitted by the OBU transmitter within a defined frequency band

3.50

U4 — maximum single side band E.I.R.P. (bore sight)

maximum E.I.R.P. transmitted by the OBU within a single side band, measured at the maximum incident power defined by D11a

Note 1 to entry: For a non-isotropic OBU antenna the single side band E.I.R.P. varies with the direction of the incident power and the direction in which the emitted power is measured.

3.51

U4a — maximum single side band E.I.R.P. (bore sight)

measurement when the incident power is in bore sight and the emitted power is measured in bore sight

3.52

U4b — maximum single side band E.I.R.P. (35°)

measurement when the incident power is in bore sight and the emitted power is measured at any angle not less than 35° away from bore sight

3.53**U5**

uplink parameter indicating the uplink polarization

3.54**U5 — cross-polarization**

uplink parameter indicating the cross-polarization

3.55**U6 — sub-carrier modulation**

keying of the sub-carrier wave by coded data

EXAMPLE Amplitude shift keying (ASK), phase shift keying (PSK), and frequency shift keying (FSK).

Note 1 to entry: U6b is not used.

3.56**U6b — duty cycle**

ratio of the length of high or low pulses to the duration of a complete cycle

Note 1 to entry: In NRZI a sequence of zero bits results in a pulse of alternating high- and low-level sections. A low-level section and the adjacent high-level section constitute a cycle of the pulse. The nominal duration of such a single section is equal to the bit duration. The cycle duration is twice the bit duration. The duty cycle is the ratio of the duration of the high-level section to the cycle duration.

3.57**U6c — modulation on carrier**

keying of the carrier wave by the modulated sub-carrier

3.58**U7 — data coding**

uplink base band signal presentation, i.e. a mapping of logical bits to physical signals

3.59**U8 — bit rate**

number of bits per second, independent of the data coding

3.60**U8a — tolerance of symbol clock**

maximum uplink deviation of the bit clock resulting from any cause, expressed in ppm

3.61**U9 — bit error ratio for communication**

maximum allowed bit error ratio valid within the dynamic range of the receiver

3.62**U11 — communication zone**

spatial region within which the OBU is situated such that its transmissions are received by the RSU with a bit error ratio of less than a specified value

3.63**U12 — conversion gain**

difference between OBU E.I.R.P. within one side band and the carrier incident power on OBU

3.64**U13 — preamble**

specific uplink layer 1-bit pattern

3.65

U13a — preamble length

length of the uplink preamble

Note 1 to entry: Preamble length is measured either in multiples of symbols or in seconds.

3.66

U13b — trailing bits

sequence of bits transmitted after the end flag of the data link layer

3.67

uplink

communication channel on which mobile equipment transmits its information

3.68

uplink communication

communication from the OBU to the RSU

3.69

vehicle service table

VST

data structure transmitted by the OBU to indicate available services

3.70

window

period of time during which the physical medium is allocated either to the fixed equipment or to the mobile equipment

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4 Abbreviated terms and symbols

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2-PSK	binary phase shift keying
ACK	acknowledge
ACn	acknowledged command with sequence bit n
ADU	application data unit
AM	amplitude modulation
APDU	application protocol data unit
ASDU	application service data unit
ASK	amplitude shift keying
C/R	command/response
CEN	European Committee for Standardization
CEPT	European Conference of Postal and Telecommunications Administrations
CW	continuous wave
DLL	data link layer
DSRC	dedicated short-range communication
EC	European Commission

EDTC	European digital tachograph communication
EFC	electronic fee collection
EN	European Standard
ERC	European Radiocommunications Committee
ERM	electromagnetic compatibility and radio spectrum matters
ETSI	European Telecommunications Standards Institute
F	final
FCS	frame check sequence
FE	fixed equipment
FM0 / FM1	bi-phase coding scheme, bit inverse to FM1 / FM0
FSK	frequency shift keying
HDLC	high-level data link control
ISM	industrial, scientific, medical
L1	layer 1 of SDTC (physical layer)
L2	layer 2 of SDTC (data link layer)
L7	layer 7 of SDTC (application layer)
LLC	logic link control
LPDU	link layer protocol data unit
LSB	least significant bit
LSDU	link layer service data unit
M	modifier function bit
MAC	medium access control
ME	mobile equipment
MSB	most significant bit
NRZ	non-return to zero
NRZI	non-return to zero inverted
OSI	open systems interconnection
P	poll
P/F	poll/final
PICS	protocol implementation conformance statement
PDU	protocol data unit