ENGINEERING
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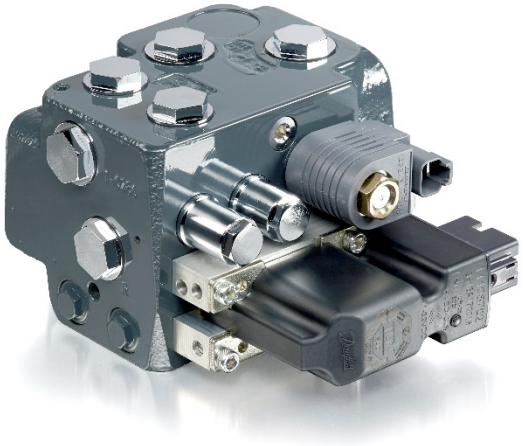
MultiAxis-Steer™

EHI Electrohydraulic steering valve with PVED-CLS controller
Communication Protocol
FW1.00



Revisions and references

Revision history

Date	Change	Revision
29 Oct 2019	MultiAxis-Steer specific communication protocol document First release FW1.00	1.02

Document references

Literature
PVED-CLS KWP2000 protocol
PVED-CLS Safety Manual
PVED-CLS User Manual

Definitions and Abbreviations

ACK	Acknowledgement
CAN	Controller Area Network
CRC	cyclic redundancy check
DA	Destination address
DLC	Data length content
DTC	Diagnostic Trouble Code
EH	electro-hydraulic a type of valve used in steering applications
FMI	Failure Mode Identifier
ISO	International Standard Organization
ISOBUS	communication protocol based on J1939, defined by ISO 11783
J1939	CAN communication protocol defined by SAE
KWP2000	Keyword Protocol 2000, a communication protocol used for on-board vehicle diagnostic systems; standardized as ISO 14230
LSB	Least significant byte
MAIN UC	main micro-controller, the one controlling the proportional valve
MMI	Man Machine Interface
MSB	Most significant byte
PGN	Parameter Group Number
PVED	Proportional Valve Electronic Digital
PVED-CL	a special type of PVED developed for steering applications
PVED-CLS	a special type of PVED being developed for new steering applications
SA	Source address
SAE	Society of Automotive Engineers
SAFETY UC	the micro-controller in the safety related channel, the one controlling the cut-off valve
SEHS	Safe EH Steering
SPN	Suspect Parameter Number
TBD	To be defined
UC	micro-controller

VSP	Vehicle speed
WA	Wheel angle
XID	Extended message identifier

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1 Introduction

This document has been created in order to present the N-axis slave communication protocol implemented in PVED-CLS – a controller in the Electro-Hydraulic Power Steering system.

Throughout this document, and in referenced documentation, N-axis or NAXIS are used as synonyms for MultiAxis-Steer mainly referencing one or more additional (n) "slave" axis.

This document describes all J1939 CAN messages used in N-axis slave PVED-CLS for communicating with external sensors, MMI etc.
Furthermore, it describes the J1939 diagnostic protocol, the service mode direct output control and the calibration features implemented in PVED-CLS for N-axis slave.

1.1 ERRATA INFORMATION

The latest errata information is always available on the Danfoss homepage via following link: www.Danfoss.com

It contains errata information for:

- PVED-CLS boot loader
- PVED-CLS application
- Documentation
- PLUS+1 Service tool
- Other topics related to the steering system

If further information to any errata is required, contact your nearest Danfoss Product Application Engineer

Attention	The system integrator and/or responsible for the target system is advised to periodically observe the errata information as new information will be added as needed.

2 High level requirements

The baud rate of 250 kbps is used in PVED-CLS.

The application uses the J1939 CAN protocol, mostly the proprietary messages A and B.

To follow the J1939 suggestions, the following rules will apply if not stated otherwise:

- The data byte numbering will start from 1;
- The bit numbering will start from 1;
- Multiple byte data will be encoded in Intel style (little-endian, LSB first);
- Valid ranges of signals which would normally require signed data types will be limited to positive values and a proper offset will be specified.

If not stated otherwise, the J1939 defined message priority is 6.
PVED-CLS will accept messages addressed both explicitly to it and to all nodes on the CAN bus - destination address set to 0xFF.

3 CANalyzer DBC file

For the PVED-CLS a CANalyzer DBC file is available. To have a link from this document to the DBC file, CAN messages DBC naming is marked inside [brackets]. This goes for names of CAN messages and signal names.

- In the DBC file, the '_X' inside of brackets are replaced with '_M' for messages from Main (Primary) controller and '_S' for messages from Safety (Redundant) controller.
- The service messages are only distinguished by the XID. The names assigned to the corresponding XID is inside {Curly Brackets}. As a special case the XID [Position capture reply] will only be sent from Main. The message byte contains information [Reply_result_from_ECU] dependent on that signal postfix shall be either '_M' or '_S'.
- In the DBC file, messages which are input (VSP, MMI etc.) for PVED-CLS slave node shall have postfix either '_P' or '_R'

Values are scaled to meaningful units. In cases where values correspond to text strings, these are decoded.
Values related to spool position and set point are scaled to [10um]
Values related to time are scaled to [ms]
Values related to voltage are scaled to [mV]
Values related to current are scaled to [mA]
Values related to speed are scaled to [kmph]

[CLAIMED_ADR_REQ]:	SA and DA can be any address
[SER_TOOL_REQ_X]:	SA can be any address
[SER_TOOL_REPLY_X]:	DA can be any address

3.1 DBC MESSAGE COMMENTS

All messages in the database has comments that identify which ECU they are related to and if they are cyclic or event based.

Cyclic messages (Status messages, DM1 etc.) have the comment 'Main_C' or 'Safe_C'. Event based messages (Address claim, service mode messages etc.) have the comment 'Main_E' or 'Safe_E'.

4 Network Management Protocol

4.1 ADDRESS ARBITRATION

PVED-CLS nodes claim their Source Addresses, i.e. broadcast their Address Claimed messages, once the initialization and the power-up tests have been completed.
After the initial, power-up, Address Claimed message has been transmitted a PVED-CLS node will give other CAN nodes 250 ms for evaluating the broadcast NAME and possibly re-claiming the address. In this period of time the PVED-CLS node will not transmit any messages other than Address Claimed or Cannot Claim Address as required by the J1939-defined address arbitration procedure.
If a PVED-CLS node has not lost an address arbitration and receives an Address Claim message from another CAN node which claims the same address, it will compare the other node's NAME with its own and:
transmit the Address Claimed message if it has won the address arbitration;
transmit the Cannot Claim Address message and enter the safe state if it has lost the address arbitration.
The above-mentioned messages will be transmitted no later than 100 ms after the Address Claimed message from another node has been received.
If a PVED-CLS node has lost the address arbitration, it will not transmit any message other than the Cannot Claim Address upon the explicit request – the broadcast Request for Address Claimed PGN.
If no address arbitration took place or the address arbitration has been won, a PVED-CLS node will transmit the Address Claimed message upon the request – the Request for Address Claimed PGN, either broadcast or addressed to the node.

4.2 ADDRESS CLAIMED [ADR_CLAIMED_X]

Priority: 6
PGN: 60928 (0xEE00)
Occurrence: as specified in the section about the address arbitration
Sent by: PVED-CLS
Sent to: all nodes if as the first message after power-up or as a step in the address arbitration procedure or a specific node if upon a request from this node

Bytes	Encoding	Value / Range	Description
1	U8	0x06	J1939 defined NAME with SEHS specific data: Identity Number (21 bits) = 0x06 Manufacturer Code (11 bits) = 0x39 ECU instance (3 bits) = 0x01(MainUC) 0x02(SafetyUC) Function instance (5 bits) = Specified by P3324 (default = 0) Function (8 bits) = 0x10 Reserved (1 bit) = 0 Vehicle system (7 bits) = 0 Vehicle system instance (4 bits) = 0 Industry group (3 bits) = 0 Arbitrary Address capable (1 bit) = 0 For more information see SAE J1939-81: Chapter: 4.2.1.1
2	U8	0x00	
3	U8	0x20	
4	U8	0x07	
5	U8	Bits 1..3: ECU instance [ECU_instance] Bits 4..8: Function instance [Function_instance]	
6	U8	0x10	
7	U8	0x00	
8	U8	0x00	

4.3 CANNOT CLAIM ADDRESS [ADR_NOT_CLAIMED_X]

Priority: 6
PGN: 60928 (0xEE00)
Occurrence: as specified in the section about the address arbitration
Sent by: PVED-CLS – **the source address of 0xFE is used**
Sent to: all nodes if as a step in the address arbitration procedure or a specific node if upon a request from this node

Bytes	Encoding	Value / Range	Description
1	U8	0x06	J1939 defined NAME with SEHS specific data: Identity Number (21 bits) = 0x06 Manufacturer Code (11 bits) = 0x39 ECU instance (3 bits) = 0x01(MainUC) 0x02(SafetyUC) Function instance (5 bits) = Specified by P3324 (default = 0) Function (8 bits) = 0x10 Reserved (1 bit) = 0 Vehicle system (7 bits) = 0 Vehicle system instance (4 bits) = 0 Industry group (3 bits) = 0 Arbitrary Address capable (1 bit) = 0 For more information see SAE J1939-81: Chapter: 4.2.1.1
2	U8	0x00	
3	U8	0x20	
4	U8	0x07	
5	U8	Bits 1..3: ECU instance [ECU_instance] Bits 4..8: Function instance [Function_instance]	
6	U8	0x10	
7	U8	0x02	
8	U8	0x00	

4.4 REQUEST FOR ADDRESS CLAIMED [CLAIMED_ADR_REQ]

Refer to section 14.2 for the format of Request PG message.
The claimed addresses can be retrieved by issuing a request for claimed address to all nodes on the CAN bus. In the below example, the vehicle speed sensor (0xFB) requests the claimed addresses.

Message ID	DLC	Byte 1	Byte 2	Byte 3
0x18EAFFFB	3	0x00	0xEE	0x00

Destination specific request for claimed address is also accepted. In the below example, vehicle speed sensor (0xFB) requests the claimed address of the PVED-CLS slave main controller (0x14).

Message ID	DLC	Byte 1	Byte 2	Byte 3
0x18EA14FB	3	0x00	0xEE	0x00

4.5 PVED-CLS MASTER SOURCE ADDRESS CONFIGURATION

The PVED-CLS master claims two addresses; one for the main controller and one for the safety controller. The source address can be programmed via the parameter shown in the below table.

CAN node	Source Address parameter	Recommended value
Main controller	P3318	0x13
Safety controller	P3318	0x5A

Table 1 PVED-CLS source addresses

Recommended value infers the default value.

4.6 PVED-CLS SLAVE SOURCE ADDRESS SELECTION

The PVED-CLS slave claims two addresses; one for the main controller and one for the safety controller. The source address can be programmed via the parameter shown in the below table.

CAN node	Source Address parameter	Recommended value
Main controller	P3322	0x14
Safety controller	P3322	0x5B

Table 2 PVED-CLS source addresses

Recommended value infers the default value.
Note: As the number of slaves goes on increasing, increment the slave source address value by 1 for Main and safety controller respectively for easier slave identification

WARNING The system integrator must ensure that the J1939 source addresses for the main and safety controller are different.

4.5 PVED-CLS BROADCAST MESSAGE PGN CONFIGURATION

The proprietary B message IDs are configurable as shown in Table 2. The PGN and the source address (SA) of the respective proprietary B message can be customized to a particular CAN network by setting the respective parameters.
The parameter addresses are the same for both the main and the safety controller.
See Table 3 for configuring the main and safety controller.

Message	Dir	Priority	PGN (MSB)	PGN offset parameter	SA
Status Message 1	Tx	6	0xFF	P3304	See Table 1
Status Message 2	Tx	6	0xFF	P3305	
Status Message 3	Tx	6	0xFF	P3306	
Status Message 4	Tx	6	0xFF	P3307	
Status Message 5	Tx	6	0xFF	P3308	
Status Message 6	Tx	6	0xFF	P3309	
Status Message 7	Tx	6	0xFF	P3310	
Status Message 8	Tx	6	0xFF	P3311	
Status Message 9	Tx	6	0xFF	P3312	
Operational Status	Tx	See note 1	0xFF	P3303	
Vehicle Speed Sensor	Rx	3	0xFF	P3313	P3320
Wheel Angle Sensor	Rx	3	0xFF	P3314	P3323
MMI	Rx	3	0xFF	P3317	P3321
N-axis Master	Rx	3	0xFF	P3316	P3318
N-axis Wheel Angle Limit	Tx	3	0xFF	P3315	P3322

Table 3 PVED-CLS broadcast message PGN configuration

Note 1: If the operation status message is used in any safety loops, it is recommended for robustness to set the operation status message priority to 3 by setting P3325 to 255 (Default: 0 (Priority 6)).

4.6 CAN SENSOR SIGNAL INPUT MAPPING

The below table shows how the PVED-CLS main and safety controller shall be parameterized in order to correctly receive primary and redundant sensor CAN messages. The table is populated with default parameter values as examples.

Sensor message	Default message ID	MAIN controller parameter	SAFETY controller parameter
Vehicle Speed – Primary	0x0CFF40FB	P3320 = 0xFB P3313 = 0x40	
Vehicle Speed – Redundant	0x0CFF41FB		P3320 = 0xFB P3313 = 0x41
Wheel Angle Sensor- Primary	0x0CFF12FA	P3323 = 0xFA P3314 = 0x12	
Wheel Angle Sensor- Redundant	0x0CFF13FA		P3323 = 0xFA P3314 = 0x13
Man Machine Interface – Primary	0x0CFF42FC	P3321 = 0xFC P3317 = 0x42	
Man Machine Interface – Secondary	0x0CFF43FC		P3321 = 0xFC P3317 = 0x43
Master Interface – Primary	0x0CFF2C13	P3318 = 0x13 P3316 = 0x2C	
Master Interface – Secondary	0x0CFF2D5A		P3318 = 0x13 P3316 = 0x2D

Table 4 CAN sensor address mapping

WARNING The system integrator must ensure that the primary and redundant CAN messages are correctly received by the main and safety controller respectively.

5 Service mode messages

5.1 ENTER SERVICE MODE [SER_TOOL_REQ_X]

The J1939 proprietary A message, available at start-up only.

Priority: 6
PGN: 61184 (0xEF00)
XID: 128 {Enter service mode}
Occurrence: if needed, within 200 ms after PVED-CL has broadcast its Address Claim message
Sent by: Any node
Sent to: PVED-CLS Slave MAIN micro-controller

Bytes	Encoding	Value / Range	Description
1	U8	128	extended message identifier [SER_TOOL_REQ_XID_X]
2	U8	 0 1 2 3	Requested Service mode [Req_service_mode_X]: Direct Output Control Wheel Angle Sensor Calibration Spool Calibration Information not available
3	U8	 0xAA 0xA5 0x5A 0x55	check value [Req_service_mode_chk_X]: Direct Output Control Wheel Angle Sensor Calibration Spool Calibration Information not available
4	U8	 0x55 0xA5 0x5A 0x55	check value [Req_service_mode_chk_X]: Direct Output Control Wheel Angle Sensor Calibration Spool Calibration Information not available
5..8	-	All 1	Reserved

Note 1: The message will be ignored if the requested Service Mode or the check value is found invalid or if there is a mismatch between the requested Service Mode and the provided check value is detected.
Note 2: PVED-CLS will also accept the message if only bytes 1–4 (DLC = 4) are sent.

5.2 DIRECT OUTPUT CONTROL

5.2.1 Direct output control request [SER_TOOL_REQ_X]

The J1939 Proprietary A message, Available in the Service mode – Direct Output control only

Priority: 6
PGN: 61184 (0xEF00)
XID: 130 {Direct output control req}
Occurrence: When needed
Sent by: Any node
Sent to: PVED-CLS Slave MAIN micro-controller

Bytes	Encoding	Value / Range	Description
1	U8	130	extended message identifier [SER_TOOL_REQ_XID_X]
2	Bits 8..7		Requested state of the coils supply switch [Req_CSS_X]:
		00	OFF
		01	ON
		10	Reserved
		11	No Change
	Bits 6..5		Requested state of the sensor supply voltage [Req_Sensor5V_X]:
		00	OFF
		01	ON
		10	Reserved
		11	No Change
	Bits 4..1	All 1	Reserved
3, 4	U16		Requested Spool position [Req_spool_pos_X]:
		0..2000	Valid spool position (-1000 Offset) in steps of 10um, where: 0 corresponds to the spool moved 10mm to the left, 1000 is the neutral position 2000 corresponds to the spool moved 10mm to the right
		2001..65279	Reserved
		65280..65535	No Change
5	U8		Requested duty cycle of the Cut-off valve PWM output [Req_COV_PWM_X]:
		0..100	Valid duty cycle [%]
		101	Closed loop current control
		102..254	Reserved
		255	No Change
6..8	-	All 1	Reserved

Note: If a requested value is out of range, i.e. Reserved, it will be ignored, and the last valid value will be used instead

5.2.2 Direct output control reply [SER_TOOL_REPLY_X]

The J1939 Proprietary A message, Available in the Service mode – Direct Output control only

Priority: 6
PGN: 61184 (0xEF00)
XID: 131 {Direct output control reply}
Occurrence: Upon reception of a Direct output control message
Sent by: PVED-CLS Slave MAIN micro-controller
Sent to: The node which the Direct output control message was received from

Bytes	Encoding	Value / Range	Description
1	U8	131	extended message identifier [SER_TOOL_REPLY _XID_X]
2	Bits 8..7		Requested state of the coils supply switch [Reply_CSS_state_X]:
		00	OFF
		01	ON
		10	Reserved
		11	Information not available
	Bits 6..5		Requested state of the sensor supply voltage [Reply_Sensor5V_state_X]:
		00	OFF
		01	ON
		10	Reserved
		11	Information not available
	Bits 4..1	All 1	Reserved
3, 4	U16		Requested Spool position [Reply_req_spool_pos_X]:
		0..2000	Valid spool position (-1000 Offset) in steps of 10um, where: 0 corresponds to the spool moved 10mm to the left, 1000 is the neutral position 2000 corresponds to the spool moved 10mm to the right
		2001..65279	Reserved
		65280..65535	Information not available
5	U8		Requested duty cycle of the Cut-off valve PWM output [Reply_req_COV_PWM_X]:
		0..100	Valid duty cycle [%]
		101	Closed loop current control
		102..254	Reserved
		255	Information not available
6..8	-	All 1	Reserved

Note: A previously requested value will be reported back if a just requested value has been found beyond the valid range, i.e. a reserved value has been received or no change has been requested

5.3 EXTERNAL SENSOR CALIBRATION

5.3.1 Position Capture Request [SER_TOOL_REQ_X]

The J1939 proprietary A message transmitted in order to make PVED-CLS capture the observed external signal values as defining the specified external sensor position. The messages in this section apply to both analog and CAN based Wheel angle

Priority: 6
PGN: 61184 (0xEF00)
XID: 142 {Pos capture req}
Occurrence: When the wheels are moved to the position which the external signals are to be captured for
Sent by: Any node
Sent to: PVED-CLS Slave MAIN micro-controller

Bytes	Encoding	Value/Range	Description
1	U8	142	extended message identifier [SER_TOOL_REQ_XID_X]
2	Bits 8..7	00 01 10 11	External sensor position to capture [Req_ANS_capture_X]: Leftmost position Neutral position Rightmost position Reserved
	Bits 6..1	All 1	Reserved
3..8	-	All 1	Reserved

Note: The request will be ignored if an invalid analog sensor position is requested to capture

5.3.2 Position Capture Reply [SER_TOOL_REPLY_X]

The J1939 proprietary A message as a reply to the received Position Capture request

Priority: 6
PGN: 61184 (0xEF00)
XID: 143 {Position capture reply}
Occurrence: Upon reception of a Position Capture Request
Sent by: PVED-CLS Slave MAIN micro-controller
Sent to: The node which the Position Capture Request has been received from

Bytes	Encoding	Value / Range	Description
1	U8	143	extended message identifier [SER_TOOL_REPLY _XID_X]
2	Bits 8..7		External sensor position captures [Reply_ANS_captured_X]:
		00	Leftmost position
		01	Neutral position
		10	Rightmost position
		11	Reserved
	Bit 6		Position Capture status [Reply_Pos_captured_X]:
		0	Position not captured
		1	Position captured
	Bit 5		Micro-Controller which the results come from [Reply_result_from_ECU_X]:
		0	Main Micro-controller
		1	Safety Micro-controller
	Bits 4..3		Micro-controller input signal status [Reply_Input_status_X]:
		00	Necessary input signals not available
		01	Necessary input signals available
		10	Necessary input signals out of valid range
		11	Reserved
	Bits 2..1		Consistency check status [Reply_Consistency_chk_X]:
		00	Consistency check has failed
		01	Consistency check has passed
		10	Reserved
		11	Information not available (some position not yet captured)
3..4	U16		External sensor signal observed at the external analogue input AD1, if analogue sensor is used, or received in the wheel angle sensor CAN messages, if CAN based sensor is used [Reply_AD1_X]:
		0..6000	Voltage [mV] or value received in CAN message
		6001..65534	Reserved

		65535	Information not available (position not captured)
5..6	U16	0..6000 6001..65534 65535	Analog sensor signal observed at the external analogue input AD2, if analogue sensor is used [Reply_AD2_X]: Voltage [mV] Reserved Information not available (position not captured or the redundant analog sensor not present or a CAN based wheel angle sensor in use)
7..8	U16	0..6000 6001..65534 65535	Sensor supply voltage [Reply_Sensor_voltage_X]: Voltage [mV] Reserved Information not available (Position not captured or a reply to a request other than capture external sensor neutral position)

Note: Main micro-controller will transmit two messages with result from Main and Safety micro-controller, respectively. In DBC-file, signals have _M or _S postfix relative to [Reply_result_from_ECU].

5.3.3 Parameter update request [SER_TOOL_REQ_X]

The J1939 proprietary A message transmitted in order to make PVED-CLS update the parameter values in the EEPROM

Priority: 6
PGN: 61184 (0xEF00)
XID: 144 {Param update req}
Occurrence: When PVED-CLS reports readiness to update the parameter values in the EEPROM
Sent by: Any node
Sent to: PVED-CLS slave MAIN micro-controller

Bytes	Encoding	Value / Range	Description
1	U8	144	extended message identifier [SER_TOOL_REQ_XID_X]
2..8	-	All 1	Reserved

5.3.4 Calibration reset request [SER_TOOL_REQ_X]

The J1939 proprietary A message transmitted in order to reset the ongoing or completed/failed calibration process.

Priority: 6
PGN: 61184 (0xEF00)
XID: 146 {Calib reset req}
Occurrence: When needed
Sent by: Any node
Sent to: PVED-CLS slave MAIN micro-controller

Bytes	Encoding	Value / Range	Description
1	U8	146	extended message identifier [SER_TOOL_REQ_XID_X]
2..8	-	All 1	Reserved

5.3.5 Calibration status [SER_TOOL_REPLY_X]

The J1939 proprietary A message transmitted in order to provide details about the ongoing calibration process.

Priority: 6
PGN: 61184 (0xEF00)
XID: 145 {Calib status}
Occurrence: When additional information needs to be shared
Sent by: PVED-CLS Slave MAIN micro-controller
Sent to: The node which the latest calibration related request has been received from

Bytes	Encoding	Value / Range	Description
1	U8	145	extended message identifier [SER_TOOL_REPLY _XID_X]
2	U8		Calibration error code [Reply_Calib_err_code_X]:
		0	Necessary input signals not available to Main microcontroller
		1	Necessary input signals not available to Safety microcontroller
		2	Input signal cross-check failure
		3	Steering wheel movement observed
		4	Not enough data to perform consistency check
		5	Consistency/Plausibility check failure in Main microcontroller
		6	Consistency/Plausibility check failure in Safety microcontroller
		7	Parameter update failure in Main microcontroller
		8	Parameter update failure in Safety microcontroller
		9	Calibration counter update failure
		10	Invalid wheel angle observed
		11	Can't calibrate valve within spool set point limits
		12	Timeout occurred at move to max point
		13	Calibration input parameters mismatch
		14	Calculated max WA cross check between Main and Safety failed
		15	Calculated Cylinder stroke volume cross check between Main and Safety failed
		16..254	Reserved
		255	No error
3	Bits 8..7		Wheel movement status – left move [Reply_WA_mov_status_L_X]:
		00	In progress
		01	Completed

		10 11	Reserved Information not available (a right move info or calibration error is reported)
	Bits 6..5	00 01 10 11	Wheel movement status – right move [Reply_WA_mov_status_R_X]: In progress Completed Reserved Information not available (a left move info or calibration error is reported)
	Bits 4..1	All 1	Reserved
4	U8	0..100 101..254 255	Indicates how close the calibration is to success with the last spool set point that met calibration criteria. 100% = calibration done for that side. [Reply_Calibration_progress_X] Reserved Information not available
5, 6	U16	0..2000 2001..65534 65535	Spool set point used during the just completed wheel move [Reply_Spl_set_last_X]: Spool position (-1000 offset) in steps of 10um, where: 0 corresponds to the spool moved 10mm to the left, 1000 is the neutral position and 2000 corresponds to the spool moved 10mm to the right Reserved Information not available (a calibration error is reported)
7, 8	U16	0 10 20..65534 65535	Time needed to complete the last move [Reply_T_last_move_X]: No time recorded yet Timeout occurred Time (-20 offset) [0.1s] 20 is 0,0s 21 is 0,1s 30 is 1,0s 620 is 60,0s Information not available (calibration error is reported)

5.1 SPOOL CALIBRATION

5.1.1 Spool calibration start request [SER_TOOL_REQ_X]

The J1939 proprietary A message transmitted in order to make PVED-CLS start the spool calibration process

Priority: 6
PGN: 61184 (0xEF00)
XID: 140 {Spool calib req}
Occurrence: When PVED-CLS reports readiness to start the spool calibration, i.e. the spool calibration trigger is armed by having the steering wheel activated for a moment
Sent by: Any node
Sent to: PVED-CLS slave MAIN micro-controller

Bytes	Encoding	Value / Range	Description
1	U8	140	extended message identifier [SER_TOOL_REQ_XID_X]
2	U8		Max. Wheel angle allowed during spool calibration [Req_WA_sweep_angle_X]:
		0	Reserved
		1..254	Wheel angle [0.1deg]
		255	Information not available
3, 4	U16		Initial spool set point [Req_Spl_init_SP_X]:
		0..1000	Absolute value of the spool position [10um]
		1001..65534	Reserved
		65535	Information not available
5	U8		Min. Time for moving the wheels in one direction [Req_Spl_calib_Tmin_X]:
		0	Reserved
		1..254	Time [0.1s]
		255	Information not available
6	U8		Max. Time for moving the wheels in one direction [Req_Spl_calib_Tmax_X]:
		0	Reserved
		1..254	Time [0.1s]
		255	Information not available
7..8	-	All 1	Reserved

Note:
1. Setting a parameter to all 1 – Information not available – will result in using an EEPROM parameter value instead.
2. The request will be ignored if found invalid, e.g. either reserved values have been provided or the max. time for moving wheel in one direction is found lower than the min. time.

5.1.2 Parameter Update Request [SER_TOOL_REQ_X]

See the message definition in section 5.3.3.

5.1.3 Calibration Reset Request [SER_TOOL_REQ_X]

See the message definition in section 5.3.4.

5.1.4 Calibration Status [SER_TOOL_REPLY_X]

See the message definition in section 5.3.5.

6 Soft Reset

6.1 SOFT RESET REQUEST [SER_TOOL_REQ_X]

The J1939 proprietary A message transmitted in order to make PVED-CLS perform a soft reset

Priority: 6
PGN: 61184 (0xEF00)
XID: 150 {Soft reset req}
Occurrence: When needed
Sent by: Any node
Sent to: PVED-CLS Slave MAIN micro-controller

Bytes	Encoding	Value / Range	Description
1	U8	150	extended message identifier [SER_TOOL_REQ_XID_X]
2..3	U16		Check value: 0xA5A5
4..8	-	All 1	Reserved

6.2 SOFT RESET REPLY [SER_TOOL_REPLY_X]

The J1939 proprietary A message transmitted as reply to the PVED-CLS soft reset request message

Priority: 6
PGN: 61184 (0xEF00)
XID: 151 {Soft reset reply}
Occurrence: Upon reception of a soft reset request message
Sent by: PVED-CLS Slave MAIN micro-controller
Sent to: Sent to the node that has requested the soft reset

Bytes	Encoding	Value / Range	Description
1	U8	151	extended message identifier [SER_TOOL_REPLY _XID_X]
2..8	-	All 1	Reserved

7 Status messages

Not all signals are available in both microcontrollers. If a signal is not present, “Information not available” is reported instead.

7.1 STATUS MESSAGE REQUEST [SER_TOOL_REQ_X]

The J1939 proprietary A message which defines transmission periods of the status messages 1 – 6.

Priority: 6
PGN: 61184 (0xEF00)
XID: 132 {Stat msg req}
Occurrence: When needed
Sent by: Any node
Sent to: PVED-CLS Slave MAIN or Safety micro-controller

Bytes	Encoding	Value / Range	Description
1	U8	132	extended message identifier [SER_TOOL_REQ_XID_X]
2	U8		Transmission rate of the Operation status message [TX_Rate_stat_msg_OP_X]:
		0	No change
		1..254	Transmission period expressed as a number of 10ms ticks
		255	No change
3	U8		Transmission rate of the status message 1 [TX_Rate_stat_msg_1_X]:
		0	Transmission stop
		1..254	Transmission period expressed as a number of 10ms ticks
		255	No change
4	U8		Transmission rate of the status message 2 [TX_Rate_stat_msg_2_X]:
		0	Transmission stop
		1..254	Transmission period expressed as a number of 10ms ticks
		255	No change
5	U8		Transmission rate of the status message 3 [TX_Rate_stat_msg_3_X]:
		0	Transmission stop
		1..254	Transmission period expressed as a number of 10ms ticks
		255	No change
6	U8		Transmission rate of the status message 4 [TX_Rate_stat_msg_4_X]:
		0	Transmission stop
		1..254	Transmission period expressed as a number of 10ms ticks

		255	No change
7	U8	0 1..254 255	Transmission rate of the status message 5 [TX_Rate_stat_msg_5_X]: Transmission stop Transmission period expressed as a number of 10ms ticks No change
8	U8	0 1..254 255	Transmission rate of the status message 6 [TX_Rate_stat_msg_6_X]: Transmission stop Transmission period expressed as a number of 10ms ticks No change

7.2 STATUS MESSAGE REQUEST 2 [SER_TOOL_REQ_X]

The J1939 proprietary A message which defines transmission periods of the status message 7 – 9.

Priority: 6
PGN: 61184 (0xEF00)
XID: 136 {Stat msg req 2}
Occurrence: When needed
Sent by: Any node
Sent to: PVED-CLS Slave MAIN or Safety micro-controller

Bytes	Encoding	Value / Range	Description
1	U8	136	extended message identifier [SER_TOOL_REQ_XID_X]
2	U8	 0 1..254 255	Transmission rate of the status message 7 [TX_Rate_stat_msg_7_X]: Transmission stop Transmission period expressed as a number of 10ms ticks No change
3	U8	 0 1..254 255	Transmission rate of the status message 8 [TX_Rate_stat_msg_8_X]: Transmission stop Transmission period expressed as a number of 10ms ticks No change
4	U8	 0 1..254 255	Transmission rate of the status message 9 [TX_Rate_stat_msg_9_X]: Transmission stop Transmission period expressed as a number of 10ms ticks No change
5..8	-	All 1	Reserved

Default transmission rates to use after power-up are defined by parameters shown in Table 4.

Status message	Transmission rate parameter index
Operation status message	P3291
Status message 1	P3292
Status message 2	P3293
Status message 3	P3294
Status message 4	P3295

Status message 5	P3296
Status message 6	P3297
Status message 7	P3298
Status message 8	P3299
Status message 9	P3300

Table 5: Parameter list for default transmission rate of status messages

7.3 STATUS MESSAGE 1 [STAT_MSG_1_X]

Priority: 6
PGN: 65280 + P3304 (Default: 0xFF21)
Occurrence: Periodic – Transmission rate defined by P3292 or the Status message request message
Sent by: PVED-CLS Slave MAIN or Safety micro-controller
Sent to: All nodes

Bytes	Encoding	Value / Range	Description
1..2	U16	0..2000 2001..65534 65535	Requested spool position [Spool_setpoint_X]: Valid spool position (-1000 offset) in [10um], where: 0 corresponds to the spool moved 10mm to the left, 1000 is the neutral position and 2000 corresponds to the spool moved 10mm to the right Reserved Information not available
3..4	U16	0..2000 2001..65534 65535	Actual spool position [Spool_position_X]: Valid spool position (-1000 offset) in [10um], where: 0 corresponds to the spool moved 10mm to the left, 1000 is the neutral position and 2000 corresponds to the spool moved 10mm to the right Reserved Information not available
5..6	U16	0..6000 6001..65534 65535	Data from the external analog input 1 [AD1_X]: Measured value at the external AD1 input in [mV] –See note 1. Reserved Information not available
7..8	U16	0..6000 6001..65534 65535	Data from the external analog input 2 [AD2_X]: Measured value at the external AD2 input in [mV] –See note 1. Reserved Information not available

Note 1: The readings are sensor supply voltage compensated if this is enabled for the transmitting micro-controller. Supply voltage compensation is controlled by P3241 for AD1 and P3242 for AD2.

7.4 STATUS MESSAGE 2 [STAT_MSG_2_X]

Priority: 6
PGN: 65280 + P3305 (Default: 0xFF22)
Occurrence: Periodic – Transmission rate defined by P3293 or the Status message request message
Sent by: PVED-CLS Slave MAIN or Safety micro-controller
Sent to: All nodes

Bytes	Encoding	Value / Range	Description
1	Bits 8..7		Actual state of the Coils supply switch [State_CSS_X]:
		00	OFF
		01	ON
		10	Error condition
		11	Information not available
	Bits 6..5		Status of the Digital output [Dout_state_X]:
		00	Reserved
		01	In good condition
		10	Error condition
		11	Information not available
	Bits 4..1	All 1	Reserved
2	U8	All 1	Reserved
3..4	U16		Data from the external analog input 3 [AD3_X]:
		0..6000	Measured value at the external AD3 input in [mV]
		6001..65534	Reserved
		65535	Information not available
5..6	U16		Measured current sourced by the Digital output [Dout_current_X]:
		0..5000	Measured current [mA]
		5001..65534	Reserved
		65535	Information not available
7..8	U16	All 1	Reserved

7.5 STATUS MESSAGE 3 [STAT_MSG_3_X]

Priority: 6
PGN: 65280 + P3306 (Default: 0xFF23)
Occurrence: Periodic – Transmission rate defined by P3294 or the Status message request message
Sent by: PVED-CLS Slave MAIN or Safety micro-controller
Sent to: All nodes

Bytes	Encoding	Value / Range	Description
1..2	U16		PCB temperature [PCB_temp_X]:
		0..170	PCB temperature (-40 offset) [degC]
		171..65534	Reserved
		65535	Information not available
3..4	U16		Battery voltage [Batt_volt_X]:
		0..36000	Battery voltage [mV]
		36001..65534	Reserved
		65535	Information not available
5..6	U16		Sensor supply voltage [Sensor5V_volt_X]:
		0..6000	Sensor supply voltage [mV]
		6001..65534	Reserved
		65535	Information not available
7	U8		Actual LVDT compensation value [LVDT_neut_comp_X]:
		0..255	LVDT offset compensation value (-100 offset) in [10um]
8	Bits 8..7	All 1	Reserved
	Bits 6..5		Spool control status [Spl_ctrl_status_X]:
		00	Spool is controlled actively
		01	Spool control released, ready for LVDT offset compensation
		10	Error condition
		11	Information not available
	Bits 4..1		LVDT offset compensation counter [LVDT_comp_count_X]:
		0..15	How many times has LVDT offset compensation been executed (counter rolls over if higher than 15)

Note: Safety controller will always send “information not available” in the spool control status field [Spl_ctrl_status_X].

7.6 STATUS MESSAGE 4 [STAT_MSG_4_X]

Priority: 6
PGN: 65280 + P3307 (Default: 0xFF24)
Occurrence: Periodic – Transmission rate defined by P3295 or the Status message request message
Sent by: PVED-CLS Slave MAIN or Safety micro-controller
Sent to: All nodes

Bytes	Encoding	Value / Range	Description
1..2	U16	0..2000 2001..65534 65535	Flow Command [Flow_Cmd_X]: Valid Flow command (-1000 offset) in [0.1%], where: 0 corresponds to 100.0% Flow to the left, 1000 is the neutral position (0.0%) and 2000 corresponds to 100.0% Flow to the right Reserved Information not available
3..4	U16	All 1	Reserved
5..6	U16	All 1	Reserved
8..7	U16	All 1	Reserved

Note 1: If the corresponding algorithm is not executed, the signal value shall be displayed as “Information not available”

7.7 STATUS MESSAGE 5 [STAT_MSG_5_X]

Priority: 6
PGN: 65280 + P3308 (Default: 0xFF25)
Occurrence: Periodic – Transmission rate defined by P3296 or the Status message request message
Sent by: PVED-CLS Slave MAIN or Safety micro-controller
Sent to: All nodes

Bytes	Encoding	Value / Range	Description
1	U8	All 1	Reserved
2	Bits 8..3	0..2000	Measured wheel angle LSB [WAS_X]: See description in byte 3
	Bits 2..1	All 1	Reserved
3	8..6	All 1	Reserved
	Bits 5..1	0..2000 2001..2048	Measured Wheel angle MSB (AD1/CAN) [WAS_X]: Valid wheel angle (-1000 offset) in [0.1%], where 0 corresponds to the left most position (-100,0%), 1000 is the neutral position and (0,0%) 2000 corresponds to the right most position (100,0%) Reserved
4..8	-	All 1	Reserved

7.8 STATUS MESSAGE 6 [STAT_MSG_6_X]

Priority: 6
PGN: 65280 + P3309 (Default: 0xFF26)
Occurrence: Periodic – Transmission rate defined by P3297 or the Status message request message
Sent by: PVED-CLS Slave MAIN or Safety micro-controller
Sent to: All nodes

Bytes	Encoding	Value / Range	Description
1..2	U16	0..10000 10001..65534 65535	Average Micro-controller load – see note 1 [Avg_CPU_load_X]: Measured load in 0.01% Reserved Information not available
3..4	U16	0..2000 2001..65534 65535	Flow command received on the SPI link from other micro-controller [SPI_Flow_command_X]: Valid Flow command (-1000 offset) in [0.1%], where: 0 corresponds 100.0% Flow to the left, 1000 is the neutral position (0.0%) and 2000 corresponds to 100.0% Flow to the right Reserved Information not available
5..6	U16	0..2000 2001.. 65534 65535	Measured Wheel angle 2 (AD2) [WAS2_X]: Valid wheel angle (-1000 offset) in [0.1%], where 0 corresponds to the left most position (-100,0%), 1000 is the neutral position and (0,0%) 2000 corresponds to the right most position (100,0%) Reserved Information not available
7	U8	0..255	Calculated spool monitoring timeout [Spool_monitoring_timeout_X]: Spool monitoring timeout in [10ms]
8	U8	0..254 255	Actual spool monitoring timeout [Spool_monitoring_time_X]: Timeout in [10ms] Information not available

Note 1: The CPU load measurement is only available for Danfoss Power solutions technicians. In normal operation always “information not available” will be displayed.

7.9 STATUS MESSAGE 7 [STAT_MSG_7_X]

Priority: 6
PGN: 65280 + P3310 (Default: 0xFF27)
Occurrence: Periodic – Transmission rate defined by P3298 or the Status message request message 2
Sent by: PVED-CLS Slave MAIN or Safety micro-controller
Sent to: All nodes

Bytes	Encoding	Value / Range	Description
1..2	U16	All 1	Reserved
3..4	U16	All 1	Reserved
5..6	U16	All 1	Reserved
7..8	U16	All 1	Reserved

7.10 STATUS MESSAGE 8 [STAT_MSG_8_X]

Priority: 6
PGN: 65280 + P3311 (Default: 0xFF28)
Occurrence: Periodic – Transmission rate defined by P3299 or the Status message request message 2
Sent by: PVED-CLS Slave MAIN or Safety micro-controller
Sent to: All nodes

Bytes	Encoding	Value / Range	Description
1	U8	All 1	Reserved
2	U8	All 1	Reserved
3..4	U16	0..2000 2001..65534 65535	Integral contribution of solenoid valve control [SVC_Integral_part_X]: Valid integral contribution (-1000 offset) in [10um], where 0 corresponds to the negative limit of the integral contribution (-10mm) and 2000 corresponds to the positive limit of the integral contribution (10mm). Reserved Information not available
5..8	-	All 1	Reserved

Note 1: The safety controller cannot send the integral contribution of solenoid valve control and will send information not available.

7.11 STATUS MESSAGE 9 [STAT_MSG_9_X]

Priority: 6
PGN: 65280 + P3312 (Default: 0xFF29)
Occurrence: Periodic – Transmission rate defined by P3300 or the Status message request message 2
Sent by: PVED-CLS Slave MAIN or Safety micro-controller
Sent to: All nodes

Bytes	Encoding	Value / Range	Description
1..2	U16	0..1099 1100..18900 18901..65534 65535	Wheel Angle Setpoint [WA_Setpoint_X]: Reserved Valid Wheel angle Setpoint (Offset -10000) in [cDeg] (-89 to 89 Deg) Reserved Information not available
3..4	U16	0..1099 1100..18900 18901..65534 65535	Wheel Angle Position [WA_Position_X]: Reserved Valid Wheel angle Position (Offset -10000) in [cDeg] (-89 to 89 Deg) Reserved Information not available
5..6	U16	All 1	Reserved
7..8	U16	0..7999 8000..12000 12001..65534 65535	Master WAS speed [Master_WAS_Speed_X]: Reserved Master WAS speed (Offset -10000) [cDeg/10mSec] Reserved Information not available

Note:
Master_WAS_Speed_X signal value is calculated for WAS and spool calibration and N-axis pre-operational mode

7.12 OPERATION STATUS MESSAGE [STAT_MSG_OP_X]

Priority: Set by P3325: 6 or 3 (Default: 6, See note 1 below the message layout definition)
PGN: 65280 + P3303 (Default: 0xFF20)
Occurrence: Periodic – Transmission rate defined by P3301 or the Status message request message
Sent by: PVED-CLS Slave MAIN or Safety micro-controller
Sent to: All nodes

Bytes	Encoding	Value / Range	Description
1	U8		Current Operation state [OperationState_X]:
		0x70	N-axis Preoperational
		0x71	N-axis Operational
		0x72	N-axis on-Road preparation
		0x73	N-axis on-Road locked
		0x74	N-axis centering before safe state
		0xD0	Off-Road Safety-Check
		0xE0	Service mode – Direct Output Control
		0xE1	Service mode – Wheel angle sensor calibration
		0xE2	Service mode – Spool calibration
		0xF0	Initialization
		0xFF	Safe State
2	U8	All 1	Reserved
3	Bits 8..7	All 1	Reserved
	Bits 6..5		Wheel angle limit on demand feature [NAXIS_WAL_On_Demand_X]
		00	Wheel angle limit on demand not received
		01	Wheel angle limit on demand received but not activated
		10	Wheel angle limit on demand activated
		11	Invalid
	Bits 4..1	All 1	Reserved
4	U8		Service mode state [Service_mode_state_X]:
		0x00	Direct output control reset
		0x01	Direct output control / Direct output control active
		0x02..0x0F	Reserved
		0x10	WAS calibration Reset
		0x11	WAS calibration in progress
		0x12..0x1C	Reserved
		0x1D	WAS calibration counter update
		0x1E	WAS calibration failure
		0x1F	WAS calibration complete
		0x20	Spool calibration reset
		0x21	Spool calibration inactive
		0x22	Spool calibration getting armed

		0x23 0x24 0x25 0x26 0x27 0x28..0x2C 0x2D 0x2E 0x2F 0x30 0x31 0x32..0x3C 0x3D 0x3E 0x3F 0x40..0xFC 0xFD 0xFE 0xFF	Spool calibration armed Spool calibration in progress Spool parameters plausibility check Spool parameters ready to update Spool parameters update Reserved Spool calibration counter update Spool calibration failure Spool calibration complete Information not available Information not available Reserved Information not available Information not available Information not available Reserved Information not available No wheel angle sensor configured Information not available (Operation state other than service mode)
5	U8	All 1	Reserved
6	Bits 8..5	All 1	Reserved
	Bits 4..1	0..15	Sequence number [OperationState_Seq_X]: Incremented by 1 in each Operation status message. Rolls over from 15 to 0
7..8	U16	0..65535	CRC16 for data bytes 1..6 [OperationState_CRC_X]: Polynomial: 0xC86C

Note 1: If the operation status message is used in any safety loops, it is recommended for robustness to set the operation status message priority to 3 by setting P3325 to 255 (Default: 0 (Priority 6)).

8 Vehicle speed messages

8.1 VSP PRIMARY MESSAGE [VSP_P]

Priority: 3
PGN: 65280 + P3313 (Default: 0xFF40)
Occurrence: Periodic – every 100ms
Sent by: Vehicle speed sensor
Sent to: All CAN nodes

Bytes	Encoding	Value / Range	Description
1	U8	All 1	Reserved
2	Bits 8..7	 00 01 10 11	Direction indication [VSP_Dir_P]: Forward Reverse Error condition Information not available
	Bits 6..1	All 1	Reserved
3..4	U16	 0..64255 64256..65535	Vehicle speed [VSP_Speed_P]: Measured vehicle speed in [1/256 KMPH] Information not available
5	-	All 1	Reserved
6	Bits 8..5	All 1	Reserved
	Bits 4..1	 0..15	Sequence number [VSP_Seq_P], incremented by 1 in each VSP primary message Rolls over from 15 to 0
7..8	U16	 0..65535	CRC16 for data bytes 1..6 [VSP_CRC_P]: Polynomial: 0xC86C

8.2 VSP REDUNDANT MESSAGE [VSP_R]

Priority: 3
PGN: 65280+ P3313 (Default: 0xFF41)
Occurrence: Periodic – every 100ms
Sent by: Vehicle speed sensor
Sent to: All CAN nodes

Bytes	Encoding	Value/Range	Description
1	U8	All 1	Reserved
2	Bits 8..7	 00 01 10 11	Direction indication [VSP_Dir_R]: Forward Reverse Error condition Information not available
	Bits 6..1	All 1	Reserved
3..4	U16	 0..64255 64256..65535	Vehicle speed [VSP_Speed_R]: Measured vehicle speed in [1/256 KMPH] Information not available
5	-	All 1	Reserved
6	Bits 8..5	All 1	Reserved
	Bits 4..1	 0..15	Sequence number [VSP_Seq_R], incremented by 1 in each VSP primary message Rolls over from 15 to 0
7..8	U16	 0..65535	CRC16 for data bytes 1..6 [VSP_CRC_R]: Polynomial: 0xC86C

9 MMI messages

9.1 MMI PRIMARY MESSAGE [MMI_P]

Priority: 3
PGN: 65280 + P3317 (default PGN: 0xFF42)
Occurrence: Periodic – every 500ms
Sent by: MMI controller
Sent to: All CAN nodes

Bytes	Encoding	Value / Range	Description
1..2	U16	0..1099 1100..18900 18901..65534 65535	Virtual Axis Angle [Virtual_Axis_Angle_P]: Reserved Valid virtual axis angle (Offset -10000) in [cDeg] (-89 to 89 Deg) Reserved Information not available
3..4	U16	0..20000 20001..65534 65535	Virtual Axis Position [Virtual_Axis_Pos_P]: Valid virtual axis position (Offset -10000) in [mm] Reserved Information not available
5	U8	All 1	Reserved
6	Bits 8..7	All 1	Reserved
	Bit 6..5	00 01 10 11	Wheel angle limit on demand feature [WAL_On_Demand_P]: Disable Enable Reserved Information not available/Disable
	Bits 4..1	0..15	Sequence number [MMI_Seq_No_P]: incremented by 1 in each message. Rolls over from 15 to 0
7..8	U16	0..65535	CRC16 for data bytes 1..6 [MMI_CRC_P]: Polynomial: 0xC86C

Note:

- Virtual Axis Angle and Position will be considered invalid if Reserved values are sent by the MMI controller.

9.2 MMI REDUNDANT MESSAGE [MMI_R]

Priority: 3
PGN: 65280 + P3317 (default PGN: 0xFF43)
Occurrence: Periodic – every 500ms
Sent by: MMI controller
Sent to: All CAN nodes

Bytes	Encoding	Value / Range	Description
1..2	U16	0..1099 1100..18900 18901..65534 65535	Virtual Axis Angle [Virtual_Axis_Angle_R]: Reserved Valid virtual axis angle (Offset -10000) in [cDeg] (-89 to 89 Deg) Reserved Information not available
3..4	U16	0..20000 20001..65534 65535	Virtual Axis Position [Virtual_Axis_Pos_R]: Valid virtual axis position (Offset -10000) in [mm] Reserved Information not available
5	U8	All 1	Reserved
6	Bits 8..7	All 1	Reserved
	Bits 6..5	00 01 10 11	Wheel angle limit on demand feature [WAL_On_Demand_R]: Disable Enable Reserved Information not available/Disable
	Bits 4..1	0..15	Sequence number [MMI_Seq_No_R]: incremented by 1 in each message. Rolls over from 15 to 0
7..8	U16	0..65535	CRC16 for data bytes 1..6 [MMI_CRC_R]: Polynomial: 0xC86C

Note:

- Virtual Axis Angle and Position will be considered invalid if Reserved values are sent by the MMI controller.

10 Wheel angle sensor messages

10.1 WAS PRIMARY MESSAGE [WAS_P]

Priority: 3
PGN: 65280 + P3314 (Default: 0xFF12)
Occurrence: Periodic – every 50ms
Sent by: Wheel angle sensor
Sent to: All CAN nodes

Bytes	Encoding	Value / Range	Description
1	U8	All 1	Reserved
2..3	U16	 0..99 100..4900 4901..5000 5001..65535	Wheel angle signal 1 [WAS_WA_P]: Error Condition Valid wheel angle signal to scale according to P3185, P3187 & P3189 Error Condition Reserved
4..5	U16	All 1	Reserved
6	Bits 8..5	All 1	Reserved
	Bits 4..1	 0..15	Sequence number [WAS_Seq_P], incremented by 1 in each WAS primary message Rolls over from 15 to 0
7..8	U16	 0..65535	CRC16 for data bytes 1..6 [WAS_CRC_P]: Polynomial: 0xC86C

10.2 WAS REDUNDANT MESSAGE [WAS_R]

Priority: 3
PGN: 65280 + P3314 (Default: 0xFF13)
Occurrence: Periodic – every 50ms
Sent by: Wheel angle sensor
Sent to: All CAN nodes

Bytes	Encoding	Value / Range	Description
1	U8	All 1	Reserved
2..3	U16		Wheel angle signal 2 [WAS_WA_R]:
		0..99	Error Condition
		100..4900	Valid wheel angle signal to scale according to P3185, P3187 & P3189
		4901..5000	Error Condition
		5001..65535	Reserved
4..5	U16	All 1	Reserved
6	Bits 8..5	All 1	Reserved
	Bits 4..1		Sequence number [WAS_Seq_R], incremented by 1 in each WAS redundant message
		0..15	Rolls over from 15 to 0
7..8	U16		CRC16 for data bytes 1..6 [WAS_CRC_R]:
		0..65535	Polynomial: 0xC86C

11 Master messages

11.1 MASTER PRIMARY MESSAGE [MASTER_P]

Priority: 3
PGN: 65280 + P3316 (Default PGN: 0xFF2C)
Occurrence: Periodic - Transmission rate defined by P3302 (default 10ms)
Sent by: Master node
Sent to: All CAN nodes

Bytes	Encoding	Value / Range	Description
1..2	U16	0..1099 1100..18900 18901..65534 65535	Master Steering Wheel Angle [Master_WA_P]: Reserved Valid master wheel angle (Offset -10000) in [cDeg] (-89 to 89 Deg) Reserved Information not available
3..5	U16	All 1	Reserved
6	Bits 8..5	0, 3..14 1 2 15	Error code [Master_error_code_P]: Reserved Master in Error, WAS not in Error Master in Error, WAS in Error No Error
	Bits 4..1	0..15	Sequence number [Master_Seq_No_P], incremented by 1 in each message Rolls over from 15 to 0
7..8	U16	0..65535	CRC16 for data bytes 1..6 [Master_CRC_P]: Polynomial: 0xC86C

11.2 MASTER REDUNDANT MESSAGE [MASTER_R]

Priority: 3
PGN: 65280 + P3316 (Default PGN: 0xFF2D)
Occurrence: Periodic - Transmission rate defined by P3302 (default 10ms)
Sent by: Master node
Sent to: All CAN nodes

Bytes	Encoding	Value / Range	Description
1..2	U16	0..1099 1100..18900 18901..65534 65535	Master Steering Wheel Angle [Master_WA_R]: Reserved Valid master wheel angle (Offset -10000) in [cDeg] (-89 to 89 Deg) Reserved Information not available
3..5	U16	All 1	Reserved
6	Bits 8..5	 0 1 2 15	Error code [Master_error_code_R]: Reserved Master in Error, WAS not in Error Master in Error, WAS in Error No Error
	Bits 4..1	 0..15	Sequence number [Master_Seq_No_R], incremented by 1 in each message Rolls over from 15 to 0
7..8	U16	 0..65535	CRC16 for data bytes 1..6 [Master_CRC_R]: Polynomial: 0xC86C

12 Wheel angle limit messages

12.1 MASTER WHEEL ANGLE LIMIT PRIMARY MESSAGE [MWA_LIMIT_P]

Priority: 3
PGN: 65280 + P3315 (Default PGN: 0xFF2A)
Occurrence: Periodic - Transmission rate defined by P3301 (default 0ms)
Sent by: N-axis slave node
Sent to: Other N-axis nodes

Bytes	Encoding	Value / Range	Description
1..2	U16	0..1099 1100..18900 18901..65534 65535	Master Steering Wheel Angle Limit Right [WA_Limit_Right_P]: Reserved Valid master wheel angle right limit (Offset -10000) in [cDeg] (-89 to 89 Deg) Reserved Information not available
3..4	U16	0..1099 1100..18900 18901..65534 65535	Master Steering Wheel Angle Limit Left [WA_Limit_Left_P]: Reserved Valid master wheel angle left limit (Offset -10000) in [cDeg] (-89 to 89 Deg) Reserved Information not available
5	Bits 8..5	1..15	Node Identification R [Node_ID_Right_P]
	Bits 4..1	1..15	Node Identification L [Node_ID_Left_P]
6	Bits 8..5	0, 2..14 1 15	Error code [WA_Limit_error_code_P]: Reserved N-Axis Node in Error No Error
	Bits 4..1	0..15	Sequence number [WA_Limit_Seq_No_P]: incremented by 1 in each message Rolls over from 15 to 0
7..8	U16	0..65535	CRC16 for data bytes 1..6 [WA_Limit_CRC_P]: Polynomial: 0xC86C

12.2 MASTER WHEEL ANGLE LIMIT REDUNDANT MESSAGE [MWA_LIMIT_R]

Priority: 3
PGN: 65280 + P3315 (Default PGN: 0xFF2B)
Occurrence: Periodic - Transmission rate defined by P3301 (default 0ms)
Sent by: N-axis slave node
Sent to: Other N-axis nodes

Bytes	Encoding	Value / Range	Description
1..2	U16	0..1099 1100..18900 18901..65534 65535	Master Steering Wheel Angle Limit Right [WA_Limit_Right_R]: Reserved Valid master wheel angle right limit (Offset -10000) in [cDeg] (-89 to 89 Deg) Reserved Information not available
3..4	U16	0..1099 1100..18900 18901..65534 65535	Master Steering Wheel Angle Limit Left [WA_Limit_Left_R]: Reserved Valid master wheel angle left limit (Offset -10000) in [cDeg] (-89 to 89 Deg) Reserved Information not available
5	Bits 8..5	1..15	Node Ident R [Node_ID_Right_R]
	Bits 4..1	1..15	Node Ident L [Node_ID_Left_R]
6	Bits 8..5	0, 2..14 1 15	Error code [WA_Limit_error_code_R]: Reserved N-Axis Node in Error No Error
	Bits 4..1	0..15	Sequence number [WA_Limit_Seq_No_R]: incremented by 1 in each message Rolls over from 15 to 0
7..8	U16	0..65535	CRC16 for data bytes 1..6 [WA_Limit_CRC_R]: Polynomial: 0xC86C

13 Parameter read related messages

13.1 PARAMETER READ REQUEST [SER_TOOL_REQ_X]

Priority: 6
PGN: 61184 (0xEF00)
XID: 134 {Param read req}
Occurrence: When needed
Sent by: Any CAN node
Sent to: PVED-CLS Main or Safety controller

Bytes	Encoding	Value / Range	Description
1	U8	134	Extended message identifier [SER_TOOL_REQ_XID_X]
2	U8		Length of the data to read [Req_param_data_length_X]:
		0	Reserved
		1..4	No of bytes
		5..255	Reserved
3..4	U16		Data address [Req_param_address_X]:
		0..16383	Parameter address in the EEPROM
		16384..65535	Reserved
5..8	-	All 1	Reserved

Note 1: Apply little-endian encoding of ‘data address’ in byte 3 and 4.
Note 2: PVED-CLS will also accept the message if only bytes 1–4 (DLC = 4) are sent.

13.2 PARAMETER READ REPLY [SER_TOOL_REPLY_X]

Priority: 6
PGN: 61184 (0xEF00)
XID: 135 {Param read reply}
Occurrence: Transmitted as reply to a parameter read request message
Sent by: PVED-CLS Main or Safety controller
Sent to: The node which the Parameter read request was received from

Bytes	Encoding	Value / Range	Description
1	U8	135	Extended message identifier [SER_TOOL_REPLY _XID_X]
2	U8	 0 1..4 5..255	Data length [Reply_param_data_length_X]: Reserved No of bytes read Reserved
3..4	U16	 0..16383 16384..65535	Data address [Reply_param_address_X]: Parameter address in the EEPROM Reserved
5	U8	 0..255 255	Low word LSB [Reply_param_value_ns_X]: Data byte available at the address of (data address), when the data length is in the range from 1 to 4 Data not available when the data length is set to 0
6	U8	 0..255 255	Low word MSB [Reply_param_value_ns_X]: Data byte available at the address of (data address + 1), when the data length is in the range from 2 to 4 Data not available when the data length is lower than 2
7	U8	 0..255 255	High word LSB [Reply_param_value_ns_X]: Data byte available at the address of (data address + 2), when the data length is set to either 3 or 4 Data not available when the data length is lower than 3
8	U8	 0..255 255	High word MSB [Reply_param_value_ns_X]: Data byte available at the address of (data address + 3), when the data length is set to 4 Data not available when the data length is lower than 4

Note 1: ns in "Reply_param_value_ns_X" correspond to the number if bytes transmitted from CLS (Data length). It also indicates if the representation in CANalyzer is signed or unsigned. Both signed and unsigned are shown in the trace window simultaneously. Possible replacements for ns: 1U, 2U, 3U, 4U, 1S, 2S, 3S, 4S
Note 2: Apply little-endian encoding of 'data address' in byte 3 and 4.

14 J1939-73 Diagnostics

PVED-CLS supports the diagnostic services listed 14.1, 14.3, 14.4, 14.6 & 14.7.

14.1 DM1 – ACTIVE DIAGNOSTIC TROUBLE CODES [DM1_X]

DM1 single frame or BAM is transmitted periodically every 1 second as well as event-based i.e. on occurrence or disappearance of faults.

Priority: 6
PGN: 65226 (0xFECA)
Occurrence: Periodic – every 1 sec, or if the content changes
Sent by: PVED-CLS Slave Main and Safety controller
Sent to: All CAN nodes

Bytes	Encoding	Value / Range	Description
1	U8		Malfunction indicator lamp status:
		0x00	No active failure
		0x04	Amber warning lamp status (for warning and info errors)
		0x10	Red stop lamp status (for critical and severe errors)
2	U8	All 1	Flash status
3	U8		Suspect Parameter Number (SPN) LSB:
		0..255	SPN LSB
4	U8		Suspect Parameter Number (SPN) Second byte:
		0..255	SPN second byte
5	Bits 8..6		Suspect Parameter Number (SPN) MSB:
		0..7	SPN MSB
	Bits 5..1		Failure mode identifier (FMI):
		0..31	FMI
6	Bit 8	0..1	Conversion method
	Bits 7..1		DTC occurrence count
		0..127	Counter value
7..8	-	All 1	Reserved

PVED-CLS controller	Main	Safety
Node-ID	0x14	0x5B
DM1 Msg-ID	0x18FECA14	0x18FECA5B

Table 6: DM1 message ID's

14.2 REQUEST PGN [REQ_PGN_X]

PVED-CLS supports request PGN for DM2, DM3, Component ID, Software ID and claimed address

Priority: 6
PGN: 59904 (0xEA00)
Occurrence: On Request
Sent by: Any node or global request
Sent to: PVED-CLS Main and Safety controller

Bytes	Encoding	Value / Range	Description
1	U8	0..255	Requested PGN MSB:
2	U8	0..255	Requested PGN LSB:
3	U8	All 0	Reserved

14.3 DM2 – PREVIOUSLY ACTIVE DIAGNOSTIC TROUBLE CODES [DM2_X]

Priority: 6
PGN: 65227 (0xFECB)
Occurrence: Periodic – every 1 sec, on request
Sent by: PVED-CLS main and safety controller
Sent to: All CAN nodes

Bytes	Encoding	Value / Range	Description
1	U8		Malfunction indicator lamp status:
		0x00	No active failure
		0x04	Amber warning lamp status (for warning and info errors)
		0x10	Red stop lamp status (for critical and severe errors)
2	U8	All 1	Flash status
3	U8		Suspect Parameter Number (SPN) LSB:
		0..255	SPN LSB
4	U8		Suspect Parameter Number (SPN) Second byte:
		0..255	SPN second byte
5	Bits 8..6		Suspect Parameter Number (SPN) MSB:
		0..7	SPN MSB
	Bits 5..1		Failure mode identifier (FMI):
		0..31	FMI
6	Bit 8	0..1	Conversion method
	Bits 7..1		DTC occurrence count
		0..127	Counter value
7..8	-	All 1	Reserved

Example:
The Previously active diagnostic trouble codes from PVED-CLS main (0x14) and safety controller (0x5B) is globally requested as shown in Table 6:

Message ID	DLC	Byte 1	Byte 2	Byte 3
0x18EA14FF	3	0xCB	0xFE	0x00
0x18EA5BFF	3	0xCB	0xFE	0x00

Table 7: Requesting DM2

14.4 DM3 – DIAGNOSTIC DATA CLEAR/RESET OF PREVIOUSLY ACTIVE DIAGNOSTIC TROUBLE CODES [DM3_X]

On issuing a request PGN for DM3, PVED-CLS resets the error counters – information to zero and erases the error history in EEPROM. Present error status will remain unchanged.

PGN: 65228 (0xFECC)
Occurrence: On Request
Sent by: Any node or global request
Sent to: PVED-CLS Main and Safety controller
See request PGN message format in section 16.2.

Note:

- Upon a successful clearing of the error history, the PVED-CLS will issue a positive acknowledgement.
- If a DM3 operation is already pursuing in the PVED-CLS and a new request for DM3 is received, then the PVED-CLS will send out a busy acknowledgement.

Example:
PVED-CLS slave main and safety controller source address are 0x14 and 0x5B respectively. Requesting node source address is 0xFF in the below example

Message ID	DLC	Byte 1	Byte 2	Byte 3
0x18EA14FF	3	0xCC	0xFE	0x00
0x18EA5BFF	3	0xCC	0xFE	0x00

Table 8: Requesting DM3

14.5 ACKNOWLEDGEMENT (J1939-21) [J1939_ACK_X]

Priority: 6
PGN: 59392 (0xE800)
Occurrence: On request
Sent by: PVED-CLS slave main and safety controller
Sent to: All nodes

Bytes	Encoding	Value / Range	Description
1	U8	 0x00 0x01 0x02	Control byte [Control byte]: Positive ACK Negative ACK Access denied (DM3 in progress)
2	-	All 0	Reserved
3..4	-	All 1	Reserved
5	U8	0x05 0xFF	Address positive ACK Reserved
6..7	U16	0..65535	Requested PGN
8	-	All 0	Reserved

Example 1:

After successful clearing the error history in the PVED-CLS main controller, the PVED-CLS will send out a positive acknowledgement.

Message ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x18E8FF14	8	0x00	0x00	0xFF	0xFF	0x05	0xCC	0xFE	0x00
0x18E8FF5B	8	0x00	0x00	0xFF	0xFF	0x05	0xCC	0xFE	0x00

Example 2:

If a DM3 operation is in progress and a new request for DM3 is received, then the PVED-CLS will send out the busy acknowledgement as follows.

Message ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x18E8FF14	8	0x02	0x00	0xFF	0xFF	0x05	0xCC	0xFE	0x00
0x18E8FF5B	8	0x02	0x00	0xFF	0xFF	0x05	0xCC	0xFE	0x00

14.6 COMPONENT ID [J1939_COMP_ID_X]

On issuing a request PGN for component ID, PVED-CLS will respond with the model number and the serial number with the format given below.

PGN: 65228 (0xFEEB)
Occurrence: On Request
Sent by: Any node or global request
Sent to: PVED-CLS Main and Safety controller
See request PGN message format in section 16.2.

PVED-CLS will report its model number (fx. 11108681) and serial number (fx. A1201171420035) through a BAM session.

BAM control message

Priority: 7
PGN: 60416 (0xEC00)
Sent by: PVED-CLS slave main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x20	BAM Control byte
2..3	U16	0x26	Number of bytes in this session
4	U8	0x06	Number of packets in this session
5	U8	0xFF	Reserved
6..8	U24	0x00FEEB	Requested PGN (Component ID)

Data message 1:

Priority: 7
PGN: 60160 (0xEB00)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x01	BAM Sequence number
2	ASCII	0x2A	Delimiter (“*”)
3..8	ASCII	-	First 6 bytes of model number in ASCII encoding

Data message 2:

Priority: 7
PGN: 60160 (0xEB00)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x02	BAM Sequence number
2..3	ASCII	-	Last 2 bytes of model number in ASCII encoding
4	ASCII	0x2A	Delimiter (“*”)
5..8	ASCII	-	Bytes 1 – 4 of serial number in ASCII encoding

Data message 3:

Priority: 7
PGN: 60160 (0xEB00)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x03	BAM Sequence number
2..8	ASCII	-	Bytes 5 – 11 of serial number in ASCII encoding

Data message 4:

Priority: 7
PGN: 60160 (0xEB00)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x04	BAM Sequence number
2..6	ASCII	-	Bytes 12 – 16 of serial number in ASCII encoding
7..8	-	All 0	Reserved

Data message 5:

Priority: 7
PGN: 60160 (0xEB00)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x05	BAM Sequence number
2..8	-	All 0	Reserved

Data message 6:

Priority: 7
PGN: 60160 (0xEB00)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x06	BAM Sequence number
2	-	All 0	Reserved
3	ASCII	0x2A	Delimiter (“*”)
4	ASCII	0x2A	Delimiter (“*”)
5..8	-	All 1	Reserved

If PVED-CLS is busy processing a component ID request (or other PGN request) while a new request is issued, PVED-CLS will send a busy acknowledgement message.

Busy acknowledgement message

Priority: 6
PGN: 60160 (0xE800)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x02	BAM busy
2	-	All 0	Reserved
3..4	-	All 1	Reserved
5	U8	0x05	Address busy Ack
6..8	U24	0x00FEEB	Requested PGN (Component ID)

14.7 SOFTWARE ID [J1939_SW_ID_X]

On issuing a request PGN for Software ID, PVED-CLS will respond with the boot loader software ID and the application software ID with the format given below

PGN: 65242 (0xFEDA)
Occurrence: On Request
Sent by: Any node or global request
Sent to: PVED-CLS Main and Safety controller
See request PGN message format in section 16.2.

Example:
PVED-CLS will report its boot loader ID (BOOT_CLS-_M_R382_KWP2000-_11153472_A-rr_151214) and application ID (APP-_CLS-_M_P192_SEHS----_11153340_-rrr_111214) through a BAM session.

BAM control message

Priority: 7
PGN: 60416 (0xEC00)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x20	BAM Control byte
2..3	U16	0x59	Number of bytes in this session
4	U8	0x0D	Number of packets in this session
5	U8	0xFF	Reserved
6..8	U24	0x00FEDA	Requested PGN (Software ID)

Data message 1:

Priority: 7
PGN: 60160 (0xEB00)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x01	BAM Sequence number
2	U8	0x02	Number of Software fields
3..8	ASCII	-	First 6 bytes of Boot loader ID in ASCII encoding

Data message 2:

Priority: 7
PGN: 60160 (0xEB00)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x02	BAM Sequence number
2..8	ASCII	-	Bytes 7 – 13 of boot loader ID in ASCII encoding

Data message 3:

Priority: 7
PGN: 60160 (0xEB00)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x03	BAM Sequence number
2..8	ASCII	-	Bytes 14 – 20 of boot loader ID in ASCII encoding

Data message 4:

Priority: 7
PGN: 60160 (0xEB00)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x04	BAM Sequence number
2..8	ASCII	-	Bytes 21 – 27 of boot loader ID in ASCII encoding

Data message 5:

Priority: 7
PGN: 60160 (0xEB00)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x05	BAM Sequence number
2..8	ASCII	-	Bytes 28 – 34 of boot loader ID in ASCII encoding

Data message 6:

Priority: 7

PGN: 60160 (0xEB00)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x06	BAM Sequence number
2..7	ASCII	-	Bytes 35 – 40 of boot loader ID in ASCII encoding
8	U8	-	Build date (day) decode in hex, read as decimal. See example in section **Data message 7**

Data message 7:

Priority: 7
PGN: 60160 (0xEB00)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x07	BAM Sequence number
2	U8	-	Build date (month) decode in hex, read as decimal. See example below
3	U8	-	Build date (year) decode in hex, read as decimal. See example below
4	ASCII	0x2A	Delimiter (“*”)
5..8	ASCII	-	First 4 bytes of application ID in ASCII encoding

Example of how to decode build date:
If build date is sent as: 0x21 (day), 0x05 (month) & 0x16 (year) this corresponds to build date: 21th of May 2016.

Data message 8:

Priority: 7
PGN: 60160 (0xEB00)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x08	BAM Sequence number
2..8	ASCII	-	Bytes 5 – 11 of application ID in ASCII encoding

Data message 9:

Priority: 7
PGN: 60160 (0xEB00)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x09	BAM Sequence number
2..8	ASCII	-	Bytes 12 – 18 of application ID in ASCII encoding

Data message 10:

Priority: 7
PGN: 60160 (0xEB00)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x0A	BAM Sequence number
2..8	ASCII	-	Bytes 19 – 25 of application ID in ASCII encoding

Data message 11:

Priority: 7
PGN: 60160 (0xEB00)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x0B	BAM Sequence number
2..8	ASCII	-	Bytes 26 – 32 of application ID in ASCII encoding

Data message 12:

Priority: 7
PGN: 60160 (0xEB00)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x0C	BAM Sequence number
2..8	ASCII	-	Bytes 33 – 39 of application ID in ASCII encoding

Data message 13:

Priority: 7
PGN: 60160 (0xEB00)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x0D	BAM Sequence number
2	ASCII	-	Byte 40 of application ID in ASCII encoding

3	U8	-	Build date (day) decode in hex, read as decimal. See example below
4	U8	-	Build date (month) decode in hex, read as decimal. See example below
5	U8	-	Build date (year) decode in hex, read as decimal. See example below
6	ASCII	0x2A	Delimiter (“*”)
7..8	-	All 1	Reserved

Example of how to decode build date:
If build date is sent as: 0x10 (day), 0x08 (month) & 0x15 (year) this corresponds to build date: 10th of August 2015.

Note:
If PVED-CLS is busy processing a software ID request (or other PGN request) while a new request is issued, PVED-CLS will send a busy acknowledgement message.

Busy acknowledgement message

Priority: 6
PGN: 60160 (0xE800)
Sent by: PVED-CLS main and safety controller
Sent to: All nodes

Bytes	Encoding	Value	Description
1	U8	0x02	BAM busy
2	-	All 0	Reserved
3..4	-	All 1	Reserved
5	U8	0x05	Address busy Ack
6..8	U24	0x00FEDA	Requested PGN (Software ID)