

Operation guide

Rotary position sensors SAE J1939 Digital output DST X510 and DST X520



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1. General Information

1.1 Contact

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1.2 General

This document represents a Danfoss SAE J1939 definition for HALL-effect single turn rotary sensors.

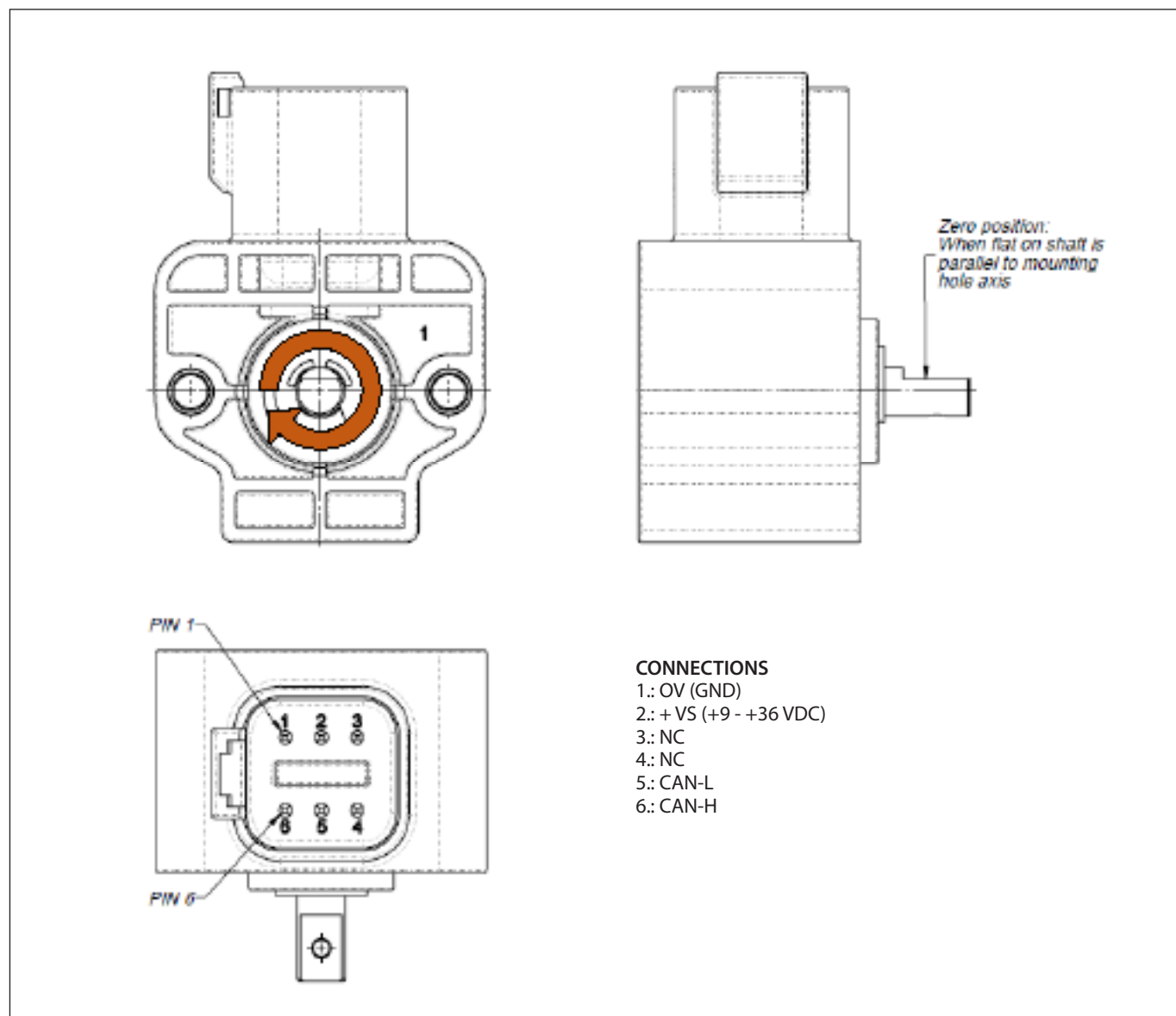
2. Abbreviations and terms

Abbreviation / Term	Definition
SAE	Society of Automotive Engineers
ECU	Electronic Control Unit
CA	Controller Application
PDU	Protocol Data Unit
NMT	Network Management
PGN	Parameter Group Number
AC	Address Claiming
MSB	Most Significant Byte
LSB	Least Significant Byte
SOF	Start Of Frame
RTR	Remote Transmission Request
CRC	Cyclic Redundancy Check
ACK	Acknowledgement
EOF	End Of Frame
SRR	Substitute Remote Request
IDE	Identifier Extension
POST	Power On Self Test
CW	Clockwise
CWW	Counterclockwise

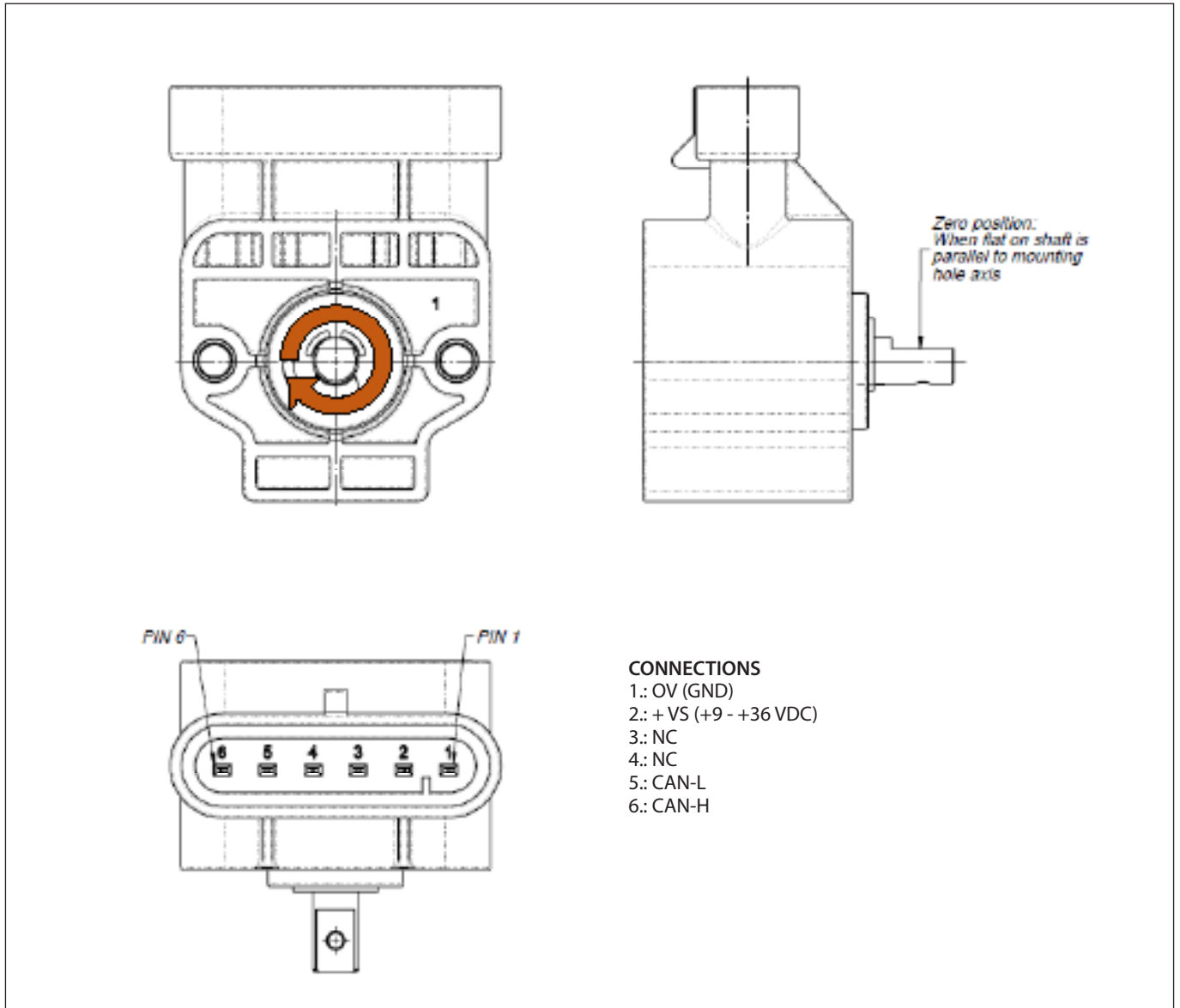
3. Reference documents

Document	Contents
J1939 - Recommended Practice for a Serial Control & Communications Vehicle Network	
J1939/11 - Physical layer - 250k bits/s, Shield Twisted Pair	Bus physical properties
J1939/13 - Off-Board Diagnostic Connector	Standard connector for diagnostic purpose
J1939/21 - Data Link Layer	CAN frame (29-bit identifier, PGN etc.), transport protocol functions, and 5 types of message types: Commands, Requests, Broadcasts/Responses, Acknowledgement, and Group Functions
J1939/31 - Network Layer	Services and functions needed for intercommunication between different segments of a J1939 network
J1939/71 - Vehicle Application Layer	Standard parameters which are grouped together in a message frame and given a PGN
J1939/73 - Application Layer - Diagnostics	Functions and messages for accessing diagnostic and calibration data
J1939/81 - Network Management	Information about the content of an ECU Name and how the ECU claims an addressing using that Name

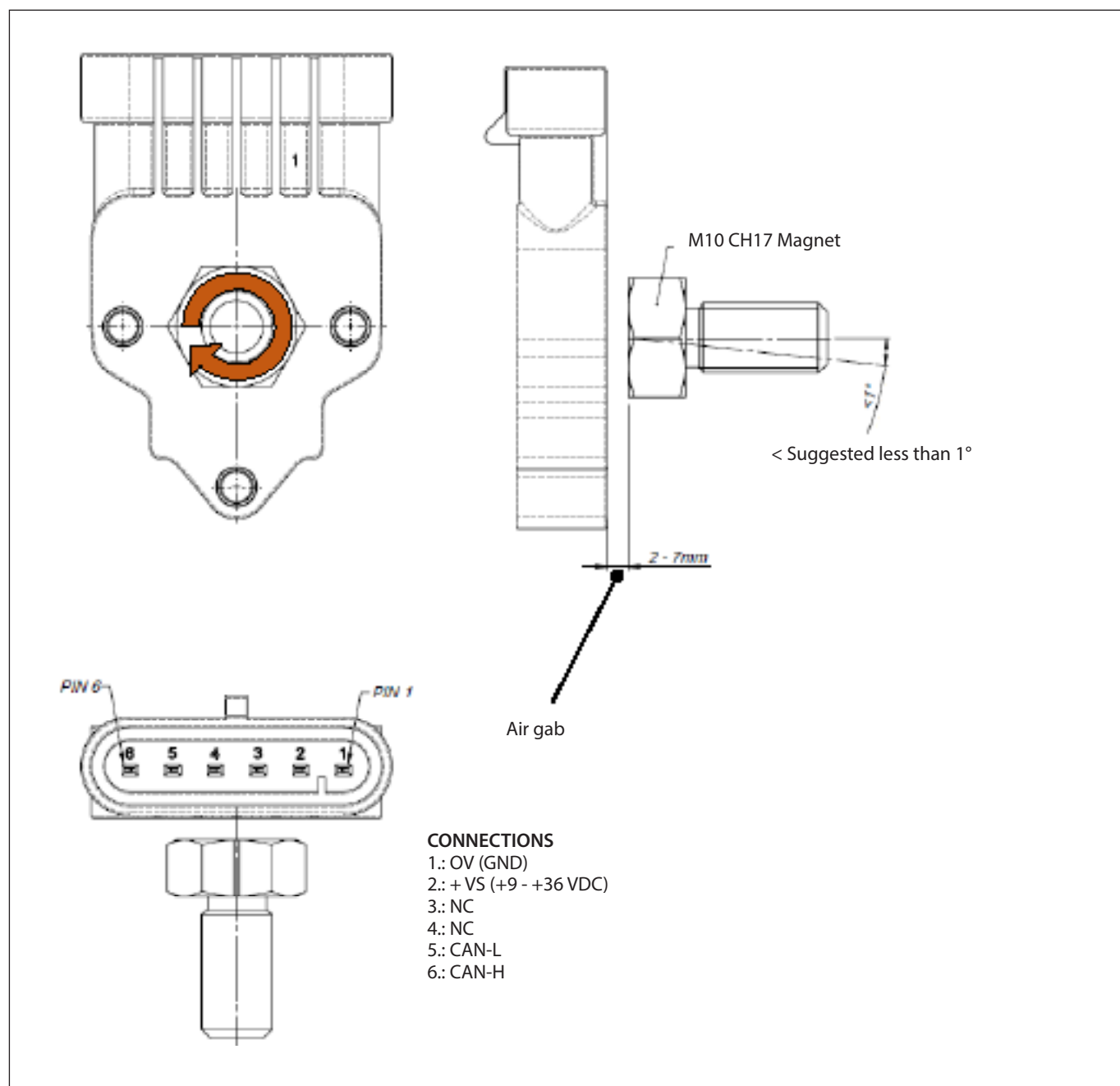
4. Electrical Connections 4.1 Deutsch version with shaft and Block diagram



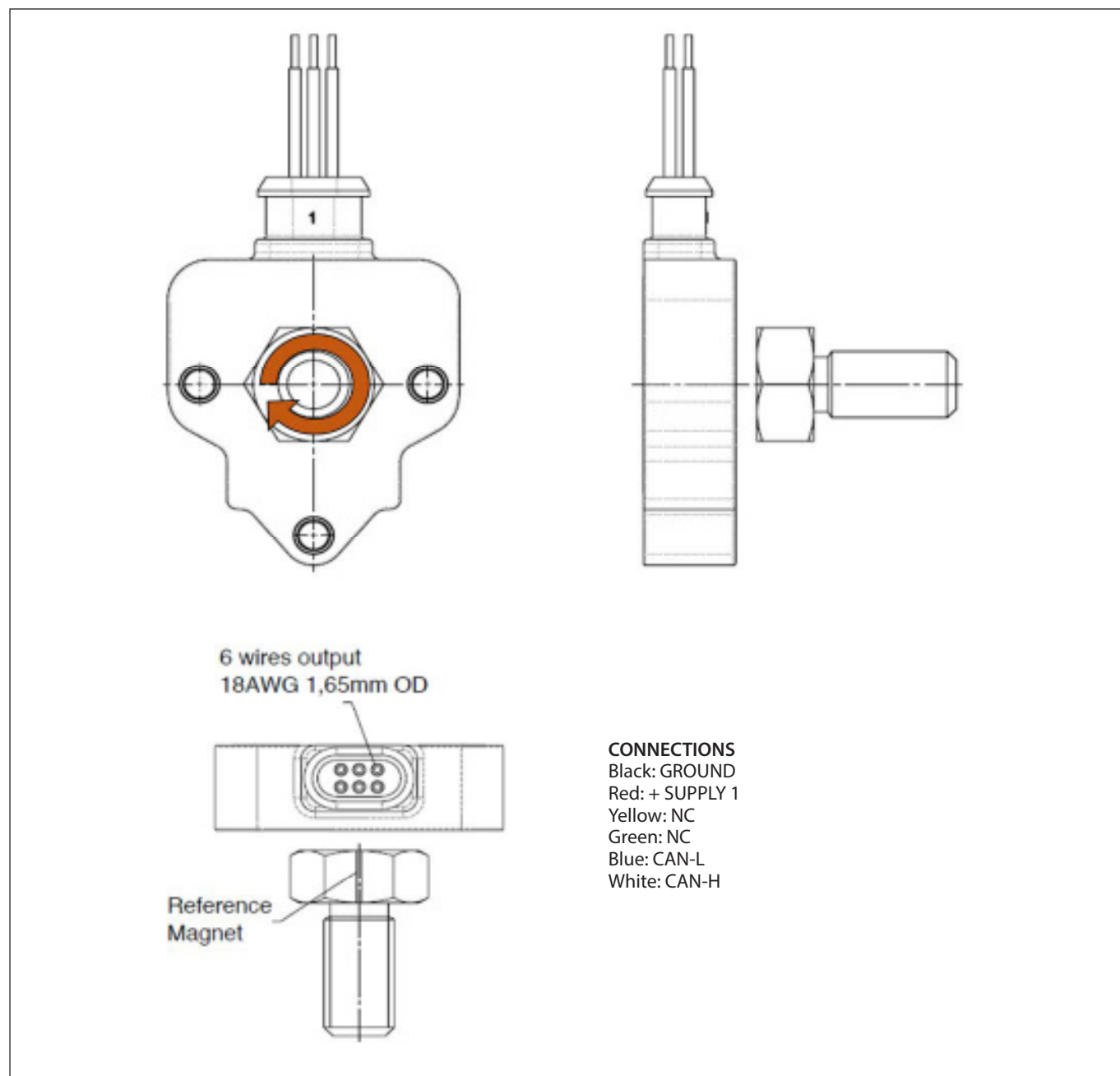
4.2 AMP version with shaft



4.3 AMP version without shaft



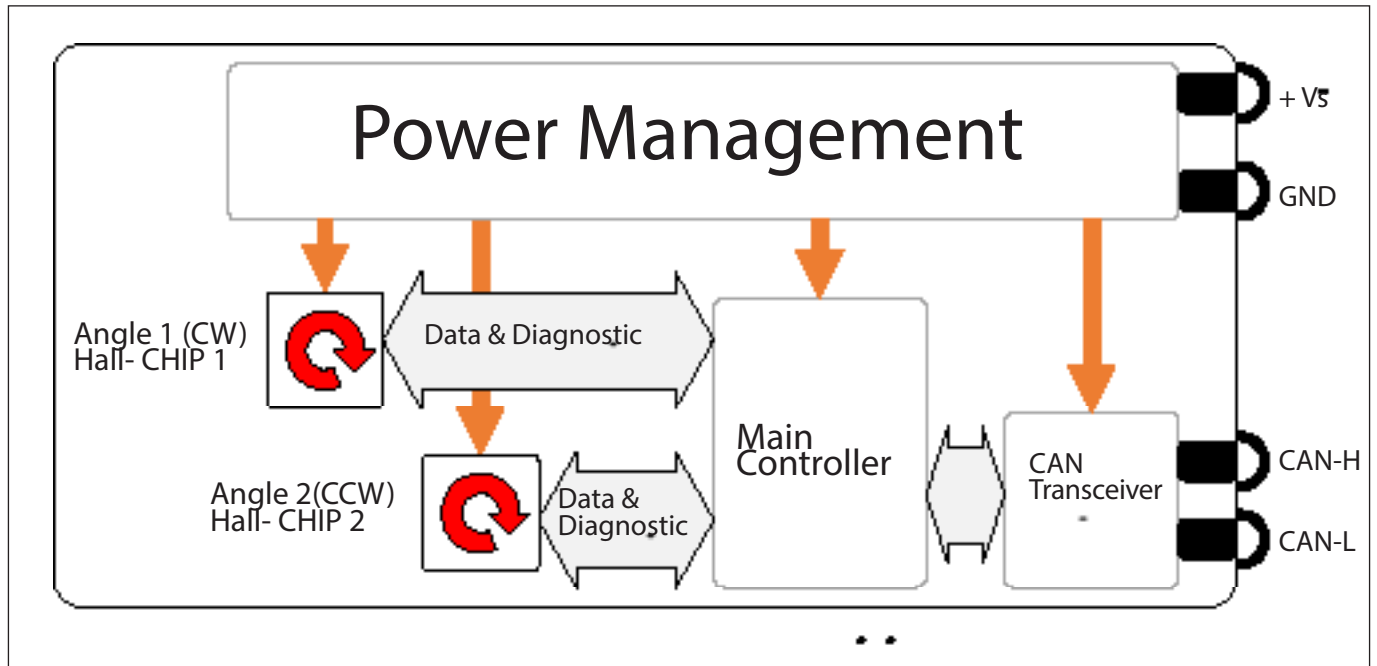
4.4 Cable without shaft



NOTE:

Make sure that the CANbus is terminated. The impedance measured between CAN-H and CAN-L must be $60\ \Omega$ that means the cable must be connected to a $120\ \Omega$ resistor on each end of the bus line. Internally the transducer is not terminated with resistor of $120\ \Omega$. Do not confuse the signal lines of the CANbus, otherwise communication with the transducer is impossible.

4.5 Danfoss Hall-effect rotary sensor: Block diagram



5. Default SAE J1939 definitions

- **Data rate:** 250 kbps
- **Arbitrary Address Capable:** 1
- **Transmission rate:** 100 ms
- **Identifier:** 18FF0B15h
- **PGN:** 65291 (OFF0Bh) - "Proprietary B"
- **Source Address:** 21(15h)
- **Priority:** 6
- **Data:**
 - Byte 0, 1: Angle 1 position unsigned int. 16 bit: 0 - 3599 (CW/CCW according to the ordering code, Angle position 0 - 359.9°; 0.1° resolution)
 - Byte 2, 3: Angle 2 position 0 - 3599 (CW/CCW according to the ordering code, Angle position 0 - 359.9°, 0.1° resolution)
 - Byte 4, 5, 6: 0xFF - Not in use
 - Byte 7: Error code
- **Diagnostic message:** DM 13 only supported

The current data rate of Danfoss Hall-effect single-turn rotary sensors with SAE J1939 output is 250 kbps. A typical message containing 8 data bytes is 128 bits long (excluding bits used for bit stuffing) which in time is approximately 500 µs.

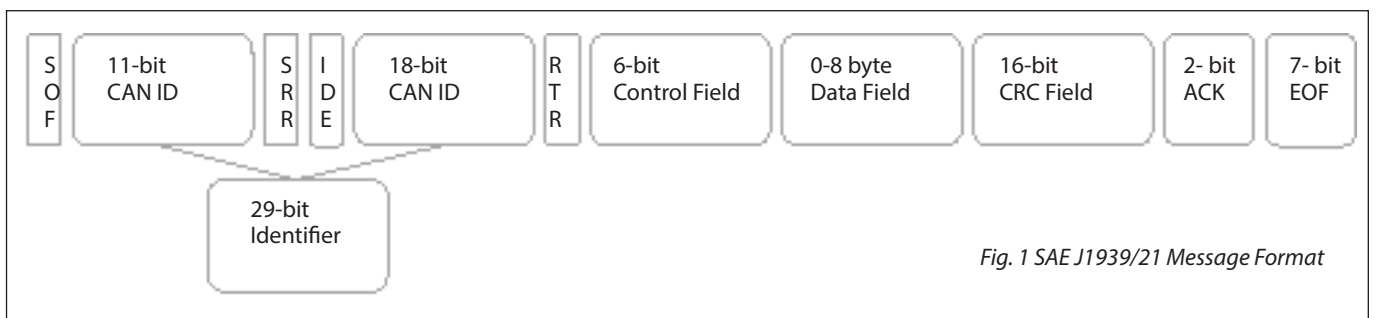


Fig. 1 SAE J1939/21 Message Format

J1939 uses 29-bit identifier defined within CAN 2.0B protocol shown in table 1.4

The device is configured as Arbitrary Address Capable device, thus it can claim other addresses, sending the Address Claimed message with the source address in the range 128 to 247 inclusive

If no other Address Claimed message with the same Source Address is received, or if the arbitration is won, the device uses that address and begins regular network communications with that address. If no address in the range of 128 to 247 is available (arbitration always lost), the device sends the Cannot Claim Address message using the NULL address (254). In this case, regular network communications are suspended.

-	3 bits	1 bit	1 bit	8 bits	8 bits	8 bits
	Priority	Reserved	Data page	PDU format	PDU specific	
				< 240: PDU1	Destination Address	
				≥ 240: PDU2	Group extension	
PGN						Source Address

Table1: Structure of 29 bit identifier

6. Getting started

- When the sensor is turned on, it sends an Address Claimed message according to PGN 60928 as shown in the example of Fig. 2 (page 10). The message is composed of:
 - **Identifier:** 18EEFFXXh (Tabel 2)
 - **Data Field:** device Name (Tabel 3)
- After the sensor has acquired a valid address, it starts sending the angle position message according to PGN 65291 as shown in the example of Fig. 3 (page 10). The message is composed of:
 - **Identifier:** 0x18FF0BXXh (Tabel 4)
 - **Data Field:** Angle position (Tabel 5)

In case of an error occurs, the angle position message will be sent with Angle 1 and Angle 2 MSB = 0xFF and LSB = 0xFF.

18h				EEh	FFh	XXh
000	110	0	0	1110 1110	1111 1111	0001 0101
-	3 bits	1 bit	1 bit	8 bits	8 bits	8 bits
	Priority: 6	Reserved	Data page	PDU format: PDU1	PDU specific: Destination Address	Source Address
		PGN 60928 (0EE00h)				

Table 2: PNG 60928 Address Claimed: Identifier definition

XXh	XXh	XXh		5Bh	XXh		XXh	XXh		XXh		
xxxx xxxx	xxxx xxxx	100	x xxxx	0101 1011	x xxxx	xxx	xxxx xxxx	xxxx xxxx	0	x	xxx	xxxx
8 bits	8 bits	3 bits	5 bits	8bits	5 bits	3 bits	8 bits	7 bits	1 bit	1 bit	3 bits	4 bits
Identity number, LSB	Identity number	Manufacturer code, LSB	Identity number, MSB	Manufacturer code, MSB	Function instance	ECU instance	Function	Vehicle system	Reserved bit	Arbitrary address bit	Industry group	Vehicle system instance

Table 3: PNG 60928 Address Claimed: Name definition

Field	Description
Arbitrary address bit	0: Single Address Capable device (not implemented) 1: Arbitrary Address Capable device
Industry group	2: Agricultural and Forestry Equipment 3: Construction Equipment
Vehicle system instance	0
Vehicle system	0
Reserved bit	0

Field	Description
Function	142 (8Eh): Rotary Sensor
Function instance	0
ECU instance	0
Manufacturer code	732 (2D Ch): Danfoss A/S
Identity number	Programmed by: Danfoss A/S

Table 4: Danfoss J1939 Name definition for Hall-effect single turn rotary sensors

18h				FFh	0Bh	XXh
000	110	0	0	1111 1111	0000 1011	0001 0101
	3 bits	1 bit	1 bit	8 bits	8 bits	8 bits
-	Priority: 6	Reserved	Data page	PDU format: PDU2	PDU specific: Group extension	Source Address
PGN 65291 (0FF0Bh)						

Table 5: PGN 65291 Proprietary B: Identifier definition

XXh	XXh	XXh	XXh	FFFFFFh	XXh
xxxx xxxx	xxxx xxxx	xxxx xxxx	xxxx xxxx	1111 11111 1111 1111 11111 1111	xxxx xxxx
8 bits	8 bits	8 bits	8 bits	24 bits	8 bits
Angle 1, MSB	Angle 1, LSB	Angle 2, MSB	Angle 2, LSB	Reserved	Error Code
Data type: 16-bit unsigned integer Resolution: 0.1 deg Ex.: 008Ah = 138 = 13.8 deg	Data type: 16-bit unsigned integer Resolution: 0.1 deg Ex.: 0D7Ch = 3452 = 345.2 deg				0000 0000 No error 0000 0001 Angle 1 sensor chip error 0000 0010 Angle 2 sensor chip error 0000 0100 Magnetic field too high/low 0010 0000 Program checksum error 0100 0000 Parameter checksum error

Table 6: PGN 65291 Proprietary B: Angle position definition

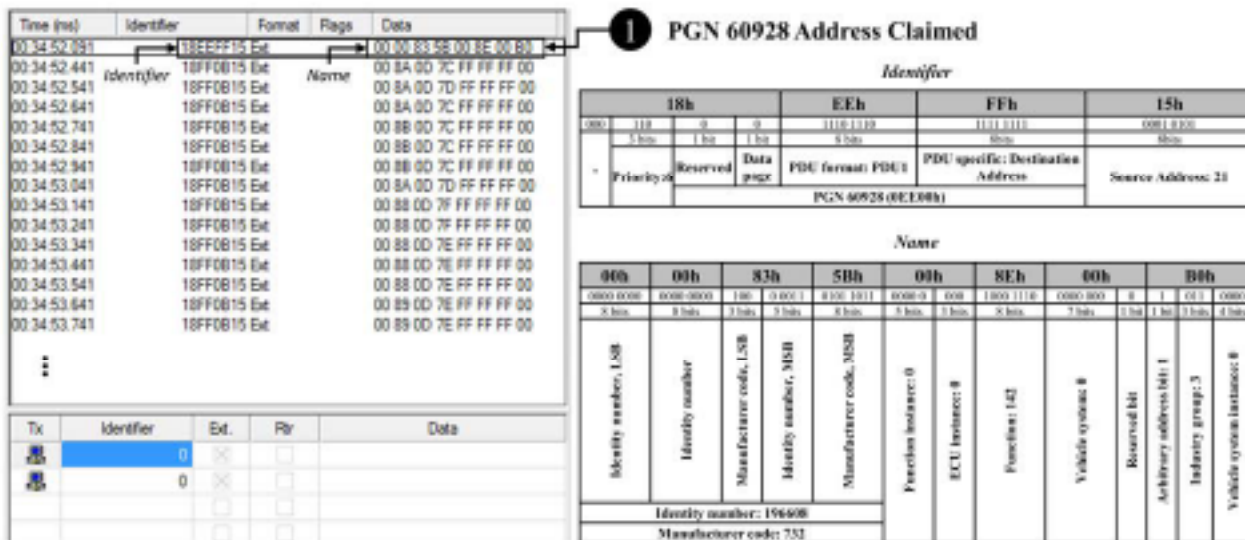


Fig. 2: Example: Address Claimed message

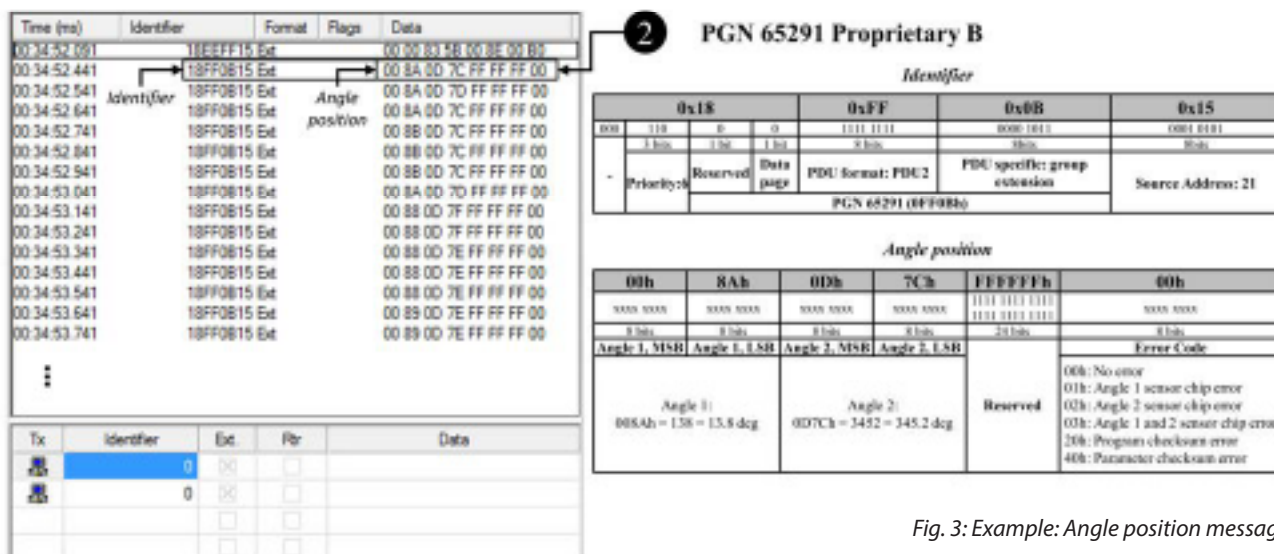


Fig. 3: Example: Angle position message

7. How to change the name

The Name of the sensor can be configured by sending Destination Specific - Propriarily Configurable Message 1 according to PNG 45312 as shown in the example in Fig.4 (page 12). The message is composed of:

- **Identifier:** 18BXXXh (table 7)
- **Note:** Consider that the Destination Address is the address of the sensor, while the Source Address refers to the address of the user CAN controller that sends the message.
- **Data field:** Propriarily Configurabe Message 1 (table 8)

18h				B1h	XXh	XXh
000	110	0	0	1011 0001	XXXX XXXX	XXXX XXXX
	3 bits	1 bit	1 bit	8 bits	8 bits	8 bits
	Priority: 6	Reserved	Data page	PDU format: PDU1	PDU specific: Destination Address	Source Address
PGN 45312 (0B100h)						

Table 7: PGN 45312 Propriarily Configurable Message 1: Identifier definition

6765672h	XXh	XXh	XXh	XXh	XXh	XXh	XXh	
0110 0111 0110 0101 0110 0110 0111 0010	xxxx x	xxx	xxxx xxxx	xxxx xxx	0	x	xxx	xxxx
32 bits	5 bits	3 bits	8 bits	7 bits	1 bit	1 bit	3 bits	4 bits
ASCII code: "gefr"	Function instance	ECU instance	Function	Vehicle system	Reserved bit	Arbitrary address bit	Industry group	Vehicle system instance

Table 8: PGN 45312 Propriarily Configurable Message 1: Messenger definition

The figure illustrates the process of changing the name of a sensor via a CAN bus message. On the left, a screenshot of a diagnostic tool shows a list of messages. A message with identifier 18B11500 is highlighted, showing its data field as 67 65 66 72 00 0E 16 A0. A blue arrow points from this message to a diagram on the right.

The diagram, titled "PGN 45312 Propriarily Configurable Message 1", shows the structure of the message. The Identifier field is defined as follows:

18h	B1h	15h	09h		
000 3 bits	0 1 bit	0 1 bit	1011 0001 8 bits		
- Priority: 6	Reserved	Data page	PDU format: PDU1		
			PDU specific: Destination Address: 21		
PGN 45312 (0B100h)					
Source Address: 0					

Changes to be made:

- Industry group: old value: 3 → new value: 2
- Vehicle system: old value: 0 → new value: 11

The Propriarily Configurable Message 1 structure is shown below:

6765672h	00h	0Eh	16h	A0h
00 67 65 66 72 00 0E 16 A0	0000 0	0000 0	0000 1110	0000 011
32 bits	4 bits	4 bits	4 bits	4 bits
ASCII code: "gefr"	Function instance: 0	ECU instance: 0	Function: 142	Vehicle system: 11
	Reserved bit	Arbitrary address bit: 1	Industry group: 2	Vehicle system instance: 0

Fig. 4: Example: How to change the name

8. How to change the transmission rate

The Transmission Rate of the sensor can be configured by sending the Destination Specific - Propriarily Configurable Message 2 according to PGN 45568 as shown in the example Fig. 5 (page 13).

The message is composed of:

- **Identifier:** 18B2XXXXh (table 9)
- **Note:** Consider that the Destination Address is the address of the sensor, while the Source Address refers to the address of the user CAN controller that sends the message.
- **Data field:** Propriarily Configurable Message 2 (table 10)

18h				B1h	XXh	XXh
000	110	0	0	1011 0010	XXXX XXXX	XXXX XXXX
	3 bits	1 bit	1 bit	8 bits	8 bits	8 bits
	Priority: 6	Reserved	Data page	PDU format: PDU1	PDU specific: Destination Address	Source Address
PGN 45568 (0B200h)						

Table 9: PGN 45568 Propriarily Configurable Message 2: Identifier definition

67656672h	XXh	XXh	0000h
0110 0111 0110 0101 0110 0110 0111 0010	xxxx xxxx	xxxx xxxx	0000 0000 0000 0000
32 bits	8 bits	8 bits	16 bits
ASCII code: "gefr"	Transmission rate LSB	Transmission rate MSB	Reserved
	Data type: 16-bit unsigned integer Resolution: 1 ms Range: 10 - 65535; 0= stop transmission Ex.: 0032h = 50 = 50 ms		

Table 10: PGN 45568 Propriarily Configurable Message 2: Message definition

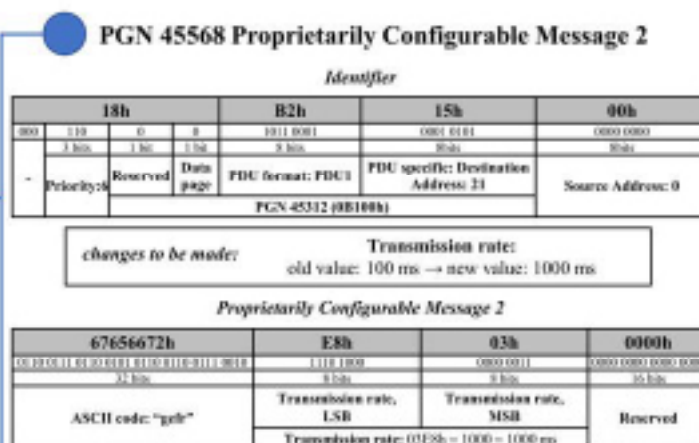
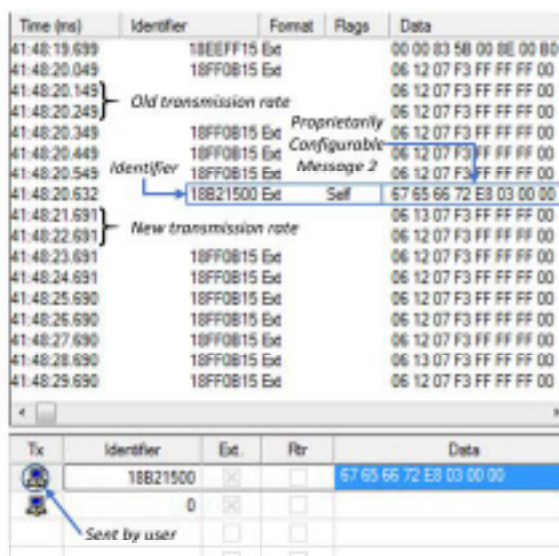


Fig. 5: Example: How to change the transmission rate

9. How to change the source address

The Source Address of the sensor can be configured by sending the Command Address Message according to PGN 65240 (FED8h). Since this message is 9-bit long, it is sent by using the Broadcast Announce Message of the Transport Protocol according to PGN 60416 and PGN 60160, as shown in the example Fig. 6 (page 14).

The messages must be sent:

a) Transport Protocol - Connection Management

- **Identifier:** 1CECFFXXh (table11)
- **Data field:** Transport Protocol - Connection Management (table 12).

1Ch				ECh	FFh	XXh
000	111	0	0	1110 1100	1111 1111	xxxx xxxx
	3 bits	1 bit	1 bit	8 bits	8 bits	8 bits
-	Priority: 7	Reserved	Data page	PDU format: PDU1	PDU specific: Destination Address	Source Address
PGN 60416 (0EC00h)						

Table 11: PGN 60416 Transport Protocol - Connection Management: Identifier definition

20h	09h	00h	02h	FFh	D8h	FEh	00h
0110 0111	0000 1001	0000 0000	0000 0010	1111 1111	1101 1000	1111 1110	0000 0000
8 bits	8 bits	8 bits	8 bits	8 bits	8 bits	8 bits	8 bits
Control byte	Total message size, number of bytes, LSB	Total message size, number of bytes, MSB	Total number of packets	Reserved	PGN of the packet message, LSB	PGN of the package message	PGN of the packet message, MSB

Table 12: PGN 60416 Transport Protocol - Connection Management - Broadcast Announce Message definition

b) Transport Protocol - Data transfer: Packet 1

- **Identifier:** 1CEBFFXXh (tabel13)
- **Data field:** Transport Protocol - Data Transfer, packet 1 (tabel 14)

1Ch				EBh	FFh	XXh
000	111	0	0	1110 1011	1111 1111	xxxx xxxx
	3 bits	1 bit	1 bit	8 bits	8 bits	8 bits
-	Priority: 7	Reserved	Data page	PDU format: PDU1	PDU specific: Destination Address	Source Address
PGN 60160 (0EB00h)						

Table 13: PGN 60160 Transport Protocol - Data Transfer: Identifier definition

01h	XXh	XXh	XXh		5Bh	XXh		XXh	XXh	
0000 0001	xxxx xxxx	xxxx xxxx	100	x xxxx	0101 1011	xxxx x	xxx	xxxx xxxx	xxxx xxx	0
8 bits	8 bits	8 bits	3 bits	5bits	8 bits	5 bits	3 bits	8 bits	7 bits	8 bits
Sequence number	Identify number, LSB	Identify number	Manufacturer code, LsB	Identify number, MSB	Manufacturer code, MSB	Function instance	ECU instance	Function	Vehicle system	Reserved bit

Table 14: PGN 60160 Transport Protocol - Data Transfer: Packet 1

c) Transport Protocol - Data transfer: Packet 2

- **Identifier:** 1CEBFFXh (tabel15)
- **Data field:** Transport Protocol - Data Transfer, packet 2 (tabel 16)

02h	XXh			XXh	FFFFFFFFh
0000 0010	x	xxx	xxxx	xxxx xxxx	1111 1111 1111 1111 1111 1111 1111 1111 1111
8 bits	1 bit	3 bits	4 bits	8 bits	
Sequence number	Arbitrary address bit	Industry group	Vehicle system instance	New Source Address	Reserved

Table 14: PGN 60416 Transport Protocol - Data Transfer: Packet 2

Time (ms)	Identifier	Format	Flags	Data
47:30:41.525	18FF0B15	Est		00 00 83 58 00 8E 00 83
47:30:41.876	Old Identifier	18FF0B15 Est	Old Source Address	05 38 08 CB FF FF FF 00
47:30:41.976	Identifier	18FF0B15 Est	Address	05 38 08 CB FF FF FF 00
47:30:42.076	18FF0B15 Est			05 38 08 CB FF FF FF 00
47:30:42.176	18FF0B15 Est			05 38 08 CB FF FF FF 00
47:30:42.276	18FF0B15 Est			05 38 08 CB FF FF FF 00
47:30:42.324	a. 1CECFD00	Est	Self	20 09 00 02 FF D8 FE 00
47:30:42.964	b. 1CEBFF00	Est	Self	01 00 00 83 58 00 8E 00
47:30:43.620	c. 1CEBFF00	Est	Self	02 B0 16 FF FF FF FF FF
47:30:43.678	New Identifier	18EEFF16	New Source Address	00 00 83 58 00 8E 00 83
47:30:43.778	18FF0B16 Est			05 38 08 CB FF FF FF 00
47:30:43.878	18FF0B16 Est			05 38 08 CB FF FF FF 00
47:30:43.978	18FF0B16 Est			05 38 08 CB FF FF FF 00
47:30:44.078	18FF0B16 Est			05 38 08 CB FF FF FF 00
47:30:44.178	18FF0B16 Est			05 38 08 CB FF FF FF 00
47:30:44.278	18FF0B16 Est			05 38 08 CB FF FF FF 00
47:30:44.378	18FF0B16 Est			05 38 08 CB FF FF FF 00

Tx	Identifier	Ext.	Pbr	Data
<input type="checkbox"/>	1CECFD00	<input checked="" type="checkbox"/>	<input type="checkbox"/>	20 09 00 02 FF D8 FE 00
<input checked="" type="checkbox"/>	1CEBFF00	<input checked="" type="checkbox"/>	<input type="checkbox"/>	01 00 00 83 58 00 8E 00
<input checked="" type="checkbox"/>	1CEBFF00	<input checked="" type="checkbox"/>	<input type="checkbox"/>	02 B0 16 FF FF FF FF FF

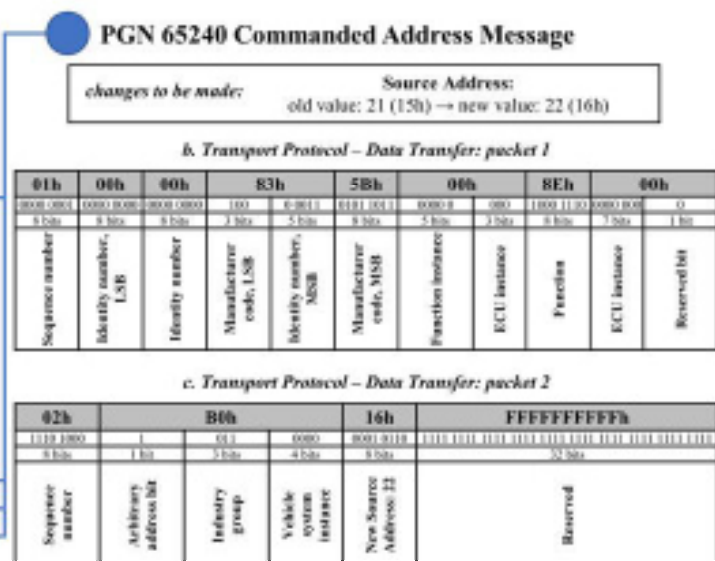


Fig. 6: Example: How to change the Source Address

