



8-Channel measuring amplifier GSV-8

Operating manual

Updated:	06/08/2017
Version	ba-gsv8_ver7h_en
Author	kab
Versions	Changelog Page 44



Table of contents

Measuring amplifier GSV-8.....	4
Description.....	5
Versions.....	5
Interfaces.....	5
Software.....	5
Features.....	6
Signal flow.....	6
Galvanic isolation.....	6
Dimensions.....	8
GSV-8DS SubD15HD.....	8
GSV-8DS DubD44HD.....	8
GSV-8AS.....	9
Specifications.....	10
Analogue input.....	10
Digital input / digital output.....	10
Analog output.....	11
Supply	11
Environmental data.....	11
Interfaces	11
Resolution of strain gauge input.....	11
Noise Amplitude at Analogue Output.....	12
Digital filters.....	12
Finite Impulse response Filter.....	12
Infinite Impulse Response Filter.....	12
Buttons and indicators.....	13
Pin Configuration.....	14
Input SUB-D15 HD.....	14
Input Sub-D44 HD.....	14
Input M16 Binder 423.....	23
Connection strain gauge quarter bridge.....	24
Connection strain gauge half bridge.....	25
Connection strain gauge full bridge.....	25
Connection of PT1000.....	26
Connection of the active sensors.....	26
Analog output SUB-D25 socket.....	26
Digital in- and outputs Sub-D25 plug connector.....	27
EtherCat M12 4-pole socket D-coded.....	28
CANbus M12 5-pole socket / plug A-coded.....	30
UART Port Sub-D9 socket.....	30
Voltage supply M8, 4-pole.....	31
Screw terminal GSV-8AS.....	32
Additional information.....	34
LED indicators.....	34
LED indicators STATUS and FUNCTION on Ethercat devices.....	34

LED-display for error condition (all device models).....	35
FUNCTION LED.....	35
STATUS LED (red).....	36
Digital inputs and outputs.....	36
Digital-I/O Numbers.....	36
Digital I/O Functions.....	37
Inverting digital inputs.....	39
Further Notes Digital I/O.....	39
Master-Slave Frame Synchronization.....	40
Data acquisition and Bandwidth.....	40
Data frames and Bandwidth.....	43
Frequency output 60kHz \pm 30kHz.....	44
Changelog.....	44



Measuring amplifier GSV-8

8-channel measuring amplifier

8x input configurable

full, half, quarter bridges, 120- 350- 1000 Ohm, PT1000, $\pm 10V$

Outputs 1x USB Port, 8x Analogue output $\pm 10V$, 4...20mA configurable, 1x UART,
alternatively EtherCat, CANbus/CANopen

16x Digital in- and output

5x Galvanic isolation: analogue-input, analogue-output, digital-I/O, UART, USB

8x 48kS/s Simultaneous sampling

6-wire technology, bridge supply 2.5V, 5.0V, 8.75V configurable

Automatic configuration of analogue and digital filters by specifying the data frequency

Additional Digital Filters IIR 4th order and FIR 14th order individually configurable

Step response of the filter configuration available (with PC software)

Resolution < 20 nV/V

Versions to connect 1-axis and 3- and 6-axis sensors

Autonomous calculation of 3 forces and moments of six-axis sensors

Two operating hours counters

Sensors with TEDS supported (readable and writable)

Integration of a Raspberry PI in the housing cover of the GSV-8AS



Figure 2: GSV-8DS front side



Figure 1: GSV-8DS back side



Figure 3: GSV-8AS

EtherCAT®

CANopen®

Description

The 8-channel measuring amplifier GSV-8 is characterised by particularly high resolution at data frequencies of 1 Hz to 48000 Hz. The 8 channels are acquired simultaneously.

Versions

Type	Sensor Input	Signal-Output
GSV-8DS SubD15HD	8x SubD15HD	1xUSB, UART, Analogue, Digital-I/O
GSV-8DS EC/SubD15HD	8x SubD15HD	1xUSB, EtherCat, Analogue, Digital-I/O
GSV-8DS CAN/SubD15HD	8x SubD15HD	1xUSB, UART, CAN, Analogue, Digital-I/O
GSV-8DS SubD44HD	4x SubD44HD	1xUSB, UART, Analogue, Digital-I/O
GSV-8DS EC/SubD15HD	4x SubD44HD	1xUSB, EtherCat, Analogue, Digital-I/O
GSV-8DS CAN/SubD15HD	4x SubD44HD	1xUSB, UART, CAN, Analogue, Digital-I/O
GSV-8AS	1x 24pol M16, screw terminal	1xUSB, UART, Analogue, Digital-I/O
GSV-8AS EC	1x 24pol M16, screw terminal	1xUSB, EtherCat, Analogue, Digital-I/O
GSV-8AS CAN	1x 24pol M16, screw terminal	1xUSB, UART, CAN, Analogue, Digital-I/O
GSV-8AS PI-3	1x 24pol M16, screw terminal	like GSV-8AS, but with Raspberry PI

Interfaces

Communication interfaces such as USB port or EtherCAT or CANbus are available. The device has 8 configurable analogue outputs (± 10 V and 4...20 mA among others). UART interface serves to control the measuring amplifier via the Raspberry PI (not for versions with EtherCat).

The interface protocol of USB and UART is identical and described in a separate documentation (ba-gsvcom.pdf). The fieldbus protocols EtherCAT and CANopen are standardized in the lower protocol layers and the application layer is described in separate documents (ba-gsv8canopen.pdf and ba-gsv8ethercat_en.pdf).

Software

The Windows programs GSVmultichannel with graphical user interface and the console terminal program Gsv8terminal are suitable. A Windows function library (MEGSV8w32.dll) with commented C header is available for self-programming users and a LabView library with wrapper VIs for this DLL for programming with LabView ©.

Features

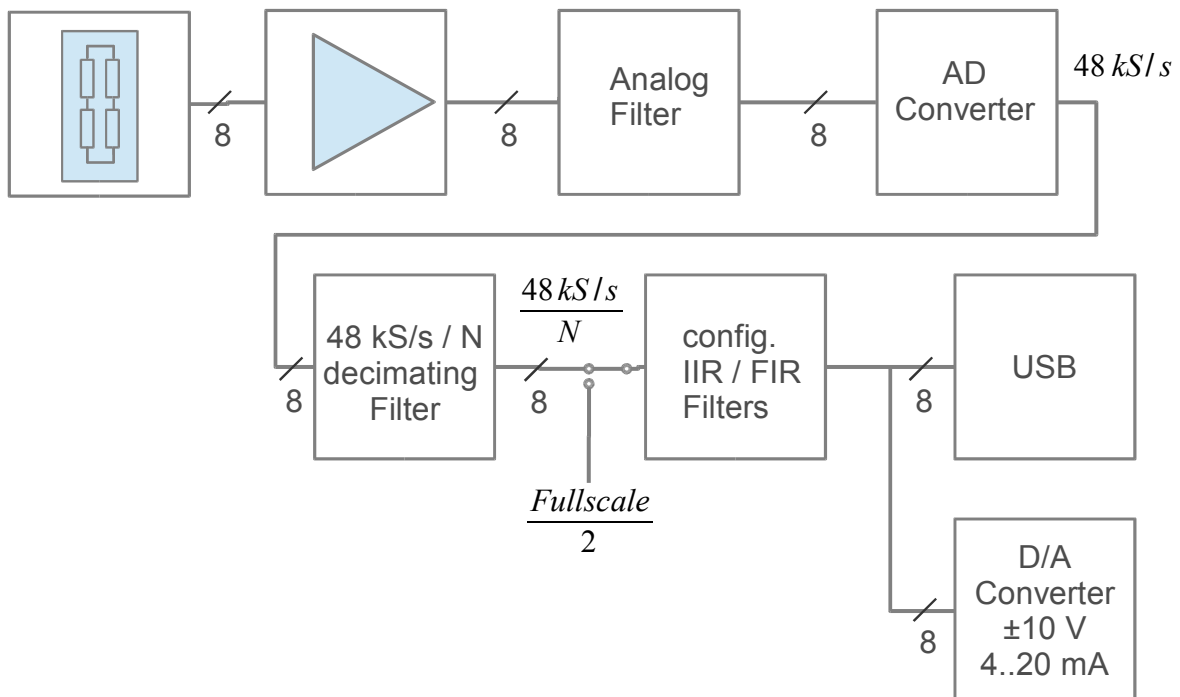
There are 8 analogue inputs available. They are individually configurable as:

- Strain gauge input for full bridges in 4 and 6 wire technology or
- Strain gauge input for half bridges or
- Strain gauge input for quarter bridges 120 ohm, 350 ohm, 1 kOhm or
- Single-ended input ± 10 V or
- Input for PT1000 temperature sensor

The strain gauge supply voltage can be switched between 8.75 V, 5.00 V and 2.5 V, assigned to input sensitivities 2 mV/V, 3.5 mV/V or 7 mV/V.

Bridge supply voltage	Resulting input sensitivity
8,75 V	2 mV/V
5 V	3,5 mV/V
2,5 V	7 mV/V

Signal flow



Galvanic isolation

The supply voltage UB+ / 0V is galvanically isolated from the modules for

- ✓ analogue input
- ✓ analogue output

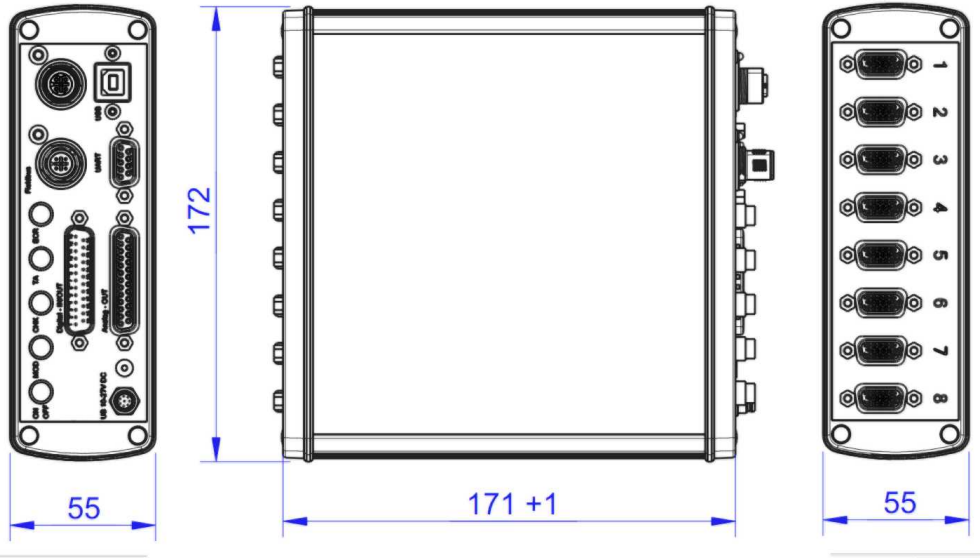
- ✓ digital in- outputs
- ✓ interfaces
- ✓ The isolation voltage is 50 V.

UB+	Supply voltage 12...28V DC
UB-	Ground Supply voltage
GNDE	Ground analogue-input
-Us	Negative bridge supply
GND A	Ground analogue-output
GNDD	Ground digital input / output
GNDU	Ground UART port („Raspberry PI Port“)
GND R	Ground RS232 port (only GSV-2AS)

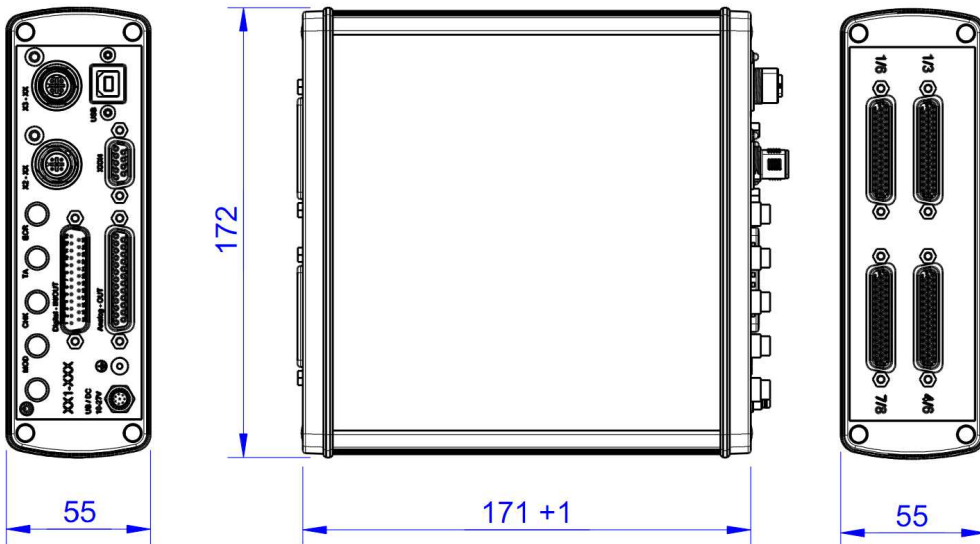


Dimensions

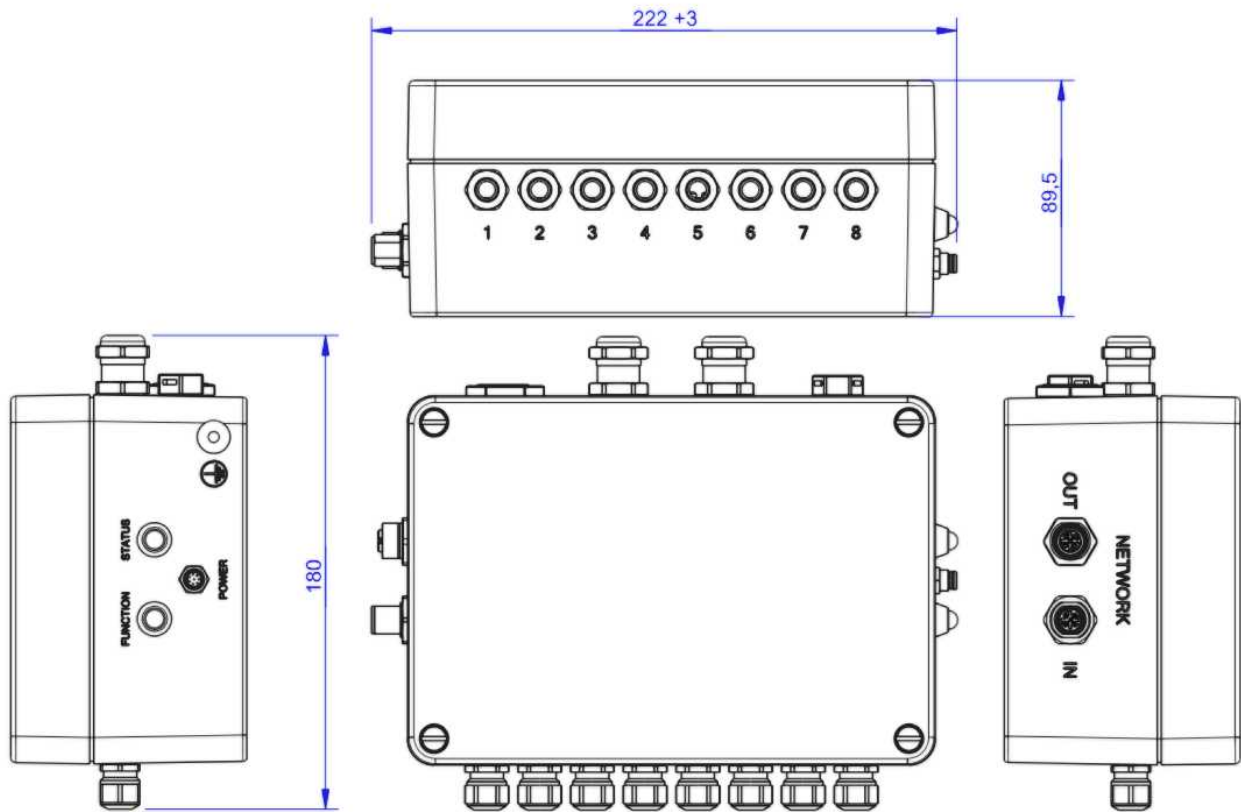
GSV-8DS SubD15HD



GSV-8DS DubD44HD



GSV-8AS





Specifications

Analogue input

Accuracy class	0,05%
Number of analogue inputs	8
Strain gauge bridge input	Quarter, half, full bridge
Input impedance	> 20 MOhm (300pF)
Common mode rejection ratio DC	> 120 dB
Common mode rejection ratio AC 100Hz	> 100 dB
Strain gauge bridge completions	120 Ohm, 350 Ohm, 1 kOhm
Strain gauge bridge supply	2.50 V, 5.00 V, 8.75 Volt
Total current across all channels	200 mA
Max. current per channel at bridge supply 2.5V	40 mA (min. bridge resistance 62,5 Ohm)
Max. current per channel at bridge supply 5V	60 mA (min. bridge resistance 83,3 Ohm)
Max. current per channel at bridge supply 8.75V	26 mA (min. bridge resistance 336,5 Ohm)
Input sensitivities	7 mV/V, 3.5 mV/V, 2 mV/V
Input voltage, single-ended	±10 V
Input resistance	10 MOhm
Input for PT1000 sensor	-230 °C ... +1500 °C
Excitation voltage PT1000	1.25 V

Digital input / digital output

Number of in-/ outputs	16
Output	TTL (0V 5V), push-pull
total current across all channels	140 mA
max. load current per output	25 mA
Input	
max. input voltage	5.5 V
min. input voltage	-0.5 V
Resistance Pullup +5V	10 kOhm
Sampling period	40 msec

Analog output

Number of analog outputs	8
Configuration of analog outputs	0...10V, -10V..+10V, 0...5V, -5V...+5V, 4...20mA

Supply

Supply voltage	12 V to 28 V
Power	< 12 W

Environmental data

Operating temperature	0 °C ... +50 °C
Power	< 12 W

Interfaces

USB	2.0 Full speed
Devices class	Communication Device Class, HID (firmware update only)
UART	Level 3.3V, galvanically isolated; auxiliary voltage 24V DC, 2A
EtherCat	protocol: CoE device profile 404, Mailbox- and buffered mode. Synchronization: Hardware-Latching
CANbus	CANopen, device profile 404, 4x TxPDOs, galvanically isolated

Resolution of strain gauge input

The resolution of measuring amplifier depends on the adjusted input sensitivity and the data frequency. The input sensitivity is assigned to the bridge supply voltage: 8.75V with 2.0 mV/V, 5V with 3.5 mV/V, 2.5V with 7 mV/V.

The excitation voltage with 8.75V is recommended only with sensors of minimum 1kOhm bridge resistance and sufficient construction size. For miniature sensors under 500g weight the bridge supply of 8.75V shall not be applied!

	+Us	10 Hz	50 Hz	100 Hz	1 kHz	5 kHz	8 kHz
3.5 mV/V	5 V	2.0 10 ⁵	1.2 10 ⁵	8.0 10 ⁴	2.5 10 ⁴	1.0 10 ⁴	8.0 10 ³
2.0 mV/V	8.75 V	3.0 10 ⁵	2.5 10 ⁵	1.5 10 ⁵	6.0 10 ⁴	4.0 10 ⁴	1.4 10 ⁴

At a data frequency of 10 Hz the measuring range from 0 to +3.5 is quantised in 2.0 10⁵ steps.

The noise amplitude is 17.5 nV/V.



At a sensor with rated force of 10 N and rated output of 0.5 mV/V the noise amplitude is

$$10 N \cdot \frac{0,5}{3,5} \cdot \frac{1}{2.0 \cdot 10^5} = 7,14 \cdot 10^{-6} N$$

Noise Amplitude at Analoge Output

The noise amplitude at the analog output is approx. 25mV (peak values) or 10mV (RMS). It is due to the galvanic isolation of the analog output. The frequency components of the noise signal are predominantly at frequencies above 300 kHz and higher. These can be largely attenuated by the use of oversampling with subsequent digital filtering (eg arithmetic averaging) in the subsequent analog-digital conversion.

Digital filters

The GSV-8 adjusts automatically the analogue filter and the „decimating“ digital input filter. The user provides only the required number of measured values per second (data frequency), which is send via USB-interface or made available to the field bus. Additionally there are two adjustable digital filters: 1x FIR filter and 1x IIR filter. Each of these filter is individually adjustable for any of the 8 input channels. In the measured data signal processing chain, the FIR filter is processed first, followed by the IIR filter.

Finite Impulse response Filter

The FIR filter is a low pass filter with which the filter order N and the cut-off frequency fg can be set. The cut-off frequency is the frequency at which the signal is already attenuated by -3 dB. This corresponds to a factor of approx. 0.7. Frequencies lying above this will continue to be attenuated.

The filter order determines the maximum and minimum adjustable cut-off frequency fg in terms of the data rate Fa, and the steepness of the attenuation range. Higher orders have a steeper slope, i.e. an increase in the signal frequency causes the attenuation to increase faster. The so-called step response is slower at higher orders however, i.e. it always takes N+1 measured values until the filter's output value corresponds to the input value.

Order	fg/Fa min in Hz	fg/Fa min in Hz
14	0,05	0,190
12	0,06	0,225
10	0,07	0,270
8	0,09	0,340
6	0,12	0,350
4	0,18	0,410

Infinite Impulse Response Filter

The infinite Impulse Response Filter (IIR) of fourth order allows four different filter types:

- 1) Low pass filter: Sensor signals at low frequency (including DC size with $f=0$) pass through the filter, signals at a higher frequency are attenuated.
- 2) High pass filter: Sensor signals at low frequency (including DC size with $f=0$) are attenuated, signals at a higher frequency pass through the filter. Note: Frequencies above half of the measured data rate cannot be processed. The measuring amplifier includes an analogue-to-digital sampling system, which in itself acts as a low pass.
- 3) Band pass filter: Signals are allowed to pass through within a frequency range, signals which are above or below this range are attenuated.
- 4) Band stop filter ('Notch filter'): Signals are attenuated within a frequency range, signals which are above or below this range are allowed to pass through.

The cut-off frequency can be configured for low and high pass filters. The cut-off frequency is the frequency at which the signal is already attenuated by -3 dB. This corresponds to a factor of approx. 0.7. Frequencies lying above for low pass and lying below for high pass will continue to be attenuated.

Two cut-off frequencies can be configured for band pass and band stop filters; the upper and the lower. Attenuation by -3 dB also occurs here. The two cut-off frequencies may not be the same. Signal frequencies lying between these are allowed to pass through for the band pass filter, and are attenuated for the band stop filter.

The maximum (and also the minimum if need be) of each cut-off frequency is dependent on the measured data rate. Cut-off frequencies can be set to $(0.49 * \text{measured data rate})$, i.e. almost to half.

The filters can be individually configured for each channel and also switched on and off. The configuration also remains the same for filters that have been switched off.

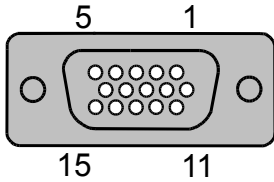
Buttons and indicators

Power-button with LED function	Switch on and off the device (only GSV-8DS) Function LED
Mod-button with Led status	a) reset the status LED; b) start the Firmware-updates, if during the Power On activates
CHK button with Check LED	Sensor Test; by pressing the CHK button the sensor signal for the unloaded condition is emulated on the input of the measuring amplifier; for sensors with calibration matrix the documented zero signals of the sensor are emulated on the inputs.
TA	„Tara“, Set-Zero“: trigger an automatic zero adjustment for all outputs (analogue and digital)
ECR-LED	EtherCat EC Run;



Pin Configuration

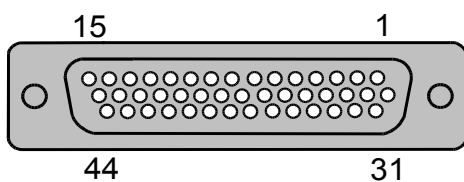
Input SUB-D15 HD



Connection of strain gauges, active sensors, TEDS. Activation of the bridge completion with bridge from "HB" (12) to -UD (10).

No	Symbol	Description
1	TEDS	Transducer Electronic Data according to IEEE 1451.4
2	-Us	Negative bridge supply
3	+Us	Positive bridge supply
4	Q350	Quarter bridge completion 350 Ohm
5	+UD	Positive differential input
6	GNDE	Ground, analogue input
7	-Uf	Negative sense line (6-wire connection only)
8	+Uf	Positive sense line (6-wire connection only)
9	Q120	Quarter bridge completion 120 Ohm
10	-UD	Negative differential input
11	Q1k	Quarter bridge completion 1000 Ohm
12	HB	Half bridge completion
13	VCCIO	Supply voltage for active sensors (optional)
14	Ue	Analogue input voltage, single ended $\pm 10V$
15	GNDIO	Ground, supply voltage (optional)
Shield	PE	Earth (housing)

Input Sub-D44 HD



Up to 3 channels can be connected to the 44-pin Sub D socket. The labeling on the front panel is 1/3 for connecting the channels 1 to 3.

1/3 Channels 1,2,3, Sub-D HD 44			
Pin	Signal	Description	Channel
Shield	PE	Earth (housing)	-
1	TEDS	Transducer Electronic Data according IEEE 1451.4	1
2	US-	Negative bridge supply	1
3	US+	Positive bridge supply	1
4	Q350	Quarter bridge completion 3500hm	1
5	UD+	Positive differential input	1
6	GNDE	Ground, analogue input	1
7	UF-	Negative sense line (6-wire connection only)	1
8	UF+	Positive sense line (6-wire connection only)	1
9	Q120	Quarter bridge completion 1200hm	1
10	UD-	Negative differential input	1
11	Q1k	Quarter bridge completion 10000hm	1
12	HB	Half bridge completion	1
13	UE	Analogue input voltage, single ended $\pm 10V$	1
14	GNDIO	Not equipped sep.galv. isol. (optional)	1
15	PE	Earth (housing)	-
16	TEDS	Transducer Electronic Data according IEEE 1451.4	2
17	US-	Negative bridge supply	2
18	US+	Positive bridge supply	2
19	Q350	Quarter bridge completion 3500hm	2
20	UD+	Positive differential input	2
21	GNDE	Ground, analogue input	2
22	UF-	Negative sense line (6-wire connection only)	2
23	UF+	Positive sense line (6-wire connection only)	2
24	Q120	Quarter bridge completion 1200hm	2
25	UD-	Negative differential input	2
26	Q1k	Quarter bridge completion 10000hm	2
27	HB	Half bridge completion	2
28	UE	Analogue input voltage, single ended $\pm 10V$	2
29	GNDIO	not equipped sep.galv.isol. (optional)	2
30	VCCIO	not equipped sep.galv.isol. (optional)	1,2,3



1/3 Channels 1,2,3, Sub-D HD 44			
Pin	Signal	Description	Channel
31	TEDS	Transducer Electronic Data acc. to IEEE 1451.4	3
32	US-	Negative bridge supply	3
33	US+	Positive bridge supply	3
34	Q350	Quarter bridge completion 3500hm	3
35	UD+	Positive differential input	3
36	GNDE	Ground, analogue input	3
37	UF-	Negative sense line (6-wire connection only)	3
38	UF+	Positive sense line (6-wire connection only)	3
39	Q120	Quarter bridge completion 1200hm	3
40	UD-	Negative differential input	3
41	Q1k	Quarter bridge completion 10000hm	3
42	HB	Half bridge completion	3
43	UE	Analogue input voltage, single ended $\pm 10V$	3
44	GNDIO	Not equipped sep.galv.isol. (optional)	3

The labeling on the front panel is 4/6 for connecting the channels 4 to 6.

4/6 Channels 4,5,6, Sub-D HD 44			
Pin	Signal	Description	Channel
Shield	PE	Earth (housing)	-
1	TEDS	Transducer Electronic Data acc. to IEEE 1451.4	4
2	US-	Negative bridge supply	4
3	US+	Positive bridge supply	4
4	Q350	Quarter bridge completion 3500hm	4
5	UD+	Positive differential input	4
6	GNDE	Ground, analogue input	4
7	UF-	Negative sense line (6-wire connection only)	4
8	UF+	Positive sense line (6-wire connection only)	4
9	Q120	Quarter bridge completion 1200hm	4
10	UD-	negative bridge supply	4
11	Q1k	Quarter bridge completion 10000hm	4
12	HB	Half bridge completion	4
13	UE	Analogue input voltage, single ended $\pm 10V$	4

4/6 Channels 4,5,6, Sub-D HD 44			
Pin	Signal	Description	Channel
14	GNDIO	Not equipped sep.galv.isol. (optional)	4
15	PE	Earth (housing)	-
16	TEDS	Transducer Electronic Data acc. to IEEE 1451.4	5
17	US-	Negative bridge supply	5
18	US+	Positive bridge supply	5
19	Q350	Quarter bridge completion 350Ohm	5
20	UD+	Positive differential input	5
21	GNDE	Ground, analogue input	5
22	UF-	Negative sense line (6-wire connection only)	5
23	UF+	Positive sense line (6-wire connection only)	5
24	Q120	Quarter bridge completion 1200hm	5
25	UD-	Negative differential input	5
26	Q1k	Quarter bridge completion 10000hm	5
27	HB	Half bridge completion	5
28	UE	Analogue input voltage, single ended $\pm 10V$	5
29	GNDIO	not equipped sep.galv.isol. (optional)	5
30	VCCIO	not equipped sep.galv.isol. (optional)	4,5,6
31	TEDS	Transducer Electronic Data acc. to IEEE 1451.4	6
32	US-	Negative bridge supply	6
33	US+	Positive bridge supply	6
34	Q350	Quarter bridge completion 350Ohm	6
35	UD+	Positive differential input	6
36	GNDE	Ground, analogue input	6
37	UF-	Negative sense line (6-wire connection only)	6
38	UF+	Positive sense line (6-wire connection only)	6
39	Q120	Quarter bridge completion 1200hm	6
40	UD-	Negative differential input	6
41	Q1k	Quarter bridge completion 10000hm	6
42	HB	Half bridge completion	6
43	UE	Analogue input voltage, single ended $\pm 10V$	6
44	GNDIO	Not equipped sep.galv.isol. (optional)	6



At the 44-pole SubD socket 1/6 up to 6 channels can be connected. The labeling on the front panel is 1/6 for connecting the channels 1 to 6. The connections are parallel to the input jacks 1/3 and 4/6 .

Channels 1,2,3,4,5,6, Sub-D HD 44			
Pin	Signal	Description	Channel
Shield	PE	Earth (housing)	-
1	UF+	Positive sense line (6-wire connection only)	1
2	US+	Positive bridge supply	1
3	UD+	Positive differential input	1
4	UD-	Negative differential input	1
5	US-	Negative bridge supply	1
6	UF-	Negative sense line (6-wire connection only)	1
7	TEDS	Transducer Electronic Data according IEEE 1451.4	1
8	UF+	Positive sense line (6-wire connection only)	2
9	US+	Positive bridge supply	2
10	UD+	Positive differential input	2
11	UD-	Negative differential input	2
12	US-	Negative bridge supply	2
13	UF-	Negative sense line (6-wire connection only)	2
14	TEDS	Transducer Electronic Data according IEEE 1451.4	2
15	PE	Earth (housing)	-
16	UF+	Positive sense line (6-wire connection only)	3
17	US+	Positive bridge supply	3
18	UD+	Positive differential input	3
19	UD-	Negative differential input	3
20	US-	Negative bridge supply	3
21	UF-	Negative sense line (6-wire connection only)	3
22	TEDS	Transducer Electronic Data according IEEE 1451.4	3
23	UF+	Positive sense line (6-wire connection only)	4
24	US+	Positive bridge supply	4
25	UD+	Positive differential input	4
26	UD-	Negative differential input	4
27	US-	Negative bridge supply	4
28	UF-	Negative sense line (6-wire connection only)	4
29	TEDS	Transducer Electronic Data acc. to IEEE 1451.4	4
30	PE	Earth (housing)	-



Channels 1,2,3,4,5,6, Sub-D HD 44			
Pin	Signal	Description	Channel
31	UF+	Positive sense line (6-wire connection only)	5
32	US+	Positive bridge supply	5
33	UD+	positive differential input	5
34	UD-	Negative differential input	5
35	US-	Negative bridge supply	5
36	UF-	Negative sense line (6-wire connection only)	5
37	TEDS	Transducer Electronic Data according IEEE 1451.4	5
38	UF+	Positive sense line (6-wire connection only)	6
39	US+	Positive bridge supply	6
40	UD+	Positive differential input	6
41	UD-	Negative differential input	6
42	US-	Negative bridge supply	6
43	UF-	Negative sense line (6-wire connection only)	6
44	TEDS	Transducer Electronic Data acc. to IEEE 1451.4	6

Note: Six-axis sensors K6D with Sub-D HD44 connectors are connected to this socket "1/6"
At the 44-pin Sub D socket 7/8 up to 2 channels can be connected (channel 7 and channel 8) .

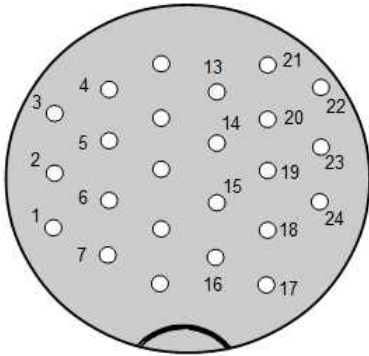
Channels 7, 8, Sub-D HD 44			
Pin	Signal	Description	Channel
Shield	PE	Earth (housing)	-
1	UE	Analogue input voltage, single ended $\pm 10V$	1
2	GNDE	Ground, analogue input	1
3	UE	Analogue input voltage, single ended $\pm 10V$	2
4	GNDE	Ground, analogue input	2
5	UE	Analogue input voltage, single ended $\pm 10V$	3
6	GNDE	Ground, analogue input	3
7	UE	Analogue input voltage, single ended $\pm 10V$	4
8	GNDE	Ground, analogue input	4
9	UE	Analogue input voltage, single ended $\pm 10V$	5
10	GNDE	Ground, analogue input	5
11	UE	Analogue input voltage, single ended $\pm 10V$	6
12	GNDE	Ground, analogue input	6
13	PE	Earth (housing)	-
14	PE	Earth (housing)	-
15	PE	Earth (housing)	-
16	TEDS	Transducer Electronic Data according IEEE 1451.4	7
17	US-	Negative bridge supply	7
18	US+	Positive bridge supply	7
19	Q350	Quarter bridge completion 350Ohm	7
20	UD+	Positiver differential input	7
21	GNDE	Ground, analogue input	7
22	UF-	Negative sense line (6-wire connection only)	7
23	UF+	Positive sense line (6-wire connection only)	7
24	Q120	Quarter bridge completion 1200hm	7
25	UD-	Negative differential input	7
26	Q1k	Quarter bridge completion 10000hm	7
27	HB	Half bridge completion	7
28	UE	Analogue input voltage, single ended $\pm 10V$	7
29	GNDIO	not equipped sep.galv.isol. (optional)	7
30	VCCIO	not equipped sep.galv.isol. (optional)	7,8



Channels 7, 8, Sub-D HD 44

Pin	Signal	Description	Channel
31	TEDS	Transducer Electronic Data according IEEE 1451.4	8
32	US-	Negative bridge supply	8
33	US+	Positive bridge supply	8
34	Q350	Quarter bridge completion 350Ohm	8
35	UD+	Positive differential input	8
36	GNDE	Ground, analogue input	8
37	UF-	Negative sense line (6-wire connection only)	8
38	UF+	Positive sense line (6-wire connection only)	8
39	Q120	Quarter bridge completion 1200hm	8
40	UD-	Negative differential input	8
41	Q1k	Quarter bridge completion 10000hm	8
42	HB	Half bridge completion	8
43	UE	Analogue input voltage, single ended $\pm 10V$	8
44	GNDIO	not equipped sep.galv.isol. (optional)	8

Input M16 Binder 423



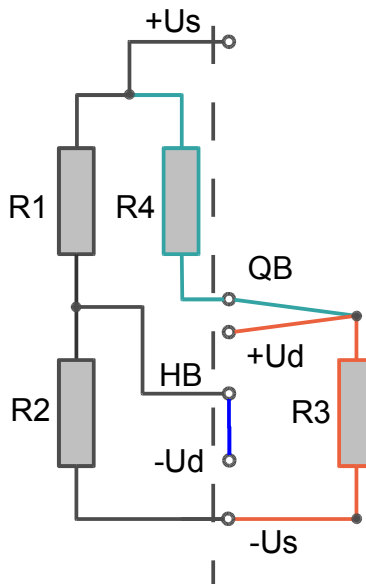
View from the plug-in side

A 6-axis sensor type K6D can be connected to the 16-pin socket of the GSV-8AS.

Channels 1,2,3,4,5,6, M16			
Pin	Signal	Description	Channel
Shield	PE	Housing	-
1	US+	Positive bridge supply	1
2	US-	Negative bridge supply	1
3	UD+	Positive bridge output	1
4	UD-	Negative bridge output	1
5	US+	Positive bridge supply	2
6	US-	Negative bridge supply	2
7	UD+	Positive bridge output	2
8	UD-	Negative bridge output	2
9	US+	Positive bridge supply	3
10	US-	Negative bridge supply	3
11	UD+	Positive bridge output	3
12	UD-	Negative bridge output	3
13	US+	Positive bridge supply	4
14	US-	Negative bridge supply	4
15	UD+	Positive bridge output	4
16	UD-	Negative bridge output	4
17	US+	Positive bridge supply	5
18	US-	Negative bridge supply	5
19	UD+	Positive bridge output	5

Channels 1,2,3,4,5,6, M16			
Pin	Signal	Description	Channel
20	UD-	Negative bridge output	5
21	US+	Positive bridge supply	6
22	US-	Negative bridge supply	6
23	UD+	Positive bridge output	6
24	UD-	Negative bridge output	6

Connection strain gauge quarter bridge

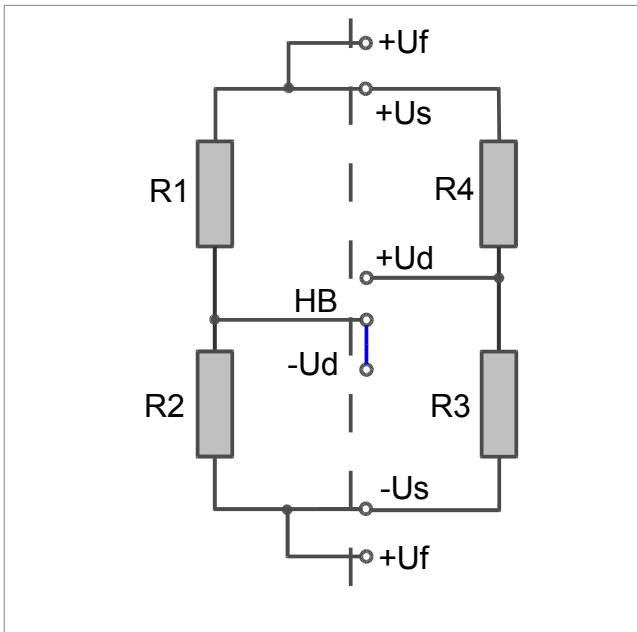


The active strain gauge R3 is connected in the 3-wire technology.

The completion resistors 120 Ohm (QB = Q120), 30 Ohm (QB = Q350) and 1 kOhm (QB = Q1k) are lead out on the connection QB.

The internal half bridge R1, R2 is activated with a wire jumper from HB to -Ud.

Connection strain gauge half bridge

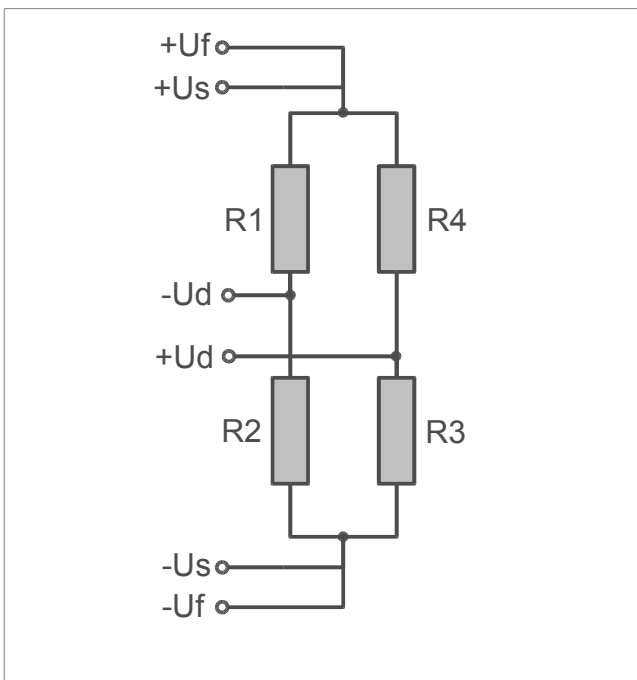


The active strain gauges R3 and R4 are connected to +Us, +Ud and -Us.

For very long cable lengths the sense lines +Uf and -Uf can be used.

The internal half bridge R1, R2 is activated with a wire jumper from HB to -Ud.

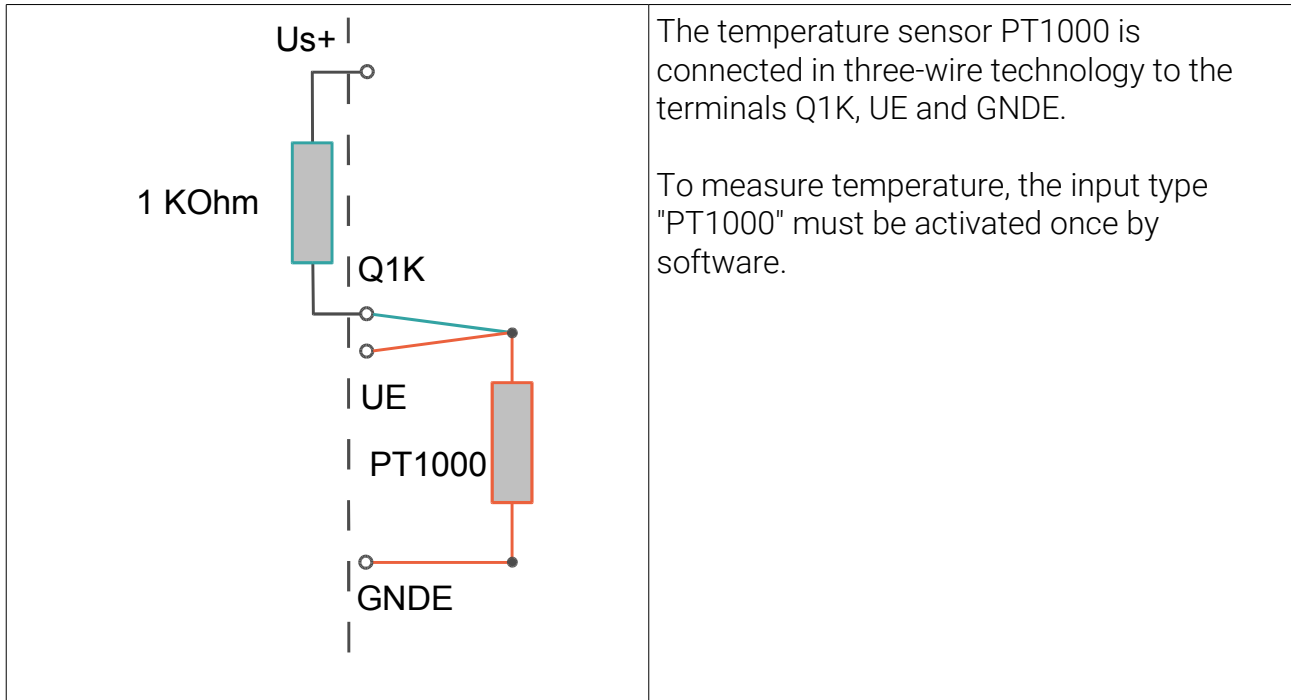
Connection strain gauge full bridge



The active strain gauges R1 to R4 are connected on +Us, -Us, +Ud, -Ud.

For very long cable lengths the sense lines +Uf and -Uf can be additionally used.

Connection of PT1000

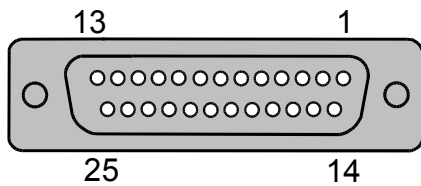


Connection of the active sensors

The single-ended voltage signal of active sensors is applied to Ue and GNDE.

Potentiometric sensors can be supplied via +Us. The energy supply for active sensors can be via galvanic isolated voltage VCCIO and GNDIO.

Analog output SUB-D25 socket

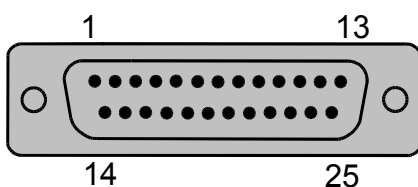


Analogue outputs voltage or current for channels 1 to 8.

Pin	Signal	Meaning
1	Ua1/ Ia1	Analog output channel 1
2	Ua2/ Ia2	Analog output channel 2
3	Ua3/ Ia3	Analog output channel 3
4	Ua4/ Ia4	Analog output channel 4
5	Ua5/ Ia5	Analog output channel 5

Pin	Signal	Meaning
6	Ua6/ Ia6	Analog output channel 6
7	Ua7/ Ia7	Analog output channel 7
8	Ua8/ Ia8	Analog output channel 8
9	/	Internal usage
10	/	Internal usage
11	/	Internal usage
12	OutB-	60kHz frequency -6V Out (optional)
13		Internal usage
14	GNDa	Analog GND
15	GNDa	Analog GND
16	GNDa	Analog GND
17	GNDa	Analog GND
18	GNDa	Analog GND
19	GNDa	Analog GND
20	GNDa	Analog GND
21	GNDa	Analog GND
22		Internal usage
23		Internal usage
24	OutB+	60kHz frequency +6V Out (optional)
25	GNDINT	GNDINT
Shield	PE	Earth (housing)

Digital in- and outputs Sub-D25 plug connector

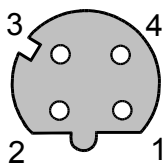


Pin	Name	Meaning
1	VCC	5V voltage supply, digital
2	DGND	Digital ground (GND)



Pin	Name	Meaning
3	DGND	Digital ground (GND)
4	DGND	Digital ground (GND)
5	DGND	Digital ground (GND)
6	DIO 2	Group 1, 1.2
7	DIO 4	Group 1, 1.4
8	DIO 6	Group 2, 2.2
9	DIO 8	Group 2, 2.4
10	DIO 10	Group 3, 3.2
11	DIO 12	Group 3, 3.4
12	DIO 14	Group 4, 4.2
13	DIO 16	Group 4, 4.4
14	DGND	Digital ground (GND)
15	DGND	Digital ground (GND)
16	DGND	Digital ground (GND)
17	DGND	Digital ground (GND)
18	DIO 1	Group 1, 1.1
19	DIO 3	Group 1, 1.3
20	DIO 5	Group 2, 2.1
21	DIO 7	Group 2, 2.3
22	DIO 9	Group 3, 3.1
23	DIO 11	Group 3, 3.3
24	DIO 13	Group 4, 4.1
25	DIO 15	Group 4, 4.3

EtherCat M12 4-pole socket D-coded

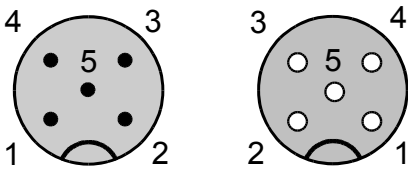


Pin	Name	Meaning
-----	------	---------



1	TD+	Transmit +
2	RD+	Receive +
3	TD-	Transmit -
4	RD-	Receive -
Shield	PE	Earth (housing)

CANbus M12 5-pole socket / plug A-coded

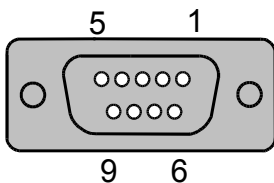


Pin	Name	Meaning
1	Shield	Shielding
2	V+	Power (UB+)
3	V-	GND (0V)
4	CAN_H	Dominant High
5	CAN_L	Dominant Low
	Housing	Shield

UART Port Sub-D9 socket

The UART Port is used for connection of Raspberry PI.

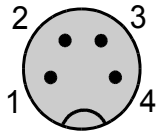
The UART Port is not available for variants "EC" with EtherCat.



Pin	Name	Meaning
1	UB-	Ground supply voltage
2	RX	Receive data of GSV-8, 3.3Volt level

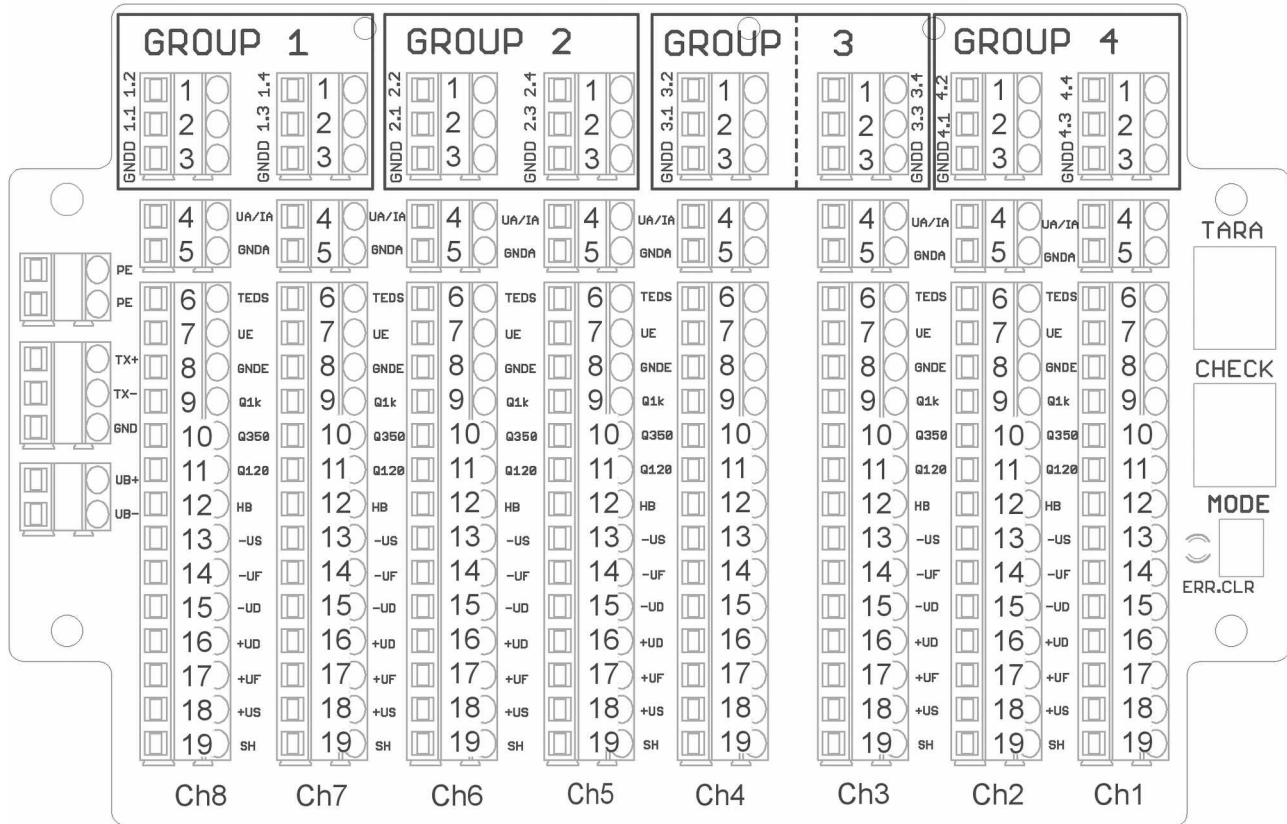
3	TX	Transmit data of GSV-8, 3.3 Volt level
4	/	Internal usage
5	UB-	Ground supply voltage
6	UB+	Supply voltage
7	/	Internal
8	UB+	Supply voltage
9	OFF	GSV-8 Disable
	Housing	Shield

Voltage supply M8, 4-pole



1	UB+	Positive supply voltage 10-27V, brown
2	PE	Earth (housing) PE, white
3	0V	Negative supply voltage (GND), blue
4	PE	Earth (housing) PE, black

Screw terminal GSV-8AS



Pos.	Terminal labelling	Description
1	n.2 / n.4 Group n	Digital In/Out No. 2 / 4 / 6 / 8 / 10 / 12 / 14 / 16
2	n.1 / n.3 Group n	Digital In/Out No. 1 / 3 / 5 / 7 / 9 / 11 / 13 / 15
3	GNDD	Ground, digital In/Out
4	UA/IA	Analog output, current or voltage
5	GNDA	Ground, Analog output
6	TEDS	Transducer Electronic Data according to IEEE 1451.4
7	UE	Voltage, Analog input
8	GNDE	Ground, Analog input
9	Q1k	Quarter bridge completion 1000 Ohm
10	Q350	Quarter bridge completion 350 Ohm
11	Q120	Quarter bridge completion 120 Ohm
12	HB	Half bridge completion
13	-US	Negative bridge supply

14	-UF	Negative sense line
15	-UD	Negative differential input
16	+UD	Positive differential input
17	+UF	Positive sense line
18	+US	Positive bridge supply
19	SH	Earth, Analogue input (shielding)

Connection of the TEDS cables for sensors with transducer elec. datasheet

The 1-wire EEPROM memory module located in the sensor or in the sensors connector is connected with two wires: the ground of the EEPROM to **GNDE** and the signal line (also its supply line) at the **TEDS** side.

TEDS, however, are only supported by GSV-8 firmware version 1.32 and hardware version 4.0 (devices purchased from 11/2016) and following.



Additional information

LED indicators

The LED indicators differ according to the housing versions AS and DS as well as the field bus versions CANopen and Ethercat. The DS housing is equipped with all the LEDs on the front panel, integrated into the buttons. The green ECR or green FUNCTION LED only has significance for Ethercat devices.

LED	Color AS	Color DS	Meaning	Position AS	Labeling DS
FUNCTION	yellow	blue	on/off, Bootloader	outside, yellow/green combined	ON OFF
	green	green	Ethercat-State EC-RUN		ECR
STATUS	red	red	Error state	outside	MOD
CHECK	yellow	yellow	Measuring value- emulation	inside	CHK

For devices with fieldbus (CANopen, Ethercat), there are two small green LEDs next to the field bus connections. These have the following meaning:

Ethercat: Link activity

CANopen: Fieldbus switched on

LED indicators STATUS and FUNCTION on Ethercat devices

Device state	FUNCTION-LED	EC-RUN-LED
EtherCAT State=INIT (not active)	Permanently on	Off
EtherCAT State=PREOP	Off	Blinking 200ms on 200ms off
EtherCAT State= SAFEOP	Off	Single flash 200ms on, 1s off
EtherCAT State= OP	Off	Permanently on
USB-Bootloader active (EtherCAT not used)	300ms on 300ms off	Off

LED-display for error condition (all device models)

Error condition	Prio	STATUS LED	Meaning
EtherCAT: State-transition inhibited	1	Blinking 200ms on 200ms off	Requested status transition impossible, e.g. because of invalid settings or invalid hardware settings
EtherCAT: State automatically reset	1	Single flash 200ms on, 1s off	Device switched from operating state to SafeOpError because of a synchronization error
EtherCAT: Application watchdog timeout	1	Double flash 200ms on, 200ms off 200ms on 1sec off	If Watchdog-timer is active: process data frame not received within watchdog time
Measuring application: Sensor error	2	Permanent on	1. A sensor or its cable is defective, for example, the cable Ud+ or Ud- could be interrupted or could have short circuited with one of the cables Us+ or Us-. 2. A measured value is saturated, i.e. the measuring signal lies outside of the measuring range. This could be ascribed to a defective sensor. 3. The maximum value is exceeded for a six-axis sensor.
Measuring application: Error at the digital output	3	Blinks slowly 500ms on 500ms off	Short-circuit at the digital output, i.e. if this is connected as an output and switched to High, it has short-circuited with GNDD, or if it is switched to Low, a voltage ≥ 3 V is applied.
Measuring application: Error at the analogue output	4	Blinks very slowly 1s on 1s off	Open current output or overheating of the output driver, for example as a result of a short-circuited voltage output.
Bootloader: Firmware-update failed	1	Permanent on	Checksum error after writing to flash memory during firmware update

FUNCTION LED

The FUNCTION LED lights up permanently in yellow (blue for GSV-8DS) during normal operation. It blinks after activating the firmware update function (see Annex A).

In EtherCAT devices, this LED lights up or blinks in green depending on the EtherCAT states (with GSV-8DS: separate green LED).



STATUS LED (red)

The STATUS LED indicates errors that have occurred:

If it lights up permanently in red, an error at the sensor input has occurred. This can be ascribed to three causes:

- A sensor or its cable is defective, for example, the cable Ud+ or Ud- could be interrupted or short circuited with one of the cables Us+ or Us-.
- A measured value is saturated, i.e. the measuring signal lies outside the measuring range. This could be ascribed to a defective sensor.
- The maximum value is exceeded for a six-axis sensor.

If the STATUS LED blinks slowly (approx. 1x/s), an error has occurred at the analogue output. This could be an open current output or overheating of the output driver, for example, as a result of a short-circuited output voltage.

If the STATUS LED blinks quickly (approx. 2x/sec), an error has occurred at the digital output, namely a short circuit, i.e. if this is connected as an output and switched to High, it has short-circuited with GNDD, or if it is switched to Low, a voltage ≥ 3 V is connected.

The status display of the error can be cleared by pressing the MODE button (located in the housing) if the error is currently no longer present.

Detailed error information is stored in the device and can be displayed by pressing the keyboard key E in the terminal program.

Digital inputs and outputs

The GSV-8 has 16 configurable 5V TTL compatible digital inputs and outputs ('DIOs'). These are organised into 4 groups which are identified on the GSV-8AS terminal connections as 'Group 1' to 'Group 4'. The respective DIOs are identified here as <GroupNo.>.<DIONo>.

The DIOs can be configured as an input or output function, whereby the DIOs within one group must all have the same data direction.

Digital-I/O Numbers

In the devices and windows API (DLL), the numbers of the DIOs are assigned to the terminal connection identification as follows:

Number in the API and	Belongs to group	Identification on the terminal board
-----------------------	------------------	--------------------------------------

terminal program		
1	1	1.1
2	1	1.2
3	1	1.3
4	1	1.4
5	2	2.1
6	2	2.2
7	2	2.3
8	2	2.4
9	3	3.1
10	3	3.2
11	3	3.3
12	3	3.4
13	4	4.1
14	4	4.2
15	4	4.3
16	4	4.4

Digital I/O Functions

The following functions can be configured:

No	Function	Data direction	Parameter Device- or DLL-Command (GSV86)Get/ SetDIOType	Short description
1	General-Purpose Input	Input	0x000004	General input. The logic level can be queried with GetDIOlevel / GSV86getDIOlevel.
2	Sync-Slave Input	Input	0x000002	Input for synchronous measurement data frame transmission in combination with several GSV-8, whereby the line is connected to the master (see no.18)
3	Zero setting single channel	Input	0x000010	The active input level sets an analogue input channel to zero.
4	Zero setting all	Input	0x000020	The active input level sets all analogue input

	channels			channels to zero.
5	Reset the maximum and minimum value determination	Input	0x000040	The active input level resets all maximum and minimum values.
6	Trigger Send actual value	Input	0x000080	Triggers the sending of a measured value frame with actual measured values via a USB interface to the inactive-to-active edge of the digital input.
7	Trigger minimum value	Input	0x000100	The maximum value determination is started for the inactive-to-active edge at the digital input (all input channels) and a frame with these maximum values is sent to the USB interface at the active-to-inactive edge.
8	Trigger minimum value	Input	0x000200	The minimum value determination is started for the inactive-to-active edge at the digital input (all input channels) and a frame with these minimum values is sent to the USB interface at the active-to-inactive edge.
9	Trigger mean value	Input	0x000400	A decimating mean value formation is started for the inactive-to-active edge on the digital input (all input channels) and a frame with these mean values is sent to the USB interface at the active-to-inactive edge.
10	Trigger Send actual value	Output	0x000800	While the input level is active, measured value frames with actual measured values are sent via a USB interface at the set data rate.
11	General-Purpose Output	Output	0x001000	General output. The actual logic level can be defined with SetDIOlevel / GSV86setDIOlevel .
12	Threshold output actual value	Output	0x010000	Threshold value output: The output is activated if the assigned measured value is larger than the upper threshold value and is deactivated if it is smaller than the lower threshold value.
13	Threshold output maximum value	Output	0x014000	Threshold value output: The output is activated if the assigned maximum value is larger than the upper threshold value and is deactivated if it is smaller than the lower threshold value.
14	Threshold output minimum value	Output	0x018000	Threshold value output: The output is activated if the assigned minimum value is larger than the upper threshold value and is deactivated if it is smaller than the lower threshold value.
15	Window	Output	0x012000	Window comparator: The output is activated if

	comparator output actual value			the assigned measured value is smaller than the upper threshold value and larger than the lower threshold value; otherwise it is deactivated.
16	Window comparator output maximum value	Output	0x016000	Window comparator: The output is activated if the assigned maximum value is smaller than the upper threshold value and larger than the lower threshold value; otherwise it is deactivated.
17	Window comparator output minimum value	Output	0x01A000	Window comparator: The output is activated if the assigned minimum value is smaller than the upper threshold value and larger than the lower threshold value; otherwise it is deactivated.
18	Sync-Master output	Output	0x020000	Output to the synchronous data frame transmission in combination with several GSV-8, whereby the line is connected to the slave (s) (see no.2)

Inverting digital inputs

The DIOs have pull-up resistances that generate high levels when the input is open. For input trigger functions that are intended to be used with a switch or button, that one must be connected between the DIO and the GNDD terminal. The line must be functionally inverted by software so that the function can be executed when the switch is closed. When using the device interfaces or DLL, the specified value in the above mentioned column 'Value' must be ORed with 0x80000 for this purpose.

The threshold value outputs can also be inverted in this way.

The terms in the above mentioned table mean:

Level	Non-inverted	Inverted
Active	Logic 1 = High = 5V	Logic 0 = Low = 0V
Inactive	Logic 0 = Low = 0V	Logic 1 = High = 5V

Only when using the general purpose functions (no. 1 and 10 in the above table) does the inversion have no effect. The functions GSV86get/setDIOlevel and Get/SetDIOlevel always read the level directly, i.e. not inverted.

Further Notes Digital I/O

The **default level** can be defined for digital outputs, i.e. the level that the output should take after restarting and after a reconfiguration. This setting also applies directly, i.e. independent of the inversion state.



The general permanent data transmission should be turned off for measured value-send-trigger functions (no. 6 to 10 in the above-mentioned table). This can be done with the button y in the terminal program.

For functions, that are associated with the acquisition of maximum and minimum values (in the above-mentioned table no. 5,7,8,13,14,16,17) the determination of maximum and minimum values of the firmware should be activated. This can be done with the button m in the terminal program.

Master-Slave Frame Synchronization

When using several GSV-8s at the same time, the transmission of the measured data frames can be synchronized via digital I / Os. For this, one of the devices must be configured as a master by selecting one of the DIO lines 13 to 16 as a synchronization line and configuring the function of this line as a sync master output (no.18). All other devices are configured as sync slave input (No. 2) on the DIO line connected to the master.

When using the optional GSV-8 master-slave adapter cable, the synchronization line for all devices is set to DIO no. 16.

The synchronization line always consists of two wires: signal (e.g., DIO 16 <-> DIO 16) and GND = digital reference mass.

Data acquisition and Bandwidth

The GSV-8 has a 24-bit sigma delta AD converter that acquires all 8 channels simultaneously (simultaneous sampling). It is set to a fixed single sampling rate of 48000 samples/second (total sampling rate = 48000/s x 8 channels = 384000/s). These are decimated down by a digital anti-aliasing filter to fixed values depending on the selected data rate, whereby all input samples are included in the calculation (output decimation). The cut-off frequencies mentioned in the following table is a result of this input filter, i.e. these apply if:

- The analogue input filter is set to the highest value of 11.4 kHz and
- The additional digital filters (see above) are switched off.

In this case, the data frequency also automatically corresponds to the update of the analog output. However, the analog output is updated up to 16000 samples / s. The analog output is switched off from 24000 samples / s and higher.

Data frequency in frames/s	Decimation divisor	-3 dB cut-off frequency in Hz
1	48000	0,4
2	24000	0,8
3	16000	1,2
4	12000	1,6
5	9600	2
6	8000	2,4

Data frequency in frames/s	Decimation divisor	-3 dB cut-off frequency in Hz
8	6000	3,2
10	4800	4
12	4000	4,8
15	3200	6
16	3000	6,4
20	2400	8
24	2000	9,6
25	1920	10
30	1600	12
32	1500	12,8
40	1200	16
48	1000	19,2
50	960	20
60	800	24
75	640	30
80	600	32
96	500	38,4
100	480	40
120	400	48
125	384	50
150	320	60
160	300	64
192	250	76,8
200	240	80
240	200	96
250	192	100
300	160	120
320	150	128
375	128	150
384	125	153,6



Data frequency in frames/s	Decimation divisor	-3 dB cut-off frequency in Hz
400	120	160
480	100	192
500	96	200
600	80	240
640	75	256
750	64	300
800	60	320
960	50	384
1000	48	400
1200	40	480
1500	32	600
1600	30	640
1920	25	768
2000	24	800
2400	20	960
3000	16	1200
3200	15	1280
4000	12	1600
4800	10	1920
6000	8	2400
8000	6	3200
9600	5	3840
12000	4	4800
16000	3	6400
24000	2	9600
48000	1	11400

Note: The configurable maximum data frequency depends on other settings of the device.

When setting the data frequency, the GSV-8 checks if the desired data frequency is possible and refuses the command, if not. The maximum configurable data frequency can be determined by a read command. Examples of settings that have an impact on the maximum data frequency, are:

- Measured data type

- Bit rate of the UART interface, if activated (if present)
- Digital FIR- and IIR-filters
- Trigger- and threshold functions of the digital I/Os
- Activated six-axis sensor measuring

At the highest data rates of 24000 / s and 48000 / s, the range of functions of the GSV-8 is limited to digital data transmission.

Data frames and Bandwidth

The GSV-8 transmits the measured data in single frames via a serial USB interface, whereby each measured data frame contains samples of all 8 channels that were acquired simultaneously.

The data format for the measured data can be changed. There are 3 different data formats available:

Data type	Description	Maximum data frequency ¹
INT16	Integer 16-Bit-value in binary offset format. Unscaled raw value.	48000 frames/s
INT24	Integer 24-Bit-value in binary offset format. Unscaled raw value.	24000 frames/s
Float	32-bit floating-point number according to IEEE 754. Measured value has been completely scaled.	12000 frames/s (six-axis sensor = off) ² 12000 frames/s (six-axis sensor = on) ³

Using the example of the strain gauge input with a bridge supply voltage of 8.75 V, the following applies for the integer measured value display INT16 and INT24:

Sensor deviation in mV/V	Integer measuring value, 16-Bit Hex	Integer measuring value, 24-Bit Hex	Read value MEGSV8w32.dll:: GSVread and other measuring value -read functions ⁴
<= -2,1	0x0000	0x000000	-1,05
-2,0	0x0618	0x061862	-1,0
0	0x8000	0x800000	0,0
2,0	0xF9E7	0xF9E79E	1,0
>= 2,1	0xFFFF	0xFFFFF7	1,05

The measuring amplifier is factory-calibrated so that the value for the nominal input sensitivity (here 2.0 mV/V) is as exact as possible.

The multiplication with the scaling value (button 'n' in the terminal program) is carried out by

- 1 This value may be smaller depending on configuration. The GSV-8 rejects an attempt to set a data frequency that is too high.
- 2 from Firmware 1.36 and higher
- 3 from Firmware 1.36 and higher
- 4 This value doesn't apply for the GSV-8, if the configured data type is float.



external software for the INT data types.

The GSV-8 independently calculates the completely scaled measured values for the **data type float** either by taking the scaling value (general sensors) into consideration or by multiplying with the coefficient matrix for the activated six-axis sensors or by using the calculation for PT1000 RTDs.

Frequency output 60kHz \pm 30kHz

The measuring signal of the channel 1 can be additionally represented as a frequency modulated square wave signal. It is a differential signal with an amplitude of 6Vpp. The signal can be picked up on the terminals Tx+, Tx- and GND.

The connection on GND is optional.

The representation of sensor zero signal is with 60kHz. At maximum positive nominal input detuning of the amplifier the frequency increases to 90kHz. At maximum negative nominal input detuning of the amplifier the frequency sinks to 30kHz.

An user scaling value can be supplied which allows for changing the output scaling.

The total range of the frequency output, however, is set to 28500Hz to 91500Hz (30000-5% from the hub to 90,000 + 5%).

Changelog

Version	Changes
ba-gsv8_ver7d.odt	updated Pin Assignment for SubD25 female (analog out)
ba-gsv8_ver7e.odt	updated formatting of document
ba-gsv8_ver7f.odt	updated formatting of document
ba-gsv8_ver7g.odt	Chapter Interfaces, Buttons & LEDs, DIOs expanded, TEDS added, corrected
ba-gsv8_ver7h.odt	Chapter "noise amplitude of analogue output"; Paragraph over the bandwidth of the analog output; Maximum bandwidth with K6D sensors;



Subject to change without notice.

All information describes our products in general form.

They are not warranted characteristics in the sense of §459 Paragraph 2, BGB (German Civil Code) or similar regulations and affect no liability.

Made in Germany

Copyright © 2017
ME-Meßsysteme GmbH
Printed in Germany