

# IB ST 24 AO 4/EF

**INTERBUS-ST analog output module,  
4 outputs, 0 - 10 V,  $\pm 10$  V, 0 - 20 mA, 4 - 20 mA**



Data sheet  
105597\_en\_01

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## 1 Description

The module is designed for use within an ST station.  
It is used to output analog voltage and current signals.

### Features

- 4 analog output channels for the connection of either voltage or current signals
- Connection of actuators in 2 and 3-wire technology

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.



This data sheet is only valid in association with the IBS SYS PRO INST UM user manual.



Make sure you always use the latest documentation.  
It can be downloaded from the product at [phoenixcontact.net/products](http://phoenixcontact.net/products).

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### 3 Ordering data

Description	Type	Order No.	Pcs. / Pkt.	
INTERBUS-ST analog output module, 4 outputs, 0 - 10 V, $\pm 10$ V, 0 - 20 mA, 4 - 20 mA, consisting of: terminal part with screw connection and module electronics	IB ST 24 AO 4/EF	2700839	1	
INTERBUS-ST analog output module, 4 outputs, 0 - 10 V, $\pm 10$ V, 0 - 20 mA, 4 - 20 mA, comprising: Module electronics only	IB STME 24 AO 4/EF	2701954	1	
Accessories	Type	Order No.	Pcs. / Pkt.	
Replacement fuse, for INTERBUS-ST modules (Fuse)	IBS TR5 0,4AT	2753478	5	
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	
Module replaced	Type	Order No.	Function	DIP switch
INTERBUS-ST analog output module, D/A resolution 13 bit, 4 outputs, 0 - 20 mA, 0 - 10 V, consisting of: Terminal part with screw connection and module electronics	IB ST 24 AO 4/SF	2754312	SF	OFF/OFF
Replacement module electronics for IB ST (ZF) 24 AO 4/SF	IB STME 24 AO 4/SF	2754354	SF	OFF/OFF
INTERBUS-ST analog output module, D/A resolution 13-bit, 4 outputs, 0 to 20 mA, 0 to 10 V, consisting of: Terminal part with spring-cage connection and module electronics	IB ST ZF 24 AO 4/SF	2750604	SF	OFF/OFF
INTERBUS-ST analog output module, D/A resolution 13-bit, 4 outputs, 4 to 20 mA, 0 to 10 V, consisting of: Terminal part with screw connection and module electronics	IB ST 24 AO 4/SF4	2750578	SF4	ON/ON
Replacement module electronics for IB ST (ZF) 24 AO 4/SF4	IB STME 24 AO 4/SF4	2750057	SF4	ON/ON
INTERBUS-ST analog output module, D/A resolution 13-bit, 4 outputs, 4 to 20 mA, 0 to 10 V, consisting of: Terminal part with spring-cage connection and module electronics	IB ST ZF 24 AO 4/SF4	2750581	SF4	ON/ON
INTERBUS-ST analog output module, D/A resolution 13-bit, 4 outputs, -10 V to +10 V, consisting of: Terminal part with screw connection and module electronics	IB ST 24 AO 4/BP	2752521	BP	ON/OFF
Replacement module electronics for IB ST (ZF) 24 AO 4/BP	IB STME 24 AO 4/BP	2750206	BP	ON/OFF
INTERBUS-ST analog output module, D/A resolution 13-bit, 4 outputs, -10 V to +10 V, consisting of: Terminal part with spring-cage connection and module electronics	IB ST ZF 24 AO 4/BP	2750617	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 mm <sup>2</sup> ... 2.5 mm <sup>2</sup> / 0.2 mm <sup>2</sup> ... 2.5 mm <sup>2</sup>
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 <sub>S</sub>
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. 48 mA (Mode BP) typ. 130 mA (SF and SF4 mode)
Power consumption	typ. 1.2 W (Mode BP) typ. 3.2 W (SF and SF4 mode)
Protection against polarity reversal	Serial diode
Transient protection	Yes
Overload protection	F1 fuse in IBS TR5 0,4AT header

**Total power consumption of the module**

Power consumption	typ. 1.7 W (Logic and I/O, BP mode) typ. 3.7 W (Logic and I/O, SF and SF4 mode)
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**Analog outputs**

Number of outputs	4 (Voltage or current)
Connection method	2, 3-conductor
D/A resolution	12 bit

**Analog outputs**

D/A conversion time	max. 1 ms (incl. slew rate)
Representation of output values	16 bit two's complement
Transient protection	Suppressor diode

**Analog outputs, Current**

Current output signal	0 mA ... 20 mA (SF and SF4 mode), 4 mA ... 20 mA (Mode SF4)
Load/output load current output	to 500 $\Omega$

**Analog outputs, Voltage**

Voltage output signal	-10 V ... 10 V (Mode BP), 0 V ... 10 V (SF and SF4 mode)
Load/output load voltage output	> 2 k $\Omega$

**Programming Data**

ID code (hex)	7D
ID code (dec.)	125
Length code (hex)	4
Length code (dec.)	4
Input address area	0 Byte
Output address area	8 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/Outputs	500 V AC, 50 Hz, 1 min
Supply voltage/Outputs	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: $\pm 0.5$ kV/ $\pm 0.5$ kV (symmetrical/asymmetrical); $\pm 1$ 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
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**Approvals**

For the latest approvals, please visit [phoenixcontact.net/products](http://phoenixcontact.net/products).

## 5 Additional tables

Tolerance and temperature response				
	Voltage outputs		Current outputs	
	Typ.	Max.	Typ.	Max.
Tolerance at 23°C	±0.10%	±0.20 %	±0.15 %	±0.20 %
Drift	±20 ppm/K	±50 ppm/K	±20 ppm/K	±90 ppm/K
Total tolerance at -25°C ... +55°C	±0.15 %	±0.25%	±0.20 %	±0.50 %

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

## 6 Internal circuit diagram

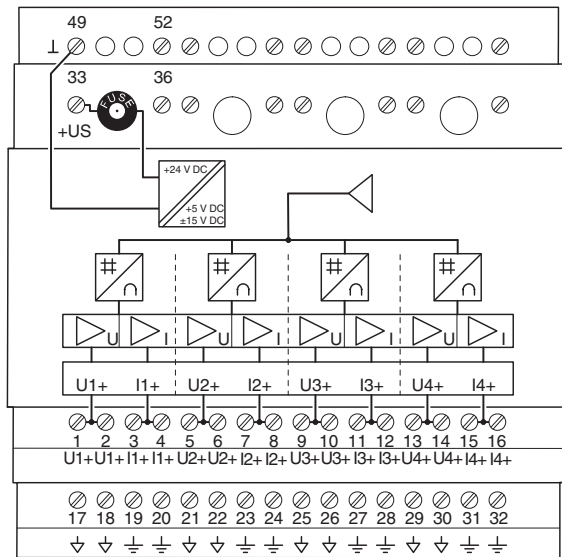





Figure 1 Internal wiring of the terminal points

Key:

-  Power supply unit with electrical isolation
-  Digital/analog converter
-  Output amplifier for current (I) or voltage (U)

## 7 Electrical isolation

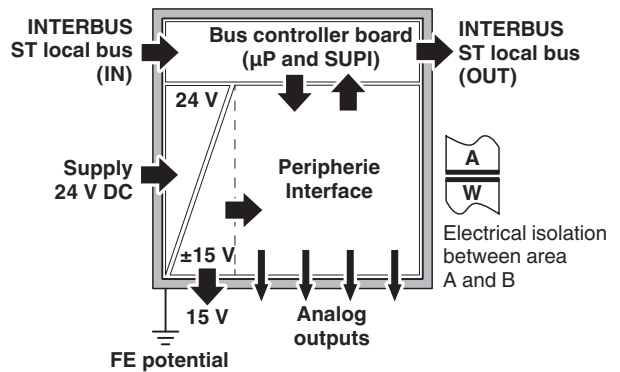


Figure 2 Electrical isolation of the individual function areas

## 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.

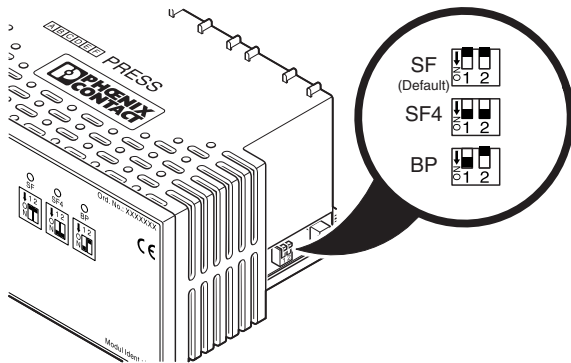


Figure 3 DIP switches

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
OFF	ON	Reserved	

Default setting                      OFF / OFF

The corresponding LED indicates the current switch setting.

## 9 Terminal point assignment

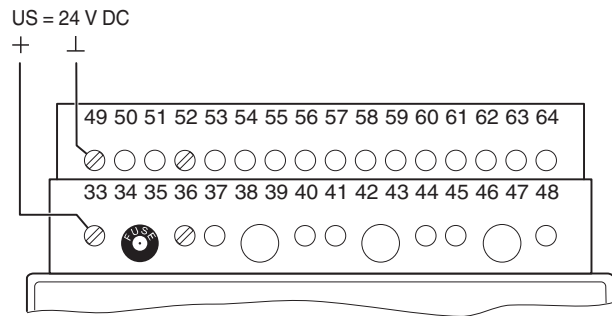


Figure 4 Connecting the supply voltage

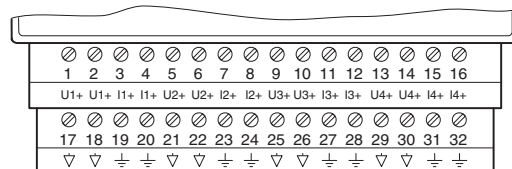


Figure 5 Terminal point assignment

Terminal point	Signal
U <sub>S</sub> +	24 V I/O supply voltage
⊥	Supply voltage ground
U1+ ... U4+	Voltage outputs channel 1 ... 4
I1+ ... I4+	Current outputs channel 1 ... 4 (not in BP mode)
▽	Analog ground
⊥	Functional earth ground (FE)



## 10 Local status and diagnostic indicators

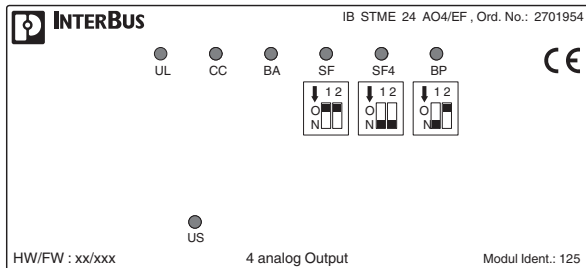


Figure 6 Local status and diagnostic indicators

Designation	Color	Meaning
UL	Green	24 V supply for the module electronics
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 actuators using shielded twisted-pair cables.

## 12 Connection examples

### 12.1 Connecting the supply voltage

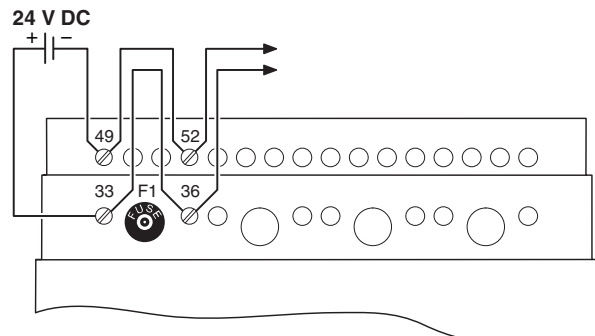


Figure 7 Connection of the supply voltage and potential routing

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 actuators

Mode: SF, SF4

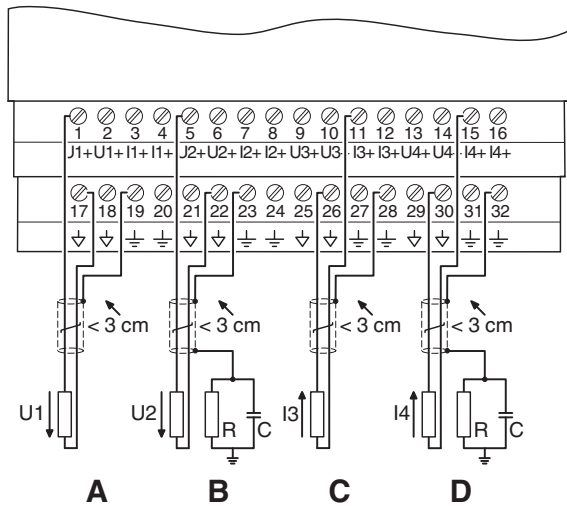


Figure 8 Connection of actuators with various cable lengths

- A Channel 1 Voltage pick-off with shield connection for cable lengths **under 10 m**
- B Channel 2 Voltage pick-off with shield connection for cable lengths **over 10 m**
- C Channel 3 Current pick-off with shield connection for cable lengths **under 10 m**
- D Channel 4 Current pick-off with shield connection for cable lengths **over 10 m**

Cable length < 10 m: when using such lengths, place the shield on one side of the analog module only.  
 Recommendation for cable length of > 10 m in environments with heavy noise: connect the shield through an RC element to FE potential of the actuator.  
 The capacitor C should typically have values of 1 nF to 15 nF. The resistor R should have a resistance of at least 10 MΩ.  
 Connect the terminal points of the shield directly with FE potential.

12.3 Connection of actuators

Mode: BP

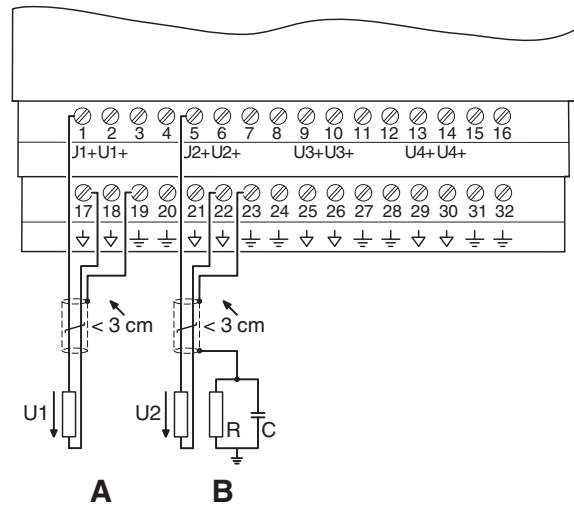


Figure 9 Connection of actuators with various cable lengths

- A Channel 1 Voltage pick-off with shield connection for cable lengths **under 10 m**
- B Channel 2 Voltage pick-off with shield connection for cable lengths **over 10 m**

Cable length < 10 m: when using such lengths, place the shield on one side of the analog module only.  
 Recommendation for cable length of > 10 m in environments with heavy noise: connect the shield through an RC element to FE potential of the actuator.  
 The capacitor C should typically have values of 1 nF to 15 nF. The resistor R should have a resistance of at least 10 MΩ.  
 Connect the terminal points of the shield directly with FE potential.

### 13 Process data

The module uses four output process data words. Each channel is mapped to a word.

#### Output words OUT1 to OUT4

The output values are transmitted from the controller board or the computer to the module using process data output words OUT1 to OUT4.

#### 13.1 Output value representation depending on mode

##### Order of the process data words

OUT1	OUT2	OUT3	OUT4
Channel 1	Channel 2	Channel 3	Channel 4

#### SF, SF4

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

- V Sign bit  
Bit 15 = 0, as the voltage and current output value is always positive.  
If bit 15 = 1, then the output value is 0 V, 0 mA (SF mode) or 4 mA (SF4 mode).
- Res Reserved

Bits 0, 1, and 2 are reserved, their content has no meaning.

#### BP

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

- V Sign bit  
Bit 15 = 0: positive output value  
Bit 15 = 1: negative output value
- Res Reserved

Bits 0, 1, 2, and 3 are reserved, their content has no meaning.

### 13.2 Assignment of the terminal points to the output process data

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



In BP mode, the respective current outputs are not used.

## 14 Significant values

Abbreviations used in the following tables

QS	Quantization step(s)
ORS	Output range start
ORF	Output range final value
1/2 ORF	Half output range final value
Bit 15	Most significant bit (MSB)
Bit 0	Least significant bit (LSB)

### SF

**Process data output word for the voltage outputs (example)**

Voltage output 0 V ... 10 V	Analog value [V]	Process data output 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 output word for the current outputs (example)**

Current output 0 mA ... 20 mA	Analog value [mA]	Process data output 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 output word for the voltage outputs (example)**

Voltage output 0 V ... 10 V	Analog value [V]	Process data output 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 output word for the current outputs (example)**

Current output 4 mA ... 20 mA	Analog value [mA]	Process data output 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

### BP

**Process data output word for the voltage outputs (example)**

Voltage output -10 V ... +10 V	Analog value [V]	Process data output 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	11110000
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
-10 V	-10.0000	8000	10000000	00000000

## 15 Output behavior of the voltage and current outputs

### 15.1 Response of the voltage and current outputs to a control command of the INTERBUS controller board

Command	State after switching operation	
	OUT1 ... OUT4	Analog outputs
STOP	Hold last value	Hold last value
ALARM STOP (reset)	Hold last value	Hold last value

### 15.2 Output behavior

Supply voltage for the module	Supply voltage of the bus terminal	Bus state	OUT1 ... OUT4	Behavior/status of the analog outputs		
				SF	SF4	BP
0 V ⇒ 24 V	24 V	Running	xxxx	Hold last value	Hold last value	Hold last value
0 V ⇒ 24 V	0 V	Running	0000	0 V / 0 mA	0 V / 4 mA	0 V
24 V ⇒ 0 V	Any	Running	xxxx	0 V / 0 mA	0 V / 0 mA	0 V
24 V	0 V ⇒ 24 V	Running	xxxx	Hold last value	Hold last value	Hold last value
0 V ⇒ 24 V	0 V ⇒ 24 V	Running	xxxx	Hold last value	Hold last value	Hold last value
24 V	24 V	Interrupted	xxxx	Hold last value	Hold last value	Hold last value
24 V	24 V	Reset	xxxx	Hold last value	Hold last value	Hold last value

Hold last value

Output of the last output value before a power supply or the bus failed. The value is stored in the module and is also available in coded format in process data words OUT1 to OUT4 (xxxx<sub>hex</sub>).

xxxx

Hexadecimal coded output value which is sent by the control or computer system in the current bus cycle.