Austrian HGV Tolling System

EETS OBE

Requirements Specification

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[EETS-OBE_req]	V3.0	released	public	19.10.2021

Table of Contents

Abbreviations and Glossary

Abbreviation, Term	Description
APDU	Application Protocol Data Unit
BST	Beacon Service Table
CE	Conformity Declaration
CEN	European Committee for Standardization
CI	Contract Issuer (= EETS Provider)
DSRC	Dedicated Short Range Communication
EETS	European Electronic Toll Service
EFC	Electronic Fee Collection
EID	Element Identifier
EN	European standards
EP	EETS provider
HGV	Heavy Goods Vehicle
ISO	International Organization for Standardization
ISO/DIS	ISO Draft International Standard
LLC	Logical Link Control
MAC	Medium Access Control
MMI	Men Machine Interface
MSB	Most Significant Bit
OBE	On-Board Equipment
PAN	Personal Account Number
RF	Radio Frequency
RSE	Road Side Equipment
SU	Service User
T-APDU	Transfer Application Protocol Data Unit
TC	Toll Charger (e.g. ASFINAG)
TSP	Toll Service Provider (e.g. the EETS provider)

UI	User Interface (= MMI)
VST	Vehicle Service Table

References

All references are listed in Annex A - References of this document. For dated references, subsequent amendments to or revisions of any of these publications apply only when incorporated in it by amendment or revision. For undated references, the latest edition of the referenced publication applies.

1 Introduction

In order to offer the European Electronic Toll Services (EETS) in Austria for the ASFINAG toll domain, EETS Providers have to issue approved, certified and personalized On-Board Equipment to their customers.

The different European toll domains and their electronic tolling systems may have different technical requirements for On-Board Equipment. This document refers to the requirements of CEN DSRC systems according to EN 15509 [IAP] considering also special demands of ASFINAG as the Austrian Toll Charger.

1.1 Objectives

This document provides the DSRC related functional requirements for On-Board Equipment (OBE) according to EN 15509 [IAP] for usage in the ASFINAG EETS context.

The information and requirements about the configuration data and the detailed transaction specification for tolling and enforcement are provided in the following documents:

- “EETS DSRC Tolling Data Specification” [EETS_data]
- “EETS DSRC Transaction for Tolling and Enforcement” [EETS_DSRC]

In case that referenced specifications or standards are conflicting, ambiguous, and incomplete or unintentionally leave room for interpretation, the EETS Provider – as OBE purchaser and issuer – is obliged to contact every EETS Toll Charger using DSRC technology for clarification.

This document includes also some recommended solutions for problems that might occur in specific situations in the ASFINAG EFC system.

1.2 Core requirements

The OBE shall provide the platform for services and functions available in the framework of a CEN DSRC communication within a vehicle.

Furthermore, the OBE shall provide the required user interface functionalities to declare the current number of axles, to display the OBE status and to give an audible signal for the transaction result.

1.2.1 Multilane free-flow ability

The OBE shall be able to communicate in a multilane environment with overlapping communication zones using different RF-channels. The performance of the OBE shall not decrease due to the multilane free-flow functionality.

1.2.2 Testing

In addition to the tests necessary for gaining the ‘EC declaration of conformity to specifications’, extensive testing of the OBE functionalities is necessary in order to ensure compatibility with the Toll Charger’s system components (‘Suitability for use’). These ‘Suitability for use’ tests will be carried out in laboratory, at a test site and within the productive road network of the ASFINAG toll domain.

All test procedures are defined in the document “EETS Acceptance Procedures” [EETS_acc].

2 CEN DSRC

2.1 DSRC Interface

2.1.1 General

The OBE supports CEN compatible DSRC communications at 5.8 GHz and shall be conform to EN 15509 [IAP]. This implies also compliance to the following underlying standards (in the versions listed in Annex A - References):

- Layer 1: EN 12253 [L1]
- Profile definition: EN 13372 [Profiles]
- Layer 2: EN 12795 [L2]
- Layer 7: ISO 15628 / EN 12834 [L7]
- Application Interface for EFC: ISO 14906 [EFC API] and EN ISO 14816 [AVI No]

2.1.2 Layer 1 – Physical Layer

The OBE shall conform to EN 15509 [IAP] and this indirectly implies the conformance to EN 12253 [L1].

All 4 downlink channels shall be supported (D1 in EN 12253 [L1]). The OBE shall be able to handle simultaneous radiation of different carrier frequencies in case of overlapping communication zones of neighboring beacons.

Physical layer parameter set L1-B shall be supported (see also [Profiles]).

2.1.3 Profiles

The OBE shall be conform to EN 15509 [IAP] and this implies conformance to EN 13372 [Profiles].

DSRC Profiles 0 and 1 shall be supported.

Set L1-B (“Set B OBE”) of EN 13372 [Profiles] has to be selected with respect to alternative physical layer parameter values.

2.1.4 Layer 2

The OBE shall be conform to EN 15509 [IAP] and this implies conformance to EN 12795 [L2].

All Layer 2 functions, as required in [L2] shall be supported.

2.1.5 Layer 7

The OBE shall be conform to EN 15509 [IAP] and this implies conformance to EN 12834 [L7].

The following services (T-APDU) shall be supported:

- INITIALISATION
- GET
- SET
- ACTION
- EVENT-REPORT

According to EN 15509 [IAP] the following DSRC layer 7 features shall be supported:

- Concatenation of multiple consecutive T-APDU fragments in one L2 frame (i.e. LLC-service) with and without chaining, if the size constraints for the LLC-frames are not violated (i.e. fit into 1 L2 frame);
- Fragmentation header length: 1 octet;
- Any “fill bit” (as defined in EN12834:2003, ch. 6.3.4) used for octet alignment shall be assigned the value zero.

2.1.6 Application Interface for EFC

The table below specifies the EFC functions that shall be supported according to [L7] and [EFC API] as actions:

Name	Action Type	Action Parameter	Response Parameter	Remarks
GET_STAMPED	0	GetStampedRq	GetStampedRs	retrieves data with an authenticator from the OBE
GET_NONCE	6	-	Octet String	Reads a random number generates by OBE Optional, not used in the ASFINAG system
SET_MMI	10	SetMMIRq		invokes an MMI function (e.g. signal Ok via buzzer)
ECHO	15	Octet String	Octet String	OBE echoes received data

Table 1: Application Interface for EFC – Action Functions

The GET and SET services (DSRC application layer functions) according to [L7] may also be used in an EFC transaction phase.

Note: GET is used to retrieve (i.e. read) value(s) of the addressed attribute(s), a reply is always expected.
SET is used to set (i.e. write) value(s) of the addressed attribute(s).

2.1.7 Frame structure

Content of the fill bits = ”0”.

Maximum length of frame = 128 Byte.

The combinations of frames supported by the OBE are listed in EN 13372 [Profiles].

2.1.8 OBE internal states and processes

To guarantee OBE interoperability during transactions, the

- states
- state transitions
- events
- internal OBE actions

defined in EN 15509 [IAP] shall be implemented. In case of doubt, reference is made to [GSS].

2.2 Application

The OBE shall support any CEN DSRC post-pay transaction whose attributes, parameters, functions and security features are according to this document, [IAP] and [EETS_data]. Regarding the transactions currently in use in the ASFINAG EETS context reference is made to [EETS_DSRC].

The transaction is permitting data exchange for tolling and enforcement.

2.2.1 Data elements

All data elements required for the CEN DSRC transaction are defined in this document, in [IAP] and in [EETS_data].

The Road Side Equipment (RSE) calculates the tariff based on following OBE data elements:

- the type of vehicle (vehicle class according to [IAP])
- the type of engine of the vehicle
- the euro emission class of the vehicle
- the current (declared) number of vehicle axels

Therefore it is necessary that the attributes related to these values stored in the OBE contain up-to-date values.

2.2.2 Tariff calculation based on number of axles

The number of axels is a dynamic parameter in the OBE because a truck may or may not pull a trailer. In addition, the truck may change its trailer or semi-trailer and therefore also the number of axles may change.

The OBE application shall have a function to change the number of axels according to the current vehicle and trailer configuration.

Remark: The trailer presence bit in the attribute VehicleClass shall be set/reset automatically by the OBE logic, depending on the value in *VehicleAxles.VehicleAxlesNumber.NumberOfAxles.TrailerAxles*

2.3 Security

2.3.1 Keys

The OBE shall store at least:

- eight (8) authentication keys
- one (1) access key

All keys stored in the OBE shall be protected against read out. There shall be no read access to authentication keys as well as to access keys.

2.3.2 Data security level

The OBE shall operate within the ASFINAG toll domain with security level 1 (according to [IAP]), this means that the OBE shall be conformant with EN 15509 IAP 1.1.

Use of Access Credentials – security level 1 – means that each attribute holds specific read and write protection rights. The OBE shall grant access to an attribute only if access credentials corresponding to its individual protection level are presented by the requesting layer 7 function.

Access credentials are calculated according to [IAP].

The RndOBE value to calculate the OBE access credentials (AC_CR) shall be set randomly for each communication.

The Access Credentials parameter (AC_CR) is supported among others by the following functions:

- GET
- GET_STAMPED
- SET

2.3.3 Authentication

Authentication is obtained by the GET_STAMPED command.

The RSE requires authentication from the OBE. For this purpose, the GET_STAMPED function is used with 2 different authenticator keys (operator and issuer authenticator). Therefore, the OBE shall authenticate the requested data.

For detailed information see also documents [IAP] and [EETS_DSRC].

For issuer authenticator calculation the authenticator keys 1 to 4 (according to [IAP]) are used with respective key references (KeyRef) 111 to 114.

For operator authenticator calculation the authenticator keys 5 to 8 (according to [IAP]) are used with respective key references (KeyRef) 115 to 118.

2.3.4 Speed of security calculations

In order to support free-flow systems the OBE shall execute security calculations with sufficient speed such that the tolling transaction duration is completed successfully in less than 70 ms. The transaction duration is measured in the communication zone of any free-flow RSE from the first BST message until the receipt of a RELEASE or ECHO message.

2.4 Additional requirements and remarks

2.4.1 Multilane free-flow ability

Tests have shown that some existing OBE types have troubles under multilane free-flow conditions. The main problematic requirements are:

- The OBE shall support all 4 downlink channels (D1 in EN 12253 [L1]).
- Physical layer parameter set L1-B shall be supported (see also EN 13372 [Profiles]).
- The OBE shall be able to handle simultaneous radiation of different carrier frequencies in case of overlapping communication zones of neighboring beacons without decrease of its performance.

2.4.2 Late response

When the OBE cannot send a response frame to a request frame in the allocated private uplink window, the late response procedure will be used. This means use of DATA_1 and DATA_2 states in the Interlayer Management and request of a private window, followed by a late response issued via an UI LLC Service.

To ensure high transaction performance with MLFF RSE like in Austria, the usage of late response procedures shall be avoided. OBE using late response will not be accepted anymore for first time acceptance procedures in the ASFINAG toll domain.

2.4.3 SET_MMI.request command

To retain compatibility with existing OBE (and RSE), the OBE shall accept SET_MMI with any value of the EID, and with Container type 69 (dec) as the preferred container type or 0 (dec) as alternate accepted.

2.4.4 Data storage

Personalization and transaction data shall be stored such that data integrity is ensured under all operating conditions, for example in battery low-voltage situations. Permanent storage of user- and vehicle data for more than 5 years without external power is required.

In situations where data integrity can not be guaranteed, the OBE shall not respond on the DSRC link (i.e. in case the OBE cannot ensure that stored data is correctly retrieved or that received data is correctly stored).

It shall be assured, that transaction data written to OBE is corresponding to the transaction data of the RSE.

2.4.5 Multiple transactions

The OBE shall not produce more than one transaction inside the RSE communication zone, even for a longer period.

The OBE shall not produce a second or multiple communication after a power-off followed by a power-on of the OBE staying inside the RSE communication zone.

3 User interface functionality

3.1 Overview of user interface elements

The OBE shall have at least the following user interface elements to fulfill the required functionality:

- An acoustic information element
- An optical element
- A vehicle axle-number declaration element

3.2 Acoustic information element

For road safety reasons, information about transaction success shall be primarily delivered acoustically to the driver. The driver shall be informed about the status of the toll transaction after passing a tolling station by the signal of a buzzer.

The buzzer shall be able to signalize the SET-MMI-Codes 0 to 2 and 255 according to the table below representing the buzzer signalization for the transaction when passing a RSE:

Transaction result	SET-MMI-Code	Buzzer
Transaction OK (payment done, no warning)	0	1 short beep
Transaction not OK (no payment effected, for example, due to expired contract)	1	4 short beeps
Warning (use is ASFINAG specific)	2	2 short beeps
Particular scope or future use	255	No beep

Table 2: Acoustic signaling of the OBE when passing an RSE

Informative example for acoustic parameters:

The used buzzer parameters below are the best practice values used in the GO-Box transaction in the ASFINAG's toll domain. The parameters have the following limits: • 75 - 85 dB A (measured in front of the OBE, distance 10 cm, measured inside an anechoic chamber) • frequency ~ 3.650 Hz • beep duration ~ 200 ms; the break between multiple beeps is around 100- 200 ms

Table 3: Informative example for acoustic parameters

3.3 Optical element

The optical element shall display the following minimum information required for the use of the OBE in the ASFINAG toll domain:

- The declared number of axles of the vehicle combination (possibly visible as tractor and trailer axles)
- The operational status of the OBE

The indication of the operational status of the OBE shall have at least the following states:

- The OBE is working correctly in the ASFINAG toll domain
- The OBE is **not** working correctly in the ASFINAG toll domain

The optical information elements shall be visible at least upon request of the EETS User.

3.4 Vehicle axle-number declaration element

This OBE element shall allow the declaration of the number of axles of the current vehicle combination based on the basic number of axles of the pulling vehicle. The number of trailer axles shall either be entered by the driver or via an automatically trailer detection function of the OBE.

The declaration of the number of trailer axles by the EETS User requires a user interface function.

The basic number of axles of the tractor vehicle shall be stored in the DSRC transaction attribute

- *VehicleAxles.VehicleAxlesNumber.NumberOfAxles.TractorAxles*

and shall not be changed by the driver using the vehicle axle-number declaration element. The possible declaration changes shall be stored in the DSRC transaction attributes

- *VehicleAxles.VehicleAxlesNumber.NumberOfAxles.TrailerAxles*
- *VehicleClass*

The declared number of axles shall have a possibility to be checked by using the optical element described in chapter 3.3 above.

3.5 User manual

The EETS Provider shall provide an electronic or printed user manual containing the description of the OBE user interface functionalities used in Austria and the reference to the respective chapters in the ASFINAG tolling regulations (http://www.asfinag.at/tolling-regulations) to the customer.

4 Miscellaneous

4.1 Power supply

In case of no power from the vehicles power supply following functionalities shall be maintained (e.g. by battery backup):

- The DSRC OBE functionality excluding the MMI functionalities for at least 2 weeks after power loss.

It is highly recommended to install a fixed connection to the vehicles power supply to ensure permanent DSRC operation.

4.2 Radio frequency interferences susceptibility

As sources of frequency interferences within or close to the frequency band used by CEN DSRC communication – among others such might be WLAN in the 5 GHz band, radio communication, and the like – the OBE shall be resilient against interferences within or close to the frequency band used. This especially means that the DSRC module of an OBE shall not be able to be woken up for communication by any other signal than by a BST received.

5 Comments on DSRC protocol related issues (Informative)

This chapter provides information on some DSRC protocol related issues often raised by OBE manufacturers and information about tolling context specific characteristics.

5.1 Comments on OBE DSRC Kernel state after Rec_PrWA event

GSS states (states according to Global Specification for Short Range Communication [GSS], chapter 6.3.5 and 6.3.6):

60	Rec_BST(BeaconId, DateTime) & BeaconId = SavedBeaconId	SavedDateTime:=DateTime, Transmit_PrWRq	DATA_2

62	Rec_PrWA	Transmit_UI(SAVE)	DATA_2

60: On reception of a BST with the same BeaconId, in state DATA_2 the OBE re-transmits the PrWRq, compare transition 50

62: This is the normal transition in state DATA_2: On reception of a PrWA the OBE transmits the delayed response using a UI frame. The state DATA_2 is not left until implicit layers 7 acknowledge was received.

Remark: Transitions 60 and 62 have the same conceptual meaning in DATA_2 state of the "most common and standardized" transactions 21 and 22 in INIT state:

21	Rec_BST(BeaconId, DateTime) & BeaconId = SavedBeaconId	SavedDateTime:=DateTime, Transmit_PrWRq	INIT
22	Rec_PrWA	Transmit_UI(VST)	INIT

21: This transition occurs if the OBE receives a BST before having received an implicit layer 7 acknowledge, i.e. an addressed frame other than PrWA. The OBE retransmits the PrWRq and stays in the INIT state.

22: A normal situation: After having issued a PrWRq (transition 12, 13 or 21) the RSE will transmit a PrWA. The OBE then transmits the VST and remains in the INIT state until another addressed frame is received.

The OBE has to remain in INIT state after having issued a VST until an "implicit layer 7 acknowledge" is received because VST should not be delivered to the RSE. Such "implicit layer 7 acknowledge" is simply the first ACn Command that implicitly assures the OBE that the VST was certainly received. In the same way, the OBE has to be sure that the RSE has received the processed data (SAVE); so has to remain in DATA_2 state as long as an "implicit layer 7 acknowledge" is not received. In this case an "implicit layer 7 acknowledge" is simply a brand new ACn Command.

5.2 Comments on Sleep after release

GSS states that an OBE upon receiving a Release command has to move to BLOCKED state. "The BLOCKED state is similar to the sleeping state, but in addition the frames are not notified, i.e. the wake-up signal is blocked". The timeout is approximately 3s, but it is rather open to the manufacturer to properly tune it.

5.3 Comments on OBE random number generation

Requirements do not impose the RndOBE to be completely random but "freely chosen by the OBE" (EN ISO 14906). Using entirely random RndOBE leads to an increase of security.

6 Annex A - References

Reference	Document Ref	Date / Version	Document title
[EETS_acc]			EETS Acceptance Procedures
[EETS_DSRC]			EETS-DSRC Transaction for Tolling and Enforcement
[EETS_data]			EETS DSRC Tolling Data Specification
[EETS_OBE-req]			EETS-OBE Requirements Specification (this document)
[IAP]	EN 15509	2014	Road Traffic and Transport Telematics (RTTT) – Electronic Fee Collection –Interoperability application profile for DSRC
[EFC API]	EN ISO 14906:2018/ Amd1:2020	2018/ Amd1:2020	Road Traffic and Transport Telematics (RTTT) – Electronic Fee Collection – Application interface definition for dedicated short range communication
[GSS]	GSS	V3.2:2003	Global Specification for Short Range Communication (Kapsch TrafficCom AB, Kapsch Telecom GmbH, Thales e-Transactions CGA SA, version 3.2, 2003-08, http://profesores.elo.utfsm.cl/~agv/elo326/1s06/ETC/GSS_32.pdf, link valid at 01.04.2021)
[L1]	EN 12253	2004	Road Transport and Traffic Telematics (RTTT) – Dedicated Short-Range Communication (DSRC) – Physical layer using microwave at 5.8 GHz
[L2]	EN 12795	2003	Road Transport and Traffic Telematics (RTTT) – Dedicated Short-Range Communication (DSRC) – DSRC data link layer: Medium access and logical link control
[L7]	ISO 15628	2003	Road Transport and Traffic Telematics (RTTT) – Dedicated Short-Range Communication (DSRC) – DSRC Application Layer. (formerly EN 12834)

Reference	Document Ref	Date / Version	Document title
[Profiles]	EN 13372	2004	Road Transport and Traffic Telematics (RTTT) – Dedicated Short-Range Communication (DSRC) – Profiles for RTTT applications
[AVI No]	EN ISO 14816	2005	Road Traffic and Transport Telematics (RTTT) – Automatic Vehicle and Equipment Identification – Numbering and Data Structures
[AVI No register]			https://www.itsstandards.eu/registries/ (link valid at 01.04.2021)