HYDAC ELECTRONIC

Protocol Description SAE J1939

SAE J1939

HDA 4000

Pressure transmitter

(Translation of original instructions)

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Content

Preface

This documentation describes the intended use of the product within a superordinate control system. It will help you to get acquainted with the provided communication interface and assist you in obtaining maximum benefit in the possible applications for which it is designed.
The specifications given in this documentation represent the state-of-the-art of the product at the time of publishing. Modifications to technical specifications, illustrations and dimensions are therefore possible.

Should you find any errors whilst using this manual, or have any suggestions for improvements, please contact:

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We look forward to receiving your input.

“Putting experience into practice”

In the event of translation, only the original version of the manual in German is legally valid.

1 Introduction

HDA has a CAN 2.0B interface and can be operated according to the process defined in the standards SAE-J1939. The interface functions are divided into 3 parts:

Address Claiming, Configuration and **Sending of measured values**

1.1 Functions

- Measuring the current pressure value using:
  - 1kHz sample rate
  - Resolution 13 bit
- Measuring the actual pressure value
- Conversion of the pressure values into a user-scaleable linear process value
- Sending the current pressure value and device temperature:
  - Cyclically, within the range from 1 millisecond up to 1 minute

2 Address Claiming

2.1 General overview

Each HDA has a name and an address. Both can be configured by the user. The name of the HDA is a 64 bit value and is clearly recognisable worldwide, the address is a 8 bit value which must be clearly recognisable at the bus. This means, it is not allowed to have two devices with the same address connected to the same bus.
During Address Claiming the HDA communicates its address and name to the other bus participants. This is a reaction to eventual address conflicts.

2.2 Name

The name consists of the following parts:

Addressing ability
- 1 Bit Arbitrary Address Capable

Function specific sections
- 3 Bit Industrial Group (i.e. Global, Marine, Agriculture, etc.)
- 7 Bit Vehicle System (depends on Industrial Group: Tractor, trailer, etc.)
- 4 Bit Vehicle System Instance (sequence number for systems of the same kind)
- 8 Bit Function (depending on Industrial Group: i.e. System Display, Levelling System, etc.)
- 5 Bit Function Instance (sequence number for functions of the same kind)
- 3 Bit ECU-Instance (sequence number for controllers having the same function)

Manufacturer specific sections
- 11 Bit Manufacturer Code
- 21 Bit Idendity
  The function-related parts are configurable, the manufacturer-related parts are firmly defined. This ensures a worldwide clear address identification.

Options for changing the J1939 name:

- Via Index 10-19
- The sensor supports the J1939 name management to standard J1939-81. By means of the "name management" - Message (PGN 37632) the J1939 name can be changed during operation. The manufacturer code of the J1939 name may not be changed, it always corresponds with the manufacturer ID.

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2.3 Address

The address can be set between 0 and 253. The address 254 is reserved for the status "no address assigned", the value 255 is used as broadcast address.
In each message the HDA sends, the address is assigned to the lowest 8 bits of the message ID.

Possibilities for addressing:

- The sensor can be configured as a "service configurable device" via an extra process which is separated from the bus. With this process, our proprietary entries will be used to address the device (Index 1).
- The sensor supports the dynamic addressing according to the J1939-81 standard. Dynamic addressing is enabled if the bit "arbitrary address capable" of the J1939 name corresponds to 1 and inactive, when it corresponds with 0. If dynamic addressing is enabled, the device sends a "request for address claim" message at start-up, in order to detect all the used addresses and to select one free address in a second step.
- The sensor supports the "commanded address" message (PGN 65240) to the J1939-81 standard. Herewith a new address can be assigned to the device after a previous failure of an address claim has occurred. The configured address is valid until next restart, however, it can be stored persistently via a subsequent configuration process by means of the entry 102.

2.4 Start-up process

After each start-up, the HDA sends an "Address Claimed" message. Thus, it communicates its address and its name to the other participants. This message can also be requested by other participants using a "request" message.
If an other participant sends an "Address Claimed" message using the same address, the reaction of the HDA depends on the name of the other participant.
If HDA name is lower than the numerical name of the other participant, it again sends an "Address Claimed" message. If the HDA name is higher, it sends a "Cannot Claim" message and will then no more be available. It needs to be briefly disconnected from the supply voltage.
After sending an "Address Claimed" message, it takes 250 ms until the HDA takes up its regular operation mode. This is one of the requirements of SAE-J1939 to give other devices having the same address enough time to respond.

3 Configuration

This protocol description is applicable for the device software V03 and newer. In order to ensure if the present description is applicable for your product, please read Index 5.

If the entry is 02xx, the product you use requires older software. The related protocol description *HDA 4000/7000 SAE J1939 protocol description D/E* (Part no. 669883) can be downloaded from our website at: https://www.hydac.com/de-en/products/sensors/pressure-sensors/pressure-transmitters/hda-4700/show/Download/index.html and https://www.hydac.com/de-en/products/sensors/pressure-sensors/pressure-transmitters/hda-7700/show/Download/index.html

3.1 Overview

The HDA has different settings which can be read and written by a master using SAE-J1939 messages. This is carried out by means of a so-called proprietary parameter group A with the PGN 61184 (0x00EF00). The data then contain information on which settings must be read or written and information on the values themselves as well.

3.2 Possible settings

All settings have an index enabling them to be addressed. In the following table, all the settings with their corresponding index are listed. Some settings are readable only (ro = read only), others are writable as well (rw = read write) or writable only (wo = write only). The data type is indicated as well.

3.2.1 Complete list of settings

In the following table, all the settings with their corresponding index are listed. The data type indicates how the data are to be interpreted. In a uint16 value for example, only the two first bytes are used and interpreted as an unsigned 16 bit integer value. Some settings can only be read (ro = read only), others can be written as well (rw = read write). The pre-set value is indicated within brackets.

Profile

Index	sub index	Data type	r/w	Settings
0	0	uint16	ro	The profile number defines the layout of the setting table. Is always 1 for HDA.

General

Index	sub index	Data type	r/w	Settings
1	0	uint8	rw	Address (1)
2	0	uint8	rw	Baud rate, see Baud rate table below. (3 = 250 kBit)
3	0	string	ro	The characters 1-4 in the internal device ID correspond with the Software ID (Hptj").
4	0	string	ro	The characters 5-8 of the internal device ID (Software ID) ("2 ")
5	0	string	ro	Version and release number (i.e. 0510=Version5, Release10)
6	0	uint32	ro	Product code, 32 bit number
7	0	uint32	ro	Serial number, 32 bit number

Name sections

Index	sub index	Data type	r/w	Settings
10	0	unit8	rw	1 Bit Arbitrary Address Capable (addressing mode)
11	0	uint8	rw	3 Bit Industrial Group (0=Global)
12	0	uint8	rw	7 Bit Vehicle System (0x7F)
13	0	uint8	rw	4 Bit Vehicle System Instance (0)
14	0	uint8	rw	8 Bit Function (0xFF)
15	0	uint8	rw	5 Bit Function Instance (0)
16	0	uint8	rw	3 Bit Control Unit Instance (0)
17	0	unit8	rw	1 Bit reserved
18	0	uint16	ro	11 Bit manufacturer code (124 = HYDAC ELECTRONIC GMBH)
19	0	uint32	ro	21 Bit Identity Number (corresponds with serial number)

Transmission of measured values

Index	sub index	Data type	r/w	Settings
21	0	uint16	rw	Transmission Rate [ms] (100)
22	0	uint8	rw	Message length [Bytes], 2..8 (8)
23	0	uint8	rw	Priority, 0..7 (6)
24	0	uint8	rw	PDU format (0xFF = proprietary B)
25	0	uint8	rw	PDU Specific (0x00)
26	0	uint8	rw	Offset of the pressure in the message [bytes]
27	0	uint8	rw	Offset of the device temperature in the message [bytes]
28	0	uint8	rw	Extended Data Page bit
29	0	uint8	rw	Data page bit

Measured values display, pressure

The default values depend on the measuring range of the pressure transmitter. In the following, the default values HDA 4700 pressure transmitter with the measuring range 0 to 250 bar are listed.

Index	sub index	Data type	r/w	Settings
31	0	uint8	rw	Unit 0: bar, 1: psi, 2: MPa (i.e. 0=bar)
32	0	uint8	rw	Data length 16 Bit (2 Byte (2)) or 32 Bit (4 Byte (4))
33	0	uint32	rw	Resolution per digit with 3 decimals (i.e. 50; increment here: 0.050)
34	0	int32	rw	Offset of the measured value with 3 decimals. (i.e. 0)
35	0	int32	ro	Lower measuring range with 3 decimals (i.e. 0)
36	0	int32	ro	Upper measuring range with 3 decimals (i.e. 250000 = 250.000bar)
37	0	uint8	wo	perform auto calibration (1= perform calibration)

Operation Data

Index	sub index	Data type	r/w	Settings
51	0	uint16	ro	Measured value, pressure
53	0	uint32	ro	Device mode / status
54	0	uint16/32	ro	Measured value, device temperature
59	0	uint8	ro	Highest sub index status channel
59	1	uint32	ro	Status Kanal 1, Druck
59	3	uint32	ro	Status channel 3 (device temperature)

Measured values display, device temperature
The measuring range of the device temperature is -25 .. 100 °C.

Index	sub index	Data type	r/w	Settings
61	0	uint8	rw	Unit 3: °C, 4: °F, 5: K (z.B. 3 =°C)
62	0	uint8	rw	Data length 16 Bit (2 Byte (2)) or 32 Bit (4 Byte (4))
63	0	uint32	rw	Resolution per digit with 3 decimals (i.e. 250; increment here: 0.250 °C)
64	0	int32	rw	Offset of the measured value with 3 decimals. (i.e. -25000 = -25.000 °C)
65	0	int32	ro	Lower measuring range with 3 decimals (i.e. -25.000 °C)
66	0	int32	ro	Upper measuring range with 3 decimals (i.e. 100000 = 100.000 °C)

Commands

Index	sub index	Data type	r/w	Settings
101	0	uint32	wo	Start editing mode (edit)
102	0	uint32	wo	Saving the settings (save)
103	0	uint32	wo	Reset to factory default settings (load)
104	0	uint32	wo	Restart (boot)

3.2.2 Setting of the Baud rate

HDA supports Baud rates of 10 kBit up to 1 MBit, according to the following table:

Index	Baud rate
0	1000 kBit
1	800 kBit
2	500 kBit
3	250 kBit
4	125 kBit
5	100 kBit
6	50 kBit
7	20 kBit
8	10 kBit

3.2.3 Settings for measured value transmission

During transmission of measured values it is defined in which message the current pressure will be transmitted and at which position and how often. This is required because in this way, certain predefined parameter groups can be realised. The data width, however, is always 16 bits, which means 2 bytes. The pressure can thus, for instance, be transmitted from the 4th byte in a message of 8 bytes length. The remaining 6 bytes in the message are empty.

The following settings are possible:

- The transmission rate (see Index 21) indicates how often the pressure value is transmitted. The value is expressed in ms. At 0 ms the pressure is only transmitted on request.
- The length of the message in which the pressure value is transmitted (see Index 22).
- The priority of the message (see Index 23).
- The PGN (Parameter Group Number) consisting of PF (Parameter Format) (see Index 24) and PS (Parameter Specific) (see Index 25). The result of this PGN combined with the priority and the address is the ID of the message by means of which the pressure value is sent.
- Offset of the pressure value in the message (see index 26).

3.2.4 Settings of measured values display

The measured values display defines how a certain pressure or the device temperature will be displayed. The following settings are possible:

- Setting of the pressure unit (bar, psi or MPa) (see Index 31) and the device temperature (°C, °F or K) (see Index 61).
- Lower and upper measurement range (see Index 35 and 36 as well as index 65 and 66). These values are readable only. The values are signed 32 bit values which are displayed with 3 decimals. Example: At an upper measuring range limit of 250 bar, for instance, the numerical value 250000 is read out.
- The data length providing the current pressure or device temperature is pre-set to 16 bit (2 bytes). It can be changed to 32 bit (see Index 32 and 62).
- By setting the resolution and the offset (see index 33 and 34 as well as index 63 and 64), you can adjust the display of the current pressure or the device temperature value. Both settings have 3 decimals as well. The resolution indicates the pressure or device temperature per digit.

HDA only sends out the correct measured values if the measured values display is configured in a way that all values of the measuring range fit into an unsigned 16 bit value. The values 0xFFFF and 0xFFFE are reserved for SAE J1939. This means, the measured value at the lower measuring range limit must be greater than or equal to 0 and the value at the upper measuring range limit must be lower than or equal to 65533.

Once the data length for the display of the measured values has been changed to 32 bits, the error values 0xFFFFFFFF and 0xFFFFFFFE and the upper measured values limit will be lower than or equal to 4294967293.
Should the measured value display not be configured properly, the sent value is always 0xFFFE, which means "error" according to SAE J1939. Furthermore, the device mode and the device status will be set accordingly.

Example 1: Pressure range form 0 to 250 bar
The current pressure value must be sent in steps of 0.05 bar. This means, a value of 1200 corresponds to 60 bar. This leads to the following settings

- Unit: 0 (=bar)
- Lower measuring range: 0 (0.000 bar)
- Upper measuring range: 250000 (250.000 bar)
- Offset: 0 (0.000 bar)
- Resolution: 50 (0.050 bar/digit)

3.2.5 Device mode and device status

The device mode and the device status (see Index 53) display the status of the device. Both indications are 32 bits long. The first byte contains the device mode, the following three bytes contain the device status. In the device status, each bit has a particular meaning.
The following table indicates which errors lead to which mode and which value corresponds to which device status. In case of multiple errors, the status will result from an or-operation of the error values.

Byte 1: Device Mode

Mode		Error
0	Ready for operation	No active error present, device is ready for operation
2	Minor fault	A minor fault has recently occurred. As soon as the error has been eliminated, the device will work again.
3	Moderate fault	A moderate fault has occurred. The error may possibly be eliminated by switching the device on / off.
4	Serious error	A severe error has occurred.

Byte 2+3: Device status

Status	Error	Mode
0x00000000	approved	0
Bit0 (0x00000001)	Loading the settings for the operation data recording has not been successful	2
Bit1 (0x00000002)	Asic error	3
Bit2 (0x00000004)	Measured value shortfall	0
Bit3 (0x00000008)	Measured value overrun	0
Bit4 (0x00000010)	Loading production setup not successful	4
Bit5 (0x00000020)	Loading factory setup not successful	4
Bit6 (0x00000040)	Loading user setup not successful	2
Bit7 (0x00000080)	Saving user setup not successful	2
Bit8 (0x00000100)	Asic error	3
Bit9 (0x00000200)	Faulty configuration of the measured values transmission	2
Bit10 (0x00000400)	Loading pcb setup not successful	0
Bit11 (0x00000800)	Loading hardware setup not successful	4
Bit12 (0x00001000)	Limit shortfall	2
Bit13 (0x00002000)	Limit overrun	2
Bit14 (0x00004000)	Error in the receive queue of the CAN handler.	3
Bit15 (0x00008000)	Error during start-up of the SAE J1939 controller.	4

3.3 Carry out configuration

Before the settings can be changed the HDA must be set to its editing mode. The changed settings must then be stored and a restart needs to be carried out. Please see chapter "commands" below.

To read and write the settings, the master sends a message with the parameter group number 61184 to the HDA's address. HDA responds by the same parameter group number and sends an acknowledge code.
In case of reading requests the requested data are sent with the code.

3.4 Message data structure

The content of the messages is listed in the following table:

Byte	Contents
0	Setting index
1	r/w, 0=read, 1=write
2	Sub index of the configuration (0 if no sub index is used)
3	Acknowledge, see remarks
4-7	Data LittleEndian

For entries in which a sub index is used, i.e. 59 (status channel) a sub index has to be set in order to inquire the channel.

The acknowledge code is always 0 with regard to the messages sent by the master. In the response of the HDA the acknowledge code means:

Ack-Code	Description
0	Ok
1	Parameters read only
2	Value too high
3	Value too low
4	Index does not exist
5	Error while saving parameters
6	Error while restoring parameters
7	Invalid r/w Byte (i.e. >1)
8	Parameters write only
9	Invalid data
10	Processor occupied
11	Error while accessing the hardware
12	Sub index does not exist

Example: Reading serial number (index=7)

Master

index	r/w	dc	ack	value (4Bytes)
7	0	0	0	0

HDA

index	r/w	dc	ack	value (4Bytes)
7	0	0	0	123456

Example: Setting of transmission rate (index=21) to 150 ms

Master

index	r/w	dc	ack	value (4Bytes)
21	1	0	0	150

HDA

index	r/w	dc	ack	value (4Bytes)
21	1	0	0	0

3.5 Commands

3.5.1 Start editing mode

Before the settings are written, the master must set the sensor to the editing mode. This is carried out by writing the string "edit" into the Index 101. In the editing mode, the sensor reacts exclusively to configuration commands. The editing mode can only be finished by restart.

Prior to restarting, the changes must explicitly be saved (Index 102). If restart is carried out without saving, all changes will be lost!

Master

Index	r/w	dc	ack	Value (→ "edit")			
(Byte 1)	**(Byte 2)**	**(Byte 3)**	**(Byte 4)**	**(Byte 5)**	**(Byte 6)**	**(Byte 7)**	**(Byte 8)**
101	1	0	0	0x65 "e"	0x64 "d"	0x69 "i"	0x74 "t"

Sensor

Index	r/w	dc	ack	Value			
(Byte 1)	**(Byte 2)**	**(Byte 3)**	**(Byte 4)**	**(Byte 5)**	**(Byte 6)**	**(Byte 7)**	**(Byte 8)**
101	1	0	0	0	0	0	0

3.5.2 Saving the settings

The changed settings will not automatically become persistent, which means, they will not be stored permanently. For this purpose, an extra storage process needs to be carried out explicitly. This is carried out by writing the string "save" into the Index 102.

Master

Index	r/w	dc	ack	Value (→ "save")			
(Byte 1)	(Byte 2)	(Byte 3)	(Byte 4)	(Byte 5)	(Byte 6)	(Byte 7)	(Byte 8)
102	1	0	0	0x73 "s"	0x61 "a"	0x76 "v"	0x65 "e"

Sensor

Index	r/w	dc	ack	Value			
(Byte 1)	(Byte 2)	(Byte 3)	(Byte 4)	(Byte 5)	(Byte 6)	(Byte 7)	(Byte 8)
102	1	0	0	0	0	0	0

3.5.3 Reset to factory default settings

The settings can be reset to factory default settings at any time. For this purpose, the string "load" must be written into Index 103.

Master

Index	r/w	dc	ack	Value (→ "load")			
(Byte 1)	(Byte 2)	(Byte 3)	(Byte 4)	(Byte 5)	(Byte 6)	(Byte 7)	(Byte 8)
103	1	0	0	0x6C "l"	0x6F "o"	0x61 "a"	0x64 "d"

Sensor

Index	r/w	dc	ack	Value			
(Byte 1)	(Byte 2)	(Byte 3)	(Byte 4)	(Byte 5)	(Byte 6)	(Byte 7)	(Byte 8)
103	1	0	0	0	0	0	0

3.5.4 Restart

A restart is carried out by briefly disconnecting HDA from the power supply. A restart can also be performed by writing the string "boot" into the index 104.

Master

Index	r/w	dc	ack	Value (→ "boot")			
(Byte 1)	(Byte 2)	(Byte 3)	(Byte 4)	(Byte 5)	(Byte 6)	(Byte 7)	(Byte 8)
104	1	0	0	0x62 "b"	0x6F "o"	0x6F "o"	0x74 "t"

4 Sending the measured value

Depending on the configuration, HDA sends the current pressure via message. The configuration was described in the previous chapter. In addition to being sent cyclically, the measured value can also be requested by means of a "request" message, PGN 59904 (0x00EA00) at any time.

5 Miscellaneous

The Software Identification (version number) can be requested by means of a "request" message on PGN 65242 (0x00FEDA).

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Note

The information in this manual relates to the operating conditions and applications described. For applications and/or operating conditions not described please contact the relevant technical department.

If you have any questions or suggestions or encounter any problems of a technical nature, please contact your HYDAC representative.