
**Road vehicles — Implementation
of World-Wide Harmonized On-
Board Diagnostics (WWH-OBD)
communication requirements —**

**Part 6:
External test equipment**

*Véhicules routiers — Mise en application des exigences de
communication pour le diagnostic embarqué harmonisé à l'échelle
mondiale (WWH-OBD) —*

Partie 6: Équipement d'essai externe



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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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: [Foreword — Supplementary information](#).

The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

ISO 27145 consists of the following parts, under the general title *Road vehicles — Implementation of Word-Wide Harmonized On-Board Diagnostics (WWH-OBD) communication requirements*:

- Part 1: General information and use case definition
- Part 2: Common data dictionary
- Part 3: Common message dictionary
- Part 4: Connection between vehicle and test equipment
- Part 6: External test equipment

Introduction

Overview

This International Standard includes the communication between the vehicle's on-board diagnostics (OBD) systems and external test equipment within the scope of the World-Wide Harmonized On-Board Diagnostics Global Technical Regulations (WWH-OBD GTR).

This International Standard has been established in order to apply the unified diagnostic services (specified in ISO 14229-1) to WWH-OBD systems.

This International Standard includes the communication between the vehicle's WWH-OBD systems and external (off-board) "generic" test equipment within the scope of the country-specific regulatory requirements.

To achieve this, it is based on the Open Systems Interconnection (OSI) Basic Reference Model specified in ISO/IEC 7498-1 and ISO/IEC 10731, which structures communication systems into seven layers. When mapped on this model, the services specified by this International Standard are broken into:

- diagnostic services (layer 7), specified in ISO 27145-3 with reference to ISO 14229-1,
- presentation layer (layer 6), specified in ISO 27145-2 with reference to SAE J1930-DA, SAE J1939-DA, SAE J1939-73, Appendix A (FMIs), SAE J1979-DA, and SAE J2012-DA,
- session layer services (layer 5), specified in ISO 14229-2,
- transport layer services (layer 4), specified in ISO 27145-4 with reference to ISO 13400-2, ISO 15765-2, and ISO 15765-4,
- network layer services (layer 3), specified in ISO 27145-4 with reference to ISO 13400-2, ISO 15765-2, and ISO 15765-4,
- data link layer (layer 2), specified in ISO 27145-4 with reference to ISO 11898-1, ISO 11898-2, ISO 13400-3, ISO 15765-4, and IEEE 802.3, and
- physical layer (layer 1), specified in ISO 27145-4 with reference to ISO 11898-1, ISO 11898-2, ISO 13400-3, ISO 15765-4, and IEEE 802.3,

in accordance with [Table 1](#).

Table 1 — WWH-OBD specification reference applicable to the OSI layers

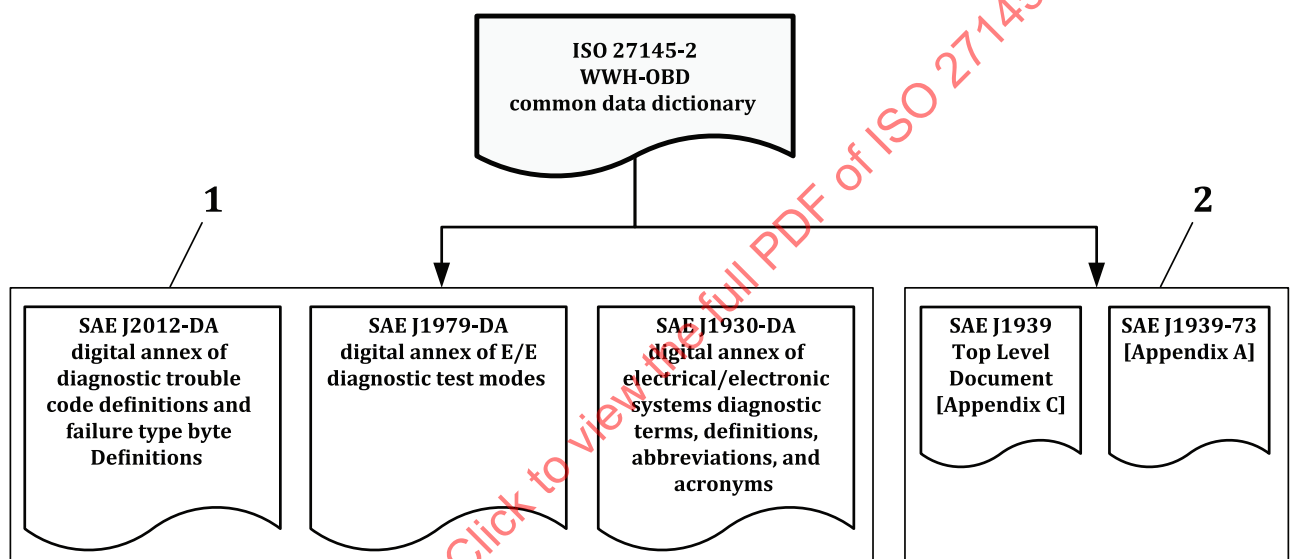
Applicability	OSI seven layer	WWH-OBD document reference			
Seven layer according to ISO/IEC 7498-1 and ISO/IEC 10731	Application (layer 7)	ISO 14229-1, 3			ISO 27145 -6
	Presentation (layer 6)	ISO 27145-2, SAE J1930-DA, SAE J1939-DA, SAE J1939-73, Appendix A (FMIs), SAE J1979-DA, SAE J2012-DA			
	Session (layer 5)	ISO 14229-2			—
	Transport (layer 4)	ISO 15765-2 DoCAN, ISO 15765-4 DoCAN	ISO 27145-4	ISO 13400-2 DoIP TCP and IP	
	Network (layer 3)				
	Data link (layer 2)	ISO 11898-1 CAN DLL, ISO 11898-2 CAN HS, ISO 15765-4 DoCAN		ISO 13400-3 DoIP, IEEE 802.3	
	Physical (layer 1)				

SAE document reference concept

This International Standard references several SAE documents which contain all terms, data and diagnostic trouble code (DTC) definitions.

ISO 27145-2 defines a common data dictionary for this International Standard, according to the definitions in the following documents ([Figure 1](#)):

- SAE J1930-DA: this digital annex contains all standardized naming objects, terms, and abbreviated terms;
- SAE J1939-DA and SAE J1939-73: The Digital Annex indexes names for suspect parameter numbers (SPNs) that provide an alternative presentation format for SAE J2012-DA DTCs. SPNs are combined with failure mode indicators (FMIs) to form the full alternative presentation. These FMIs are described in SAE J1939-73, Appendix A;
- SAE J1979-DA: this digital annex contains all standardized data items such as data identifiers (DIDs), test identifiers (TIDs), monitor identifiers (MIDs), and infotype identifiers (ITIDs);
- SAE J2012-DA: this digital annex contains all standardized data items such as DTC definitions and FTB (failure type byte) definitions.



Key

- 1 SAE digital annexes: data definitions
- 2 SAE J1939 series of documents: DTC definitions

Figure 1 — SAE digital annex document reference

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Road vehicles — Implementation of World-Wide Harmonized On-Board Diagnostics (WWH-OBD) communication requirements —

Part 6: External test equipment

1 Scope

This part of ISO 27145 defines the requirements for the external test equipment as listed:

- a means of establishing communications between a WWH-OBD-equipped vehicle and external test equipment;
- a set of diagnostic services, including addressing methods, to be provided by the external test equipment in order to exercise the services defined in ISO 27145-3.

This part of ISO 27145 describes the minimum capabilities or functions in the external test equipment. Additional functionality, e.g. non WWH-OBD protocols or retrieval of repair and maintenance information, can be integrated into the external test equipment according to the test equipment manufacturer needs. The external test equipment designer ensures that no such capability or function can adversely affect either a WWH-OBD-equipped vehicle connected to the equipment, or the equipment itself.

When the external test equipment implements functionality, which is not covered by ISO 27145-3, this functionality is not linked to the timing requirements defined in this International Standard.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7637-2:2011, *Road vehicles — Electrical disturbances from conduction and coupling — Part 2: Electrical transient conduction along supply lines only*

ISO 13400 (all parts), *Road vehicles - Diagnostic communication over Internet Protocol (DoIP)*

ISO 14229-1, *Road vehicles — Unified diagnostic services (UDS) — Part 1: Specification and requirements*

ISO 14229-2, *Road vehicles — Unified diagnostic services (UDS) — Part 2: Session layer services*

ISO 15031-3, *Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics — Part 3: Diagnostic connector and related electrical circuits, specification and use*

ISO 15765-4, *Road vehicles — Diagnostic communication over Controller Area Network (DoCAN) — Part 4: Requirements for emissions-related systems*

ISO 16750-2:2010, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 2: Electrical loads*

ISO 27145-1:2012, *Road vehicles — Implementation of World-Wide Harmonized On-Board Diagnostics (WWH-OBD) communication requirements — Part 1: General information and use case definition*

ISO 27145-2:2012, *Road vehicles — Implementation of World-Wide Harmonized On-Board Diagnostics (WWH-OBD) communication requirements — Part 2: Common data dictionary*

ISO 27145-3:2012, *Road vehicles — Implementation of World-Wide Harmonized On-Board Diagnostics (WWH-OBD) communication requirements — Part 3: Common message dictionary*

ISO 27145-4:2012, *Road vehicles — Implementation of World-Wide Harmonized On-Board Diagnostics (WWH-OBD) communication requirements — Part 4: Connection between vehicle and test equipment*

SAE J1930-DA, *Digital Annex, Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms*

SAE J1939, *Companion Spreadsheet (CS 1939)*

SAE J1939-73, *Recommended Practice for a Serial Control and Communication Vehicle Network — Application layer — Diagnostics*

SAE J1979-DA, *Digital Annex, E/E Diagnostic Test Modes*

SAE J2012-DA, *Digital Annex, Diagnostic Trouble Code Definitions*

3 Terms, definitions, symbols, and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 27145-1, ISO 27145-2, ISO 14229-1, and the following apply:

3.2 Abbreviated terms

CALID	calibration identification
CAN	Controller Area Network
DoCAN	Diagnostics over CAN
DoIP	Diagnostics over IP
DTC	Diagnostic Trouble Code
EMC	electromagnetic compatibility
ESD	electrostatic discharge
ETEREC	external test equipment recommendation
ETEREQ	external test equipment requirement
GTR	Global Technical Regulations
HMI	Human-Machine Interface
IP	Internet Protocol
IUPR	In Use (Monitor) Performance Ratio
MVCI	Modular Vehicle Communication Interface
MI	Malfunction Indication

MIL	Malfunction Indication Lamp
NRC	Negative Response Code
ODX	Open Diagnostic data eXchange

4 Conventions

This International Standard is based on the conventions discussed in the OSI Service Conventions (ISO/IEC 10731) as they apply to diagnostic services.

5 Document overview

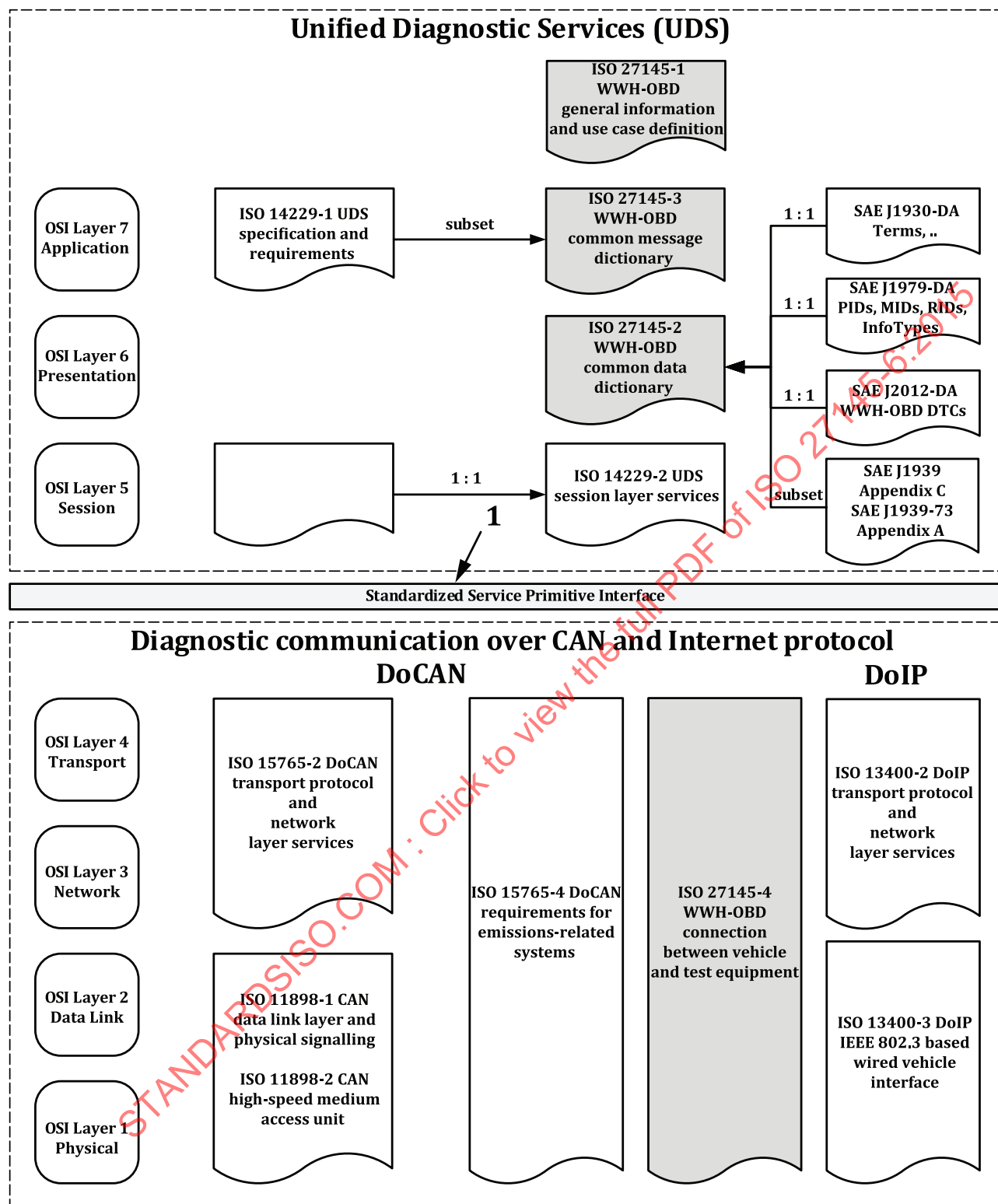
[Figure 2](#) shows the reference documents for this International Standard.

This International Standard specifies the following references:

- a) ISO 27145-1 specifies the general structure of this International Standard and the use cases applicable to WWH-OBd GTR;
- b) ISO 27145-2 specifies the common data dictionary with references to the following:
 - 1) SAE J1930-DA, which defines the terms, definitions, abbreviated terms, etc.;
 - 2) SAE J1939-DA contains all SPNs (parameters), PGNs (messages), and other SAE J1939 data previously published in the SAE J1939 top level document;

NOTE The SAE J1939 series of documents is concerned with the definition of emissions-related SPNs and FMIs for use as DTCs.

 - 3) SAE J1939-73, Appendix A, which specifies the FMIs;
 - 4) SAE 1979-DA, which specifies all data items;
 - 5) SAE J2012-DA, which specifies the DTC definitions and failure type byte definitions.
- c) This part of ISO 27145 specifies the diagnostic services defined in ISO 14229-1 that are applicable to WWH-OBd GTR;
- d) ISO 14229-2 specifies the standardized service primitive interface to separate application and session layers from protocol transport and network layers;
- e) ISO 27145-4 specifies the initialization procedure and includes references to:
 - 1) ISO 15765-4 DoCAN;
 - 2) ISO 13400 (all parts) DoIP.



Key

- 1 The standardized service primitive interface is specified in ISO 14229-2.

Figure 2 — Reference documents for implementation of WWH-OBD on CAN and WWH-OBD on IP according to the OSI model

6 Requirements overview and principles

6.1 Basic principles for the graphical notation

The flow graphs show the behaviour of the external test equipment. Hierarchical references e.g. are shown using round edged transparent rectangles. [Figure 3](#) shows the notation semantics.

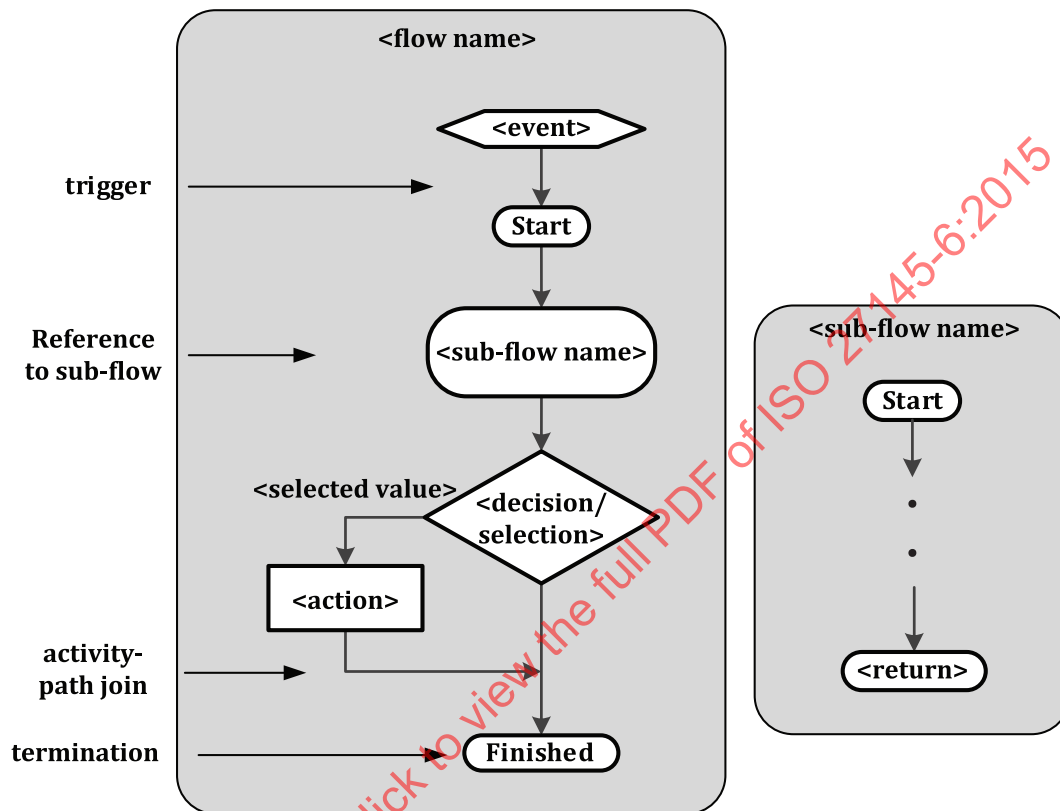


Figure 3 — Flow graph notation semantics used in this document

6.2 Requirements clustering

6.2.1 Overview

Each requirement in this part of ISO 27145 is assigned to one requirements cluster. The clusters cover technical areas where the assigned requirements apply for.

[Table 2](#) lists the technical requirements clusters. The table provides an overview of all requirements clusters and the associated technical requirements. This list is a summary of the requirements included in this part of ISO 27145.

Each technical requirement is identified by the mnemonic “ETEREQ-” and an alpha-numeric number. In addition, the alpha-numeric number includes the requirement cluster classifier according to [Table 2](#).

Recommendations intended to guide the implementation are identified by the mnemonic “ETEREC-”, which is shown in italic style for differentiation.

6.2.2 Main requirements clusters

[Table 2](#) provides an overview of the main clusters of external test equipment requirements. A requirement cluster has at least one requirement and optional recommendations.

Table 2 — Main requirements clusters

#	Main title of cluster	Classifier	Brief description	Related requirements
1	Mechanical requirements	M	Requirements to mechanically connect the external test equipment	ETEREQ-M01, ETEREQ-M02, ETEREQ-M03, ETEREQ-M04, ETEREQ-M05, ETEREQ-M06
2	Electrical requirements	E	Electrical hardware related requirements and recommendations	ETEREQ-E01, ETEREC-E02, ETEREQ-E03, ETEREQ-E04, ETEREQ-E05
3	Communication setup and session	S	Automatic hands-off determination of the communication interface — Hands-free DoCAN protocol initialization — Hands-free DoIP protocol initialization and setup initialization.	ETEREQ-S01, ETEREQ-S02, ETEREC-S03, ETEREQ-S04, ETEREQ-S05, ETEREQ-S06, ETEREQ-S07, ETEREQ-S08, ETEREQ-S09, ETEREQ-S10, ETEREQ-S11
4	Diagnostic messages	D	Requirements and recommendations related to the diagnostic messages, like addressing information, sequences, dependencies	ETEREQ-D01, ETEREQ-D02, ETEREC-D03, ETEREQ-D04, ETEREQ-D05, ETEREQ-D06, ETEREQ-D07, ETEREQ-D08

Table 2 (continued)

#	Main title of cluster	Classifier	Brief description	Related requirements
				ETEREQ-D09, ETEREQ-D10, ETEREQ-D11, ETEREQ-D12, ETEREQ-D13, ETEREQ-D14, ETEREQ-D15, ETEREQ-D16, ETEREQ-D17, ETEREQ-D18, ETEREQ-D19, ETEREQ-D20, ETEREQ-D21, ETEREQ-D22, ETEREQ-D23, ETEREQ-D24, ETEREQ-D25, ETEREQ-D26, ETEREQ-D27, ETEREQ-D28, ETEREQ-D29, ETEREQ-D30, ETEREQ-D31
5	Error handling	F	Requirements to have a proper communication error handling	ETEREQ-F01, ETEREQ-F02, ETEREQ-F03, ETEREQ-F04
6	Use case specific requirements	U	Requirements only related to specific use cases.	ETEREQ-U01, ETEREQ-U02, ETEREQ-U03, ETEREQ-U04, ETEREQ-U05, ETEREQ-U06

7 External test equipment requirements

7.1 General

This clause specifies all requirements which are applicable to the external test equipment. The Introduction, [Clause 9](#), and [Clause 10](#) (respectively use cases 1, 2, and 3 as specified in ISO 27145-1) include references to the requirements stated in this clause. The term 'external test equipment' addresses

all equipment that will be used in compliance with the use cases stated in this part of ISO 27145, e.g. a repair shop external test equipment or an installed diagnostic data recorder. As the test equipment is to be used for legislated OBD, it can be mounted in the car and attached to the OBD diagnostic interface, but not integrated into the internal network.

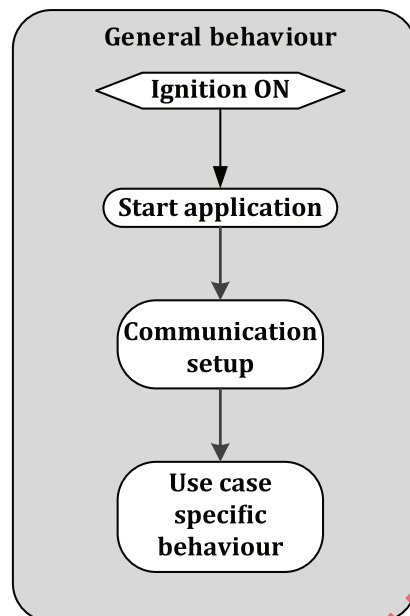


Figure 4 — General behaviour of external test equipment

7.2 Applicability of requirements according to local legislation

This part of ISO 27145 is based on the requirements established by the GTR #5, only. Local legislation can require additional data to be supported for each use case as specified in this part of ISO 27145. The additional data are defined in SAE J1979-DA.

7.3 User instructions and guidelines

ETEREQ-M01 If the chosen connector supports detection of ignition/run status, the external test equipment shall verify that ignition is active before starting any action.

ETEREQ-M02 If the chosen connector does not support the detection of ignition/run status, the external test equipment shall ask the user to confirm ignition/run status active before starting any action.

7.4 Cluster “Mechanical requirements”

ETEREQ-M03 To connect the external test equipment to the vehicle one of the following, ISO 15031-3 type connectors shall be used:

- type A (12 V DC) or
- type B (12 V DC or 24 V DC).

- ETEREQ-M04** The length of the cable (from external test equipment interface transceiver to diagnostic connector) shall not exceed the recommended length for this data link (e.g. 5 m for CAN). More restrictive requirements always supersede less restrictive requirements.
- Refer to ISO 13400-3 (DoIP) or ISO 15765-4 (DoCAN) for applicable cable length specification.
- ETEREQ-M05** If the external test equipment supports the DoCAN protocol, the cable mechanical (and electrical) configuration and characteristics shall be in accordance with ISO 15765-4.
- ETEREQ-M06** If the external test equipment supports the DoIP protocol, the cable mechanical (and electrical) configuration and characteristics shall be in accordance with ISO 13400-3.

7.5 Cluster “Electrical requirements”

- ETEREQ-E01** If the external test equipment is powered from the vehicle diagnostic connector, it shall comply with the electrical characteristics of either 12 V DC or 24 V DC vehicle battery systems. External test equipment shall comply with diagnostic connector specifications for DoCAN (ISO 15031-3), or DoIP (ISO 13400) and requirements detailed in [Table 3](#).

Table 3 — Additional interface requirements

Requirement definition	12 V DC	24 V DC	Unit
Survive a vehicle battery voltage for at least 10 min	24	36	V
Survive, non-operationally, a reverse vehicle battery voltage for at least 10 min	24	36	V

- ETEREC-E02** During engine crank event, the external test equipment should withstand cranking so that communications and data shall not be lost during vehicle battery voltage reductions as specified in ISO 16750-2 or ISO 7637-2.
- ETEREQ-E03** In regards to EMC, the external test equipment shall not interfere with the normal operation of the vehicle electrical system.
- ETEREQ-E04** In regards to EMC, the normal operation of the external test equipment shall be immune from conducted and radiated emissions present in a service environment and when connected to a vehicle.
- ETEREQ-E05** The external test equipment shall meet the electrical requirements specified in ISO 15031-3.

7.6 Cluster “Communication setup” and connections

7.6.1 Connections

A connection ends when the external test equipment does not communicate with any ECU for the time specified below.

- ETEREQ-S01** The connection ends when the external test equipment does not send any request to the vehicle for more than 5 min.

ETEREQ-S02

If communication is to be performed after the connection has ended, the external test equipment has to restart with the communication setup process.

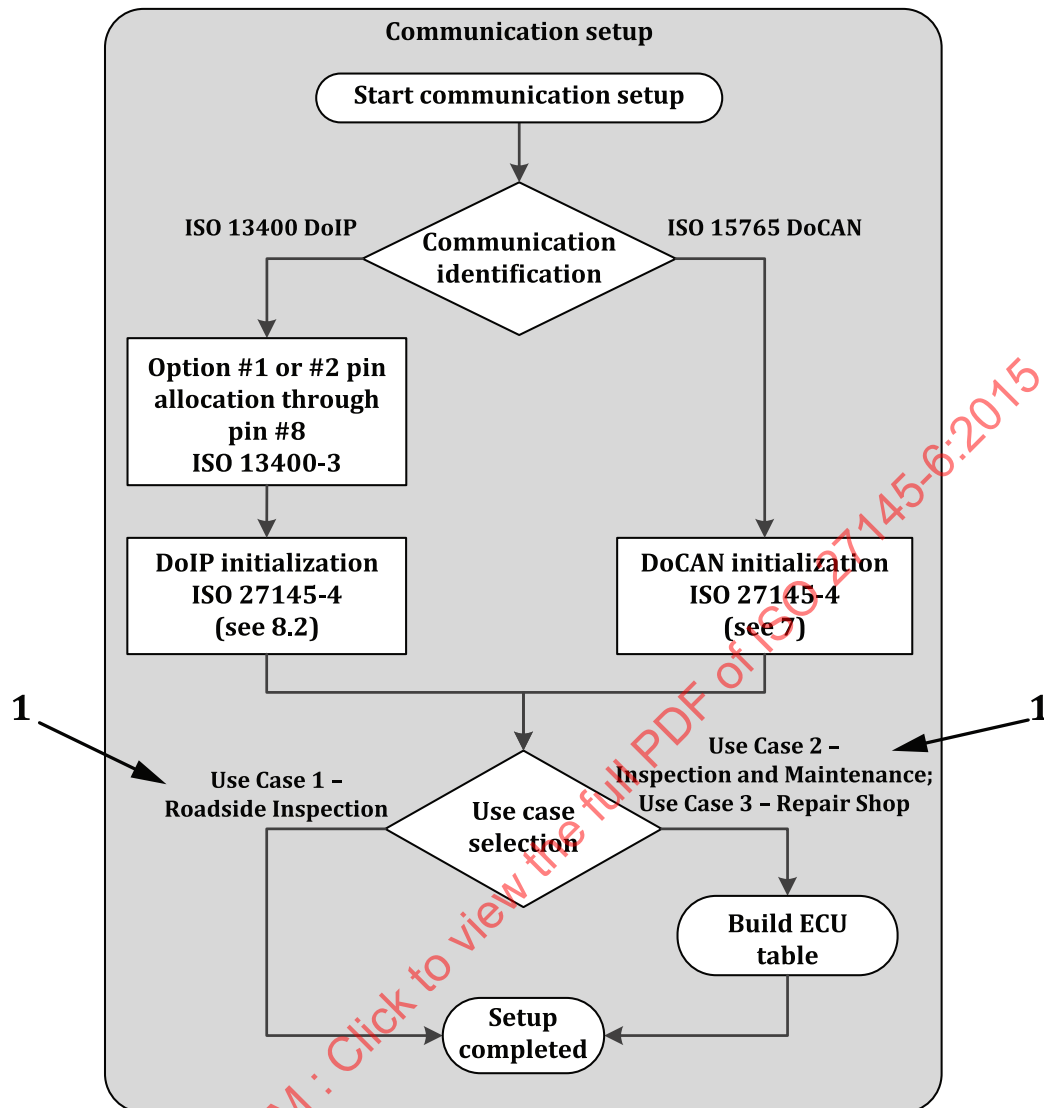
ETEREC-S03

If the external test equipment can be sure to be connected to the same vehicle, it can bypass the following steps asking for static information:

- Connector determination (DoIP or DoCAN)
 - DoCAN: Baudrate detection
 - DoCAN: 11 bit or 29 bit CANID support
- Build ECU table (but it has to send the functional F8₁₆, 10₁₆ request to indicate a connection start; valid for 11-bit and 29-bit CANIDs).
- Read GTR (SAE J1979-DA specifies an InfoType to retrieve the WWH-OBID GTR number).
- Read VIN (SAE J1979-DA specifies an InfoType to retrieve the VIN number)
- Read the Software Calibration Identification number (CALID) (SAE J1979-DA specifies an InfoType to retrieve the CALID number)
- Read the calibration verification number (CVN) (SAE J1979-DA specifies an InfoType to retrieve the CVN number)

7.6.2 Communication setup

[Figure 5](#) shows the communication setup.

**Key**

1 See ISO 27145-1

NOTE No simultaneous protocol determination.

Figure 5 — Communication setup

The communication setup defines the different steps needed to initialize communication to the vehicle. At first, the external test equipment has to determine the interface to be used, either by selection by the user or by probing the available interfaces using the respective initialization procedure (either DoCAN or DoIP). As a result, it constructs the ECU table, including the ECU names, which the external test equipment needs to perform the use case specific communications. Use cases 2 and 3 need ECU addressing information for the subsequent physical communication with the ECUs. Use case 1, which uses only functional requests, can bypass this step.

The communication setup has to be executed just once per connection; it queries only static information that does not change. This sequence is not to be part of any cyclic measurements.

ETEREQ-S04 The external test equipment shall employ an “Automatic Protocol Determination” feature to determine the communication protocol used in a given vehicle. No user intervention shall be required during this phase.

- ETEREQ-S05** The external test equipment shall allow the user to select the protocol for WWH OBD, either before automatic interface determination or after the determination, when the detection process received an ambiguous result.
- ETEREQ-S06** The connected external test equipment shall not cause failures on the in-vehicle network, e.g. CAN bus off.
- ETEREQ-S07** The external test equipment shall perform an automatic DoCAN protocol initialization according to ISO 27145-4.
- ETEREQ-S08** The external test equipment shall perform an automatic DoIP protocol initialization according to ISO 27145-4.
- ETEREQ-S09** The external test equipment shall inform the user that initialization is occurring.
- ETEREQ-S10** The external test equipment shall inform the user about the selected protocol in use.

7.7 Cluster “Diagnostic messages”

7.7.1 Overview

All ECU communication is done by diagnostic messages. To retrieve the information from the ECUs, the following diagnostic messages are used. Subclause 7.7 is divided into the different communication phases.

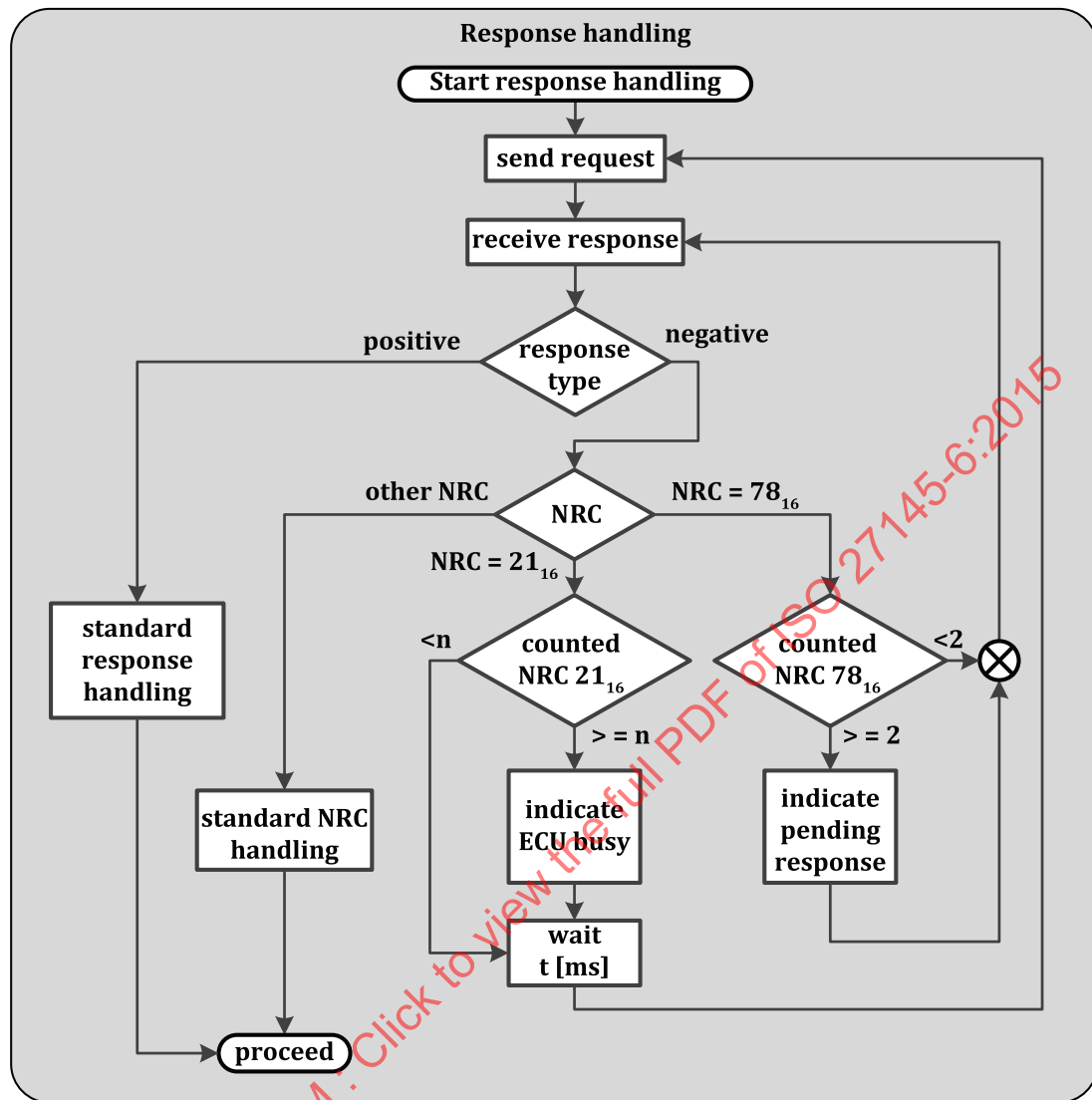
7.7.2 Timing

- ETEREQ-D01** The client shall utilize the P_{Client} reload mechanism as described in ISO 14229-2 for DoCAN and ISO 27145-3 for DoIP.

7.7.3 Negative response handling

Besides the standard response codes that indicate non conformant communication, like missing parameters, unsupported functions, etc., there are two responses that have to be handled in a special way. For details, refer to ISO 14229-1.

[Figure 6](#) shows the response handling.

**Key**

n 5 loops
t 200 ms

Figure 6 — Response handling

- ETEREQ-D02** When the external test equipment receives a NRC 21₁₆ (busyRepeatRequest), it shall retry to request the information. Between each retry, it shall wait for a minimum of 200 ms.
- ETEREC-D03** When the external test equipment receives a NRC 21₁₆ (busyRepeatRequest), the test equipment should use a 1 s interval between retries.
- ETEREQ-D04** After receiving five consecutive NRC 21₁₆ (busyRepeatRequest) or 1 s after the first NRC 21₁₆ received, the external test equipment shall indicate to the user that the ECU is busy [e.g. “wait(busy)”].
- ETEREQ-D05** When the external test equipment receives a NRC 78₁₆ (requestCorrectlyReceived-ResponsePending), it shall wait for the specified time (ISO 27145-3, Table 13) to receive a further response.

ETEREQ-D06 After receiving two consecutive NRC 78₁₆ (requestCorrectlyReceived-ResponsePending), the external test equipment shall indicate to the user that the response from the respective ECU is pending [e.g. “wait(response pending)”].

7.7.4 Error handling of no response from the vehicle

An ECU can fail to respond to a request message from the external test equipment because of incorrect transmission or because the module does not support that message. There might be several other reasons for an ECU to not respond to a request.

Figure 7 shows how to handle that situation.

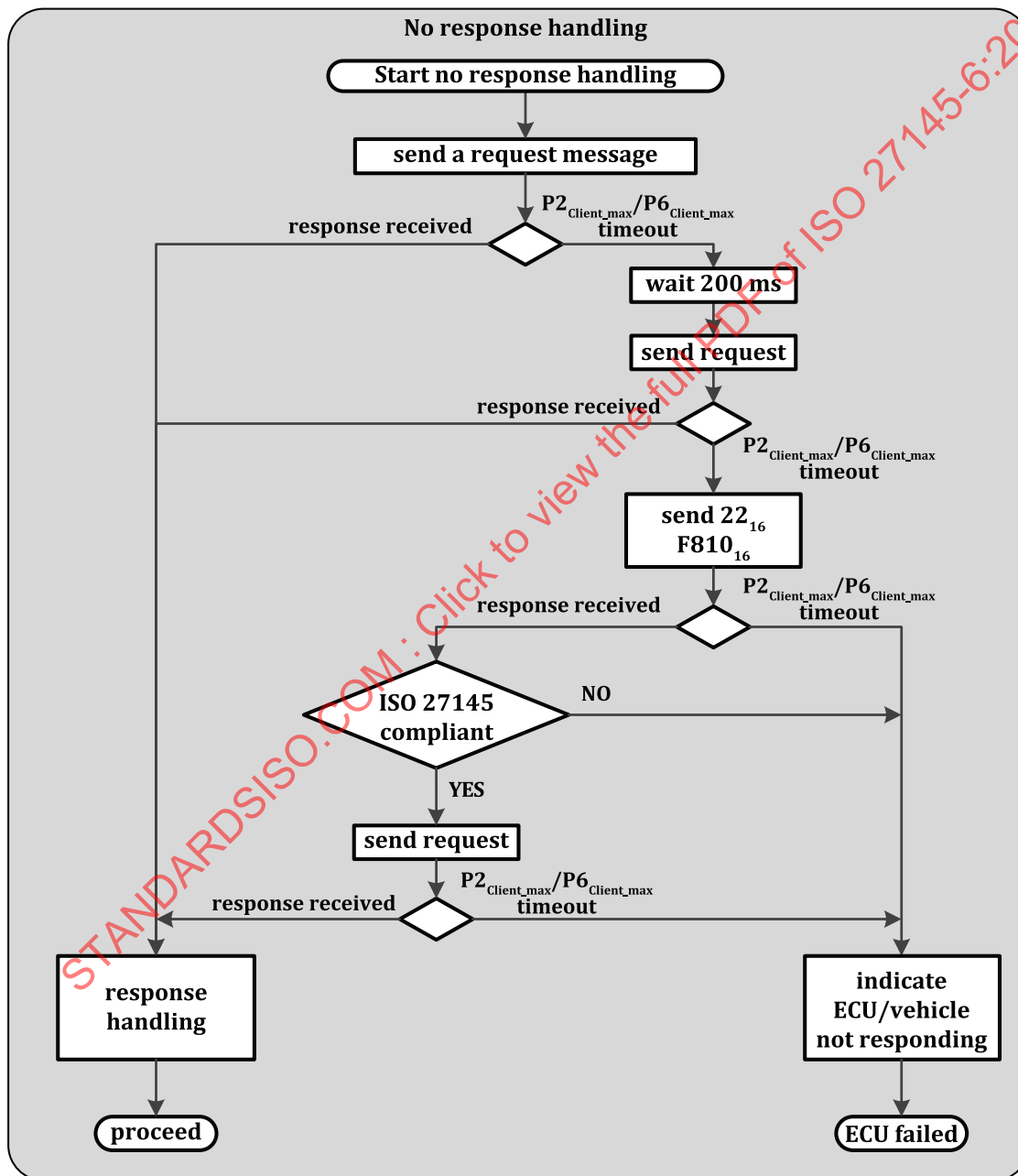


Figure 7 — No response handling

- ETEREQ-F01** If a response is not received within the $P2_{Client_max}/P6_{Client_max}$ timeout period prescribed by the protocol, the test equipment shall
- retransmit the request message one more time after 200 ms;
 - if there is still no response, transmit a service 22_{16} UDID $F810_{16}$ request message in order to determine if communication with the vehicle is still possible;
 - if a service 22_{16} UDID $F810_{16} = 1$ response is received, retransmit the original request one more time;
 - if the previous step fails again then indicate to the user, as appropriate, that communication with the vehicle cannot be performed, that communication with the module cannot be performed or that the information the user has selected is not available.
- ETEREQ-F02** If the server indicates that the information is supported (i.e. by setting the corresponding bit in the DID supported, i.e. $F400_{16} - F5C0_{16}$, $F800_{16} - F8C0_{16}$) but does not respond to a physical request or responds with a negative response code, then the data shall be presented as “Failed”.
- ETEREQ-F03** The external test equipment shall inform the user about any communication errors that prevent the external test equipment from reading out information.
- ETEREQ-F04** Communication errors, which the error handling process was not able to rectify, shall be reported to the user.

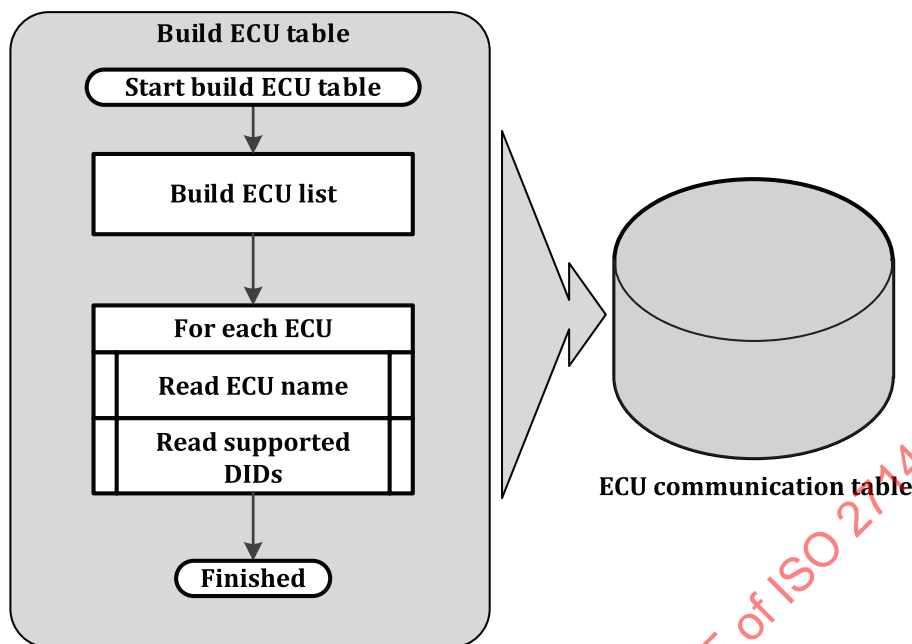
7.7.5 Setup of ECU list

- ETEREQ-D07** For use case 2 or 3, the external test equipment shall use the responses of functional service 22_{16} , $F810_{16}$ to collect the ECU addresses and store them in a list. Only those responses shall be stored, that indicate ISO 27145 compliance.
- [Table 4](#) defines the external test equipment initialization message sequence. For details refer to ISO 14229-1.

Table 4 — External test equipment initialization message sequence

Msg#	Description	Addressing type	Application message name	PDU message content
1	Read protocol identification	functional	ReadDataByIdentifier(ITID($F810$))	22_{16} $F816$ 10_{16}
2	PositiveResponse to $F810_{16}$	physical	Read Protocol identification – positive response ITID (High Byte = $F816$) ITID (Low Byte = 10_{16}) only accept 01_{16} (see ISO 27145-4)	62_{16} $F816$ 10_{16} 01_{16}
OR				
2	NegativeResponse to $F810_{16}$	physical	NRC Request Service ID: ReadDataByIdentifier Negative Response Code	$7F_{16}$ 22_{16} < NRC_{16} >

7.7.6 Setting up ECU communication list



ETEREQ-D08 The client shall build a list of all ECUs responding to the functional Service 22₁₆ F810₁₆ request and use this information for physical requests. This step is not necessary for use case 1, “roadside inspection”, and can be bypassed there.

Figure 8 — Build ECU communication and data information lists

ETEREQ-D09 The external test equipment shall store the address of each ECU responding to service 22₁₆ F810₁₆ with a result of 01₁₆ (=WWH-OBD).

ETEREQ-D10 For each ECU, the external test equipment shall query the ECU’s name using service 22₁₆ F80A₁₆. Finally, the table has, as a minimum, the following data entries:

- ECU address
- ECU name

This information is static, so it is not necessary to have this as part of a cyclic reading.

ETEREQ-D11 The ECU table shall be built only once after communication setup.

7.7.7 Setting up data information list

ETEREQ-D12 The client shall send physically addressed Service 22₁₆ ReadDataByIdentifier requests to gather all supported DIDs (PIDs, MIDs and ITIDs). It shall query those ECUs that have responded to the service 22₁₆ F810₁₆ request during initialization [SAE J1979, Appendix A]. This step is not necessary for use case 1, “roadside inspection”, and can be bypassed there.

- PIDs: F400₁₆; F420₁₆; F440₁₆; ... F5E0₁₆
- MIDs: F600₁₆; F620₁₆; ... F7E0₁₆
- ITIDs: F800₁₆; F820₁₆; ... F8E0₁₆

ETEREQ-D13 Based on the results, the external test equipment shall store the information about the supported DIDs for each ECU.

- ETEREQ-D14** The external test equipment shall only query those DIDs that have been marked to be supported by the respective ECU.
- ETEREQ-D15** When the external test equipment requests DID data, it shall not mix different DID ranges in one request, i.e. it shall send separate requests for PIDs, for MIDs, and for ITIDs.
- ETEREQ-D16** When the external test equipment requests ITID data, it shall request one ITID value per request.
- ETEREQ-D17** The external test equipment shall send a maximum of six DIDs (PIDs or MIDs, not mixed) in one physical request (refer to ISO 27145-3).

7.7.8 Reading DTCs

DTCs can be read at any time after the communication setup, either once after setup, continuously, or on user request.

- ETEREQ-D18** The client shall send physically addressed requests to all ECUs to read the applicable DTCs per class of DTC.
- ETEREQ-D19** The client shall retrieve the class A, B1, B2, and C DTCs which are pending, confirmed, and active or previously active.
- ETEREQ-D20** The client can request DTCs from all classes and at all stages, but needs to sort the DTCs into the different classes and states.

7.7.9 Setting up DTC information list

Figures 9 and 10 show the read DTC information and the updating of snapshot and extended data support. See definition in ISO 14229-1.

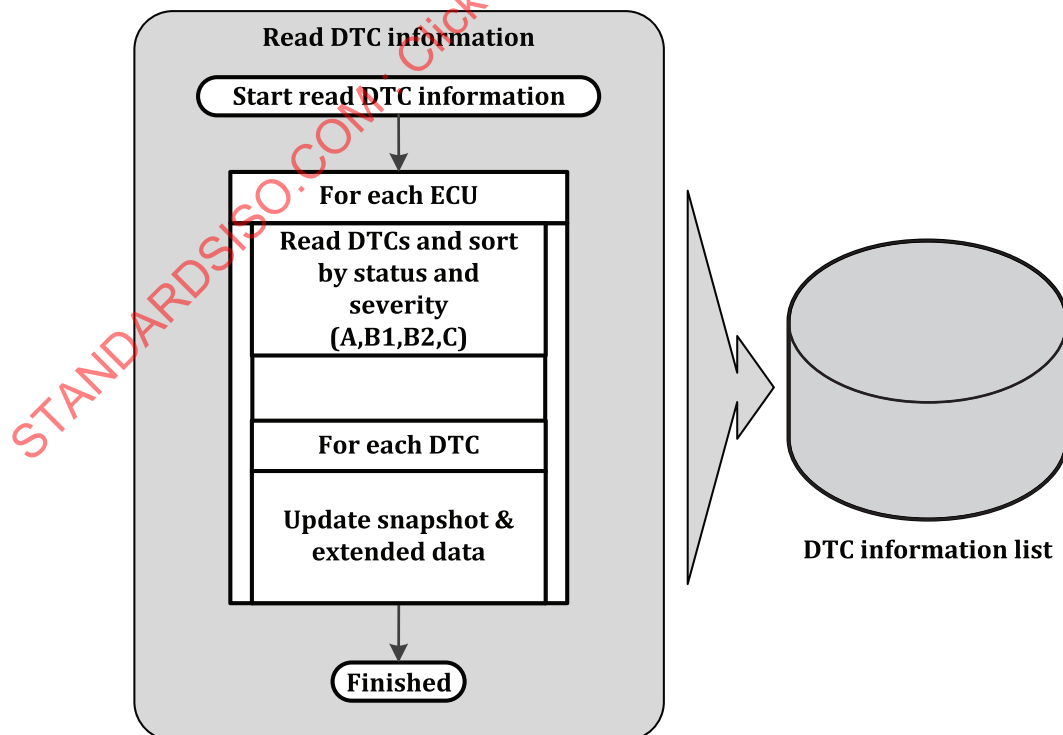


Figure 9 — Read DTC information

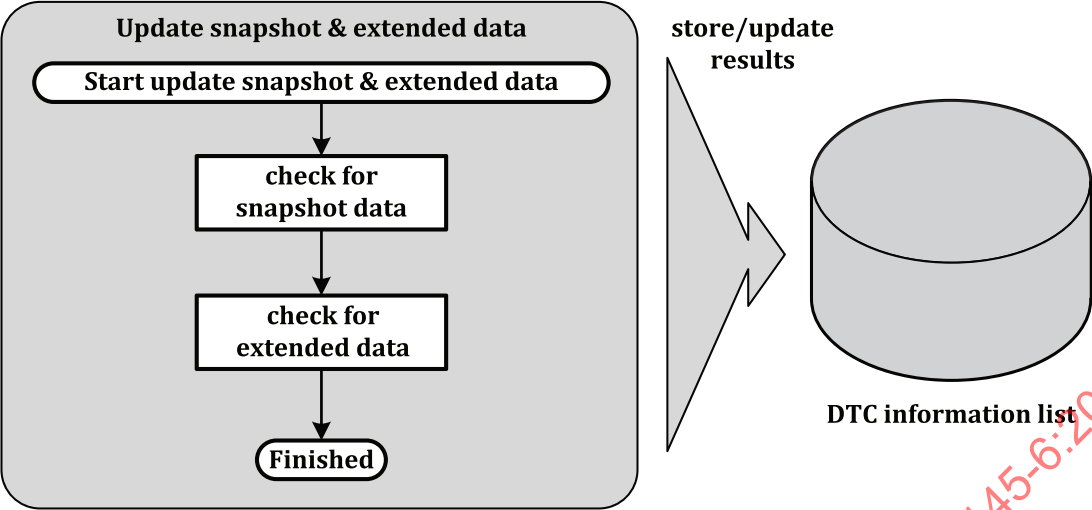


Figure 10 — Updating snapshot and extended data support

ETEREQ-D21 The external test equipment shall construct lists of all emissions-related DTCs for retrieving snapshot data and extended data. It shall use the following request for all relevant ECUs (for details refer to ISO 14229-1), with the DTCSeverityMask set according to the use case:

Table 5 — Use case related DTCSeverityMask

Use Case #	Relevant severity classes	DTCSeverityMask value
1	not applicable	not applicable
2	A, B1, B2	0E ₁₆
3	A, B1, B2, C	1E ₁₆

Table 6 — External test equipment DTC reading message sequence

Msg#	Description	Addressing type	Application message name	PDU message content
1	Read DTC information	physical	ReadDTCInformation sub-function = reportWWHOBDDTCByMaskRecord FunctionalGroupID = OBD DTCStatusMask DTCSeverityMask (see Table 5)	19 ₁₆ 42 ₁₆ 33 ₁₆ 0C ₁₆ 0E ₁₆ or 1E ₁₆ XX ₁₆

Table 6 (continued)

Msg#	Description	Addressing type	Application message name	PDU message content
2	Positive response	physical	ReadDTCInformation – positive response sub-function FunctionalGroupID DTCStatusAvailabilityMask DTCSeverityAvailabilityMask DTCFormatIdentifier DTCAndSeverityRecord[] = [DTCSeverity #1 DTCHighByte #1 (MSB) DTCMiddleByte #1 DTCLowByte #1 statusOfDTC #1 : DTCSeverity #m DTCHighByte #m (MSB) DTCMiddleByte #m DTCLowByte #m statusOfDTC #m]	59 ₁₆ 42 ₁₆ 33 ₁₆ 00 ₁₆ – FF ₁₆ 00 ₁₆ – FF ₁₆ 02 ₁₆ /04 ₁₆ DTCS DTCHB DTCMB DTCLB SODTC : DTCS DTCHB DTCMB DTCLB SODTC
OR				
2	Negative response	physical	Negative Response Service Identifier Request Service ID: ReadDTCInformation NRC	7F ₁₆ 19 ₁₆ <NRC ₁₆ >

ETEREQ-D22 The external test equipment shall sort the DTC information according to the severity information (Class A, B1, B2, C), i.e. it shall maintain one list of DTCs per class.

ETEREQ-D23 The external test equipment shall evaluate the GTR-Status of each DTC as follows:

Table 7 — External test equipment GTR status evaluation (refer to ISO 27145-3)

GTR-status	statusOfDTC.bit3 (confirmedDTC)	statusOfDTC.bit2 (pendingDTC)
Pending ^a	0	1
Previously Active	1	0
Confirmed and Active	1	1
^a “Potential” is the term used in the regulation for “Pending”.		

ETEREQ-D24 When reading Pending DTCs and the statusOfDTC.bit3 (confirmedDTC) = 0, the DTC status shall be displayed as Pending (Potential).

- ETEREQ-D25** When reading Confirmed DTCs and the statusOfDTC.bit2 (pendingDTC) = 0, the DTC status shall be displayed as Previously Active.
- ETEREQ-D26** When reading Pending DTCs and the statusOfDTC.bit3 (confirmedDTC) = 1, the DTC status shall be displayed as Confirmed and Active.
- ETEREQ-D27** The external test equipment shall store the DTC format identifier for each DTC in order to be able to interpret DTC data. The DTC information list shall, as a minimum, cover the following entries per ECU per DTC:
- DTCFormat
 - DTCStatus (GTR-status)
 - DTCSeverity (Class A, B1, B2, or C)
 - SnapshotData
 - ExtendedData
- DTCFormat is one of the supported formats specified in ISO 27145-3, Table 4.
- If the ECU responds positively to a request for SnapshotData but the response does not include any SnapshotData related to a specific DTC, then that specific DTC does not have any snapshot data. The same holds true for ExtendedData.
- ETEREQ-D28** The external test equipment shall continue to request the snapshot data for all DTCs and mark those DTCs which have snapshot data stored. For details refer to ISO 14229-1. [Table 8](#) shows the message sequence.

Table 8 — External test equipment snapshot data reading message sequence

Msg#	Description	Addressing type	Application message name	PDU message content
1	Read DTC snapshot data information	physical	ReadDTCInformation	19 ₁₆
			sub-function. = reportDTCSnapshotRecordByDTCNumber	04 ₁₆
			DTCMaskRecord[] = [	
			DTCHighByte	12 ₁₆
			DTCMiddleByte	34 ₁₆
			DTCLowByte]	56 ₁₆
			DTCSnapshotRecordNumber	00 ₁₆

Table 8 (continued)

Msg#	Description	Addressing type	Application message name	PDU message content
2	Positive response	physical	ReadDTCInformation – positive response reportType = reportDTCSnapshotRecordByDTCNumber DTCAndStatusRecord[] = [DTCHighByte DTCMiddleByte DTCLowByte statusOfDTC] DTCSnapshotRecordNumber DTCSnapshotRecordNumberOfIdentifiers dataIdentifier [byte#1] (MSB) dataIdentifier [byte#2] (LSB) DTCSnapshotRecord [data#1] = ECT DTCSnapshotRecord [data#2] = TP DTCSnapshotRecord [data#3] = RPM DTCSnapshotRecord [data#4] = RPM DTCSnapshotRecord [data#5] = MAP	59 ₁₆ 04 ₁₆ 12 ₁₆ 34 ₁₆ 56 ₁₆ 24 ₁₆ 00 ₁₆ 01 ₁₆ 47 ₁₆ 11 ₁₆ A6 ₁₆ 66 ₁₆ 07 ₁₆ 50 ₁₆ 20 ₁₆
OR				
2	Negative response	physical	Negative Response Service Identifier Request Service ID: ReadDTCInformation NRC	7F ₁₆ 19 ₁₆ <NRC ₁₆ >

NOTE [Table 8](#) includes example data.

ETEREQ-D29 The external test equipment shall continue to request the extended data for all DTCs and mark those DTCs which have extended data stored. For details refer to ISO 14229-1, Table 9 shows the message sequence.

Table 9 — External test equipment extended data reading message sequence

Msg#	Description	Addressing type	Application message name	PDU message content
1	Read DTC extended data information	physical	ReadDTCInformation sub-function = reportDTCExtDataRecordByDTCNumber DTCMaskRecord[] = [DTCHighByte DTCMiddleByte DTCLowByte] DTCExtendedDataRecordNumber (either FE ₁₆ , or selectively 90 ₁₆ and 91 ₁₆)	19 ₁₆ 06 ₁₆ 12 ₁₆ 34 ₁₆ 56 ₁₆ 90 ₁₆

Table 9 (continued)

Msg#	Description	Addressing type	Application message name	PDU message content
2	Positive response	physical	ReadDTCInformation – positive response reportType = reportDTCExtDataRecordByDTCNumber DTCAndStatusRecord[] = [DTCHighByte DTCMiddleByte DTCLowByte statusOfDTC] DTCExtendedDataRecordNumber = FailureSpecificB-1Counter DTCExtDataRecord [byte#1] [29 h 6 min] DTCExtDataRecord [byte#2]	59 ₁₆ 06 ₁₆ 12 ₁₆ 34 ₁₆ 56 ₁₆ 24 ₁₆ 90 ₁₆ 01 ₁₆ 23 ₁₆
OR				
2	Negative response	physical	Negative Response Service Identifier Request Service ID: ReadDTCInformation NRC	7F ₁₆ 19 ₁₆ <NRC ₁₆ >

NOTE Table 9 includes example data.

7.7.10 Clear diagnostic information

To clear diagnostic information, the message sequence in [Table 10](#) has to be used.

Table 10 — External test equipment clear diagnostic information message sequence

Msg#	Description	Addressing type	Application message name	PDU message content
1	Clear DTC information	functional	ClearDiagnosticInformation([DTCGroup]) groupOfDTC[] = [groupOfDTCHighByte groupOfDTCMiddleByte groupOfDTCLowByte] Delete all emissions-related DTC information	14 ₁₆ FF ₁₆ FF ₁₆ 33 ₁₆
2	Positive response	physical	ClearDiagnosticInformation – positive response	54 ₁₆
OR				
2	Negative response	physical	Negative Response Service Identifier Request Service ID: ClearDiagnosticInformation NRC	7F ₁₆ 14 ₁₆ <NRC ₁₆ >

7.7.11 Continuously reading ECU data

To be able to detect changes in the data read from the vehicle, it is necessary to read some data cyclically, the external test equipment has to resend some requests multiple times. Repeatedly requested values can be DTCs or measurement values that are to be monitored by the external test equipment. [Figure 11](#) shows the cyclic data reading.

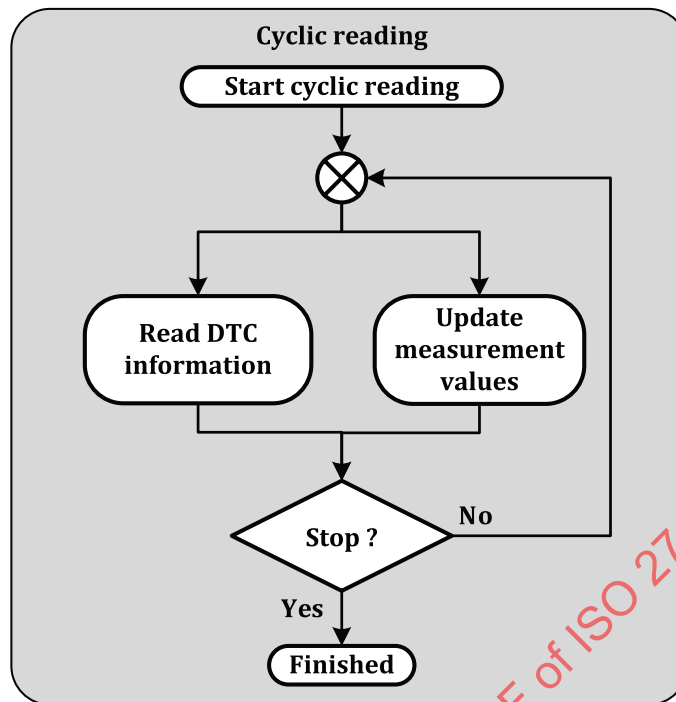


Figure 11 — Cyclic data reading

- ETEREQ-D30** To minimize the busload, the external test equipment shall only re-read values which can change e.g. Engine Speed, Throttle Position, ...
- ETEREQ-D31** The external test equipment shall only use physical addressing for repeatedly requested data.

8 Roadside inspection test equipment

8.1 Definition

The use case #1 Roadside Inspection (see ISO 27145-1) is intended for checking vehicles at the roadside. In the future, this might also be done in a drive-by (i.e. wireless communication to a road portal) scenario. The intention is to check if the vehicle has any malfunctions which cause illumination of the MI. For details refer to ISO 27145-1.

For the road side inspection test only limited functionality is necessary to check whether or not the vehicle is roadworthy. The general process is shown in [Figure 12](#).

8.2 Related use cases

The use case is meant to give a quick indication of road worthiness of the vehicle under test. No further investigation has to be supported. If the vehicle is not roadworthy, further investigation will be covered by one of the other use cases.

The roadside inspection test equipment could be connected directly to the vehicle by one of the supported interfaces and could perform the check immediately after connecting. Future systems might use a wireless connection and can be without the need to stop the vehicle, i.e. it could be in some station near the road or within another vehicle.

8.3 Implementation requirements

8.3.1 Overview

ETEREQ-U01 The external test equipment shall only use functional requests for the roadside inspection.

ETEREQ-U02 The external test equipment shall read out the data once per connection cycle.

8.3.2 Application layer

[Figure 12](#) shows use case 1.

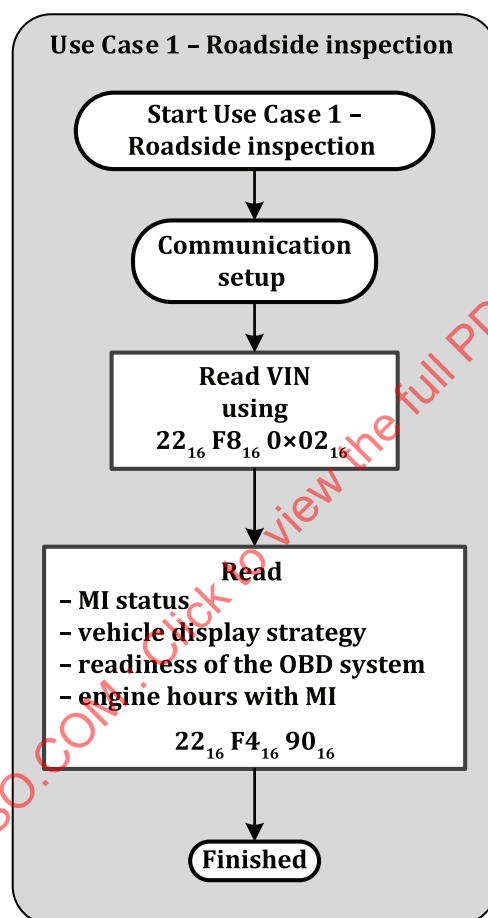


Figure 12 — Use case 1 - Roadside inspection

As specified in ISO 27145-3, within this use case, only functional requests are used. As the information is not a target for change, no cyclic reading is necessary.

ETEREQ-U03 The external test equipment shall read out the data using the sequence shown in [Table 11](#) and in [Figure 12](#), respectively.

Table 11 — Roadside inspection test equipment application message sequence definition

Msg#	Description	Addressing type	Application message name	PDU message content
1	Read VIN	functional	ReadDataByIdentifier(F802 ₁₆)	22 ₁₆ F8 ₁₆ 02 ₁₆

Table 11 (continued)

Msg#	Description	Addressing type	Application message name	PDU message content
2	Read vehicle display strategy Read status of MI Read readiness of the OBD system Read the number of engine hours during which a continuous-MI was activated.	functional	ReadDataByIdentifier(F490 ₁₆) NOTE The F490 ₁₆ DID contains all data items as listed in the column "Description".	22 ₁₆ F4 ₁₆ 90 ₁₆

9 Inspection and maintenance (I/M) test equipment

9.1 Definition

The use case #2 (see ISO 27145-1), Road Worthiness, is meant to be used to check vehicle readiness and characterize the malfunctions detected by the OBD system. For details, refer to ISO 27145-1.

9.2 Related use cases

For inspection and maintenance, more specific information is necessary than for use case 1. The test equipment has to be able to perform the use case 1 tests, and also read out data per ECU in order to be able to precisely classify and document the vehicle's readiness.

9.3 Implementation requirements

9.3.1 General

National legislation can require that specific DIDs are continuously reported by the external test equipment for I/M use. For those applications, the requirement of use case 3 can apply. It is up to the test equipment manufacturer to ensure that all legislated requirements are fulfilled.

9.3.2 Application layer

In addition to the use case 1, it is necessary that the external test equipment reads out detailed information from specific ECUs. Also, it might be necessary to continuously read out data in order to detect changes in the results. [Figures 13](#) and [14](#) show the inspection and maintenance use case 2 and its measurement update sequence.