

EasyGo+ RSE functional requirements

Enclosure D to Document 202 “Roadside and on board equipment”

This copy of the document was published on www.easygo.com and is for information purposes only. It may change without further notice.

Table of contents

DOCUMENT REVISION HISTORY	3
ABBREVIATIONS	4
1 INTRODUCTION	6
1.1 SCOPE OF THE DOCUMENT	6
2 FUNCTIONAL REQUIREMENTS	6
2.1 DSRC COMMUNICATION	6
2.2 TRANSACTION RECORD	13
2.3 TARIFF MANAGEMENT	13
2.4 LIST MANAGEMENT	14
3 DSRC INTERFACE	16
3.1 BASIC REQUIREMENTS	16
3.2 EN15509 TOLLING TRANSACTION	21
3.3 DATA SPECIFICATION	23
3.4 SECURITY FEATURES	24
4 EXAMPLE FOR TOLL TRANSACTION DATA (INFORMATIVE)	25
5 REFERENCES	27
5.1 STANDARDS AND EXTERNAL DOCUMENTS	27
5.2 EASYGO DOCUMENTS	30

Document revision History

Version	Date	Author	Main changes
0.1	11.06.2010	HHA	First draft
0.2	22.06.2010	RL, HHA	Revision by RL, HHA
0.3	01.07.2010	RL, HHA	Open items solved, example for transaction data record included (Annex A)
0.31	05.07.2010	RL	Clarifications in ch. 2.1.3/ table 2
1.00	18.11.2010	HHA	Document release
V1.50		HHA	Adaptation as enclosure to EasyGo document 202
V1.51	18.11.2011	HHA	Editorial changes
V1.52	11.04.2013	HHA	References updated
2.0	02.05.2013		Approved by steering committee

Abbreviations

Abbreviation, Term	Description
3DES	Triple Data Encryption Standard
ADU	Application Data Unit
AID	DSRC-Application Entity Identifier
AP	Application Process
APDU	Application Protocol Data Unit
ASN.1	Abstract Syntax Notation One (ISO/IEC 8824-1)
AttrID	Attribute Identifier
AuKey_Iss	TSP Authentication Key (Issuer authentication key)
BST	Beacon Service Table
CA OBU	Central Account OBU
CI	Contract Issuer, Toll Service Provider
CS	Central System for all TS
DES	Data Encryption Standard
DSRC	Dedicated Short-Range Communication
EAcK	ElementAccessKey
Exception list	Blacklist
EFC	Electronic Fee Collection
EID	Element Identifier
FCS	Frame Check Sequence
HF	High Frequency
HMI	Human-Machine Interface (= Man-Machine Interface MMI)
HV	Heavy Vehicle (> 3.5 tons)
HGV	Heavy Goods Vehicle = HV
IID	Invoker Identifier
I-OBU	Interoperable OBU (EN15509 compliant)
L1	Layer 1 of DSRC (Physical Layer)

Abbreviation, Term	Description
L2	Layer 2 of DSRC (Data Link Layer)
L7	Layer 7 of DSRC (Application Layer)
LID	Link Identifier
LLC	Logical Link Control
LPN	Licence Plate Number
LSB	Least Significant Bit
MAC	Medium Access Control
MAS	DSRC Toll station (First Source)
MEAcK	MasterElementAccessKey
MEAuK	MasterElementAuthenticationKey
MMI	Man-Machine Interface
MSB	Most Significant Bit
NTP	Network Time Protocol
OBE	On-Board Equipment
OBU	On-Board Unit
OSI	Open Systems Interconnection
PDU	Protocol Data Unit
RSE	Roadside Equipment
TS	Tolling Station
TSP	Toll Service Provider, Contract Issuer
UTC	Coordinated Universal Time
VST	Vehicle Service Table

1 Introduction

1.1 Scope of the document

This document describes DSRC related requirements for a DSRC Tolling Station (TS) where the DSRC interface shall be compliant to EN15509 like necessary for the EasyGo+ service.

The Tolling Station shall be able to detect the presence of OBUs in the vehicle and handle a complete DSRC tolling transaction with such OBUs.

2 Functional Requirements

2.1 DSRC communication

2.1.1 Implemented transactions

The TS shall perform transactions with EN 15509 compliant OBUs and the tolling transaction shall provide all needed information for charging the customer's account for the due fee.

The TS shall be able to recognise the following types of OBUs:

- Central Account Interoperable OBU compliant with EN15509
- Other local transactions

The type of OBU shall be detected in the content of EFC-ContextMark and EquipmentClass/ManufacturerId transmitted in the OBU's Vehicle Service Table.

The TS is the master of the communication and is therefore generally free to request any available data attribute stored in the OBU. The TS can decide which transaction to perform with the present OBU. The OBU only responds to "requests" of the TS and the TS shall decide which data to retrieve and hence which transaction to perform based on the OBU's characteristics.

During the communication and depending on the data retrieved from the OBU, the TS shall perform actions and decisions in order to determine the logical result of the transaction.

The TS decides whether the transaction is valid or not valid according to the logical decision flow associated to the transaction as depicted in Figure 1. The following subchapters explain the detailed phases and the outcome of the transaction.

Note that Figure 1 does not depict the actual flow of the transaction, but only the logical flow to determine the result of the transaction. The actual flow always respects the relevant specifications.

Access to data in the OBU will be regulated by specific Access Credentials when Security Level 1 (acc. to EN15509) is applied in interoperable context. If the OBU answers with an access denial the transaction is aborted.

The output of the decision flow is the logical transaction result that can have one of the following values:

- Valid
- Valid, but warning
- Not valid, expired
- Not valid

The logical transaction result is used to:

- determine the value of the OBU data element ReceiptData1_SessionResult
- trigger the OBU's MMI (see [OBU_req]),
- set the transaction result field of the Transaction Record

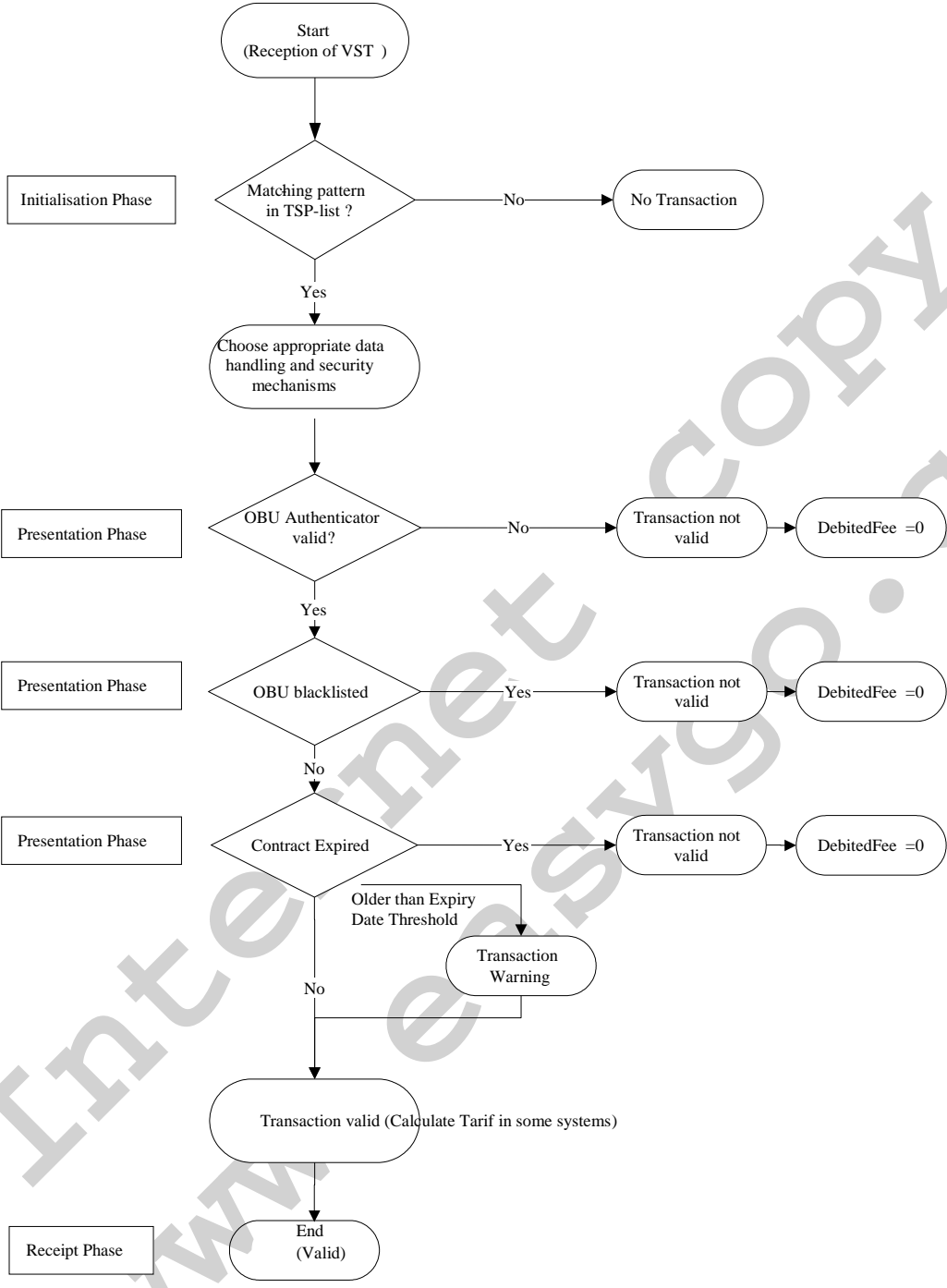


Figure 1 Logical decision flow

2.1.2 Initialisation Phase

The TS beacons periodically broadcast a Beacon Service Table (BST) with ApplicationID = 1 (EFC). The content of the BST is specified in document 202-C “EASYGO+ DSRC transaction for tolling and enforcement”.

At the passage of a vehicle with a system compliant OBU under the TS, the OBU receives the BST. If the OBU contains an EFC-Context Mark with ApplicationId = 1, it answers with a Vehicle Service Table. The content of the VST is specified in document 202-C “EASYGO+ DSRC transaction for tolling and enforcement”.

Each time the RSE receives a VST from an OBU, it analyses the attribute EFC-ContextMark and the data elements EquipmentClass/ManufacturerID and decides how to handle the OBU (i.e. which application to use).

If the attribute EFC-ContextMark and the data elements EquipmentClass/ManufacturerID match one of the entries in the Toll Service Provider (TSP) List, the RSE shall use the associated application to perform a transaction (Either the interoperable EN15509 transaction or local transaction).

If the VST contains a list of (more than one) EFC-ContextMark, the first entry shall be used in the TSP List. Hence, even for a VST with more than one EFC-ContextMark only one transaction shall be performed.

If the EFC-ContextMark and EquipmentClass/ManufacturerID matches a valid entry in the TSP List, the transaction continues to the Presentation Phase; otherwise the transaction is terminated. A communication that does not reach the Presentation Phase is not considered as a “transaction” and shall not be further registered by the TS and no Transaction Record will be created.

Use of Access Credentials, blacklisting, authentication, VehicleAxles handling, debiting details and SetMMI mode is controlled by data in the TSP List.

2.1.3 Presentation Phase

The TS requests the OBU to present some parts or all of its data. This is done by requesting the content of specific data attributes in the OBU. If the Access Credential (Security Level 1) is not accepted by the OBU no further data is retrieved.

Based on the response of the OBU, the TS shall evaluate the content of the retrieved data attributes according Table 1.

Table 1 Scenarios I, MMI response and Transaction Result

Scenario	Payment Means Authenticator (TC Authenticator)	OBU present on Exception List or EquipmentStatus blacklist bit set*	OBU PaymentMeans ExpiryDate	SET_MMI request	Transaction Result
OBU does not accept Access Credentials	Not Applicable	Don't care	Don't care	no SET_MMI (no beep)	“not valid, incomplete”
OBU fails	Wrong	Don't care	Don't care	NOK	”not

Scenario	Payment Means Authenticator (TC Authenticator)	OBU present on Exception List or EquipmentStatus blacklist bit set*)	OBU PaymentMeans ExpiryDate	SET_MMI. request	Transaction Result
authentication				4 beep code (1), if auth. Is checked at RSE,	valid"
OBU authenticated and not blacklisted	Correct or not checked	Not present	See Table 2		
OBU Blacklisted	Correct or not checked	Present	See Table 3 in section 2.1.2.2.		

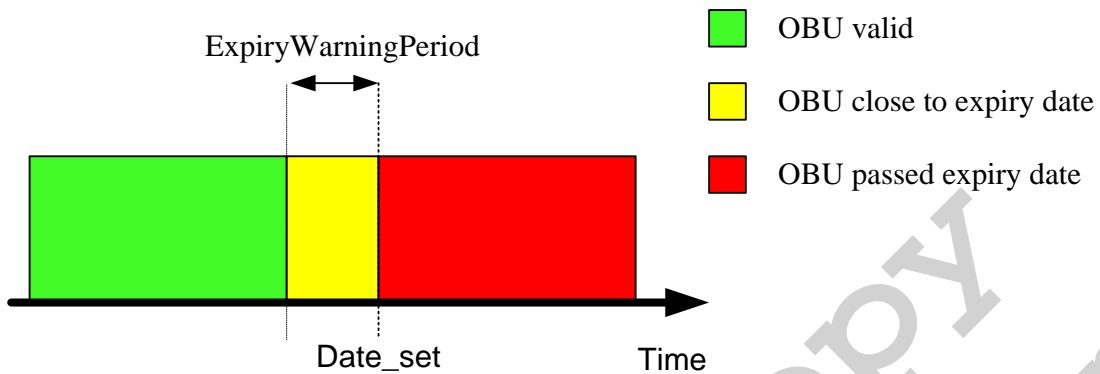
*) Implementing procedures to interpret the Blacklist bit in EquipmentStatus is up to the TC, but for possible future demands implementation is recommended.

Various types of OBUs exist. OBUs that have the PaymentMeansExpiryDate set to a real date and OBUs that have the PaymentMeansExpiryDate set to 0. Depending on the TS date (TS Current date) and the retrieved OBU PaymentMeansExpiryDate (Date_set) the OBUs shall be handled as given in Table 2.

Table 2 Scenarios II, MMI response and Transaction Result

Case	OBU PaymentMeans ExpiryDate	Condition	SET_MMI. Request	Transaction Result
OBU passed expiry date	Date_set	$(Date_set - TS\ Current\ date) < 0$	NOK 4 beeps (1)	"not valid, expired"
OBU close to expiry date	Date_set	$((Date_set - TS\ Current\ date) < ExpiryWarningPeriod)$ AND $((Date_set - TS\ Current\ date) \geq 0)$	WARNING 2 beeps (2)	"Valid, but warning"
OBU valid	Date_set	$(Date_set - TS\ Current\ date) > ExpiryWarningPeriod$	OK 1 beep (0)	"Valid"
OBU with no expiry date	0	NA	OK 1 beep (0)	"valid"

The ExpiryWarningPeriod shall be configurable with a default value of: 61 days. Due to different interpretations of the standards, the "beep code" for "Valid" transaction differs and shall be as instructed in the TSP List.



2.1.2.1 Access Credentials

Access Credentials are used if the entry in the TSP List indicates to do so (AC_CRFlag).

The Access Credentials Master Keys (16 Bytes) shall be available at the TS and the TSP list is pointing to the key to apply for a specific OBU (with a specific contract).

2.1.2.2 Blacklisting (OBU on Exception List and/or OBU with blacklist bit (Bit 15th in EquipmentStatus set))

For indication of a blacklisted OBU there are two significant parameters:

The Exception List, which is searched for the OBU ID or PAN and dependent on the content of the BlacklistBitMode field of the OBU's TSP List entry for the value of 15th bit of EquipmentStatus in the OBU:

Table 3 Transaction result and MMI as function of BlacklistBitmode in TSP List

BlacklistBitmode in TSP List	EquipmentStatus (Bit 15th)	OBU present on Exception List	SET_MMI. Request	Transaction Result *)
1 or 3	Ignore	yes	NOK 4 beeps (1)	"Blacklisted by OBU-ID"
1 or 3	Ignore	no	OK 1 beep (0)	"OK"
2 or 4	Set	Don't care	NOK 4 beeps (1)	"Blacklisted by bit 15"
2 or 4	Not set	yes	NOK 4 beeps (1)	"Blacklisted by OBU-ID"
2 or 4	Not set	no	OK 1 beep (0)	"OK"

*) Transaction result see example for transaction data in Annex A

2.1.2.3 GET_STAMPED.request,. authenticator check

GET_STAMPED.request will be done to get authenticators: (TSP authenticator and if applicable TC Authenticator).

The first GET_STAMPED.request is performed with the KeyRef_TSP as listed in the TSP List for that EFC-ContextMark to get the TSP authenticator.

If required, the second GET_STAMPED.request is performed with the KeyRef_OP as listed in the TSP List for that EFC-ContextMark TC Authenticator.

The RndRse number is the same for both GET_STAMPED.request.

Depending on application and configuration in TSP List, a check of the TC Authenticator will be done in TS and the transaction is concluded with a corresponding TransactionResult.Note: TC Authenticator checking can be done in CS too.

2.1.4 Receipt Phase

In the Receipt Phase the following application data shall be written to the OBU:

- Attribute ReceiptData1: a “receipt” of the current transaction. The following values are used:
 - StationLocation: the identification of the TS location (= StationID),
 - SessionTime: the time of passage in UTC according to the TS’s internal clock, which is synchronized via NTP
 - optional: SessionFee = “DebitedFee”
 - SessionResult = logical transaction result (Valid, Warning, Not Valid)
- Attribute ReceiptData2: the data of the previous ReceiptData1 (read out in the Presentation Phase) is copied to the attribute ReceiptData2
- The Transaction Counter contained in the attribute EquipmentStatus, which has been read-out in the Presentation Phase, is incremented by one unit and written back.

Details of the values of ReceiptData1 can be found in document 202-B “EasyGo+ OBU data description”.

In addition to this the TS sends a command to trigger the OBU MMI (SET_MMI.Request) according to the Transaction Result. This command contains the following values each meant to trigger a specific action of the OBU’s MMI:

Transaction Result	Command	Value	MMI Action
Valid	OK	0	1 beep
Valid/Warning	WARNING	2	2 beeps
Not valid	NOK	1	4 beeps

2.1.5 Tracking and closing

It is up to the Toll Charger to use either of the following functionality at the TS:

- Tracking: to track the position of the OBU (the vehicle) on the road until it leaves the communication zone.
- Closing to release the OBU: Applicable if no tracking is used (up to the Toll Charger).

2.2 Transaction Record

At completion of the DSRC transaction the TS generates a Transaction Record for the transaction.

The Transaction Record is stored in the database at the TS in order to be transferred to the TC's Central System.

The Transaction Record contains a.o.:

- Date and time of the DSRC transaction
- Location of the transaction, according to the TS location numbering scheme
- Application data retrieved from/written into the OBU (Mandatory data + data needed for toll calculation for the resp. toll context, see chapter 3.2)
- The fee due, if applicable
- The completeness of the transaction
- The transaction result

Transactions which are interrupted after the Presentation Phase are marked as incomplete (see Annex A- field TransactionCompleted); incomplete transactions may be delivered as valid transactions when all charge relating data is available (up to the Toll Charger).

2.3 Tariff management

The fee due ("*FeeDue*") for the vehicle's passage is the tariff valid at the specific station for that vehicle at a certain point in time. Its up to the Toll Charger (TC) to use local Tariff List at TS or calculating tariff in CS.

2.4 List management

2.4.1 Lists distributed to the Tolling Stations

Among others the following lists are periodically updated at the TS from the CS, a complete refresh of the TS- lists can be initiated by both TS and CS:

- Exception List: to detect blacklisted OBUs at the moment of their passage and handle them correctly
- TSP List: gives information about the applicable procedure for a specific OBU type
- Tariff List: Optional, if needed for tariff calculation.

2.4.1.1 Exception List

The Exception List (OBU- Blacklist) will be scanned at each transaction. If the OBU-ID or PAN is found on the Exception List, no valid transaction (in sense of payment) will be carried out.

2.4.1.2 TSP List

The TSP List, see Table 4, holds information about OBU and contract types to be accepted for tolling and further about applicable authentication and tariff calculation.

To avoid multiple entries due to not significant selection criteria, wildcard bit masks are foreseen for data in EFCCContextMark, EquipmentClass and ManufacturerID.

Table 4 Example of a TSP List

Data field	Comment
TSP-ID	Unique reference number to a TSP List entry (consecutive numbering)
EFCCContextMarkContractProvider	Valid ContractProvider as received in the VST (country code + TSP ID)
EFCCContextMarkTypeOfContract	Valid TypeOfContract as received in the VST
EFCCContextMarkContextVersion	Valid ContextVersion as received in the VST
EquipmentClass	EquipmentClass as received in the data element ObeConfiguration in the VST: technical information about the OBU.
ManufacturerID	ManufacturerID as received in the data element ObeConfiguration in the VST: technical information about the OBU.
BitmaskContractProvider	Bitmask for wildcard entries in decimal coding. This bitmask maps the EFCCContextMarkContractProvider (0 =*)

Data field	Comment
BitmaskTypeOfContract	Bitmask for wildcard entries in decimal coding. This bitmask maps the EFCCContextMarkTypeOfContract (0=*)
BitmaskContextVersion	Bitmask for wildcard entries in decimal coding. This bitmask maps the EFCCContextMarkContextVersion (0=*)
BitmaskEquipmentClass	Bitmask for wildcard entries in decimal coding. This bitmask maps the EquipmentClass (0=*)
BitmaskManufacturerID	Bitmask for wildcard entries in decimal coding. This bitmask maps the ManufacturerID (0=*)
Application	Application to be started: 0 ... EN15509, 1, 2,
BlacklistBitMode	Behaviour for interpreting and writing of bit 15 in EquipmentStatus: 1= do not interpret, do not change 2= do interpret, do not change 3= do not interpret, do change 4= do interpret, do change
SetMMIMode	SetMMI Mode: 0 = use SetMMI with ActionParameter = 0; 1 = use SetMMI with ActionParameter = 69
AC_CRFlag	Indicates if Access Credentials are to be used in the transaction: 0 = AC not used 1 = AC used
KeyRef_TSP	KeyRef to be used in the first GET_STAMPED.request (range 111 to 118)
KeyRef_OP	KeyRef to be used in the second GET_STAMPED.request (range 111 to 118)

2.4.1.3 Tariff List

The Tariff List is stored in the database at the TS, if applicable.

3 DSRC interface

3.1 Basic requirements

The TS must conform to [IAP], this implies compliance with the DSRC standards for Profiles, L1, L2 and L7 [Profiles], [L1], [L2], [L7].

Compliance to [GSS] is required, e.g. state transitions must be processed compliant to [GSS] and [IAP] by TS.

Furthermore it is pointed out, that TS shall be compatible with OBU both with and without slow response.

3.1.1 Layer 1

Downlink and Uplink Parameters are given in Table 5 and Table 6 respectively. All 4 downlink channels shall be supported (D1).

Table 5 Layer 1, Downlink Parameter

Item No.	Parameter	Value(s)	Remark
D1	Carrier Frequencies	Downlink channel 1: 5,7975 GHz Downlink channel 2: 5,8025 GHz Downlink channel 3: 5,8075 GHz Downlink channel 4: 5,8125 GHz	
D1a	Tolerance of Carrier Frequencies	within ± 5 ppm	-
D2	RSU Transmitter Spectrum Mask	1) Out band power: see ETSI EN 300674-1 2) In band power: $\leq +33$ dBm 3) Unwanted emission for unmodulated carrier wave shall be less than: Co-channel uplink at 1,5 MHz: ≤ -27 dBm in 500 kHz. Co-channel uplink at 2,0 MHz: ≤ -27 dBm in 500 kHz. Adjacent channel uplinks: ≤ -47 dBm in 500 kHz. 4) For in-band unwanted emission with modulated carrier wave, class C is to be used: Class C: Co-channel uplink at 1,5 MHz: ≤ -27 dBm in 500 kHz. Co-channel uplink at 2,0 MHz: ≤ -27 dBm in 500 kHz. Adjacent channel uplinks: ≤ -47 dBm in 500 kHz.	Class A should not be used in new installations. Equipment complying with the different classes will result in different re-use distances. See ETSI EN 300674-1 for more details
D4	Maximum E.I.R.P.	+33 dBm	-
D4a	Angular E.I.R.P. mask	$Q \leq 70^\circ$: $\leq +33$ dBm $Q > 70^\circ$: $\leq +18$ dBm	Perpendicular to street surface

Item No.	Parameter	Value(s)	Remark
D5	Polarisation	Left hand circular	-
D5a	Cross-Polarisation	XPD: In bore sight: $RSU_t \geq 15$ dB At -3 dB area: $RSU_t \geq 10$ dB	
D6	Modulation	Two level amplitude modulation.	—
D6a	Modulation Index	0,5 ... 0,9	—
D7	Data Coding	FM0 "1" bit has transitions only at the beginning and end of the bit interval. "0" bit has an additional transition in the middle of the bit interval compared to the "1" bit.	
D8	Bit rate	500 kbit/s	—
D8a	Tolerance of Bit Clock	better than ± 100 ppm	—
D9	Bit error ratio for communication	$\leq 10^{-6}$ when incident power at OBU is in the range given by [D11 a to D11b].	
D11	Communication zone	Spatial region within which a bit error ratio according to D9 is achieved	—
D12	Cut-off power level of OBU	-60 dBm	Applicability of this parameter is subject to profiles and sets defined in EN 13372
D13	Preamble	Preamble is mandatory.	—
D13a	Preamble Length	16 bits ± 1 bit	—
D13b	Preamble Wave form	An alternating sequence of low level and high level with pulse duration of 2 μ s. The tolerance is given by D8a	
D13c	Trailing Bits	The RSU is permitted to transmit a maximum of 8 bits after the end flag. An OBU is not required to take these additional bits into account.	

Table 6 Layer 1, Uplink Parameter

Item No.	Parameter	Value(s)	Remark
U1	Sub-carrier Frequencies	The RSU shall support both 1,5 MHz and 2,0 MHz	
U1a	Tolerance of Sub-carrier Frequencies	within $\pm 0,1\%$	-
U1b	Use of Side Bands	Same data on both sides	-
U5	Polarisation	Left hand circular transmitted when left hand circular received	-

Item No.	Parameter	Value(s)	Remark
U5a	Cross Polarisation	XPD: In bore sight: $RSU_r \geq 15$ dB At -3 dB: $RSU_r \geq 10$ dB	-
U6	Sub-carrier Modulation	2-PSK Encoded data synchronised with sub-carrier: Transitions of encoded data coincide with transitions of sub-carrier.	-
U6b	Duty Cycle	$50\% \pm \alpha$, $\alpha \leq 5\%$	-
U6c	Modulation on Carrier	Multiplication of modulated sub-carrier with carrier.	-
U7	Data Coding	NRZI	-
U8	Bit Rate	250 kbit/s	-
U8a	Tolerance of Bit Clock	Within ± 1000 ppm	—
U13	Preamble	Preamble is mandatory.	—
U13a	Preamble Length and Pattern	32 μ s to 36 μ s modulated with sub-carrier only, then 8 bits of NRZI coded "0" bits.	
U13b	Trailing Bits	The OBU is permitted to transmit a maximum of 8 bits after the end flag. A RSU is not required to take these additional bits into account.	

3.1.2 Profiles

Table 7 gives the DSRC Profiles (0 and 1) acc. to [Profiles] that shall be supported.

Table 7 Profiles

Parameter		Profile 0	Profile 1
D12	Cut-off power level of OBU	-60 dBm	-60 dBm
U1	Sub-carrier Frequencies	1,5 MHz	2,0 MHz
U4a	U4a Maximum Single Side Band E.I.R.P. (bore sight)	-21 dBm	-21 dBm
U12a	Conversion Gain (lower limit)	1 dB for each side band Range of angle: Circularly symmetric between bore sight and $\pm 35^\circ$	1 dB for each side band Range of angle: Circularly symmetric between bore sight and $\pm 35^\circ$
U12b	Conversion Gain (upper limit)	10 dB for each side band	9 dB
N1	Length of private link address (LID)	4 Byte	4 Byte
N2	Maximum number of octets in frame in downlink window	128 Byte	128 Byte

Parameter		Profile 0	Profile 1
N3	Maximum number of octets in frame in private uplink window	128 Byte	128 Byte
N4	Maximum number of octets in frame in public uplink window	9 Byte	9 Byte
N5	Number of simultaneously allocated public uplink windows	3	3
N8	max. value for „Random Delay Counter“	3	3
N12	max. private medium response time	1	1
T1	Minimum uplink to downlink turn around time	32 μ s	32 μ s
T2	Minimum downlink to downlink window time	0 μ s	0 μ s
T3	downlink to uplink turn around time	160 μ s	160 μ s
T4a	Maximum time to start of transmission in private uplink window	320 μ s	320 μ s
T4b	Maximum time to start of transmission in public uplink window	32 μ s	32 μ s
T5	Time duration of public uplink window	448 μ s	448 μ s
N13FE	Acknowledgement time for RSE	1	1
N13ME	Acknowledgement time for OBE	1	1

3.1.3 Layer 2

The TS shall conform to [L2] and [GSS].

Supported frame combinations for Downlink is given in Table 8 and for Uplink in Table 9.

Table 8 Supported combinations for Downlink

No	LID	MAC	LLC	APDU	Remark
1	Private	20/28	None	None	Private Uplink Window Allocation
2	Broadcast	A0	03	INIT.request (BST)	Broadcast UI command with window allocation
3	Private	80	03	SET. request, mode = 0 ACTION. request, mode = 0	Private UI command no window allocation
4	Private	80	03	EVENT_REPORT. request (RELEASE), mode = 0	Private UI command no window allocation
5	Private	A0/A8	67/E7	SET. request, mode = 0 ACTION. request, mode = 0	Private AC command mit p = 0 with window allocation
6	Private	A0/A8	77/F7	GET. request SET. request, mode = 1 ACTION. request, mode = 1	Private AC command mit p = 1 with window allocation

Table 9 Supported combinations for Uplink

No	LID	MAC	LLC	LLC status	APDU	Remark
1	Private	60	None	None	None	Private Uplink Window Req. (in public uplink window only)
2	Private	C0	03	None	INIT.response (VST)	Private UI command no window request
3	Private	C0	03	None	GET. response, SET. response, ACTION. response	Private UI command no window request
4	Private	D0	67/E7	40	None (APDU not requested)	Private ACn response f = 0 no window request
5	Private	D0	77/F7	30	None (APDU not available)	Private ACn response f = 1 no window request
6	Private	D0	77/F7	00	GET. response, SET. response, ACTION. response	Private ACn response f = 1 no window request

3.1.4 Layer 7

The TS shall conform to EN 15509 [IAP] (this implies indirect reference to EN 12834 [L7]), implementation shall follow [GSS], if applicable.

The following **T-APDU** are supported:

- Initialisation
- Get
- Set
- Action
- Event-Report

According to [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;

Valid combinations of APDUs are listed in EN 13372 [Profiles].

Application Interface for EFC

Table 10 specifies the EFC Functions that are supported according to [L7] and [EFC API] as Actions:

Table 10 Action Functions

Name	Action Type	Action Parameter	Response Parameter	Remarks
Get_Stamped	0	GetStampedRq	GetStampedRs	retrieves data with an authenticator from the OBE
Get_Instance	4	GetInstanceRq	GetInstanceRs	retrieves a number of entries out of an attribute's multiple instances
Get_Nonce	6	-	Octet String	Reads a random number generates by OBU Optional, not used in the system
Set_MMI	10	SetMMIRq	-	invokes an MMI function (e.g. signal Ok via buzzer)
Echo	15	Octet String	Octet String	OBU echoes received data

The AccessCredentials parameter is supported in the following functions:

- Get
- Get_Stamped
- Get_Instance
- Set

The data field EFC-ContextMark is supported.

Due to ambiguities in previous versions of the standards the TS shall send SET_MMLrequest command with ActionParameter (Container Type) "0" ("Integer") as well as "45"(hex)"/"69"(dec) depending on the corresponding entry in the TSP List.

3.2 EN15509 tolling transaction

In general the EN15509 tolling transaction is based on the "pick what you need" idea, following EN15509. So only those data will be read from OBU, which is needed for tolling in the respective tolling context together with other data needed for the payment claims.

Table 11 provides an overview of the attributes involved in the data exchanges of DSRC tolling transactions associated with an EN15509 OBU, e.g. an EasyGo+ OBU.

In Annex A an example for a toll transaction data record is shown.

Table 11 Overview of attributes in the data exchange of DSRC tolling transaction

ATTRIBUTES (EID>0)	AttrId	Type	Length in bytes	Easy Go+ Use	Remarks
CONTRACT					Information associated with the service rights of the Contract Provider (ETS Provider)
EFC Context Mark	0	32	6	M	Contains the Contract Provider Identification. Transmitted as part of the VST.
PAYMENT					Data associated with the Payment transaction.
PaymentMeans (including PAN)	32	64	14	M	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	M	Length of the attribute, incl. Country code, Alphabet Indicator and length. **)
VehicleClass	17	49	1	O	
VehicleDimensions	18	50	3	O	
VehicleAxles	19	51	2	O	
VehicleWeightLimits	20	52	6	O	
VehicleSpecificCharacteristics	22	54	4	O	
EQUIPMENT					Information pertaining to the OBU.
EquipmentOBUID	24	56	5 (=4+1)	M	Length of EquipmentOBUID is fixed to 4+1 bytes as specified in EN 15509
EquipmentStatus	26	58	2	O	Includes transaction counter and black list flag
RECEIPT					Information associated with a specific session, including both financial and operational data.
ReceiptData1 (last)	33	65	28	O	
ReceiptData2 (penultimate)	34	66	28	O	

Column "EASYGO+ Use": M= mandatory, N= no use, O= optional (up to the toll charger's needs- TO BE DEFINED FOR EACH TOLL CONTEXT)

**) Acc. to EN15509 the length of this attribute is fixed to 14+3= 17 bytes, but for compatibility reasons the implementation of a variable length is recommended.

3.3 Data specification

For details on specification of attributes see document 202-B “EasyGo+ OBU Data description”.

3.3.1 EquipmentOBUID

If the attribute EquipmentOBUID is shorter than 4 Byte (+1 Byte length indicator), it is rightpadded with 0'B to achieve the desired length of 4 Bytes before being inserted in the RSE's database (see example in document 202-C).

3.3.2 VehicleLicensePlateNumber

Note: ASFINAG is coding non-latin 1 license plate characters by use of lower case characters within latin 1 alphabet according into the OBU acc. to the translation table below.

For license plate information received by OBU using non Latin1 alphabets the same translation to Latin 1 at RSE has to apply to avoid foreign character sets in the central systems.

If the attribute VehicleLicencePlateNumber is longer than 10 characters, it is cut to achieve a total length of 10 characters.

If the Alphabet Indicator in the attribute VehicleLicencePlateNumber indicates that the LPN string is written in the alphabet Latin-2 or Cyrillic, a translation into Latin-1 (lower case letters) is applied for not supported characters, according to Table 12.

Table 12 Translation of Non Latin 1 character to lower case Latin1 character

Alphabet	Non latin 1 character	Translation to lower case latin1
ISO-8859-2 (Latin2)	Č-č	c
ISO-8859-2 (Latin2)	Š-š	s
ISO-8859-2 (Latin2)	Ž-ž	z
ISO-8859-5 (Cyrillic)	Б-б	v
ISO-8859-5 (Cyrillic)	Г-г	g
ISO-8859-5 (Cyrillic)	Д-д	d
ISO-8859-5 (Cyrillic)	Ё-ё	e
ISO-8859-5 (Cyrillic)	Ж-ж	x
ISO-8859-5 (Cyrillic)	З-з	k
ISO-8859-5 (Cyrillic)	И-и	n
ISO-8859-5 (Cyrillic)	Й-й	j
ISO-8859-5 (Cyrillic)	Л-л	l
ISO-8859-5 (Cyrillic)	П-п	p
ISO-8859-5 (Cyrillic)	У-у	y

Alphabet	Non latin 1 character	Translation to lower case latin1
ISO-8859-5 (Cyrillic)	Ф-ф	o
ISO-8859-5 (Cyrillic)	Ц-ц	u
ISO-8859-5 (Cyrillic)	Ч-ч	i
ISO-8859-5 (Cyrillic)	Ш-ш	w
ISO-8859-5 (Cyrillic)	Щ-щ	m
ISO-8859-5 (Cyrillic)	Ъ-ъ	b
ISO-8859-5 (Cyrillic)	Ы-ы	q
ISO-8859-5 (Cyrillic)	Ь-ь	h
ISO-8859-5 (Cyrillic)	Э-э	f
ISO-8859-5 (Cyrillic)	Ю-ю	t
ISO-8859-5 (Cyrillic)	Я-я	r

When other not supported characters, which are not inserted in the translation table, are detected, they are substituted with the character “ * ” (star).

If the Alphabet Indicator in the attribute VehicleLicencePlateNumber indicates an alphabet other than Latin-1, Latin-2, or Cyrillic, the LPN string is left untranslated (the coding is simply written as Latin-1 coding), substituting only the first (left) character with an “ - ” (hyphen).

3.4 Security features

The EASYGO+ DSRC transaction comprises the following security features (see [IAP] for details):

- **Transaction counter**, increased by the RSE, allowing detection of transaction sequencing anomalies in the Central System.
- **Authentication to the TSP**, i.e. challenge-response of PaymentMeans data using the GET_STAMPED function with the TSP Key
- **Authentication to the TC**, i.e. challenge-response of PaymentMeans data using the GET_STAMPED function with the Operator Key (TC key)
- **Protected access to the OBU data**, through the implementation of Access Credentials. The Access Credential are not needed to access the OBU's data when Security Level 0 applies.

4 Example for toll transaction data (informative)

The following table is showing exemplary a toll transaction data record to be transmitted from RSE to CS. Note that not all shown elements might be necessary (or useful) for all EASYGO+ toll contexts, resp. other data elements can be necessary.

Column	Mandatory/ optional	Description
LSID.TransactionId	M	Unique transaction Id for the specific location
LSID	M	LocationStation ID
LocationLane	O	Lane ID
TimeStamp	M	Time stamp of the DSRC Transaction (UTC)
EFCCContextMark.ContractProvider	M	ContractProvider
EFCCContextMark.TypeOfContract	M	TypeOf Contract
EFCCContextMark.ContextVersion	M	ContextVersion
PaymentMeansPAN	M	PAN
PaymentMeansExpiryDate	M	Expiry date of the OBU/Contract
PaymentMeansUnits	O	account balance units
EquipmentOBUIDManufacturer	M	Manufacturer – Code of the OBU-ID
EquipmentOBUIDSerial	M	Serialnumber part of the OBU-ID
EquipmentStatusRead	O	EquipmentStatus as read from OBU
VehicleLicensePlateNationality	M	Nationality code (from OBU, hex)
VehicleLicensePlateAlphabet	M	Alphabet indicator
VehicleLicensePlateLicensePlate	M	Licence plate
VehicleClass	M	Derived from CCC part of attribute VehicleClass
VehicleAxles	O	Number of axles (lower 6 bit of attribut VehicleAxles)
VehicleSpecificCharacteristics	O	Contains EmissionClass

Column	Mandatory/ optional	Description
TariffID	O	ID of the Tariff Table
FeeDue	M	Amount of fee due for the passage
FeeUnitDue	M	Fee unit of the fee due
TransactionCompleted	O	Transaction completeness: complete Incomplete – Access denied Incomplete –no response for Presentation Phase Incomplete- no response for Debit phase Incomplete - no response for Receipt Phase
TransactionResult	M	Clearing Information OK (valid) permanent exemption temporary exemption Contract Expired (valid) Authenticator not valid (not valid) OBU blacklisted by OBU-ID (not valid) OBU blacklisted by bit 15 of EquipmentStatus (not valid)
IssuerAuthenticator	M	An authenticator computed with the secret key of the TSP Used by the TSP to check the validity of the present transaction
RndRSE	M	Random number sent by the RSE to the OBE for authenticator calculation
KeyRef_CI	M	Key reference for the issuer authenticator (range 111 to 118)
CI-ID	O	Applied entry of CI-List

5 References

5.1 Standards and external documents

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 publication referred to applies.

Reference	Document Ref	Date / Version	Document title
[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]	ISO15628 / EN12834	2007/ 2003	Road Transport and Traffic Telematics (RTTT) – Dedicated Short-Range Communication (DSRC) – DSRC Application Layer
[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
[EFC API]	ISO/DIS 14906.2	16.02.2010	Road Traffic and Transport Telematics (RTTT) – Electronic Fee Collection – Application interface definition for dedicated short range communication
[OBU DSRC tests]	CEN ISO/TS 14907-2	2006	Road Traffic and Transport Telematics (RTTT) – Electronic Fee Collection – Testprocedures for user and fixed equipment - Part 2: EFC application interface conformance test specification
[ETSI]	EN 300 674	2004	Electromagnetic Compatibility and Radio Spectrum Matters (ERM) - RTTT -DSRC- transmission equipment

Reference	Document Ref	Date / Version	Document title
[ISO CC]	EN ISO 3166-1		Codes for the representation of names of countries and their subdivisions – Part 1: Country code
[ISO 4217]	ISO 4217		Codes for the representation of currencies and funds
[ISO 7812-1]	EN ISO/IEC 7812-1	2000	Identification cards - Identification of issuers - Part 1: Numbering system
[ISO 8731-1]	ISO 8731-1	1987	Banking -- Approved algorithms for message authentication -- Part 1: DEA
[ASN.1]	ISO/IEC 8824-1	2004	Information technology - Abstract Syntax Notation One (ASN.1): Specification of basic notation
[ASN.1 PER]	ISO/IEC 8825-2	2004	Information technology - ASN.1 encoding rules: Specification of Packed Encoding Rules (PER)
[CEI EN 60086-4]	IEC 60086-4		Primary batteries - Part 4: Safety standards for lithium batteries
[EN 301 489-3]	EN 301489-3	V 1.4.1:2002	Electromagnetic compatibility and Radio spectrum Matters (ERM) - ElectroMagnetic Compatibility (EMC) standard for radio equipment and services - Part 3: Specific conditions for Short-Range Devices (SRD) operating on frequencies between 9 kHz and 40 GHz; V1.4.1 :2002
[EN 60950]	EN 60950		Information technology equipment - Safety

Reference	Document Ref	Date / Version	Document title
[Env Class]	EN 60721-3		Classification of environmental conditions –Part 3: Classification of groups of environmental parameters and their severities
[ENV tests]	EN 60068-2		IEC 60068-2 Environmental testing Part 2
[IAP]	EN 15509	2007	EN 15509:2007 Road Traffic and Transport Telematics (RTTT) – Electronic Fee Collection – Interoperability application profile for DSRC
[TS102486-L2]	ETSI TS 102486-1	V1.1.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Road Transport and Traffic Telematics (RTTT); Test specifications for DSRC transmission equipment; Part 1: DSRC data link layer: medium access and logical link control; Sub parts 1 - 3
[TS102486-L7]	ETSI TS 102486-2	V1.1.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Road Transport and Traffic Telematics (RTTT); Test specifications for DSRC transmission equipment; Part 2: DSRC application layer; Sub parts 1 - 3
[MOPTT]	MOPTT	V1.0:2002	Conformance tests to the specification for interoperability in the beacon – transponder transaction (Public Works, Transport and Telecommunications Ministry, Chile, Version 1.0, 2002-01-22, CEN/TC278/WG1 N677)

Reference	Document Ref	Date / Version	Document title
[CARDME]	CARDME	2002	CARDME-4/ D4.1 – The CARDME concept (Final, 1 June 2002)
[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)
[CESARE]	CEASARE	2002	CEASRE II – D032.1 Detailed CESARE Technical Specification – Version 3, 27.02.02

5.2 EasyGo documents

Reference	Document Ref	Date / Version	Document title
[PROCESS]	401		Business Process Definitions for EasyGo+
[OBU_req]	202-A		EasyGo+: Functional requirements for OBU
[OBU_data]	202-B		EasyGo+: OBU Data description (EasyGo+ OBU Personalization, Configuration and Operating Parameters)
[DSRC]	202-C		EasyGo+: DSRC Transaction for Tolling and Enforcement

Reference	Document Ref	Date / Version	Document title
	202-D		EASYGO+: RSE Functional Requirements
	202-E		EASYGO+: OBU Compatibility Tests

Internet
www.easygo.com