SAE J1939 Protocol for Joysticks

Project No.: **09-0075**
Project Name: **J4,5,6 Multifunktionsgriff CAN Interface**
Customer: **elobau**

Document: **09-0075 SAE J1939 Protocol for Joysticks v01.18.doc**

Revision History

Version	Date	Author	Revision	Distr. List
01.00	2009-10-19	Bummele	First draft.	
01.01	2009-11-26	Golubovic	Memory Access Function.	
01.02	2009-12-01	Bummele	Memory Access Function: DA added.	
01.03	2009-12-07	Bummele	Presence sensor added.	
01.04	2009-12-15	Golubovic	Memory Access Function: Response	
01.05	2009-12-17	Bummele	Error Behaviour and Memory Access added modified.	
01.06	2010-01-28	Golubovic	RQST/NACK message	
01.07	2010-02-12	Bummele	Annex C and Reference Documents modified. Proprietary A Joystick LED Command Message (PAJLCM) added. Configuration and Network Management added.	
01.08	2010-03-01	Bummele	DM1 message and error handling modified.	
01.09	2010-03-02	Bummele	Annex E: Position, Detent and Direction Definition added.	
01.10	2010-03-24	Golubovic	Plausibility type and test	
01.11	2011-01-20	Bummele	LED command modified.	
01.12	2011-07-04	Bummele	Plausibility calculation.	

01.13	2013-07-04	Bummele	PGN Software Identification (SOFT) modified. Thumb Wheel C definitions modified.	
01.14	2013-07-15	Bummele	Thumb Wheel C definitions extended.	
01.15	2013-07-26	Bummele	Zero Position after Power On + Bus Off modified.	
01.16	2013-07-29	Bummele	SOFT PGN modified.	
1.17	2013-12-10	Notz	LED 2-1 and LED 2-2 swapped Picture of thumb wheel LED positions	
1.18	2014-10-01	Notz	In PAJLCM position of button 9 and 10 swapped in this way like current software does it	

Revisions will be documated in blue.

Contents

Table of Figures

Table of Tables

1 Scope

This document represents the SAE J1939 Controller Area Network (CAN) message protocol for elobau joysticks.

2 Abbreviations And Acronyms

Abbreviation / Acronym	Definition and Meaning
SAE	Society of Automotive Engineers
SA	Source Address
DA	Destination Address
DP	Data Page
PF	PDU Format
PS	PDU Specific
PGN	Parameter Group Number
BJM	Basic Joystick Message
EJM	Extended Joystick Message
NACK	Negative Acknowledgement
NA	Not Available
ADC	Analogue Digital Converter
DTC	Diagnostic Trouble Code
SPN	Suspect Parameter Number
FMI	Failure Mode Indicator

Table 1: Abbreviations and terms

3 Reference Documents

Index []	Document (in valid version)
1	Software Specification for Joysticks
2	Hardware Specifications
3	SAE J1939 Recommended Practice for a Serial Control and Communications Vehicle Network
4	SAE J1939-21 Data Link Layer
5	SAE J1939-71 Vehicle Application Layer
6	SAE J1939-73 Application Layer - Diagnostics
7	SAE J1939-81 Network Management
8	SAE J1939 Joystick Parameter Table
9	Definition Nummerierung 36xG und 34xG

Table 2: Reference documents

4 Zero Position after Power On + Bus Off

If configured, after power on or bus off, axis and thumb wheel signals must be in zero position, otherwise the zero position is sent permanently.

5 Configuration

The joystick can be configured by a set of parameters. To read and write this parameters the joystick uses the J1939 memory access messages (DM14, DM15 and DM16).

6 Network Management (Address Claiming Process)

The joystick supports minimum network management functionality using non-configurable addressing mode. That means, the joystick source address is hard coded into the controller (parameter).

The address claiming process uses the J1939 address claiming message (AC) and the request message (RQST).

For more details about the address claiming process refer to SAE J1939-81.

7 Error Handling

All errors can be divided in signal errors and system errors.

All signal errors are signalised within the corresponding signal message (BJM1/2/3, EJM1/2/3) and as diagnostic trouble code within the DM1 message.

All system errors are signalised as diagnostic trouble code within the DM1 message (DM1) and some of them have additional outcome.

All detectable errors are defined as Diagnostic Trouble Codes (DTCs). A DTC is made up of four independent fields, as follows:

Suspect Parameter Number (SPN)	19 bits
Failure Mode Identifier (FMI)	5 bits
Occurrence Count	7 bits (not used: 127 / 0x7F)
SPN Conversion Method	1 bit (0: DTC represent as Intel format)

The joystick uses proprietary suspect parameter numbers (Proprietary SPNs) from 0x7F000 through 0x7FFFF.

7.1 Error Detection

All detectable errors are described in the following table.

DTC OC + SPN CM	DTC FMI***	DTC SPN***	Name	Indication / Behaviour	Remarks
0x7F	0xEC	0xF001	Application Program Checksum Error	Joystick sends / receives no CAN message.	CRC32

0x7F	0xEC	0xF002	Parameter Checksum Error	Joystick sends / receives no CAN message. Only Memory Access (DM14/DM15/DM16) possible.	CRC32 This error is also set until first parameter saving process.
0x7F	0xEC	0xF003	Not used		
0x7F	0xEC	0xF004	Not used		
0x7F	0xEC	0xF005	RAM Test Error		Not supported.
0x7F	0xE2	0xF010	X Axis, Signal 1, Out Of Range	Indication within BJM.	
0x7F	0xE2	0xF011	X Axis, Signal 2, Out Of Range	Indication within BJM.*	
0x7F	0xE2	0xF012	X Axis, Plausibility Error	Indication within BJM.**	
0x7F	0xE2	0xF020	Y Axis, Signal 1, Out Of Range	Indication within BJM.	
0x7F	0xE2	0xF021	Y Axis, Signal 2, Out Of Range	Indication within BJM.*	
0x7F	0xE2	0xF022	Y Axis, Plausibility Error	Indication within BJM.**	
0x7F	0xE2	0xF030	Thumb Wheel A, Signal 1, Out Of Range	Indication within EJM.	
0x7F	0xE2	0xF031	Thumb Wheel A, Signal 2, Out Of Range	Indication within EJM.*	
0x7F	0xE2	0xF032	Thumb Wheel A, Plausibility Error	Indication within EJM.**	
0x7F	0xE2	0xF040	Thumb Wheel B, Signal 1, Out Of Range	Indication within EJM.*	
0x7F	0xE2	0xF041	Thumb Wheel B, Signal 2, Out Of Range	Indication within EJM.*	
0x7F	0xE2	0xF042	Thumb Wheel B, Plausibility Error	Indication within EJM.**	
0x7F	0xE2	0xF050	Thumb Wheel C, Signal 1, Out Of Range	Indication within EJM.	
0x7F	0xE2	0xF051	Thumb Wheel C, Signal 2, Out Of Range	Indication within EJM.*	
0x7F	0xE2	0xF052	Thumb Wheel C, Plausibility Error	Indication within EJM.**	
0x7F	0xFF	0xF061	Button 1 Timeout	Indication within BJM.	
0x7F	0xFF	0xF062	Button 2 Timeout	Indication within BJM.	
0x7F	0xFF	0xF063	Button 3 Timeout	Indication within BJM.	
0x7F	0xFF	0xF064	Button 4 Timeout	Indication within BJM.	
0x7F	0xFF	0xF065	Button 5 Timeout	Indication within BJM.	
0x7F	0xFF	0xF066	Button 6 Timeout	Indication within BJM.	
0x7F	0xFF	0xF067	Button 7 Timeout	Indication within BJM.	
0x7F	0xFF	0xF068	Button 8 Timeout	Indication within BJM.	

0x7F	0xFF	0xF069	Button 9 Timeout	Indication within BJM.	
0x7F	0xFF	0xF06A	Button 10 Timeout	Indication within BJM.	
0x7F	0xFF	0xF06B	Button 11 Timeout	Indication within BJM.	
0x7F	0xFF	0xF070	LED Message Timeout		Not implemented.

Table 3: Diagnostic Trouble Codes

* Signal 2 can have opposite or same direction of signal 1 and is not visible within the corresponding signal message. Signal 2 is only used for plausibility check. If Signal 2 has an « Out of Range » error it causes also an error within the corresponding signal message.

** Plausibility calculation:

There are two types of plausibility test:

Case 1: Signal 2 has the same direction of signal 1.
Signal 1 - Signal 2 = 0mV +/- « Maximal Difference Signal 1_2 »

Case 2: Signal (on Channel) 2 has the opposite direction of signal (on Channel) 1.
Signal 1 + Signal 2 = 5000mV +/- « Maximal Difference Signal 1_2 »

This « Plausibility Error » causes also an error within the corresponding signal message. Plausibility Error will be displayed in case that Maximal Difference Signal 1_2 value is greater than 0 and if Plausibility type is not 0.

To guarantee reliability of the joystick a debounce filter shall be implemented for the plausibility monitoring.

*** Supported FMI codes:
2: Data Erratic, Intermittent Or Incorrect
12: Bad Intelligent Device Or Component
31: Condition Exists
This field contains also the three most significant bits of the SPN. In this case, that we are using proprietary suspect parameter numbers, this three bits are always set to one.

**** SPN Field without three most significant bits.

7.2 Error Storage

Not supported.

8 CAN Communication

The joysticks will be connected to a Controller Area Network (ISO 11898, CAN Specification 2.0B) using SAE J1939 protocol with a baudrate of 250kbit/s.

9 CAN 29 Bit ID Field

29 Bit Identifier																											
Priority			R	DP	PDU Format (PF)								PDU Specific (PS)								Source Address							
28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Figure 1: 29 Bit Identifier

Priority ï these bits control the bus arbitration and message latency of the CAN message relative to other messages. The priority is defined for each message transmitted.

R1 ï Reserved by SAE. This shall be set to 0 for all messages transmitted and shall be validated as being 0 for all messages received.

DP ï Data Page - This shall be set to 0 for all messages transmitted and shall be validated as being 0 for all messages received.

PF Field ï Transmitted message identifier. The PF field is defined for each message transmitted.

PS Field ï Transmitted message identifier extension or destination address. The PS field is defined for each message transmitted. See individual Joystick PGN definitions for PF and PS field information.

Source Address ï Transmitted message identifier. The source address is defined for each component on the CAN network. The source address is hard coded into the controller (parameter). The following table describes the joystick source address coding (other values are optional possible).

Joystick No.	Source Address
1	0x33
2	0x34
3	0x35

Table 4: Joystick source address

10 Joystick Messages

10.1 Basic Joystick Message 1/2/3 (BJM1/BJM2/BJM3)

The Basic Joystick Message (BJM) is used to transfer the information about the measured status of the joystick x-axis and y-axis and up to 12 buttons of the joystick grip.

	Definition	Remarks
Transmission Rate	100ms	Parameter
Data Length	8	
Extended Data Page	0	
Data Page	0	
Default Priority	3	
Parameter Group Number (PGN)	Refer to table PGN.	
Parameters	Refer to table parameters.	

Table 5: Basic Joystick Message (BJM) Definition

The PGN (Parameter Group Number) for the Basic Joystick Message (BJM) is hard coded into the controller (parameter). The following table describes the PGN (Parameter Group Number) for the Basic Joystick Message (BJM):

Joystick No.	Basic Joystick Message	PGN
1	BJM1	0xFDD6
2	BJM2	0xFDD8
3	BJM3	0xFDDA

Table 6: Joystick PGN definition for BJM

The following table shows the Basic Joystick Message (BJM) parameters:

Parameter Position		Length	Description
Byte 1	Bit 8...7	2 Bit	X-Axis Position (Bit 2...1)
	Bit 6...5	2 Bit	X-Axis Right Position Status
	Bit 4...3	2 Bit	X-Axis Left Position Status
	Bit 2...1	2 Bit	X-Axis Neutral Position Status
Byte 2	Bit 8...1	8 Bit	X-Axis Position (Bit 10...3)
Byte 3	Bit 8...7	2 Bit	Y-Axis Position (Bit 2...1)
	Bit 6...5	2 Bit	Y-Axis Forward Position Status
	Bit 4...3	2 Bit	Y-Axis Back Position Status
	Bit 2...1	2 Bit	Y-Axis Neutral Position Status
Byte 4	Bit 8...1	8 Bit	Y-Axis Position (Bit 10...3)
Byte 5	Bit 8...7	2 Bit	X-Axis Detent Position Status
	Bit 6...5	2 Bit	Y-Axis Detent Position Status
	Bit 4...3	2 Bit	not used (NA)
	Bit 2...1	2 Bit	not used (NA)
Byte 6	Bit 8...7	2 Bit	Grip Button 1 Status
	Bit 6...5	2 Bit	Grip Button 2 Status

	Bit 4...3	2 Bit	Grip Button 3 Status
	Bit 2...1	2 Bit	Grip Button 4 Status
Byte 7	Bit 8...7	2 Bit	Grip Button 5 Status
	Bit 6...5	2 Bit	Grip Button 6 Status
	Bit 4...3	2 Bit	Grip Button 7 Status
	Bit 2...1	2 Bit	Grip Button 8 Status
Byte 8	Bit 8...7	2 Bit	Grip Button 9 Status
	Bit 6...5	2 Bit	Grip Button 10 Status
	Bit 4...3	2 Bit	Grip Button 11 Status
	Bit 2...1	2 Bit	Grip Button 12 Status - Presence Sensor

Table 7: Basic Joystick Message (BJM) parameters

X/Y-Axis Position is analogue signal which is proportional to the axis position. This 10 bit value is in range from 0,0...100,0% (0x000 to 0x3E8), resolution 0,1%/bit, 0 offset. In neutral position value is 0. If an error occurs, value 1022 (0x3FE) is sent.

X/Y-Axis Status has two bits for representation:

00 Not In Position
01 In Position
10 Error Indicator
11 Not Available (NA)

Each Button has two bits for representation:

00 Button Not Pressed
01 Button Pressed
10 Error Indicator
11 Not Available (NA)

The presence sensor is also handled like a button and transmitted via CAN bus as button 12.

10.2 Extended Joystick Message 1/2/3 (EJM1/EJM2/EJM3)

The Extended Joystick Message (EJM) is used to transfer the information about the measured status of up to 3 thumb wheels of the joystick grip. This message will not be sent in case that all three thumb wheels are not in used (marked with configuration parameters)

	Definition	Remarks
Transmission Rate	100ms	Parameter
Data Length	8	
Extended Data Page	0	
Data Page	0	
Default Priority	3	
Parameter Group Number (PGN)	Refer to table PGN.	
Parameters	Refer to table parameters.	

Table 8: Extended Joystick Message (EJM) Definition

The PGN (Parameter Group Number) for the Extended Joystick Message (EJM) is hard coded into the controller (parameter). The following table describes the PGN (Parameter Group Number) for the Extended Joystick Message (EJM):

Joystick No.	Extended Joystick Message	PGN
1	EJM1	0xFDD7
2	EJM2	0xFDD9
3	EJM3	0xFDDB

Table 9: Joystick PGN definition for EJM

The following table shows the Extended Joystick Message (EJM) parameters:

Parameter Position		Length	Description
Byte 1	Bit 8...7	2 Bit	Thumb Wheel A Position (Bit 2...1)
	Bit 6...5	2 Bit	Thumb Wheel A Top Position Status
	Bit 4...3	2 Bit	Thumb Wheel A Down Position Status
	Bit 2...1	2 Bit	Thumb Wheel A Neutral Position Status
Byte 2	Bit 8...1	8 Bit	Thumb Wheel A Position (Bit 10...3)
Byte 3	Bit 8...7	2 Bit	Thumb Wheel B Position (Bit 2...1)
	Bit 6...5	2 Bit	Thumb Wheel B Top Position Status
	Bit 4...3	2 Bit	Thumb Wheel B Down Position Status
	Bit 2...1	2 Bit	Thumb Wheel B Neutral Position Status
Byte 4	Bit 8...1	8 Bit	Thumb Wheel B Position (Bit 10...3)
Byte 5	Bit 8...7	2 Bit	Thumb Wheel C Position (Bit 2...1)
	Bit 6...5	2 Bit	Thumb Wheel C Right Position Status (in case of a left hand joystick) or Thumb Wheel C Left Position Status (in case of a right hand joystick) or Thumb Wheel C Top Position Status

	Bit 4...3	2 Bit	Thumb Wheel C Left Position Status (in case of a left hand joystick) or Thumb Wheel C Right Position Status (in case of a right hand joystick) or Thumb Wheel C Down Position Status
	Bit 2...1	2 Bit	Thumb Wheel C Neutral Position Status
Byte 6	Bit 8...1	8 Bit	Thumb Wheel C Position (Bit 10...3)
Byte 7	Bit 8...7	2 Bit	Thumb Wheel A Detent Position Status
	Bit 6...5	2 Bit	Thumb Wheel B Detent Position Status
	Bit 4...3	2 Bit	Thumb Wheel C Detent Position Status
	Bit 2...1	2 Bit	not used (NA)
Byte 8	Bit 8...1	8 Bit	not used (NA)

Table 10: Extended Joystick Message (EJM) parameters

A/B/C-Thumb Wheel Position is analogue signal which is proportional to the thumb wheel position. This 10 bit value is in range from 0,0...100,0% (0x000 to 0x3E8), resolution 0,1%/bit, 0 offset. In neutral position value is 0. If an error occurs, value 1022 (0x3FE) is sent.

A/B/C-Thumb Wheel Status has two bits for representation:

00 Not In Position
01 In Position
10 Error Indicator
11 Not Available (NA)

10.3 Proprietary A Joystick LED Command Message (PAJLCM)

The Proprietary A Joystick LED Command Message (PAJLCM) is used to control the joystick button and thumb wheel LEDs.

	Definition	Remarks
Transmission Rate	Per user requirement.	
Data Length	8	
Extended Data Page	0	
Data Page	0	
Default Priority	3	
Parameter Group Number (PGN)	0xEFDA	DA: Destination Address
Parameters	Refer to table parameters.	

Table 11: Proprietary A Joystick LED Command Message (PAJLCM) definition

The following table shows the Proprietary A Joystick LED Command Message (PAJLCM) parameters:

Parameter Position		Length	Description
Byte 1	Bit 8...7	2 Bit	Grip Button 2, LED 2
	Bit 6...5	2 Bit	Grip Button 2, LED 1
	Bit 4...3	2 Bit	Grip Button 1, LED 2
	Bit 2...1	2 Bit	Grip Button 1, LED 1
Byte 2	Bit 8...7	2 Bit	Grip Button 4, LED 2
	Bit 6...5	2 Bit	Grip Button 4, LED 1
	Bit 4...3	2 Bit	Grip Button 3, LED 2
	Bit 2...1	2 Bit	Grip Button 3, LED 1
Byte 3	Bit 8...7	2 Bit	not used (NA)
	Bit 6...5	2 Bit	not used (NA)
	Bit 4...3	2 Bit	Grip Button 5, LED 2
	Bit 2...1	2 Bit	Grip Button 5, LED 1
Byte 4	Bit 8...7	2 Bit	not used (NA)
	Bit 6...5	2 Bit	not used (NA)
	Bit 4...3	2 Bit	not used (NA)
	Bit 2...1	2 Bit	not used (NA)
Byte 5	Bit 8...7	2 Bit	not used (NA)
	Bit 6...5	2 Bit	not used (NA)
	Bit 4...3	2 Bit	not used (NA)
	Bit 2...1	2 Bit	not used (NA)
Byte 6	Bit 8...7	2 Bit	not used (NA)
	Bit 6...5	2 Bit	Thumb Wheel A, LED 1+3 or LED 1+2+3 (if LED 2 not separated) or LED 2-3 (if only LED available) Alternative: Grip Button 10, LED 1
	Bit 4...3	2 Bit	Thumb Wheel A, LED 2-1 Alternative: Grip Button 8, LED 2
	Bit 2...1	2 Bit	Thumb Wheel A, LED 2-2 Alternative: Grip Button 8, LED 1

Byte 7	Bit 8...7	2 Bit	not used (NA)
	Bit 6...5	2 Bit	Thumb Wheel B, LED 1+3 or LED 1+2+3 (if LED 2 not separated) or LED 2-3 (if only LED available) Alternative: Grip Button 10, LED 2
	Bit 4...3	2 Bit	Thumb Wheel B, LED 2-1 Alternative: Grip Button 9, LED 2
	Bit 2...1	2 Bit	Thumb Wheel B, LED 2-2 Alternative: Grip Button 9, LED 1
Byte 8	Bit 8...7	2 Bit	not used (NA)
	Bit 6...5	2 Bit	not used (NA)
	Bit 4...3	2 Bit	not used (NA)
	Bit 2...1	2 Bit	not used (NA)

Table 12: Proprietary A Joystick LED Command Message (PAJLCM) parameters

Each LED has two bits for representation:

Coding (bit1bit0)	**Function**
00	LED off
01	LED on
10	LED blink (periodically off/on)
11	Not Available (NA) Or Not Installed Or No Change On Previously LED Function

10.4 Request (RQST)

This message type can be used to request Parameter Group Number (PGN) information globally (source address 255) or from specific destination. That means the Destination Address (DA) can be globally or specific.

General rules of operation for determining whether to send a Parameter Group Number (PGN) to a global or specific destination:

- If the Request is sent to a global address, then the response is sent to global address. A global response shall not be responded to with a NACK when a particular PGN is not supported by a node.

- If the Request is sent to a specific address, then the response is sent to a specific address. A NACK is required if the PGN is not supported.

It is generally recommended that Requests occur no more than 2 or 3 times per second.

	Definition	Remarks
Transmission Rate	Per user requirement.	
Data Length	3	
Extended Data Page	0	
Data Page	0	
Default Priority	6	
Parameter Group Number (PGN)	0xEADA	DA: Destination Address
Parameters	Refer to table parameters.	

Table 13: Request (RQST) definition

Parameter Position		Length	Description
Byte 3...1	Bit 24...1	3 Bytes	Parameter Group Number (PGN) being requested. See table PGN field definition.

Table 14: Request (RQST) parameters

The following table shows the filed definition and the byte order of the Parameter Group Number (PGN) in the data field of the Request message.

Byte 1	Byte 2	Byte 3
PDU Specific (PS)	PDU Format (PF)	0x00

Table 15: PGN field definition and byte order

The joystick supports the following PGNs by using this Request service:

PGN	Name	Acronym
0x00FEFF or 0x00FEDA	Software Identification	SOFT
0x00EE00	Address Claiming	AC
0x00FECA	Active Diagnostic Trouble Codes	DM1

Table 16: Supported PGNs

NACK message has PGN: E8DA and data fields like in following example

Position	Data Example	Description
Byte 1	0x01	Control byte=1, Negative Acknowledgment (NACK)
Byte 2	0x00	Group Function Value
Byte 3	0xFF	Reserved for assignment by SAE
Byte 4	0xFF	Reserved for assignment by SAE
Byte 5	0xFF	Address negative acknowledgment
Byte 6	0x00	PGN of requested information
Byte 7	0x12	PGN of requested information
Byte 8	0x34	PGN of requested information

Table 17: NACK example

10.5 Software Identification (SOFT)

The Software Identification (SOFT) message contains the software version and checksum information of the joystick. This message is transmitted as response to a Request (RQST) message.

	Definition	Remarks
Transmission Rate	On request.	
Data Length	Variable	
Extended Data Page	0	
Data Page	0	
Default Priority	6	
Parameter Group Number (PGN)	0xFEFF or 0xFEDA	Not standard conform!
Parameters	Refer to table parameters.	

Table 18: Software Identification (SOFT) definition

Parameter Position		Length	Description
Byte 1	Bit 8...1	8 Bits	Number of Software Identification Fields (0x02)
Byte 2	Bit 8...1	8 Bits	SW Version Major
Byte 3	Bit 8...1	8 Bits	SW Version Minor
Byte 4	Bit 8...1	8 Bits	'*'
Byte 5	Bit 8...1	8 Bits	HW Version
Byte 6	Bit 8...1	8 Bits	'*'
Byte 7	Bit 8...1	8 Bits	Not used (0x00)
Byte 8	Bit 8...1	8 Bits	Not used (0x00)

Table 19: Software Identification (SOFT) parameters

10.6 Component Identification (CI) - Option

The Component Identification (CI) message contains the serial number information of the joystick. This message is transmitted as response to a Request (RQST) message.

	Definition	Remarks
Transmission Rate	On request.	
Data Length	Variable	
Extended Data Page	0	
Data Page	0	
Default Priority	6	
Parameter Group Number (PGN)	0xFEEB	
Parameters	Refer to table parameters.	

Table 20: Component Identification (CI) definition

Parameter Position		Length	Description
Byte 1	Bit 8...1	8 Bits	Delimiter (ASCII "*")
Byte 2	Bit 8...1	8 Bits	Delimiter (ASCII "*")
Byte 3	Bit 8...1	8 Bits	Serial Number [8] (ASCII)
Byte 4	Bit 8...1	8 Bits	Serial Number [7] (ASCII)
Byte 5	Bit 8...1	8 Bits	Serial Number [6] (ASCII)
Byte 6	Bit 8...1	8 Bits	Serial Number [5] (ASCII)
Byte 7	Bit 8...1	8 Bits	Serial Number [4] (ASCII)
Byte 8	Bit 8...1	8 Bits	Serial Number [3] (ASCII)
Byte 9	Bit 8...1	8 Bits	Serial Number [2] (ASCII)
Byte 10	Bit 8...1	8 Bits	Serial Number [1] (ASCII)
Byte 11	Bit 8...1	8 Bits	Delimiter (ASCII "*")
Byte 12	Bit 8...1	8 Bits	Delimiter (ASCII "*")

Table 21: Component Identification (CI) parameters

10.7 Address Claiming (AC)

The Address Claiming (AC) message is sent by the joystick to claim an address on the network after power on. This message is also transmitted as response to a Request (RQST) message.

The Address Claiming (AC) message contains the 64 bit J1939 Name Field.

For more details about the address claiming process refer to SAE J1939-81.

	Definition	Remarks
Transmission Rate	As required.	
Data Length	8	
Extended Data Page	0	
Data Page	0	
Default Priority	6	
Parameter Group Number (PGN)	0xEE00	
Parameters	Refer to table parameters.	

Table 22: Address Claiming (AC) definition

Parameter Position		Length	Description
Byte 1	Bit 8...1	8 Bits	Name - Identity Number LSB
Byte 2	Bit 8...1	8 Bits	Name - Identity Number Second Byte
Byte 3	Bit 8...6	3 Bits	Name - Manufacturer Code LSB
	Bit 5...1	5 Bits	Name - Identity Number MSB
Byte 4	Bit 8...1	8 Bits	Name - Manufacturer Code MSB
Byte 5	Bit 8...8	5 Bits	Name - Function Instance
	Bit 3...1	3 Bits	Name - ECU Instance
Byte 6	Bit 8...1	8 Bits	Name - Function
Byte 7	Bit 8...2	7 Bits	Name - Vehicle System
	Bit 1	1 Bit	Name - Reserved
Byte 8	Bit 8	1 Bits	Name - Arbitrary Address Capable
	Bit 7...5	3 Bits	Name - Industry Group
	Bit 4...1	4 Bits	Name - Vehicle System Instance

Table 23: Address Claiming (AC) parameters

J1939 joystick Name definition:

Identity Number:	0
Manufacturer Code:	152 / 0x98
ECU Instance:	0
Function Instance:	0
Function:	66 / 0x42 (I/O Controller)
Reserved Filed:	0
Vehicle System:	0
Vehicle System Instance:	0
Industry Group:	3 (Construction Equipment) or

	alternative 2 (Agricultural and Forestry Equipment)
Arbitrary Address Capable:	0

10.8 Active Diagnostic Trouble Codes (DM1)

The DM1 message should be used to communicate any fault that the joystick can detect. Immediately when a fault is detected, the joystick ECM should transmit this message at a rate of 1 time per second. If a fault is no longer detected, the message shall send one message indicating that there is no longer a fault detected.

This message is also transmitted as response to a Request (RQST) message.

The DM1 message shall be broadcasted every one second, even when there is no active error.

For more details about this active diagnostic trouble codes, refer to SAE J1939-73.

	Definition	Remarks
Transmission Rate	On request, on occurrence or cyclic (1s)	
Data Length	variable	
Extended Data Page	0	
Data Page	0	
Default Priority	6	
Parameter Group Number (PGN)	0xFECA	
Parameters	Refer to table parameters.	

Table 24: Active Diagnostic Trouble Codes (DM1) definition

Parameter Position		Length	Description
Byte 1	Bit 8...7	2 Bits	Malfunction Indicator Lamp Status (not used: 00b)
Byte 1	Bit 6...5	2 Bits	Red Stop Lamp Status (not used: 00b)
Byte 1	Bit 4...3	2 Bits	Amber Warning Lamp Status (not used: 00b)
Byte 1	Bit 2...1	2 Bits	Protect Lamp Status (not used: 00b)
Byte 2	Bit 8...7	2 Bits	Flash Malfunction Indicator Lamp Status (not used: 11b)
Byte 2	Bit 6...5	2 Bits	Flash Red Stop Lamp Status (not used: 11b)
Byte 2	Bit 4...3	2 Bits	Flash Amber Warning Lamp Status (not used: 11b)
Byte 2	Bit 2...1	2 Bits	Flash Protect Lamp Status (not used: 11b)
Byte 3	Bit 8...1	8 Bits	DTC SPN (LSB - most significant at bit 8)
Byte 4	Bit 8...1	8 Bits	DTC SPN (most significant at bit 8)
Byte 5	Bit 8...6	3 Bits	DTC SPN (MSB - most significant at bit 8)
Byte 5	Bit 5...1	5 Bits	DTC FMI (most significant at bit 5)
Byte 6	Bit 8	1 Bit	DTC SPN Conversion Method (0: DTC represent as Intel format)
Byte 6	Bit 7...1	7 Bits	DTC Occurrence Count (not used: 127)
Byte 7	Bit 8...1	8 Bits	Not used (0xFF)
Byte 8	Bit 8...1	8 Bits	Not used (0xFF)

Table 25: Active Diagnostic Trouble Codes (DM1) parameters

The following illustrates the message format for when a request of the DM1 is made and there are zero active errors, or when there are zero active errors and the message is being transmitted at its regular one second interval:

Byte 1	Indicator Lamps	0x00
Byte 2	Flashing Lamps	0xFF
Byte 3...6	DTC	0x00000000
Byte 7	Not used	0xFF
Byte 8	Not used	0xFF

The following illustrates the message format for when there is more than one active DTC:

Indicator Lamps
Flashing Lamps
DTC 1
DTC 2
DTC n

In this case, the transport protocol of SAE J1939-21 will have to be used to send the information because it requires more than 8 data bytes.

10.9 Start Stop Broadcast (DM13) - Option

This message is used to start or stop the cyclic broadcast messages of the joystick.

After power on, the joystick starts automatically (if address claiming process is successful) transmitting the BJM and EJM messages. With the stop broadcast command (DM13), this transmission can be stopped.

To keep the joystick in the stop broadcast state, this DM13 message with the command hold current state set have to be sent cyclic every 5 seconds. If the joystick does not receive this command within 6 seconds, it will automatically go back in broadcast mode and send the cyclic broadcast messages BJM and EJM.

For more details about this memory access messages, refer to SAE J1939-73.

	Definition	Remarks
Transmission Rate	On request.	
Data Length	8	
Extended Data Page	0	
Data Page	0	
Default Priority	6	
Parameter Group Number (PGN)	0xDF00	
Parameters	Refer to table parameters.	

Table 26: DM13 definition

Parameter Position		Length	Description
Byte 1	Bit 8...7	2 Bits	Current Data Link: 00 Stop Broadcast 01 Start Broadcast 10 Reserved 11 Don't Care / Take no action (leave as is)
Byte 1	Bit 6...5	2 Bits	J1587
Byte 1	Bit 4...3	2 Bits	J1922
Byte 1	Bit 2...1	2 Bits	J1939 Network #1, Primary vehicle network
Byte 2	Bit 8...7	2 Bits	J1939 Network #2
Byte 2	Bit 6...5	2 Bits	ISO 9141
Byte 2	Bit 4...3	2 Bits	J1850
Byte 2	Bit 2...1	2 Bits	Other, Manufacturer Specified Port
Byte 3	Bit 8...7	2 Bits	J1939 Network #3
Byte 3	Bit 6...5	2 Bits	SAE Reserved
Byte 3	Bit 4...3	2 Bits	SAE Reserved
Byte 3	Bit 2...1	2 Bits	SAE Reserved
Byte 4	Bit 8...5	4 Bits	Hold Signal: 0000 All devices 0001 Devices whose broadcast state has been modified 0010...1110 Reserved 1111 Not Available

Byte 4	Bit 4...1	4 Bits	Suspend Signal
Byte 6...5	Bit 16...1	16 Bits	Suspend Duration
Byte 7	Bit 8...1	8 Bits	SAE Reserved
Byte 8	Bit 8...1	8 Bits	SAE Reserved

Table 27: DM13 parameters

10.10 Memory Access (DM14/DM15/DM16)

The joystick can be configured by a set of parameters. To read and write this parameters the joystick uses the J1939 memory access messages DM14, DM15 and DM16.

The whole parameter table will be secured by a checksum calculation CRC32.

The parameter table of the joystick is specified in the SAE J1939 Joystick Parameter Table.

For more details about this memory access messages, refer to SAE J1939-73.

10.10.1 Memory Access Request (DM14)

The DM14 message (Memory Access Request) is used to request a read or write memory access to the joystick parameter table.

	Definition	Remarks
Transmission Rate	On request.	
Data Length	8	
Extended Data Page	0	
Data Page	0	
Default Priority	6	
Parameter Group Number (PGN)	0xD9DA	DA: Destination Address
Parameters	Refer to table parameters.	

Table 28: DM14 definition

Parameter Position		Length	Description
Byte 1	Bit 8...1	8 Bits	Length / Number Requested (LSB)
Byte 2	Bit 8...6	3 Bits	Length / Number Requested (MSB)
Byte 2	Bit 5	1 Bit	Pointer Type - Always 0 ï Direct MA
Byte 2	Bit 4...2	3 Bits	Command: 0 Erase ï Not used 1 Read 2 Write 3 Status Request ï Not used 4 Operation Completed 5 Operation Failed 6 Boot Load ï Not used 7 EDCP Generation ï Not used
Byte 2	Bit 1	1 Bit	SAE Reserved (sent as 1)
Byte 3	Bit 8...1	8 Bits	Pointer (LSB): Index
Byte 4	Bit 8...1	8 Bits	Pointer: Index
Byte 5	Bit 8...1	8 Bits	Pointer (MSB): Index
Byte 6	Bit 8...1	8 Bits	Pointer Extension ï Not used
Byte 8...7	Bit 16...1	16 Bits	Key / User Lever ï Not used

Table 29: DM14 parameters

10.10.2 Memory Access Response (DM15)

The DM15 message (Memory Access Response) is used by the joystick to response to a memory access request.

	Definition	Remarks
Transmission Rate	On request.	
Data Length	8	
Extended Data Page	0	
Data Page	0	
Default Priority	6	
Parameter Group Number (PGN)	0xD8DA	DA: Destination Address
Parameters	Refer to table parameters.	

Table 30: DM15 definition

Parameter Position		Length	Description
Byte 1	Bit 8...1	8 Bits	Length / Number Allowed (LSB)
Byte 2	Bit 8...6	3 Bits	Length / Number Allowed (MSB)
Byte 2	Bit 5	1 Bit	SAE Reserved
Byte 2	Bit 4...2	3 Bits	Status: 0 Proceed 1 Busy 2 Reserved 3 Reserved 4 Operation Completed 5 Operation Failed 6 Reserved 7 Reserved
Byte 2	Bit 1	1 Bit	SAE Reserved
Byte 5...3	Bit 24...1	24 Bits	Error Indicator / EDC Parameter
Byte 6	Bit 8...1	8 Bits	EDCP Extension: 0x06 Data in Error Indicator / EDC Parameter is an Error Indicator
Byte 8...7	Bit 16...1	16 Bits	Seed ï Not used

Table 31: DM15 parameters

Bit States	Error Indicator States
0x000000	No Error
0x000001	Currently processing for someone else
0x000011	Currently processing Read Request
0x000012	Currently processing Write Request
0x000101	Addressing Error - Address not on a valid boundary
0x010003	Transport of data NOT initiated within the time allowed
0x010004	Transport of data NOT completed within the time allowed
	Other error indicator states are not used

Table 32: DM15 error indicator

10.10.3 Binary Data Transfer (DM16)

The DM16 message (Binary Data Transfer) is used to transfer the memory access data (parameter table).

	Definition	Remarks
Transmission Rate	On request.	
Data Length	8	
Extended Data Page	0	
Data Page	0	
Default Priority	6	
Parameter Group Number (PGN)	0xD7DA	DA: Destination Address
Parameters	Refer to table parameters.	

Table 33: DM16 definition

Parameter Position		Length	Description
Byte 1	Bit 8...1	8 Bits	Number of Occurrences of Raw Binary Data
Byte 2	Bit 8...1	8 Bits	Raw Binary Data Byte #1 LSB
Byte 3	Bit 8...1	8 Bits	Raw Binary Data Byte #2
Byte 4	Bit 8...1	8 Bits	Raw Binary Data Byte #3
Byte 5	Bit 8...1	8 Bits	Raw Binary Data Byte #4 MSB
Byte 6	Bit 8...1	8 Bits	Raw Binary Data ï not used
Byte 7	Bit 8...1	8 Bits	Raw Binary Data ï not used
Byte 8	Bit 8...1	8 Bits	Raw Binary Data ï not used

Table 34: DM16 parameters

10.10.4 Read Data Sequence

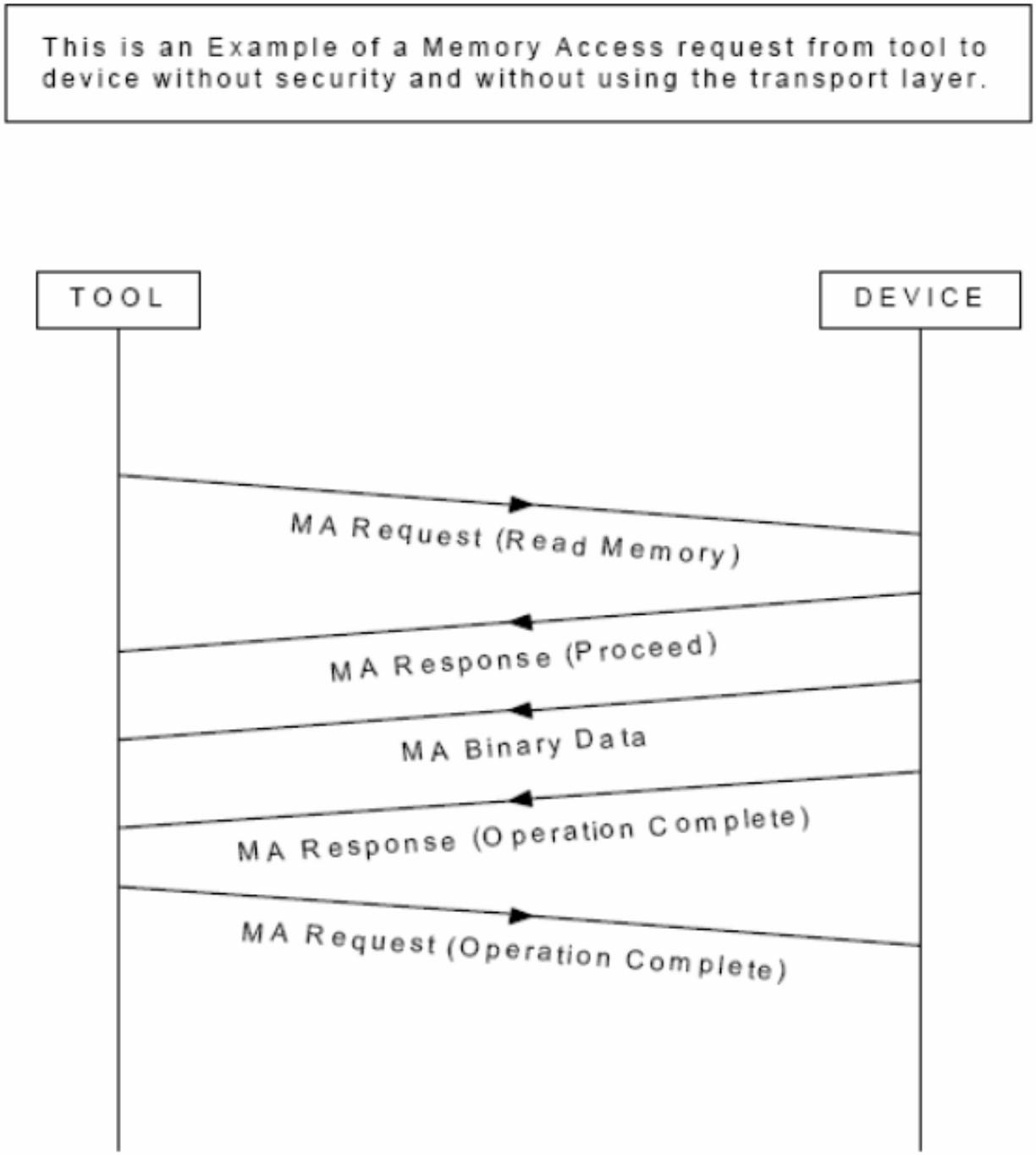

Figure 2: Read Data Sequence

10.10.5 Write Data Sequence

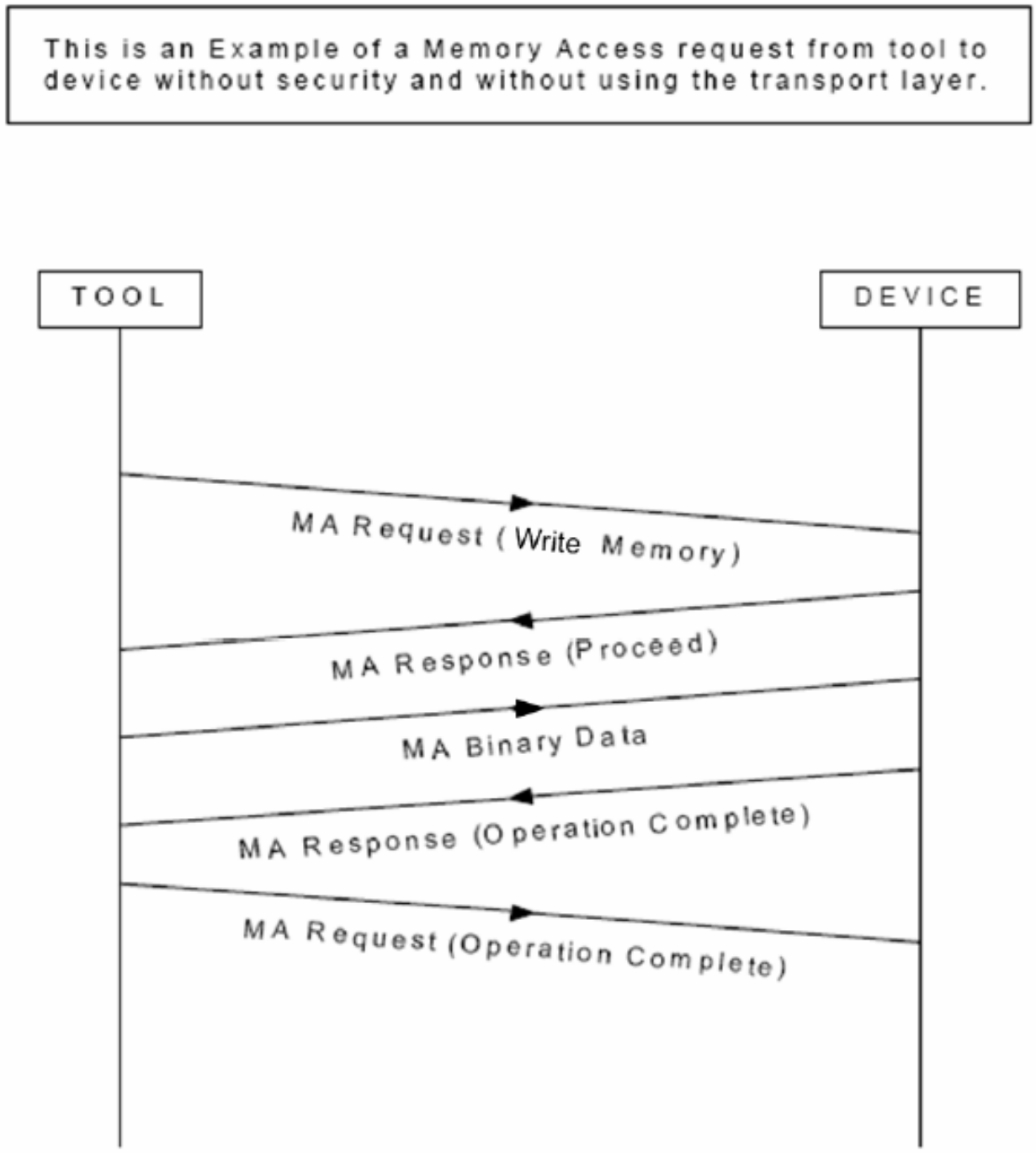

Figure 3: Write Data Sequence

11 Annex A: Joystick Axis Definition

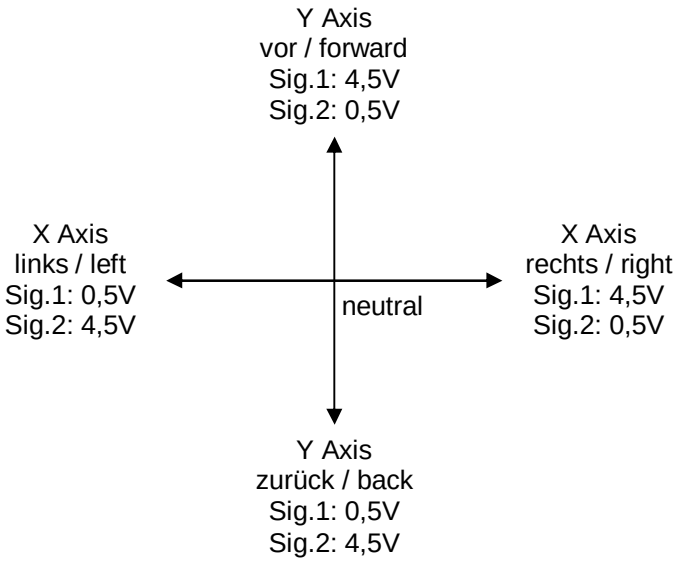

Figure 4: Joystick Axis Definition

Notes:

- The signal voltage values are ideal values.
- Please find detailed signal voltages with tolerances in the corresponding component data sheets of joysticks.
- Signal 2 not available in standard version. Optional possible.

12 Annex B: Thumb Wheel A/B Definition

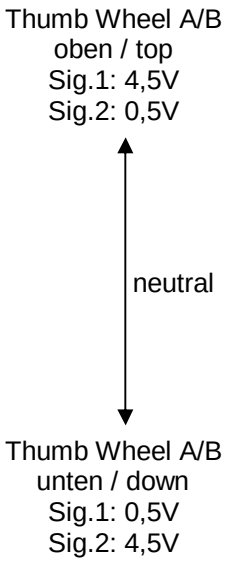

Figure 5: Thumb Wheel A/B Definition

Notes:

- The signal voltage values are ideal values. Please find detailed signal voltages with tolerances in the corresponding component data sheets of thumb wheels.
- Signal 2 not available in standard version. Optional possible.

13 Annex C: Thumb Wheel C Definition

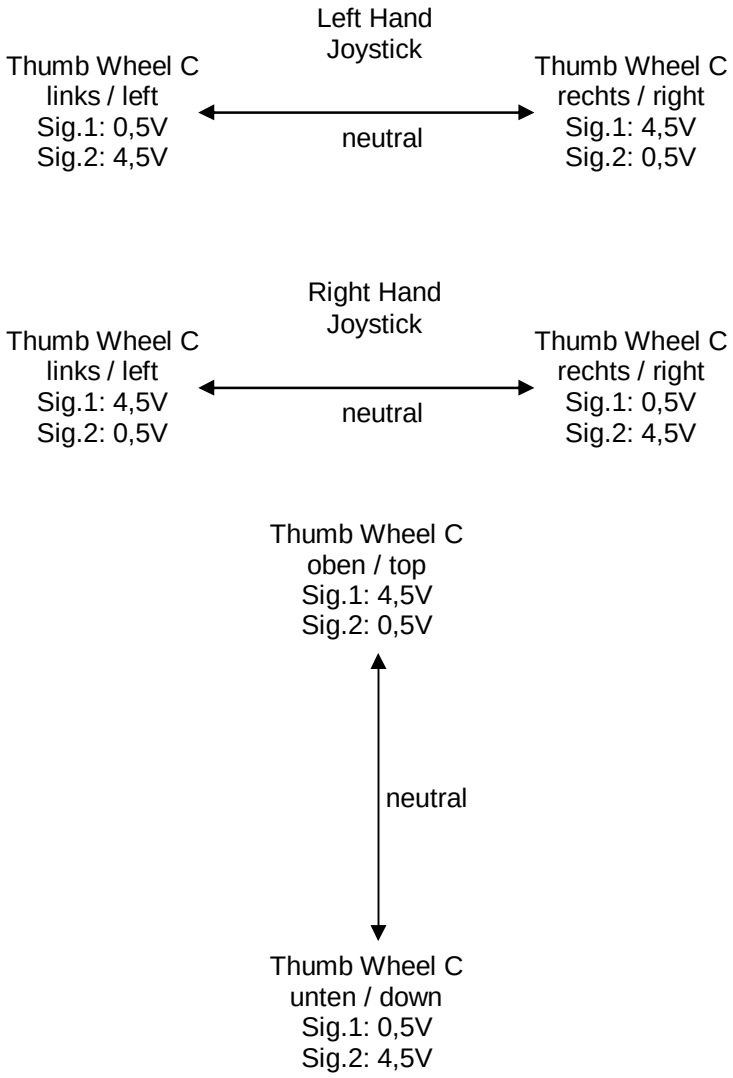

Figure 6: Thumb Wheel C Definition

Notes:

- The signal voltage values are ideal values. Please find detailed signal voltages with tolerances in the corresponding component data sheets of thumb wheels.
- Signal 2 not available in standard version. Optional possible.
- The direction left/right is seen from the operator side That means if the operator moves the thumb wheel from his state of view into the left side, left signal must be generated.

14 Annex D: Thumb Wheel A/B LED Definition

This figure shows position of LEDs included in thumb wheel.

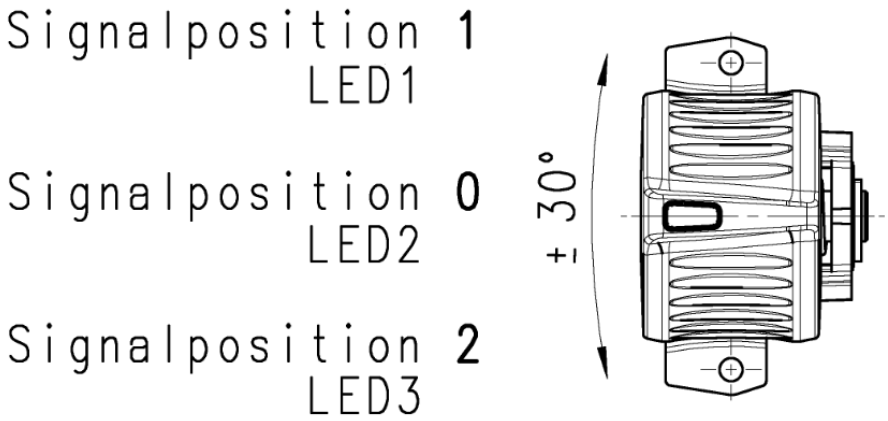

Figure 7: Thumb Wheel A/B LED Definition

15 Annex E: Multifunctional Grip Definition

Refer to additional specifications.

16 Annex F: Position, Detent and Direction Definition

This two examples show the J1939 BJM and EJM position, detent and direction definition. This examples consider no tolerances.

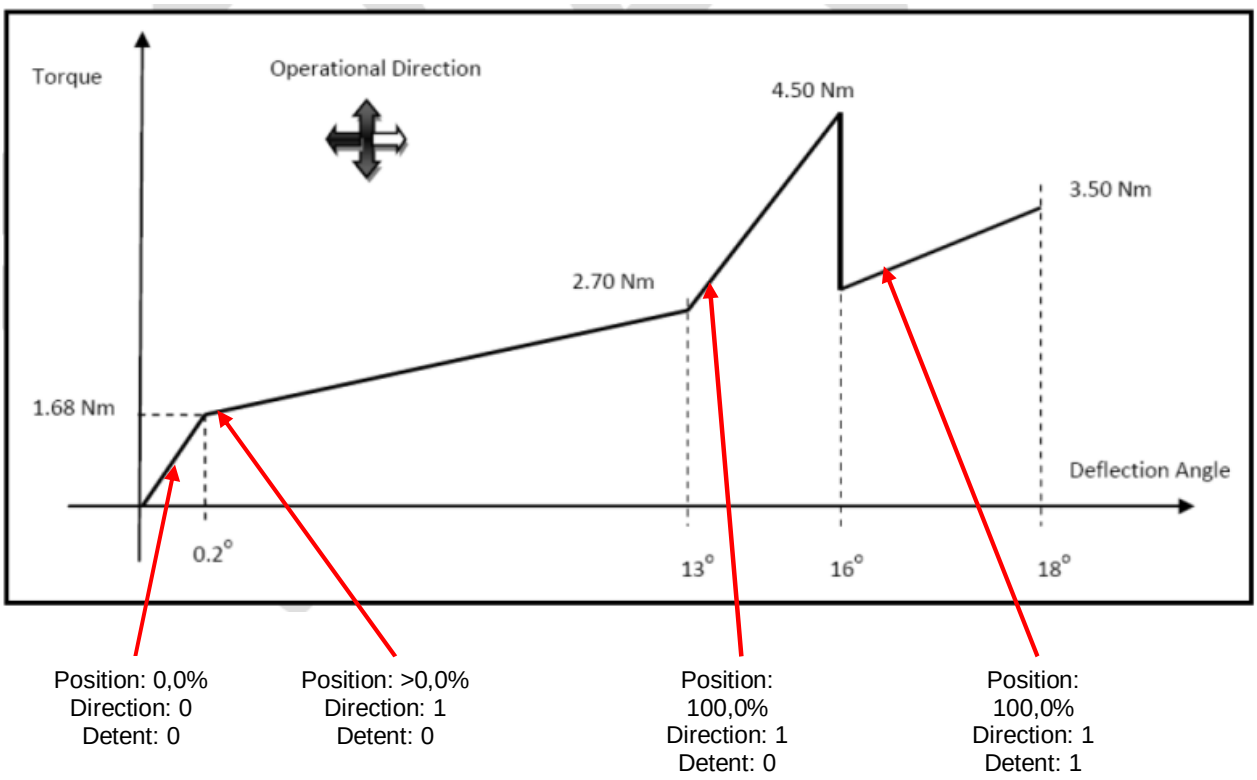

Figure 8: Example 1: With mechanical detent

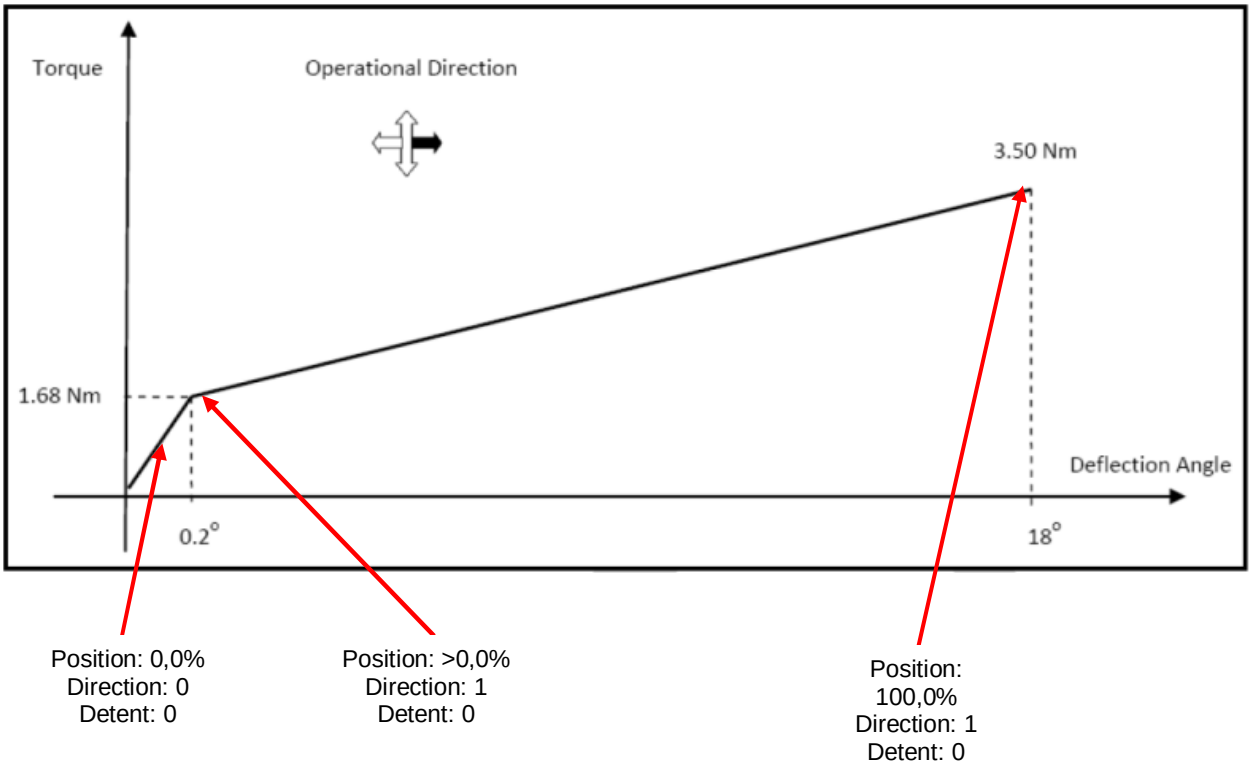

Figure 9: Example 2: Without mechanical detent