HYDAC ELECTRONIC

Protocol Description SAE J1939

SAE J1939

ETS 4000

Temperature transmitters

(Translation of original instructions)

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Content

Preface

This manual provides you, as user of our product, with key information on the operation and maintenance of the equipment.

It will help you to familiarise yourself with the product and assist you in obtaining maximum benefit in the applications for which it is designed.

Always keep the manual with the instrument for immediate reference.
Please note: the specifications given in this documentation regarding the instrument technology were correct 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.

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1 Introduction

ETS has a CAN 2.0 B 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 temperature value using:
  - 1kHz sample rate
  - < 1°C accuracy
  - 1/8 °C Resolution
- Conversion of the temperature value into a user-scaleable linear process value.
- Sending the current process value:
  - Cyclically, within the range from 1 millisecond to 1 minute

2 Address Claiming

2.1 General overview

Each ETS has a name and an address. Both can be configured by the user. The name of the ETS 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 ETS 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, ...)
- 7 Bit Vehicle System (depends on Industrial Group: Tractor, trailer, …)
- 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, …)
- 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.

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 ETS sends, the address is assigned to the lowest 8 bits of the message ID.

2.4 Start-up process

After each start-up, the ETS 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 ETS depends on the name of the other participant.
If the name of the ETS is lower than the numerical name of the other participant, it again sends an "Address Claimed" message. If the name of the ETS is higher, it sends a "Cannot Claim" message and will then no more be available. It must be briefly disconnected from the supply voltage.
After sending an "Address Claimed" message, it takes 250 ms until the ETS 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.

ETS is a "Service Configurable Device". This means, the address is adjustable, but it cannot be assigned a new address in normal bus mode. Going through a configuration process, ETS must be assigned a clearly defined address for its later bus, before it is getting connected to the bus for normal operation. The configuration process is described in the next chapter.

If 3 devices having the same address are connected to the bus, two of them will send a "Cannot Claim" message which is sent out at the same time in the worst case. This can lead to a bus error. For this reason, the user must make sure that the address at the bus is clearly defined.

3 Configuration

3.1 General overview

The ETS 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 by means of which they can 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 is to be interpreted. In a uint16 value for example, only the two first bytes are used and interpreted as 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	Data type	r/w	Settings
0	uint16	ro	The profile number defines the layout of the setting table. It is always 1 for ETS.

General information

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

Name sections

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

Transmission of measured values

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

Measured values display

The default values depend on the measuring range of the temperature transmitter. In the following, the default values for an ETS 4100 temperature transmitter are listed.

Index	Data type	r/w	Settings
31	uint8	rw	Unit 3: °C, 4: °F, 5: K (z.B. 3 =°C)
32	uint8	rw	Data length 16 Bit (2 Byte (2)) or 32 Bit (4 Byte (4))
33	uint32	rw	Resolution per digit with 3 decimal places (i.e. 50)
34	int32	rw	Offset of the measured value with 3 decimal places. (i.e. 0)
35	int32	ro	Lower measuring range with 3 decimal places (i.e. 0)
36	int32	ro	Upper measuring range with 3 decimal places (i.e. 75000 = 75 °C)
37	uint8	wo	perform auto calibration (1= perform calibration)

Operation Data

Index	Data type	r/w	Settings
51	uint16	ro	Measured value
53	uint24	ro	Device mode / status

Commands

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

3.2.2 Setting of the Baud rate

ETS 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 the measured values it is defined in which message the current temperature 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 temperature 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 temperature value is transmitted. The value is expressed in ms. At 0 ms the temperature is only transmitted on request.
- The length of the message in which the temperature 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 temperature value is sent.
- Temperature value offset in the message (see Index 26).

3.2.4 Settings of measured values display

The settings of the measured values display define how a certain temperature will be displayed. The following settings are possible:

- Setting of the temperature unit (°C,°F, or K), (see Index 31).
- Lower and upper measurement range (see Index 35 and 36). These values are readable only. The values are signed 32 bit values which are displayed with 3 decimal places. At an upper measuring range limit of 125°C, for instance, the numerical value 125,000 is read out.
- The data length providing the current temperature is pre-set to 16 bit (2 bytes). It can be changed to 32 bit (see Index 32).
- Setting the resolution and offset (see Index 33 and 34), you can adjust the display of the current temperature. Both settings have 3 decimal places as well. The resolution indicates the temperature per digit.

ETS only sends out the correct measured values if the measured values display is configured in a way that all values within 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 Temperature range from 0 to 125°C
The current temperature value must be transmitted in 0.05°C steps. This means, a value of 1200 corresponds with 60°C This leads to the following settings

- Unit: 3 (=°C)
- Lower measurement range: 0 (0.000 °C)
- Upper measurement range:125000 (125.000 °C)
- Offset: 0 (0.000 °C)
- Resolution: 50 (0.050 °C/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 24 bits long. The first byte contains the device mode, the following two 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
Bit0 (0x00000001)	approved	0
Bit1 (0x00000002)	Asic error	3
Bit2 (0x00000004)	Measured value underrun	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)	approved	0
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 underrun	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 ETS 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 ETS's address. ETS 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	Content
0	Setting index
1	r/w, 0=read, 1=write
2	always 0, dont care
3	Acknowledge, see remarks
4-7	Data LittleEndian

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

Example: Reading serial number (index=7)

Master

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

ETS

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

ETS

index	r/w	dc	ack	value (4Bytes)
7	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 be explicitly 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 ETS 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, ETS sends the current temperature 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 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.