Austrian HGV Tolling System

EETS OBE

Functional Requirements Specification

For information only

(Subject to change without notice)

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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 context, EETS Providers have to issue approved, certified and personalized On-Board Equipment to their customers.

The several European 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 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 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]

As it can never be guaranteed that referenced specifications or standards are not 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 which 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 on-the-road.

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/DIS 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] of alternative physical layer parameter values has to be selected.

2.1.4 Layer 2

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

All Layer 2 functions, as required in [Profiles] 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: Action Functions

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].

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 the current document, in [IAP] and in [EETS_data].

An overview of the attributes is given in chapter 5 of this document.

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

- the type of vehicle (vehicle class according to EN 15509)
- the euro emission class of the vehicle
- the current (declared) number of vehicle axels

Therefore it is necessary that the related attributes to these values 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 pull or 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) AuthenticationKeys
- one (1) AccessKey

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 EN 15509 [IAP]).

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 EN 15509 [IAP].

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

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

- GET
- GET_STAMPED
- GET_INSTANCE
- 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].

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 70ms. 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 - without decrease of its performance - simultaneous radiation of different carrier frequencies in case of overlapping communication zones of neighboring beacons.

2.4.2 Late response

When the OBE cannot send an answer 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 e.g. in Austria, the use of late response procedures shall be avoided. OBE using late response will not be accepted anymore for first time acceptance procedures.

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 =0(dec). and 69(dec).

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 cannot 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 3 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: Signalization 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 context:

- The declared number of axles of the vehicle combination (possibly visible as tractor and trailer axles).
- The transaction status of the last transaction in parallel to the acoustic signal acc. to chapter 3.2
- 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 context.
- The OBE is **not** working correctly in the ASFINAG toll context.

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.

5 EETS OBE application element contents

The table below shows an overview of the application data elements, for the detailed description see document EETS-OBE Personalization, Configuration and Operation Data Description [EETS_data].

Attributes (EID>0)	AttrId ***)	Type	Length in Bytes	Read	Write	Remarks
CONTRACT						Information associated with the service rights of the Contract Provider (EETS Provider)
EFC Context Mark	0	32	6	Yes	No	Contains the Contract Provider Identification. Transmitted as part of the VST.
PAYMENT						Data associated with the Payment transaction.
PaymentMeans (including PAN)	32	64	14	Yes	No	Includes: - The Personal Account Number, including the Payment Means Issuer (identified by the IIN), - The PAN Expiry Date - The payment means Usage Control
VEHICLE						Information pertaining to the identification and characteristics of the vehicle.
VehicleLicencePlateNumber	16	47	Variable 13 to 17 bytes	Yes	No	Length of the attribute, incl. Country code, Alphabet Indicator and length. **)
VehicleClass	17	49	1	Yes	No	
VehicleDimensions	18	50	3	Yes	No	
VehicleAxles	19	51	2	Yes	No	

VehicleWeightLimits	20	52	6	Yes	No	
VehicleSpecificCharacteristics	22	54	4	Yes	No	
EQUIPMENT						Information pertaining to the OBE.
EquipmentOBEId	24	56	5 (=4+1)	Yes	No	Length of EquipmentOBEID is fixed to 4+1 bytes as specified in EN 15509
EquipmentStatus	26	58	2	Yes	Yes	Includes transaction counter and black list flag
RECEIPT						
ReceiptData1 (last)	33	65	28	Yes	Yes	
ReceiptData2 (penultimate)	34	66	28	Yes	Yes	

Table 4: EETS OBE application element contents

Implementation of additional attributes for compatibility reasons to other existing systems (like AttrID. 4 and 23) is up to the TSP.

**) According to EN15509 the length of this attribute can be (10 to 14)+3 bytes. Though the RSE can read LPN information with a length of up to 14 characters, only the first 10 significant characters are further processed in the central systems.

***) Container choice type value

“Read” and “Write” define access rights to a given attribute for GET, GET_STAMPED or SET used by RSE.

Each attribute contains one or several data fields. Personalization shall be made by the Contract Issuer (EP) as specified in [EETS_data], which is based on [EFC API].

For further details on specification of attributes, security features (authentication mechanisms to be implemented, etc.), which have to be implemented and supported in interoperable context, see [EETS_data] and [IAP].

6 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.

6.1 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.

6.2 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.

6.3 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.

7 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-OBE_req]			EETS-OBE Requirements Specification (this document)
[EETS_data]			EETS DSRC Tolling Data Specification
[IAP]	EN 15509	2014	Road Traffic and Transport Telematics (RTTT) – Electronic Fee Collection –Interoperability application profile for DSRC
[EFC API]	EN ISO 14906:2011/ Amd1:2015	2011/ Amd1:2015	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://www.etc-interop.com/pdf/gss_32.pdf)
[L1]	EN 12253		Road Transport and Traffic Telematics (RTTT) – Dedicated Short-Range Communication (DSRC) –Physical layer using microwave at 5.8 GHz
[L2]	EN 12795		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		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]			http://www.tc278.eu/index.php/14816-register