BRITISH STANDARD

BS ISO 26021-3:2009

Road vehicles — End-of-life activation of on-board pyrotechnic devices

Part 3: Tool requirements

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British Standards

National foreword

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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.

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ISO 26021-3 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

ISO 26021 consists of the following parts, under the general title *Road vehicles — End-of-life activation of on-board pyrotechnic devices*:

— *Part 1: General information and use case definitions*

— *Part 2: Communication requirements*

— *Part 3: Tool requirements*

— *Part 4: Additional communication line with bidirectional communication*

— *Part 5: Additional communication line with pulse width modulated signal*

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Introduction

Worldwide, nearly all new vehicles are equipped with one or more safety systems. This can include advanced protection systems based on pyrotechnic actuators. All components which contain pyrotechnic substances can be handled in the same way.

Recycling these vehicles demands a new process to ensure that the deactivation of airbags is safe and cost-efficient. Due to the harmonization of the on-board diagnostic (OBD) interface, there is a possibility of using it for on-board deployment, which is based on the same tools and processes.

Representatives of the global automobile industry agreed that automobile manufacturers

— do not support reuse as an appropriate treatment method for pyrotechnic devices,

— believe treatment of pyrotechnic devices is required before shredding, and

— support in-vehicle deployment as the preferred method.

Based on this agreement, the four big associations of automobile manufacturers (ACEA, Alliance, JAMA and KAMA) started to develop a method for the "in-vehicle deployment of pyrotechnic components in cars with the pyrotechnic device deployment tool (PDT)". The objective is that in the future a dismantler will use only one tool without any accessories to deploy all pyrotechnic devices inside an end-of-life vehicle (ELV) by using an existing interface to the car.

It is necessary to test and to validate the development of the disposal functionality inside the pyrotechnical control unit (PCU).

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Road vehicles — End-of-life activation of on-board pyrotechnic devices —

Part 3:
Tool requirements

1 Scope

This part of ISO 26021 specifies the technical requirements to realize tool requirements for end-of-life activation of on-board pyrotechnic devices. It defines a test tool for ISO 26021 disposal functionality as well as the requirement for the final pyrotechnical device deployment tool (PDT). The focus is the definition of the human interface and the interfaces to the vehicle. It also defines general requirements for tests to validate the disposal functionality of the PCU. It specifies two tool use cases.

- Tool use case 1 – deployment test tool (DTT):
  - a development tool used to test and validate the PCU;
  - the target users of this tool are the engineers of the PCU suppliers and the OEMs;
  - the use case defines the human interface, the interfaces to the vehicle (CAN & ACL) and concrete test sequences.
- Tool use case 2 – pyrotechnic device deployment tool (PDT):
  - the final tool that is used to dispose of pyrotechnical devices in vehicles;
  - the target users of this tool are dismantlers;
  - the use case defines the human interface, the interfaces to the vehicle (CAN & ACL), the environmental conditions and the deployment sequences.

2 Normative references

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

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

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 15031-4, *Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics — Part 4: External test equipment*

ISO 26021-1, *Road vehicles — End-of-life activation of on-board pyrotechnic devices — Part 1: General information and use case definitions*

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ISO 26021-2:2008, *Road vehicles — End-of-life activation of on-board pyrotechnic devices — Part 2: Communication requirements*

ISO 26021-4:2008, *Road vehicles — End-of-life activation of on-board pyrotechnic devices — Part 4: Additional communication line with bidirectional communication*

ISO 26021-5:2008, *Road vehicles — End-of-life activation of on-board pyrotechnic devices — Part 5: Additional communication line with pulse width modulated signal*

3 Terms and definitions

For the purposes of this document, the definitions given in ISO 14229-1 and the following apply.

3.1
key
data value sent from the external test equipment to the on-board controller in response to the seed for gaining access to the locked services

3.2
pyrotechnic device deployment tool
tool to be plugged into the diagnostic connector in order to communicate via the in-vehicle network with all control units which are able to activate pyrotechnic devices, implementing the communication sequence as defined in ISO 26021-1, ISO 26021-2, ISO 26021-4 and ISO 26021-5, to trigger the PCUs to perform the required deployment sequence

3.3
pyrotechnic control unit
electronic control unit on the vehicle network, which controls the activation of pyrotechnic devices

3.4
safing unit
part of the PCU, for example an electromechanical switch or separate processor, that allows the deployment microprocessor (µP) to deploy the pyrotechnic devices via the driver stage

3.5
safing
mechanism of which the primary purpose is to prevent an unintended functioning of the PCU processor prior to detection of a crash situation

3.6
ScrappingProgramModule
program module responsible for firing the selected pyrotechnic device loops one by one

3.7
ScrappingProgramModuleLoader
program module loader responsible for converting the scrapping program module to an executable format

3.8
seed
data value sent from the on-board controller to the external test equipment, which is processed by the security algorithm, to produce the key

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4 Symbols and abbreviated terms

ACL	additional communication line
AB	airbag
CAN	controller area network
DTT	deployment test tool
DTT-LB	deployment test tool load box
ELV	end-of-life vehicle
GND	ground
ID	identification
IDIS	international dismantling information system[1)]
I/O	input/output
LSB	least significant bit
MSB	most significant bit
OBD	on-board diagnostic
OEM	original equipment manufacturer
PC	personal computer
PCU	pyrotechnic control unit
PDT	pyrotechnic device deployment tool
PWM	pulse width modulated
RAM	random access memory
SRS	supplementary restraint system
TTL	transistor–transistor logic
µP	microprocessor
U_{BATT}	battery voltage

5 Conventions

ISO 26021 is based on the conventions discussed in the OSI. Service Conventions (ISO/IEC 10731:1994) as they apply for diagnostic services.

1) To create IDIS, most of the OEMs worldwide provide all legally necessary information to the dismantlers (for further information, see Reference [5]).

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6 General requirements and assumptions

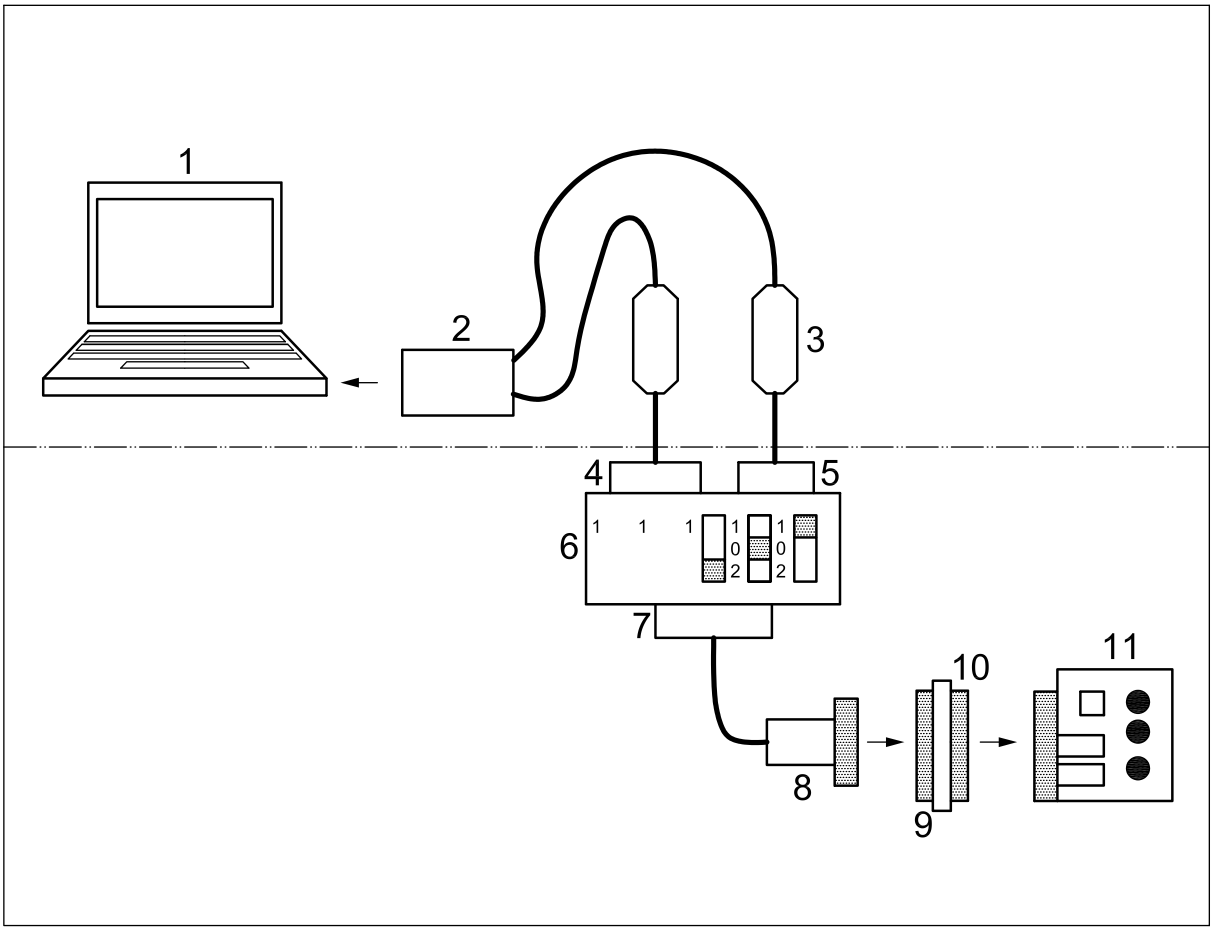
CAN communication:	see ISO 26021-2 for detailed information.
ACL line with PWM:	see ISO 26021-5 for detailed information.
ACL line with bidirectional communication:	see ISO 26021-4 for detailed information.

The PCU is not powered by the DTT. A standard diagnostic connector (male) in accordance with ISO 15031-3 is used to connect the DTT/PDT.

7 Description of tool use case 1 – deployment test tool (DTT)

7.1 General

Figure 1 shows an example of a possible setup.



Key

1 standard PC
2 CAN interface
3 I/O interface
4 input for CAN interface
5 input for IO interface
6 deployment test tool load box
7 diag out
8 ISO 15031-3 type B male connector
9 ISO 15031-3 female connector
10 OEM-specific interface
11 PCU with OEM-specific connector

NOTE The OEM-specific interface is used to connect the female ISO 15031-3 connector with the OEM-specific PCU connector.

Figure 1 — Deployment test tool system overview

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7.2 Hardware requirements for deployment test tool (DTT)

7.2.1 Simulation of CAN messages

To simulate all required CAN messages in accordance with ISO 26021-2 a CAN interface is required.

7.2.2 Simulation of ACL with PWM

The DTT shall be able to generate a PWM signal in accordance with ISO 26021-5 and to modify the timing in accordance with Table 1.

Table 1 — ACL timing requirements

	Range	Accuracy
Period	1 Hz to 20 Hz (0,2 Hz step size)	± 1,5 %
Duty Cycle	1 % to 99 % (1 % step size)	± 1,5 %

The voltage level of the ACL signal is adjusted in the external load box defined in Table 2.

Table 2 — ACL voltage requirements

	Range	Accuracy
Low	0 V to 4 V (0,1 V step size)	± 2 %
High	4 V to 18 V (0,1 V step size)	± 2 %

7.2.3 Simulation of ACL with bidirectional communication

The DTT shall be able to generate a bidirectional signal in accordance with ISO 26021-4

7.2.4 Simulation of errors with deployment test tool load box

The DTT-LB is used to simulate the hardware errors defined in Table 3.

An example of the load box is given in Figure 2.

Table 3 — Loadbox error conditions

CAN high	CAN low	ACL
Open	Open	Open
Short to Pin 4 (GND)	Short to Pin 4 (GND)	Short to Pin 4 (GND)
Short to Pin 16 (U_{Batt})	Short to Pin 16 (U_{Batt})	Short to Pin 16 (U_{Batt})
Short to Pin 14 (CAN-L)	Short to Pin 6 (CAN-H)	Short to Pin 6 (CAN-H)
Short to Pin 15 (ACL)	Short to Pin 15 (ACL)	Short to Pin 14 (CAN-L)

All pins listed in Table 3 shall be accessible in order to apply any resistance or voltage and shall be protected against shortages with a maximum current of 1 A.

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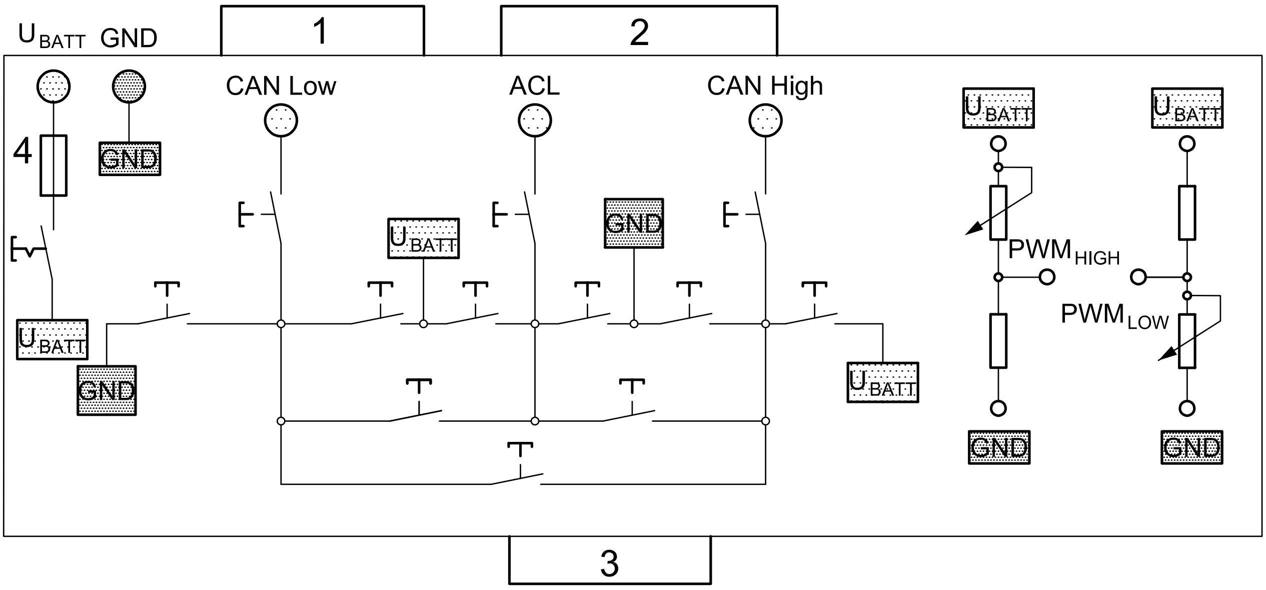

Key

1 CAN connector
2 I/O connector
3 diag out
4 fuse

Figure 2 — Load box example

7.2.5 Power supply

The load box shall be connected to an external power supply. The provided voltage range shall be compliant with ISO 15031-4. The required accuracy for the power supply is ± 5 %.

7.2.6 Diagnostic connector

A diagnostic connector as defined in ISO 15031-3 is used as connection to the PCU.

Only the following subset of the specified pins is used:

— Pin 4: chassis ground;

— Pin 5: signal ground;

— Pin 6: CAN-H;

— Pin 14: CAN-L;

— Pin15: ACL (earlier L-line);

— Pin 16: permanent positive voltage.

It is not necessary to separate the connector for the 12 V and 24 V system because the 24 V male connector can mate with both 12 V female *and* 24 V female connectors. The battery voltage value of the PCU provided to the PDT via Pin 16 can dictate the appropriate hardware parameter of the PDT.

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7.3 General requirements for tests performed with a deployment test tool (DTT)

7.3.1 General

This clause describes the minimum test requirements for ACL and CAN which shall be supported by the DTT.

7.3.2 Test requirements for CAN

Only tests for application layer (7) are in the scope of this part of ISO 26021.

Table 4 — Test requirements for CAN

Test conditions	Detailed description
Correct service sequence.	Send correct service sequence in accordance with ISO 26021-2.
Wrong service sequences.	Send correct services in wrong sequence. EXAMPLE Loop deployment request before safety system diagnostic session is entered.
Wrong request within “correct” sequence.	DTT shall be able to send a wrong request within a correct sequence, e.g. send a wrong local identifier.
PCU switched off during communication.	PCU can be switched off during communication with the DTT.
Test for negative responses.	Send any of the disposal-function-related service individually (not as part of the standard sequence) for example: — conditions not correct; — wrong data length.
Delayed sending of services.	DTT shall provide the possibility for configuration of time delays T [20 ms to 1 h] between sending of the different services in the sequence.
Timeout conditions for Disposal Session (e.g. tester present timeout, …).	DTT shall provide the possibility to suppress tester present message to check timeout conditions. Timeout = [1 s to 60 s]
Transmit service with wrong dismantler information and without dismantler information.	DTT shall be able to send out wrong or no dismantler information. [e.g. > 17 byte]
Transmit sequence without Security Access.	DTT shall be able to send “correct” sequence without Security Access.
Send wrong Security Access Key.	Tool should be able to send wrong Security Access, e.g. wrong key, wrong data length.
Send deployment commands for any squib.	DTT shall be able to send out deployment commands for non-configured squibs (even if not listed in the Deployment Loop Table read-out service 22 FA 06 hex).
Send sequences with missing squibs (e.g. multi-stage restraint systems).	Tool should be able to send out sequences with missing squibs (e.g. only second stage if a dual-stage airbag is mounted).
Short CAN High to Battery and Short CAN High to GND.	Short-circuit resistance < 100 Ω.
Short CAN Low to Battery and Short CAN Low to GND.	Short-circuit resistance < 100 Ω.
Short between CAN High and CAN Low.	Short-circuit resistance < 100 Ω.

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7.3.3 Test requirements for ACL with PWM

Table 5 — Test requirements for ACL with PWM

Test conditions	Detailed description
Open ACL line (PWM)	ACL line switched to open (> 1 MΩ).
ACL timing tolerance (PWM)	Modify ACL timing (period and duty cycle). See ISO 26021-5:2008, 7.4 (signal description).
ACL voltage tolerance (PWM)	Modify ACL voltage (low level and high level). See ISO 26021-5:2008, 7.4 (signal description).
ACL communication interrupts (PWM)	It shall be possible to simulate communication interrupts: Interruption after start ACL signal: After “X” times 50 ms Interruption duration: “X” times 50 ms “X” = [1 to 200] During interruption the output is constant high or low. The function shall be repeatable.
No ACL signal during disposal sequence	DTT shall be able to send sequence without ACL signal.
ACL short to CAN High (PWM)	It shall be possible to short ACL to CAN High at any point in time.

NOTE Short to Battery and short to GND tests are covered by adjusting ACL voltage.

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7.3.4 Test requirements for ACL with bidirectional communication

Table 6 — Test requirements for ACL with bidirectional communication

Test conditions	Detailed description
Open ACL line (bidirectional communication)	ACL line will be switched to open (> 1 MΩ).
ACL timing tolerance (bidirectional communication)	Measure P2 and P4 timing parameters of the PCU. Modify P3 timing parameter of the DTT. See ISO 26021-4:2008, 7.6.2 (P2, P3 and P4 timing requirements).
ACL voltage tolerance (bidirectional communication)	Check compliance to ISO 14230-1. See ISO 26021-4:2008, 6.2 (Physical layer).
ACL communication interrupts (bidirectional communication)	It shall be possible to simulate communication interrupts: Interruption after start ACL signal: After “X” times 50 ms Interruption duration: “X” times 50 ms “X” = [1 to 200] During interruption the output is constant high or low. The function shall be repeatable.
Send wrong sequence (bidirectional communication)	The DTT shall be able to send the commands specified in ACL steps 1 to 3 in wrong sequences.
ACL short to CAN High (bidirectional communication)	It shall be possible to short ACL to CAN High at any point in time.
ACL short to CAN Low (bidirectional communication)	It shall be possible to short ACL to CAN Low at any point in time.

NOTE Short to Battery and short to GND tests are covered by adjusting ACL voltage.

8 Description of tool use case 2 – pyrotechnic device deployment tool (PDT)

The PDT shall fulfil all requirements specified in ISO 26021-1, ISO 26021-2, ISO 26021-4 and ISO 26021-5. This International Standard does not specify the detailed design of the PDT. However, this clause specifies additional basic requirements for the human interface and the design of the PDT.

8.1 User interface example of a PDT

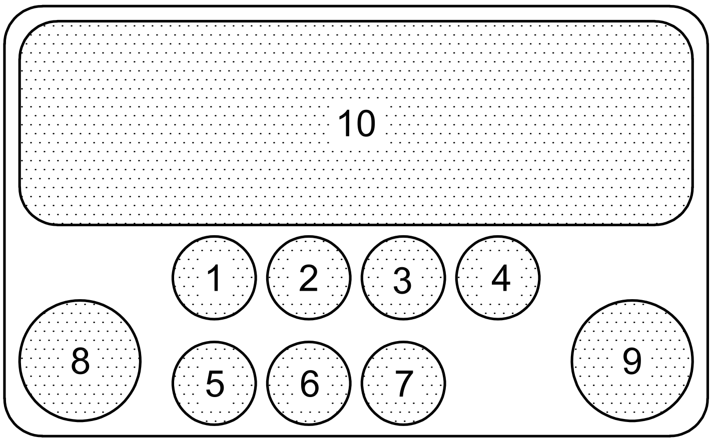

Figure 3 — Example of a PDT user interface

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Use of the PDT shall be intuitive. This example provides possibilities as to how a comfortable PDT user interface could be designed. The following control elements could be provided (see Figure 3):

1) on/off element to switch on or off the PDT;

2) manual/automatic element to activate manual or automatic deployment sequence;

3) confirm element to confirm the successful deployment of a pyrotechnical device after optical and acoustic check of the dismantler; if deployment was not successful, the repeat element could be used to repeat the deployment;

4) repeat element to activate the deployment of a specific loop a second time (e.g. if deployment failed);

5) next element to proceed with the deployment of the next loop (e.g. if deployment failed);

6) abort element to abort the deployment sequence;

7) reset element to reset the PCU;

8) check element to start the deployment session and to perform sys-init and documentation (see ISO 26021-2:2008, Figure 5); check element could also be used as additional safety element which has to be pressed during the deployment sequence;

9) ignition element to trigger the deployment of the pyrotechnic devices (automatic sequence or manual deployment);

10) display to provide information to the user/dismantler; the following data could be displayed:

    i) safety instructions for the usage of the PDT and for the deployment process;

    ii) the loop ID, description and status of the current pyrotechnical device to be deployed;

    iii) if deployment sequence is in progress;

    iv) if deployment sequence is finished;

    v) if an error has occurred.

8.2 Basic design requirements for the PDT

The PDT has to be designed in accordance with legal requirements for the protection of health and safety at work and the safety instructions for neutralization of pyrotechnic devices given in the IDIS[5].

For safety reasons, the PDT shall try to deploy each configured pyrotechnical device at least once independent of the status of the bits specified in ISO 26021-2:2008, Table B.2.

A PCU may need to transmit negative response messages including response code 78 hex (request correctly received — response pending) for each service specified in ISO 26021-2. The PDT shall be able to handle this situation.

PDTs shall provide interfaces

— to allow software updates, and

— to provide access to the recorded data (e.g. printer interface).

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8.3 Example sequence for deployment method version 1

This is an example sequence conforming to ISO 26021-2. Other sequences are allowed provided that they conform to ISO 26021-2. The tester-present message shall be sent cyclically during sequences.

Assumption:

— There is only one PCU equipped in the vehicle.

— The PCU supports the reset service (11 hex) for this function.

— The VIN can be retrieved from the PCU via the ReadDataByIdentifier service (22 hex) dataIdentifier, F 190 hex.

The PCU supports the write-documentation capability via the WriteDataByIdentifier (2E hex) service dataIdentifier, FA 07 hex.

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Table 7 — Example sequence for deployment method version 1

Test step	PDT behaviour	Expected result from PCU	Remark
1	Send request “0x 22 FA 00” (read number of PCUs)	PCU sends response “0x 62 FA 00 xx”	Initiation of the communication between PDT and PCU as specified in ISO 26021-2:2008, 8.3.
2	Send request “0x 22 FA 01” (read version of deployment method)	PCU sends response “0x 62 FA 01 + data bytes”	If another version than “deployment method version 1” is returned, the PDT shall stop the sequence.
3	Send request “0x 22 FA 00” (read number of PCUs)	PCU sends response “0x 62 FA 00 xx”	Read number of pyrotechnical control units which support disposal according to ISO 26021.
4	Send request “0x 22 FA 02” (read address information of PCU)	PCU sends response “0x 62 FA 02 + data bytes”	Read address information of pyrotechnical control units which support disposal in accordance with ISO 26021.
5	Send request “0x 22 F1 90” (read VIN number)	PCU sends response “0x 62 F1 90 + data bytes”	The vehicle identification number (VIN) shall be stored for the deployment protocol.
6	Send request “0x 2E FA 07 + data bytes” (write dismantler info)	PCU sends response “0x 6E FA 07”	Save dismantler information to non-volatile memory in the PCU.
7	Send request “0x 22 FA 06” (read deployment loop table)	PCU sends response “0x 62 FA 06 + data bytes”	Read supported pyrotechnical devices out of PCU and store the information in order to access the devices that shall be fired.
8	Send request “0x 10 04” (DiagnosticSessionControl; safetySystemDiagnosticSession)	PCU sends response “0x 50 04”	Set PCU to disposal mode.
9	Send correct seed and key sequence (services 0x 27 5F and 0x 27 60)	PCU sends seed by sending response 0x 67 5F and grants access by sending response “0x 67 60”	Request security access and transmit key.
10	Send request “0x 31 01 E2 00 01” (routine control; EcecuteSPL; Load SPM to RAM and convert)	PCU sends response “0x 71 01 E2 00 yy 01”	Activate scrapping program loader.
11	Send request “0x 31 01 E2 01 nn” for all devices listed in the response of “read deployment loop table” independent of the deployment loop status of the devices. Minimum delay between firing of different devices: 1 s.	PCU sends response “0x 71 01 E2 01 yy nn xx” for each pyrotechnical device.	Fire pyrotechnical devices listed in the deployment loop table. Fired devices shall be stored for the deployment protocol.
12	Send request “0x 11 81” (hard reset)	PCU sends no response	Set PCU back to normal operation mode. NOTE If the power supply is cut off in step 11, it might be that this service is not effective.

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[4] ISO 14230-1, *Diagnostic systems — Keyword protocol 2000 — Part 1: Physical layer*

[5] IDIS official homepage: http://www.idis2.com/

2) ISO 15031-2 replaces ISO 4092, which has been withdrawn.

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