Baumer

Manual

Inclination sensor GIM500R with SAE J1939 interface

Firmware Version 1.00 and up

Baumer

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1 Introduction

1.1 Scope of delivery

Please check the delivery upon completeness prior to commissioning.
Depending on sensor configuration and part number delivery is including:
- Sensor
- Describing file and manual (also available as download at www.baumer.com)

1.2 Product assignment

Product	Product Code	Measuring direction	Device name	EDS File
GIM500R	0x40	**1-dimensional**	GIM500	160502_GIM500R_V1_00_PDO_1_1_Axis
GIM500R	0x40	**2-dimensional**	GIM500	160502_GIM500R_V1_00_PDO_1_2_Axis

2   Safety and operating instructions

Intended use
- The inclination sensor is a precision measuring device to determine angular positions and to supply the downstream device with measured values in the form of electronic output signals. The inclination sensor must not be used for any other purpose.
- Make sure the appropriate safety measures are present to prevent damage to persons, the system or operating facilities in case of sensor error or failure.

Personnel qualification
- The inclination sensor must only be installed by a qualified electronics and precision mechanics.
- Observe the user manual of the machine manufacturer.

Maintenance
- The inclination sensor is maintenance-free and must not be opened or modified in its electronics or mechanical design. Opening the sensor can lead to personal injury.

Disposal
- The inclination sensor contains electronic components. At its disposal, local environmental guidelines must be followed.

Installation
- Avoid mechanical impacts or shocks on the housing.

Electrical commissioning
- Do not perform any electrical modifications at the inclination sensor.
- Do not carry out any wiring work when the inclination sensor is live.
- Do not dock or undock the electrical connection while the inclination sensor is live.
- Ensure that the entire equipment is installed in line with EMC requirements. Ambient conditions and wiring affect the electromagnetic compatibility of the inclination sensor. Install sensor and supply cables separately or far away from lines with high interference emissions (frequency converters, contactors, etc.).
- Provide separate power supply for the inclination sensor where working with consumers that have high interference emissions.
- Completely shield the inclination sensor housing and connecting cables.
- Connect the sensor to protective earth (PE) using shielded cables. The braided shield must be connected to the cable gland or connector. Ideally, aim at a bilateral connection to protective earth (PE), the housing via the mechanical assembly and the cable shield via the downstream devices. In case of earth loop problems, earth on one side only as a minimum requirement.

Supplementary information
- This manual is intended as a supplement to already existing documentation (i.e. catalogue, product information and mounting instruction).

3 CAN bus and SAE J1939 communication

CAN bus (CAN: Controller Area Network) was developed by Bosch and Intel for high-speed, economic data transmission in automotive applications. Today CAN bus has been commercialized for use in industrial automation.

CAN bus is a fieldbus system (standards administered by CAN in Automation, CiA) for communication between appliances, actors and sensors of different brands.

3.1 CAN bus characteristics

• Data rate of 1 MBaud with network expansion up to 40 m
• Network connected on both sides
• The bus medium is a twisted-pair cable
• Real time capability: Defined maximum waiting time for high-priority messages.
• Theoretically 127 users at one bus, but physically only 32 are possible (due to the driver).
• Ensures data consistency across the network. Damaged messages are notified as faulty for all network nodes.
• Message-oriented communication
   The message is identified by a message identifier. All network nodes use the identifier to test whether the message is of relevance for them.
• Broadcasting, multicasting
   All network nodes receive each message simultaneously. Synchronization is therefore possible.
• Multimaster capability
   Each user in the field bus is able to independently transmit and receive data without being dependent upon the priority of the master. Each user is able to start its message when the bus is not occupied. When messages are sent simultaneously, the user with the highest priority prevails.
• Prioritization of messages
   The identifier defines the priority of the message. This ensures that important messages are transmitted quickly via the bus.
• Residual error probability
   Safety procedures in the network reduce the probability of an undiscovered faulty data transmission to below 10^{-11}. In practical terms, it is possible to ensure a 100% reliable transmission.
• Function monitoring
   Localization of faulty or failed stations. The CAN protocol encompasses a network node monitoring function. The function of network nodes which are faulty is restricted, or they are completely uncoupled from the network.
• Data transmission with short error recovery time
   By using several error detection mechanisms, falsified messages are detected to a high degree of probability. If an error is detected, the message transmission is automatically repeated.

In the CAN Bus, several network users are connected by means of a bus cable. Each network user is able to transmit and receive messages. The data between network users is serially transmitted.

Examples of network users for CAN bus devices are:
• Automation devices such as PLCs
• PCs
• Input and output modules
• Drive control systems
• Analysis devices, such as a CAN monitor
• Control and input devices as Human Machine Interfaces (HMI)
• Sensors and actuators

3.2 SAE J1939

SAE J1939 is the vehicle bus standard developed by the Society of Automotive Engineers (SAE) and used for communication and diagnostics among components of cars, heavy duty trucks, utility and specialized vehicles. J1939 is based on the physical layer of CAN bus.

SAE J1939 protocol is used in the commercial vehicle area for communication throughout the vehicle. Several international standards for trucks and trailer rigs, forest and agricultural machines as well as for marine applications are based on SAE J1939. Data transmission method, content and structure of the message as well as data packets are defined by the relevant specification.

J1939: General network description.
J1939/0X: General application description.
J1939/01: Utility vehicles, trucks and buses.
J1939/7X: Application Layer.
J1939/71: Vehicle Application Layer. Vehicle.
J1939/73: Application Layer Diagnostics,
J1939/81: Network Management.
J1939/31: Network Layer. Bridge, Router, Gateway, Filter.
J1939/21: Data Link Layer.
J1939/1X: Physical Layer.
J1939/11: Physical Layer, STP cable, 250 kbit/s.
J1939/12: Physical Layer, star quad, 250 kbit/s.
J1939/13: Off-Board Diagnostic connector

SAE J1939 uses the 29-bit/ "extended" identifier in the CAN data frame.
The 8-bit address embedded in the identifier is used as source and target address for the SAE-J1939 nodes.

The information is output in the form of electronic signals and compiled in the PGNs.

The SAE J1939 protocol applied in commercial and railway vehicles, agricultural machines and ships considers segmentation, flow control, transmission method; message acknowledged yes/no and specifies the message content.

3.2.1 Interpretation of the CAN Identifier

The CAN identifier of a J1939 message comprises Parameter Group Number (PGN), source address, priority, data page bit, extended data page bit and a target address (peer-to-peer PG only).

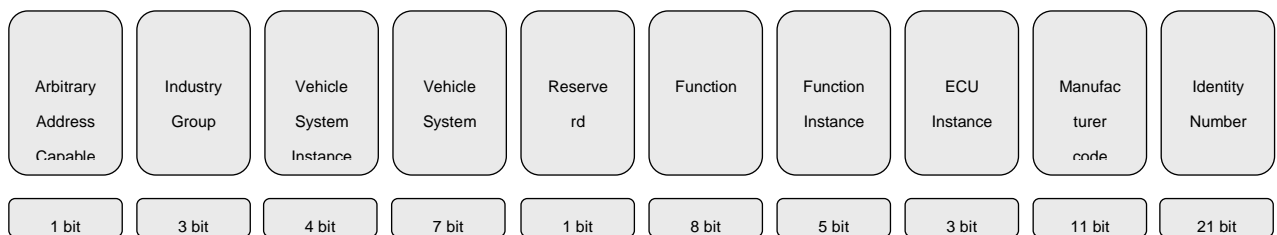| Priority	Extended Data Page	Data Page	PDU Format	PDU Specific	Source Address
3 bit	1 bit	1 bit	8 bit	8 bit	8 bit

- In the PDU format < 240 (peer-to-peer), the PDU includes the target address. Global (255) can also be used as target address. In this case, the parameter group is addressed to all devices, and the PGN exists only in the PDU format.
- If PDU format >= 240 (broadcast), the PDU format together with the Group Extension in the PDU specific field form the PGN of the transmitted parameter group.

3.2.2 NAME field

The device will transmit its NAME after power on (J1939 NAME field).

J1939/81 specifies a 64-bit NAME – message for the clear identification of each ECU (electronic control unit). The NAME Field comprises 10 entries, 5 are SAE-specific and 5 either represent the network properties or are vendor-specific. For more information please refer to J1939/81.

J1939 NAME Field

Arbitrary Address Capable	Industry Group	Vehicle System Instance	Vehicle System	Reserverd	Function	Function Instance	ECU Instance	Manufacturer code	Identity Number
1 bit	3 bit	4 bit	7 bit	1 bit	8 bit	5 bit	3 bit	11 bit	21 bit

3.2.3 Process data – PDU Proprietary B message

The transmission rate for both variants can be configured and is therefore omitted in the following description.

3.2.3.1 PGN 653631: 1-dimensional device message

Proprietary B message interpretation of 1-dimensional inclination sensors:

Data length: 8 bytes
Extended Data Page: 0
Data page: 0
PF: 255 (Prop. B)
PS: 83
Priority: 6
PG Number: 65363 (00FF53h)

Description of data payload:

Byte: 1   X-Axis signed word LSB Tilt Reading (0.1° Resolution)
Byte: 2   X-Axis signed word MSB Tilt Reading (0.1° Resolution)
Byte: 3,4 Reserved
Byte: 5   Internal Temperature in °C signed byte
Byte: 6   Module ID
Byte: 7,8 Error ID

3.2.3.2 PGN 65363: 2-dimensional device message

Proprietary B message interpretation of 2-dimensional inclination sensors:

Data length: 8 Bytes
Extended Data Page: 0
Data page: 0
PF: 255 (Prop. B)
PS: 83
Priority: 6
PG Number: 65363 (00FF53h)

Description of data payload::

Byte: 1   X-Axis signed word LSB Tilt Reading (0.01° Resolution)
Byte: 2   X-Axis signed word MSB Tilt Reading (0.01° Resolution)
Byte: 3   Y-Axis signed word LSB Tilt Reading (0.01° Resolution)
Byte: 4   Y-Axis signed word MSB Tilt Reading (0.01° Resolution)
Byte: 5   Internal Temperature in °C signed byte
Byte: 6   Module ID
Byte: 7,8 Error ID

3.2.4   Error diagnostics

As described in chapter "process data", every PDU includes three bytes for error communication on the bus.

Description PDU Data:
Byte 6:   Error Module ID
Byte 7,8:   Error ID

These three bytes being other than 00h means an error occurred and the transmitted inclination information must be considered invalid.
The LED is red continuous as long as the error is present.

3.2.5   Configuration data PDU Proprietary-A (PDU-1 peer-to-peer)

The device configuration can be changed by specific messages. The payload complies with the CANopen data payload (without COB-ID).

Example:

Object	Subndex	Type	Description	Access
2102h	0	Unsigned 8	SAE J1939 ECU address	rw

To change the address, the device must be properly addressed and the correct data must be transmitted in the format below:

COB-ID	Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0
	Command	Object No.		Subindex	Data A	Data B	Data C	Data D
18EFF753h	22h	02h	21h	00h	F8h	00h	00h	00h

Example: device communication:

COBID (example)	Direction	RAW-Data
18EFF753h	write to device	0x 22 02 21 00 F8 00 00 00
18EF53F7h	received from device	0x 60 02 21 00 00 00 00 00

For each configuration an example is added in the following sections.

The following configuration options are available:

Index	Name
2102h	SAE J1939 ECU address
2103h	SAE J1939 PDU Proprietary B Group Extension
2104h	SAE J1939 PDU Proprietary B Transmission Rate
2576h	Offset X/Y-Axis Tilt Position
2577h	Preset Zero
2578	Tilt reverse
2603h	Filter cutoff frequency
1010h	Store Parameters
1011h	Restore Default Parameters

3.2.5.1 SAE J1939 ECU address, Index 2102h

Sub Index	Data type	Access	Description	Default	Saved on Access
0	Unsigned 8	rw	SAE J1939 ECU address	0xF7	no

The new address is adopted and effective after a save command in object 1010h and a power cycle.

Example: change ECU address in 0xF8

COBID (example)	Direction	RAW-Data
0x18EFF753	write to device	0x 22 02 21 00 F8 00 00 00
0x18EF53F7	received from device	0x 60 02 21 00 00 00 00 00

3.2.5.2 SAE J1939 PDU Proprietary B Group Extension, Index 2103h

Sub Index	Data type	Access	Description	Default	Saved on Access
0	Unsigned 8	rw	SAE J1939 PDU Prop. B Group Extension	0x53	no

The new group extension is adopted and effective after a save command in object 1010h and a power cycle.

Example: change group extension in 0x54

COBID (example)	Direction	RAW-Data
0x18EFF753	write to device	0x 22 03 21 00 54 00 00 00
0x18EF53F7	received from device	0x 60 03 21 00 00 00 00 00

3.2.5.3 SAE J1939 PDU Proprietary B Transmission Rate, Index 2104h

Sub Index	Data type	Access	Description	Default	Saved on Access
0	Unsigned 8	rw	SAE J1939 PDU Prop. B Transmission Rate in milliseconds	200d	no

The new transmission rate is adopted and effective after a save command in object 1010h and a power cycle.

Example: change transmission rate to 500ms (=1F4h)

COBID (example)	Direction	RAW-Data
0x18EFF753	write to device	0x 22 04 21 00 F4 01 00 00
0x18EF53F7	received from device	0x 60 04 21 00 00 00 00 00

3.2.5.4 Offset X/Y Axis tilt position, Index 2576h

Sub Index	Data type	Access	Description	Default	Saved on Access
1	Signed 16	rw	Offset X-Axis Tilt Position.	0d	no
2	Signed 16	rw	Offset Y-Axis Tilt Position.	0d	No

Example: change Offset X-Axis to 500 (= 01F4h)

COBID (example)	Direction	RAW-Data
0x18EFF753	write to device	0x 22 76 25 01 F4 01 00 00
0x18EF53F7	received from device	0x 60 76 25 01 00 00 00 00

Example: change Offset Y-Axis to -500 (= FE0Ch)

COBID (example)	Direction	RAW-Data
0x18EFF753	write to device	0x 22 76 25 02 0C FE 00 00
0x18EF53F7	received from device	0x 60 76 25 02 00 00 00 00

3.2.5.5 Preset Zero, Index 2577h

Sub Index	Data type	Access	Description	Default	Saved on Access
1	Unsigned 8	wo	X-Axis Preset Position.	-	No
2	Unsigned 8	wo	Y-Axis Preset Position (If available)	-	No

Example: execute X-Axis preset zero

COBID (example)	Direction	RAW-Data
0x18EFF753	write to device	0x 22 77 25 01 00 00 00 00
0x18EF53F7	received from device	0x 60 77 25 01 00 00 00 00

Example: execute Y-Axis preset zero

COBID (example)	Direction	RAW-Data
0x18EFF753	write to device	0x 22 77 25 02 00 00 00 00
0x18EF53F7	received from device	0x 60 77 25 02 00 00 00 00

3.2.5.6 Tilt reverse, Index 2578h

Sub Index	Data type	Access	Description	Default	Saved on Access
0	Unsigned 32	rw	Tilt reverse (Only available for 1-Axis variant)	0d	no

Example: enable Tilt reverse

COBID (example)	Direction	RAW-Data
0x18EFF753	write to device	0x 22 78 25 00 01 00 00 00
0x18EF53F7	received from device	0x 60 78 25 00 00 00 00 00

Example: disable Tilt reverse

COBID (example)	Direction	RAW-Data
0x18EFF753	write to device	0x 22 78 25 00 00 00 00 00
0x18EF53F7	received from device	0x 60 78 25 00 00 00 00 00

3.2.5.7 Digital Filter Cutoff Frequency, Index 2603h

Sub Index	Data type	Access	Description	Default	Saved on Access
0	Unsigned 32	rw	Filter cutoff frequency in 0.1Hz for second order Butterworth filter. 0 for no filtering. The following frequencies are available: 0.1Hz ... 1Hz in 0.1Hz 1Hz… 30Hz in 1Hz. I.e. to choose 5Hz cutoff frequency, transmit "50".	50 (5Hz)	no

Example: change cutoff frequency to 0.4Hz (= 0x4)

COBID (example)	Direction	RAW-Data
0x18EFF753	write to device	0x 22 03 26 00 04 00 00 00
0x18EF53F7	received from device	0x 60 03 26 00 00 00 00 00

3.2.5.8 Store Parameters

Parameters can be saved with ASCII-command "save" in parameter 0x1010, subindex 1 with a specific key (similar to CANopen Store command). A store command is important for all parameters which are not saved at access (i.e. Digital Filter Cutoff Frequency)

Example:

COBID (example)	Direction	RAW-Data
0x18EFF753	write to device	0x 22 10 10 01 73 61 76 65
0x18EF53F7	received from device	0x 60 10 10 01 00 00 00 00

3.2.5.9 Restore default

ASCII command "load" in parameter 0x1011, subindex 1 will restore the device default configuration.

Example:

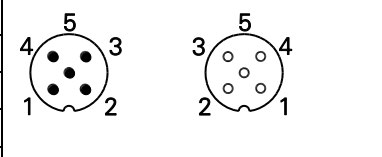| COBID (example)	Direction	RAW-Data
0x18EFF753	write to device	0x 22 11 10 01 6C 6F 61 64
0x18EF53F7	received from device	0x 60 11 10 01 00 00 00 00

3.2.6   Supported features

3.2.6.1 Address Claiming

Two devices with the same address in the same bus network will have the address claiming function executed, meaning the new address is being assigned to the device of higher priority while the second device is being assigned a higher address.

4 Terminal assignment and commissioning

4.1 Terminal assignment

M12 flange connector, 5 female contacts

Pin	Assignment	Description	M12 (male/female)
1	GND_GND	Ground connection relating to CAN	
2	+Vs	Supply voltage	
3	GND	Ground connection relating to +Vs	
4	CAN_H	CAN bus signal (dominant High)	
5	CAN_L	CAN bus signal (dominant Low)	

Terminals with the same designation are internally hardwired and identical in their functions. Maximum load applied on UB-UB / GND-GND is 1 A each.

4.2 Activity indicator (DUO-LED)

A DUO-LED is provided at the sensor housing.

LED green	LED red	Activity / Significance
off	off	No power supply present
on	off	Operational Mode
off	on	error