IB ST 24 AI 4/EF

**INTERBUS-ST analog input module,
4 inputs, 0 - 10 V, ±10 V, 0 - 20 mA, 4 - 20 mA**

Data sheet
105596_en_01

1 Description

The module is designed for use within an ST station.

It is used to acquire analog voltage and current signals.

Features

– 4 analog, differential input channels for the connection of either voltage or current signals
– Connection of sensors in 2, 3, and 4-wire technology
– Sensor supply +15 V DC

This module replaces the modules which have been discontinued and are listed under "ordering data".

Use the DIP switch to configure the functions which the module should apply.

i	This data sheet is only valid in association with the IBS SYS PRO INST UM user manual.
i	Make sure you always use the latest documentation. It can be downloaded from the product at phoenixcontact.net/products.

2   Table of contents

3   Ordering data

Description	Type	Order No.	Pcs. / Pkt.
INTERBUS-ST analog input module, 4 inputs, 0 - 10 V, ±10 V, 0 - 20 mA, 4 - 20 mA, IP20 protection, consisting of: terminal part with screw connection and module electronics	IB ST 24 AI 4/EF	2700838	1
INTERBUS-ST analog input module, 4 inputs, 0 - 10 V, ±10 V, 0 - 20 mA, 4 - 20 mA, degree of protection IP20, comprising: Module electronics only	IB STME 24 AI 4/EF	2701955	1

Accessories	Type	Order No.	Pcs. / Pkt.
Insertion bridges, divisible, isolated comb spine, color blue, 84-pos. (Bridges)	EB 84 IB ST BU	2836269	5
Insertion bridges, divisible, isolated comb spine, color red, 84-pos. (Bridges)	EB 84 IB ST RD	2836272	5
Replacement fuse, for INTERBUS-ST modules (Fuse)	IBS TR5 0,2AT	2753452	5
Replacement fuse, for INTERBUS-ST modules (Fuse)	IBS TR5 0,4AT	2753478	5

Module replaced	Type	Order No.	Function	DIP switch
INTERBUS-ST analog input module, 4 inputs, 0 - 20 mA, 0 - 10 V, IP20 protection, consisting of: Terminal part with screw connection and module electronics	IB ST 24 AI 4/SF	2754309	SF	OFF/OFF
INTERBUS-ST analog input module, 4 inputs, 0 - 20 mA, 0 - 10 V, IP20 protection, consisting of: Terminal part with screw connection and module electronics	IB ST 24 AI 4/SF-WT	2752534	SF	OFF/OFF
Replacement module electronics for IB ST (ZF) 24 AI 4/SF	IB STME 24 AI 4/SF	2754383	SF	OFF/OFF
Replacement module electronics for IB ST (ZF) 24 AI 4/SF-WT Replacement electronics module	IB STME 24 AI 4/SF-WT	2752602	SF	OFF/OFF
INTERBUS-ST analog input module, 4 inputs, 0 - 20 mA, 0 - 10 V, IP20 protection, consisting of: Terminal part with spring-cage connection and module electronics	IB ST ZF 24 AI 4/SF	2750620	SF	OFF/OFF
INTERBUS-ST analog input module, 4 inputs, 4 - 20 mA, 0 - 10 V, IP20 protection, consisting of: Terminal part with screw connection and module electronics	IB ST 24 AI 4/SF4	2750565	SF4	ON/ON
INTERBUS-ST analog input module, 4 inputs, 4 - 20 mA, 0 - 10 V, IP20 protection, consisting of: Terminal part with spring-cage connection and module electronics	IB ST ZF 24 AI 4/SF4	2750594	SF4	ON/ON
Replacement module electronics for IB ST (ZF) 24 AI 4/SF4	IB STME 24 AI 4/SF4	2750060	SF4	ON/ON
INTERBUS-ST analog input module, 4 inputs, 4 - 20 mA, -10 to +10 V, IP20 protection, consisting of: Terminal part with screw connection and module electronics	IB ST 24 AI 4/BP	2751564	BP	ON/OFF
Replacement module electronics for IB ST (ZF) 24 AI 4/BP Replacement electronics module	IB STME 24 AI 4/BP	2751551	BP	ON/OFF
INTERBUS-ST analog input module, 4 inputs, 4 - 20 mA, -10 to +10 V, IP20 protection, consisting of: Terminal part with spring-cage connection and module electronics	IB ST ZF 24 AI 4/BP	2724737	BP	ON/OFF

Documentation	Type	Order No.	Pcs. / Pkt.
User manual, English, Configuring and installing INTERBUS	IBS SYS PRO INST UM E	-	-

4 Technical data

Dimensions (nominal sizes in mm)	
Width	118 mm
Height	116 mm
Depth	117 mm

General data	
Weight	600 g
Operating mode	Process data mode with 4 words
Ambient temperature (operation)	-25 °C ... 55 °C
Ambient temperature (storage/transport)	-25 °C ... 70 °C
Permissible humidity (operation)	10 % ... 95 % (non-condensing)
Permissible humidity (storage/transport)	10 % ... 95 % (non-condensing)
Air pressure (operation)	80 kPa ... 106 kPa (up to 2000 m above sea level)
Air pressure (storage/transport)	80 kPa ... 106 kPa (up to 2000 m above sea level)
Degree of protection	IP20
Protection class	III, IEC 61140, EN 61140, VDE 0140-1
Processor monitoring	Watchdog circuit

Connection data	
Designation	Termination block
Connection method	Screw connection
Conductor cross section solid / stranded	0.2 mm² ... 2.5 mm² / 0.2 mm² ... 2.5 mm²
Conductor cross section [AWG]	24 ... 12
Stripping length	8 mm

Interface ST local bus	
Connection method	ST local bus connector
Number	2
Transmission speed	500 kBit/s
Transmission physics	Copper

Communications power	
Supply voltage	9 V DC (from the ST local bus)
Current consumption	typ. 54 mA, max. 80 mA
Power consumption	typ. 0.5 W

Periphery supply voltage	
Designation	U_S
Supply voltage	24 V DC
Nominal supply voltage range	19.5 V DC ... 30.2 V DC (including all tolerances, including ripple)
Current consumption	typ. 45 mA (I_b = 0 mA (I_b = total current for supplying passive sensors for all channels)) typ. 120 mA (I_b = 100 mA (I_b = total current for supplying passive sensors for all channels))
Power consumption	typ. 1.1 W (I_b = 0 mA (I_b = total current for supplying passive sensors for all channels)) typ. 2.9 W (I_b = 100 mA (I_b = total current for supplying passive sensors for all channels))

Periphery supply voltage

Protection against polarity reversal	Serial diode
Transient protection	Yes
Overload protection	F1 fuse in IBS TR5 0,4AT header

Passive sensor supply

Designation	U_B (generated internally)
Supply voltage	15 V ±6 %
Current consumption	max. 100 mA (Total for all channels)
Precision	< 0.1 % (Network control 18.5 V DC ... 30.2 V DC)
Load control	typ. 0.6 % (0 % ... 100 % Load)
Temperature coefficients	typ. 0.01 %/K (I_b = 100 mA (I_b = total current for supplying passive sensors for all channels))
Transient protection	Yes
Overload protection	F2 fuse in IBS TR5 0,2AT header

Total power consumption of the module

Power consumption	typ. 1.6 W (Logic and I/O, I_b = 0 mA) typ. 3.4 W (Logic and I/O, I_b = 100 mA)

Analog inputs

Number of inputs	max. 4 (differential inputs, voltage or current)
Connection method	2, 3, 4-wire (shielded)
A/D conversion time	max. 10 µs (per channel)
Measured value representation	16 bit two's complement
Process data update	max. 750 µs (per channel) max. 3 ms (all channels)
Common mode rejection (CMR)	> 100 dB

differential inputs, voltage

Number of inputs	4
Voltage input signal	0 V ... 10 V (SF and SF4 mode), -10 V ... 10 V (Mode BP)
Input resistance of voltage input	200 kΩ
Open circuit response	Goes to 0 V
Resolution A/D	12 bit (4096 steps; 4.88 mV/quantization step (BP mode); 2.44 mV/quantization step (SF and SF4 mode))
Common mode voltage range signal - ground	-35 V DC ... 35 V DC

differential inputs, current

Number of inputs	4
Current input signal	0 mA ... 20 mA (SF mode), 4 mA ... 20 mA (BP and SF4 mode)
Input resistance current input	50 Ω
Open circuit response	Going to 0 mA; open-circuit detection from 4 mA ... 20 mA
Resolution A/D	12 bit (4096 steps; 4.88 µA/quantization step (SF mode); 3.91 µA (SF4 mode); 7.8 µA (BP mode))
Max. permissible current	± 100 mA (rms)

Programming Data

ID code (hex)	7E
ID code (dec.)	126
Length code (hex)	4
Length code (dec.)	4
Input address area	8 Byte

Programming Data

Output address area	0 Byte
Parameter channel (PCP)	0 Byte
Register length (bus)	8 Byte

Error messages to the higher level control or computer system

Failure of the internal I/O supply	I/O error message sent to the bus coupler
F1 fuse failure	I/O error message sent to the bus coupler
I/O supply failure	I/O error message sent to the bus coupler

Electrical isolation/isolation of the voltage areas

Test section	Test voltage
Bus/Inputs	500 V AC, 50 Hz, 1 min
Supply voltage/inputs	500 V AC, 50 Hz, 1 min
Supply voltage/Ground conductor	500 V AC, 50 Hz, 1 min
I/O voltage/Ground conductor	500 V AC, 50 Hz, 1 min

Conformance with EMC Directive 2004/108/EC

Noise immunity test in accordance with EN 61000-6-2

Electrostatic discharge (ESD) EN 61000–4–2/IEC 61000–4–2	Criterion B; 6 kV contact discharge, 8 kV air discharge
Electromagnetic fields EN 61000–4–3/IEC 61000–4–3	Criterion A; Field intensity: 10 V/m
Fast transients (burst) EN 61000–4–4/IEC 61000–4–4	Criterion B, 2 kV
Transient surge voltage (surge) EN 61000–4–5/IEC 61000–4–5	Criterion B; supply lines DC: ±0.5 kV/±0.5 kV (symmetrical/asymmetrical); ±1 kV to shielded I/O cables
Conducted interference EN 61000–4–6/IEC 61000–4–6	Criterion A; Test voltage 10 V

Noise emission test as per EN 61000-6-4

EN 55011	Class A

Approvals

For the latest approvals, please visit phoenixcontact.net/products.

5   Additional tables

Tolerance and temperature response

	Voltage inputs				Current inputs	
	0 V ... 10 V		-10 V ... +10 V			
	Typ.	Max.	Typ.	Max.	Typ.	Max.
Tolerance at 23°C	±0.024 %	±0.05%	±0.10%	±0.60 %	±0.05%	±0.15 %
Drift	±12 ppm/K	±50 ppm/K	±12 ppm/K	110 ppm/K	±12 ppm/K	±50 ppm/K
Total tolerance at -25°C ... +55°C	±0.05%	±0.20 %	±0.25%	±0.98 %	±0.075 %	±0.25%

No additional tolerances occur when influenced by electromagnetic interference. The module electronics function within the specified limits.

Cut-off frequencies of the analog voltage and current input filters

| Limit frequency	Voltage inputs	Current inputs
Limit frequency (3 dB)	69 Hz	32 Hz
Cut-off frequency (0.002 dB) for 12-bit accuracy of the A/D converter	1.6 Hz	0.8 Hz
Cut-off frequency (3 dB) for common mode suppression filter	1900 Hz	1900 Hz

6   Internal circuit diagram
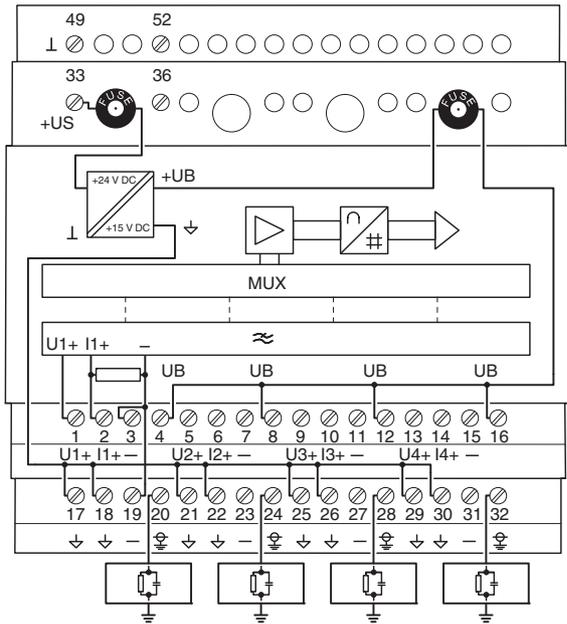
Figure 1   Internal wiring of the terminal points

Key:

	Power supply unit with electrical isolation
	Analog/digital converter
	Input amplifier
	Coupling network
	Filter

# 7   Electrical isolation
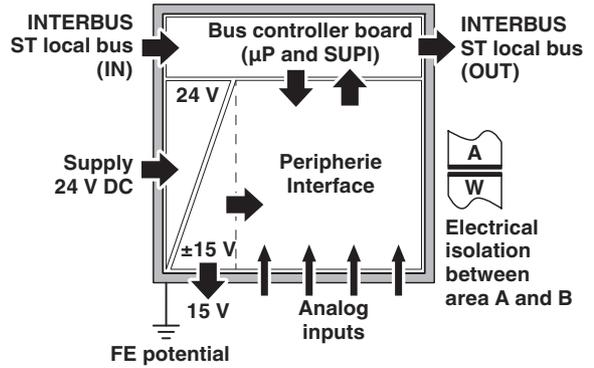
Figure 2   Electrical isolation of the individual function areas

8 Configuration via DIP switches

Use the DIP switches to set the function of the module.

Set the DIP switches before you connector the module electronics onto the terminal block base.

The configuration is transferred by applying the power supply for the bus logic. The communications power is fed to the bus terminal and then made available to the bus terminal for the entire ST station.
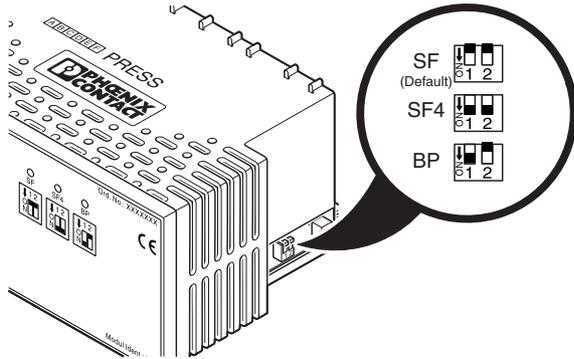

Figure 3   DIP switches

Switch		Function	
1	2		
OFF	OFF	SF	0 V ... 10 V, 0 mA ... 20 mA
ON	ON	SF4	0 V ... 10 V, 4 mA ... 20 mA
ON	OFF	BP	-10 V ... +10 V, 4 mA ... 20 mA
OFF	ON	Reserved	

Default setting   OFF / OFF

The corresponding LED indicates the current switch setting.

9 Terminal point assignment

US = 24 V DC
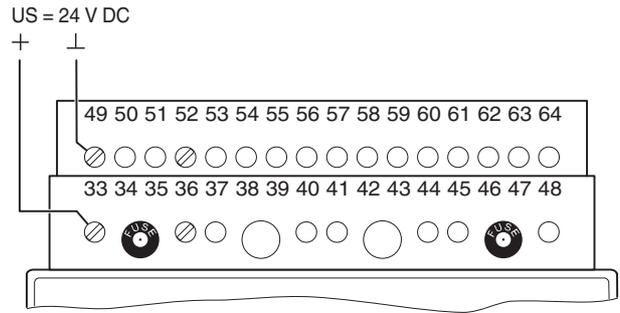
Figure 4   Connecting the supply voltage
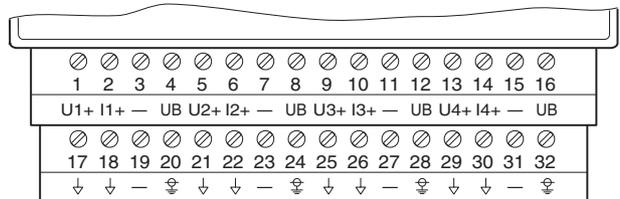
Figure 5   Terminal point assignment

Terminal point	Signal
U$_S$+	24 V I/O supply voltage
⊥	Supply voltage ground
U1+ ... U4+	Voltage inputs channel 1 ... 4
I1+ ... I4+	Current inputs channel 1 ... 4
-	Signal reference for current and voltage signal
UB	Sensor supply for passive sensors 15 V DC
▽	Analog ground
⏚	Shield connection

10 Local status and diagnostic indicators
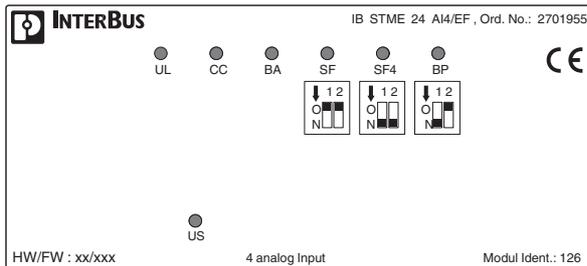
Figure 6   Local status and diagnostic indicators

Designa-tion	Color	Meaning	
UL	Green	24 V supply for the module elec-tronics	
CC	Green	Cable check	
BA	Green	Bus active	
SF	Green	Mode:	SF
SF4	Green	Mode:	SF4
BP	Green	Mode:	BP
US	Green	24 V I/O supply voltage	

11 Connection notes

Ground the DIN rail. The module is grounded by snapping it onto the DIN rail.

Always connect the analog sensors using shielded, twisted pair cables.

12 Connection examples

12.1 Connecting the supply voltage
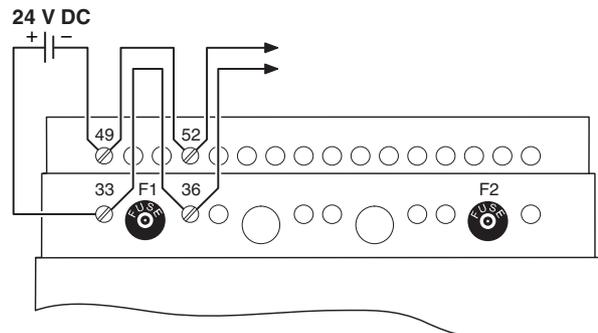
Figure 7   Connection of the supply voltage and potential routing

If you wish to connect more modules, an external jumper is required between terminal points 33 and 36 (U_S) as well as between 49 and 52 (ground).

12.2 Connection of analog active or passive sensors

Mode: SF, SF4
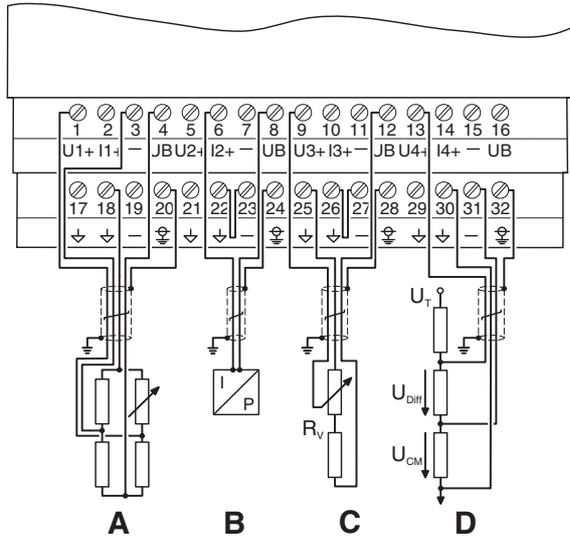
Figure 8   Connection of analog active or passive sensors

A   Channel 1   Passive measuring bridge with shield connection

B   Channel 2   Passive pressure sensor with shield connection

C   Channel 3   Passive potentiometer with shield connection

D   Channel 4   Voltage divider with shield connection

R_V Dimension the R_V in such a way that a maximum of +10 V is applied on the differential voltage inputs (terminal point 9).

> **NOTE: Electronics may be damaged when overloaded**
>
> Do not connect voltages above ±5 V to a current input. The module electronics will be damaged, as the maximum permissible current of ±100 mA will be exceeded.

12.3 Connection of active sensors in 2 and 3-wire technology

Mode: SF, SF4, BP
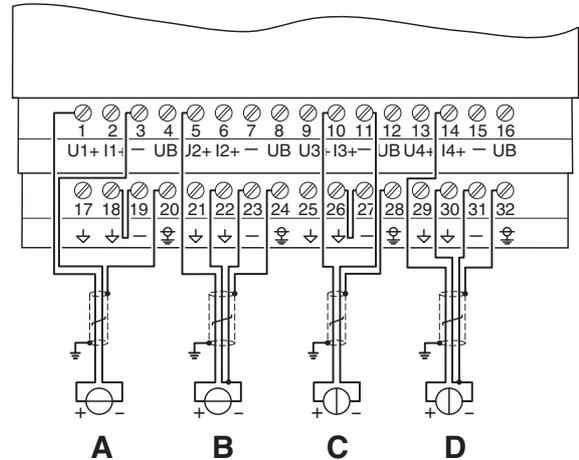
Figure 9   Connection of active current and voltage sensors

		Connection	SF	SF4	BP
A	Channel 1	2-wire	0 V ... 10 V	0 V ... 10 V	-10 V ... +10 V
B	Channel 2	3-wire	0 V ... 10 V	0 V ... 10 V	-10 V ... +10 V
C	Channel 3	2-wire	0 mA ... 20 mA	4 mA ... 20 mA	4 mA ... 20 mA
D	Channel 4	3-wire	0 mA ... 20 mA	4 mA ... 20 mA	4 mA ... 20 mA

12.4 Integration of a current input in a current measuring loop

Mode: SF, SF4, BP
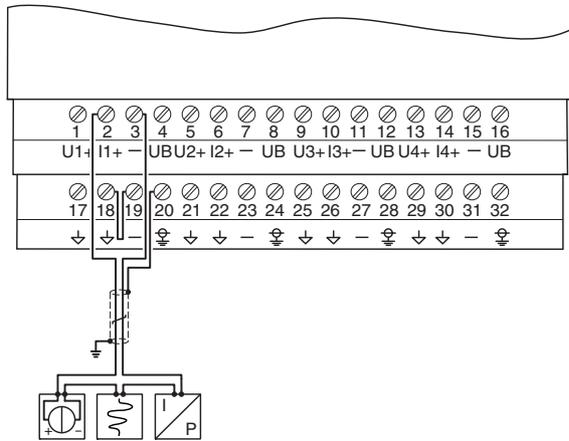
Figure 10   Integration of a current input in a current measuring loop

 Supply

 Writer

 Pressure sensor
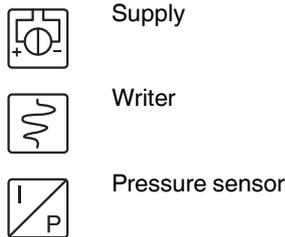
When connecting electrically isolated input signals, for each signal, create a reference ground between the signal reference input (-) and the analog mass.

12.5 Connection of a passive sensor with external power supply unit

Mode: SF, SF4, BP
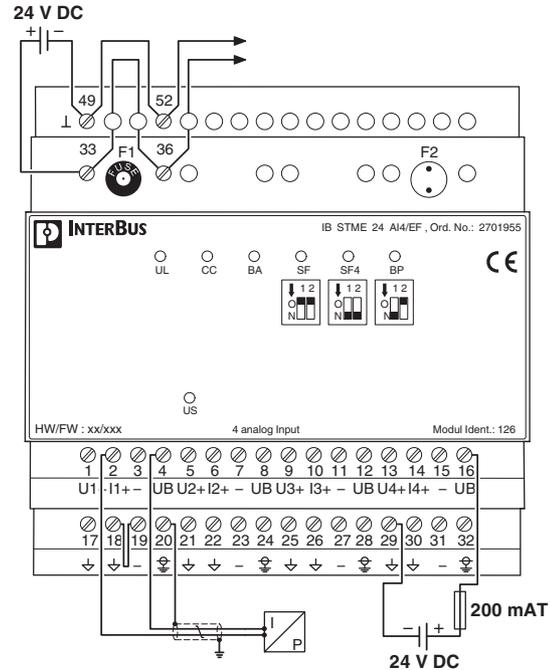
Figure 11   Connection of a passive sensor with external power supply unit
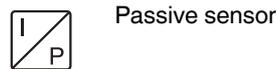
 Passive sensor

SF	0 mA ... 20 mA
SF4	4 mA ... 20 mA
BP	4 mA ... 20 mA

When using a passive sensor with a supply voltage of more than 15 V, there is the option of using the 4, 8, 12, and 16 terminal points.

To do this, proceed as follows:

• Remove the F2 fuse and insulate the fuse contacts.
• Connect the plus pole (+) of the external voltage source to one of the 4, 8, 12, or 16 terminal points.
• Connect the minus pole (-) to one of the 17/18, 21/22, 25/26 or 29/30 terminal points.

12.6 Cell monitoring of a battery charging station

Mode: SF, SF4, BP
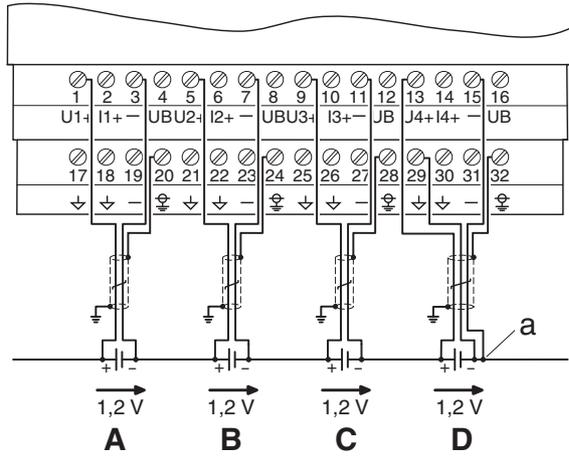
Figure 12 Cell monitoring of a battery charging station

A Channel 1
B Channel 2
C Channel 3
D Channel 4
a Separate reference ground

Connect the shield directly to terminal blocks 20, 24, 28 or 32.

Additional wiring is not necessary.

Connect the shield of the sensor with FE potential.

12.7 Integration of four passively operated current inputs in current measuring loops which are supplied by a common power supply unit

Mode: SF, SF4, BP
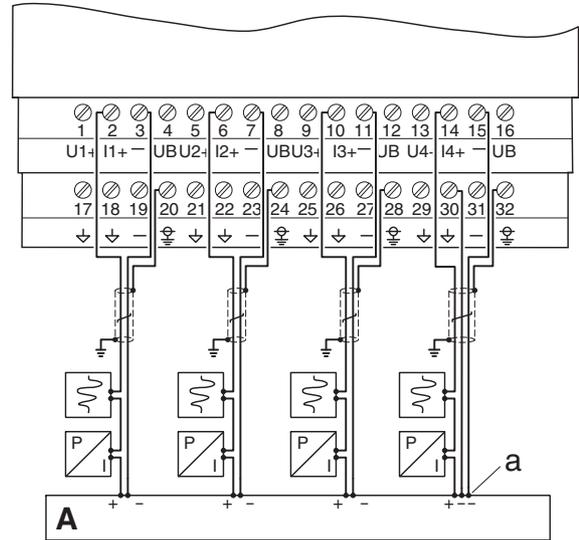
Figure 13 Integration of four passively operated current inputs in current measuring loops which are supplied by a common power supply unit

A Supply or active inputs with overall ground
a Separate reference ground

 Writer

 Pressure sensor

> **NOTE**
>
> As the current loops come from one isolated group, only one reference ground must be installed from the negative connection of the power supply unit or from the controller board to the analog ground point of the module (here terminal point 30).

13   Process data

The module uses four words of IN process data.

Each channel is mapped to a word.

Input words IN1 to IN4

The measured values are transmitted to the controller board or the computer using process data input words IN1 to IN4.

13.1   Measured value representation depending on mode

Order of the process data words

IN1	IN2	IN3	IN4
Channel 1	Channel 2	Channel 3	Channel 4

SF

Voltage and current measurement															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
V	Measured value												Res		

V   Sign bit
         Bit 15 = 0, as the voltage and current measured value is always positive.

Res   Reserved
         The content of the reserved bits has no meaning.

The measuring range comprises 0 V ... 10 V and 0 mA ... 20 mA.

SF4

Voltage measurement															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
V	Measured value												Res		

Current measurement															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res	Measured value											Res	OC		Res

V   Sign bit
         Bit 15 = 0, as the voltage measured value is always positive.

OC   Open circuit detection
         OC = 0   I > 3.2 mA (current loop functioning)
         OC = 1   I < 3.2 mA (open circuit)

Res   Reserved

Voltage measurement:

The measuring range comprises 0 V ... 10 V.

Current measurement:

The measuring range comprises 4 mA ... 20 mA.

Bit 1 indicates an open circuit in the current loop.

BP

Voltage measurement															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
V	Measured value												Res		

Current measurement															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res	Measured value											Res	OC		Res

V   Sign bit
         Bit 15 = 0, as the voltage measured value is always positive.

OC   Open circuit detection
         OC = 0   I > 3.2 mA (current loop functioning)
         OC = 1   I < 3.2 mA (open circuit)

Res   Reserved
         The content of the reserved bits has no meaning.

Voltage measurement:

The measuring range comprises -10 V ... +10 V.

Current measurement:

The measuring range comprises 4 mA ... 20 mA.

Bit 1 indicates an open circuit in the current loop.

13.2 Assignment of the terminal points to IN process data

(Word.bit) view	Word	x		
	Bit	**15**	**...**	**0**
Channel 1	Signal	1: voltage input 2: current input		
	GND	3, 19		
	Analog ground	17, 18		
	Shielding	20		
	Sensor voltage	4		
Channel 2	Signal	5: voltage input 6: current input		
	GND	7, 23		
	Analog ground	21,22		
	Shielding	24		
	Sensor voltage	8		
Channel 3	Signal	9: voltage input 10: current input		
	GND	11, 27		
	Analog ground	25, 26		
	Shielding	28		
	Sensor voltage	12		
Channel 4	Signal	13: voltage input 14: current input		
	GND	15, 31		
	Analog ground	29, 30		
	Shielding	32		
	Sensor voltage	16		

14 Significant values

Abbreviations used in the following tables

QS	Quantization step(s)
ORS	Start of range
Middle	Middle of measuring range
MRF	Measuring range final value
1/2 ORF	Half of measuring range final value
Bit 15	Most significant bit (MSB)
Bit 0	Least significant bit (LSB)

SF

Process data input word for the voltage inputs (example)

Voltage input 0 V ... 10 V	Analog value [V]	Process data input word		
		hex	Binary (two's complement)	
			15 ... 8	**7 ... 0**
10 V - 1 QS	9.9976	7FF8	01111111	11111000
10 V - 2 QS	9.9951	7FF0	01111111	11110000
1/2 ORF	5.0000	4000	01000000	00000000
1 QS	0.00244	0008	00000000	00001000
Zero	0.0000	0000	00000000	00000000

Process data input word for the current inputs (example)

Current input 0 mA ... 20 mA	Analog value [mA]	Process data input word		
		hex	Binary (two's complement)	
			15 ... 8	**7 ... 0**
20 mA - 1 QS	19.995	7FF8	01111111	11111000
20 mA - 2 QS	19.990	7FF0	01111111	11110000
1/2 ORF	10.000	4000	01000000	00000000
1 QS	0.00488	0008	00000000	00001000
Zero	0.0000	0000	00000000	00000000

SF4

Process data input word for the voltage inputs (example)

Voltage input 0 V ... 10 V	Analog value [V]	Process data input word		
		hex	Binary (two's complement)	
			15 ... 8	7 ... 0
10 V - 1 QS	9.9976	7FF8	01111111	11111000
10 V - 2 QS	9.9951	7FF0	01111111	11110000
1/2 ORF	5.0000	4000	01000000	00000000
1 QS	0.00244	0008	00000000	00001000
Zero	0.0000	0000	00000000	00000000

Process data input word for the current inputs (example)

Current input 4 mA ... 20 mA	Analog value [mA]	Process data input word		
		hex	Binary (two's complement)	
			15 ... 8	7 ... 0
20 mA - 1 QS	19.996	7FF8	01111111	11111000
20 mA - 2 QS	19.992	7FF0	01111111	11110000
1/2 ORF	12.000	4000	01000000	00000000
4 mA + 1 QS	4.0039	0008	00000000	00001000
ORS	4.0000	0000	00000000	00000000
Open circuit	< 3.2	XXX2	xxxxxxxx	xxxxxx1x

An x in the binary representation implies that the binary point as well as a 0 or a 1 could be contained.

BP

Process data input word for the voltage inputs (example)

Voltage input - 10 V ... +10 V	Analog value [V]	Process data input word		
		hex	Binary (two's complement)	
			15 ... 8	7 ... 0
10 V - 1 QS	9.9951	7FF0	01111111	11110000
10 V - 2 QS	9.9902	7FE0	01111111	11100000
1/2 ORF (+)	5.0000	4000	01000000	00000000
1 QS (+)	4.882 mV	0010	00000000	00010000
Zero	0.0000	0000	00000000	00000000
1 QS (-)	-4.882 mV	FFF0	11111111	11110000
1/2 ORF (-)	-5.000	C000	11000000	00000000
-10 V + 1 QS (+)	-9.9951	8010	10000000	00010000

Process data input word for the current inputs (example)

Current input 4 mA ... 20 mA	Analog value [mA]	Process data input word		
		hex	Binary (two's complement)	
			15 ... 8	7 ... 0
20 mA - 1 QS	19.992	7FF0	01111111	11110000
20 mA - 2 QS	19.984	7FE0	01111111	11100000
Middle	12.000	4000	01000000	00000000
4 mA + 1 QS	4.0078	0010	00000000	00010000
ORS	4.0000	0000	00000000	00000000
Open circuit	< 3.2	XXX2	xxxxxxxx	xxxxxx1x

An x in the binary representation implies that the binary point as well as a 0 or a 1 could be contained.

An X in the hexadecimal representation implies that the point could contain any hex value.