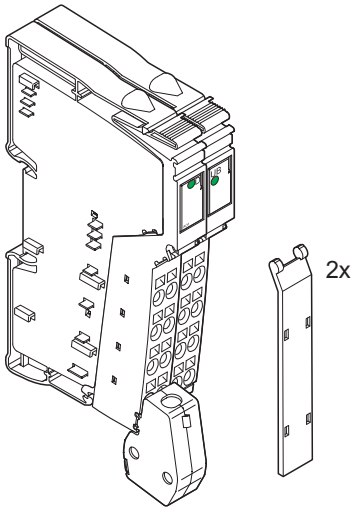
IB IL AO 1/SF (-PAC)

Inline Terminal With One Analog Output



AUTOMATIONWORX

Data Sheet
5562_en_06

Description

The terminal is designed for use within an Inline station.
It is used to output analog voltage or current signals. The signals are available with a 16-bit resolution.

Features

- 1 analog signal output to connect either voltage or current signals
- Actuator connection in 2-wire technology with shield connection
- 2 current range, 1 voltage range:
  0 mA up to 20 mA, 4 mA up to 20 mA, 0 V up to 10 V
- Process data update including conversion time of the digital-to-analog converter < 1 ms

Only **one** output can be used on the terminal.
Use a connector with shield connection when installing the actuator.

This data sheet is only valid in association with the IL SYS INST UM E user manual or the Inline system manual for your bus system.

Make sure you always use the latest documentation.
It can be downloaded at www.download.phoenixcontact.com.
A conversion table is available on the Internet at
www.download.phoenixcontact.com/general/7000_en_00.pdf.

This data sheet is valid for the products listed on the following page.

Ordering Data

Products

Description	Type	Order No.	Pcs./Pkt.
Inline Terminal with one analog output either for voltage or current signals, complete with accessories (connectors and labeling fields)	IB IL AO 1/SF-PAC	2861315	1
Inline Terminal with one analog output either for voltage or current signals, without connectors	IB IL AO 1/SF	2726298	1

The connectors listed below are needed for the complete fitting of the IB IL AO 1/SF terminal.

Accessories

Description	Type	Order No.	Pcs./Pkt.
The following shield connector must be used to connect the actuator:			
Shield connector, for analog Inline terminals (green, w/o color print);	IB IL SCN-6 SHIELD	2726353	5
On the base side that is not used for actuator connection, one of the following connectors can be used:			
Shield connector, for analog Inline terminals (green, w/o color print);	IB IL SCN-6 SHIELD	2726353	5
Connector, for digital 1, 2 or 8-channel Inline terminals (green, w/o color print)	IB IL SCN-8	2726337	10
Inline connector, colored	IB IL SCN-8-CP	2727608	10

Documentation

Description	Type	Order No.	Pcs./Pkt.
User manual: "Configuring and Installing the INTERBUS Inline Product Range"	IB IL SYS PRO UM E	2743048	1
User manual: "Automation Terminals of the Inline Product Range"	IL SYS INST UM E	2698737	1
Application note: "InlineTerminals for Use in Zone 2 Potentially Explosive Areas"	AH EN IL EX ZONE 2	7217	

Technical Data

General Data	
Housing dimensions (width x height x depth)	24.4 mm x 120 mm x 71.5 mm
Weight	90 g (without connectors), 100 g (including connectors)
Operating mode	Process data mode with 1 word
Transmission speed	500 kbps
Connection method for actuators	2-wire technology
Ambient temperature (operation)	-25°C to +55°C
Ambient temperature (storage/transport)	-25°C to +85°C
Permissible humidity (operation/storage/transport)	10 % to 95 %, according to DIN EN 61131-2
Permissible air pressure (operation/storage/transport)	70 kPa to 106 kPa (up to 3,000 m above sea level)
Degree of protection	IP20 according to IEC 60529
Class of protection	Class 3 according to VDE 0106, IEC 60536
Connection data for Inline connector	
Connection method	Spring-cage terminals
Conductor cross section	0.2 mm^2 to 1.5 mm^2 (solid or stranded), AWG 24 - 16

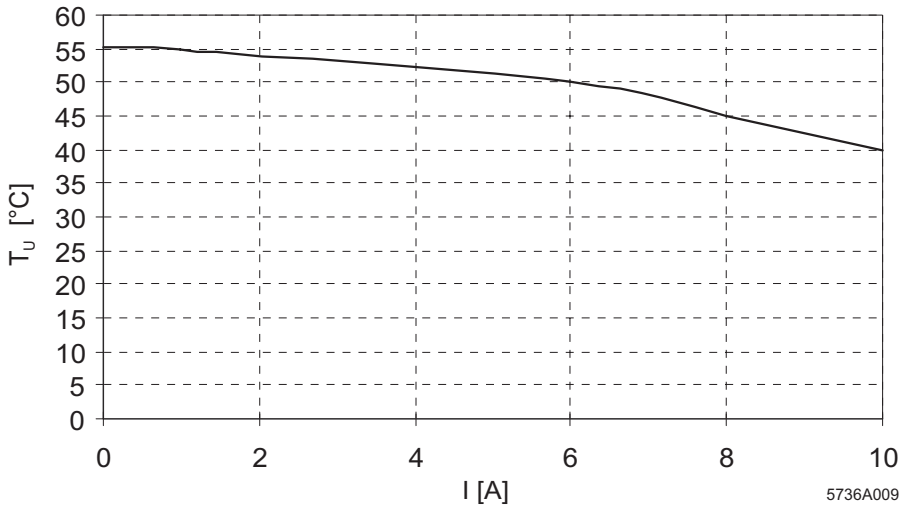
Deviations From Common Technical Data That Are Indicated in the IB IL SYS PRO UM E User Manual	
Mechanical Requirements	
Shock test according to EN 60068-2-27, IEC 60068-2-27	15g load for 11 ms, half sinusoidal wave, three shocks in each space direction and orientation 25g load for 6 ms, half sinusoidal wave, three shocks in each space direction and orientation

Interface	
Local bus	Through data routing

Power Consumption	
Communications power U_L	7.5 V
Current consumption from U_L	30 mA, typical; 40 mA, maximum
I/O supply voltage U_{ANA}	24 V DC
Current consumption at U_{ANA}	50 mA, typical; 65 mA, maximum
Total power consumption	1.425 W, typical

Supply of the Module Electronics and I/O Via the Bus Coupler/Power Terminal	
Connection method	Potential routing

Derating: Permissible Ambient Temperature Depending on the Current of the Potential Jumpers U_M and U_S (Total Current)



T_A [°C]	Ambient temperature in °C
I [A]	Current through potential jumpers U_M and U_S

Analog Output

Number		1; configured depending on the terminal point used	
Signals/resolution in the process data word (quantization)			
Voltage	0 to 10 V	0 to 9.99985 V	0.153 mV/LSB
Current	0 to 20 mA	0 to 19.9997 mA	0.305 µA/LSB
	4 to 20 mA	4 to 19.99976 mA	0.244 µA/LSB
Measured value representation		16 bit straight binary	
Basic error limit in the current range		±0.05%, typical	
Output load			
Voltage output		2 kΩ, minimum	
Current output		500 Ω, maximum	
Process data update including conversion time of the digital-to-analog converter		1 bus cycle (depending on the bus configuration); < 1 ms	
Slew rate (> 99% of the final value)		< 10 µs	

Tolerance Behavior and Temperature Response of the Voltage Output (The tolerance values refer to the output range final value of 10 V.)	Typical	Maximum
Tolerance at 23°C		
Total offset voltage	±0.03%	±0.05%
Tolerance due to increase	±0.10%	±0.15%
Differential non-linearity	±0.0012%	±0.003%
Total tolerance at 23°C	**±0.15%**	**±0.25%**
Temperature response at -25°C to 55°C		
Offset voltage drift T_{KVO}	±10 ppm/K	±65 ppm/K
Gain drift T_{KG}	±30 ppm/K	±35 ppm/K
Total voltage drift $T_{Ktot} = T_{KVO} + T_{KG}$	±40 ppm/K	±100 ppm/K
Total error of the voltage outputs (-25°C to +55°C) Tolerance due to offset, increase, linearity and drift	**±0.30%**	**±0.60%**

Tolerance Behavior and Temperature Response of the Current Output (0 mA to +20 mA) (The tolerance indications refer to the output range final value of 20 mA.)	Typical	Maximum
Tolerance due to offset at 23°C		
Offset current I_{oc}	±0.05%	±0.15%
Tolerance due to increase	±0.09%	±0.25%
Differential non-linearity	±0.0012%	±0.003%
Total tolerance at 23°C	**±0.15%**	**±0.25%**
Temperature response at -25°C to 55°C		
Offset current drift T_{KIO}	±25 ppm/K	±65 ppm/K
Gain drift T_{KG}	±10 ppm/K	±35 ppm/K
Total current drift $T_{Ktot} = T_{KIO} + T_{KG}$	±35 ppm/K	±100 ppm/K

Tolerance Behavior and Temperature Response of the Current Output (4 mA to +20 mA) (The tolerance indications refer to the output range final value of 20 mA.)	Typical	Maximum
Tolerance due to offset at 23°C		
Offset current I_{oc}	±0.15%	±0.45%
Tolerance due to increase	±0.25%	±0.45%
Differential non-linearity	±0.003%	±0.005%
Total tolerance at 23°C	**±0.25%**	**±0.46%**
Temperature response at -25°C to 55°C		
Offset current drift T_{KIO}	±28 ppm/K	±70 ppm/K
Gain drift T_{KG}	±15 ppm/K	±40 ppm/K
Total current drift $T_{Ktot} = T_{KIO} + T_{KG}$	±43 ppm/K	±110 ppm/K

Note:
The specified data are related to operation under nominal conditions at the IBS IL 24 BK-T bus coupler at the preferable installation location.

Additional Tolerances Influenced by Electromagnetic Fields

Type of Electromagnetic Interference	Criterion	Typical Relative Deviation of the Measuring Range Final Value
Electromagnetic fields Field strength 10 V/m according to EN 61000-4-3/IEC 61000-4-3	A	< 1%
Fast transients (burst) Supply 2 kV, output 1 kV according to EN 61000-4-4/IEC 61000-4-4	B	< 1%
Conducted interference Class 3 (test voltage 10 V) according to EN 61000-4-6/IEC 61000-4-6	A	< 6%

Safety Equipment

None

Electrical Isolation/Isolation of the Voltage Areas

The electrical isolation of the logic level from the I/O area is ensured through the DC/DC converter.

Common Potentials

24 V I/O voltage, 24 V segment voltage, and GND have the same potential. FE is a separate potential area.

Separate Potentials in the System Consisting of Bus Coupler/Power Terminal and I/O Terminal

- Test Distance	- Test Voltage
7.5 V supply (bus logic) / 24 V supply U_{ANA} / I/O	500 V AC, 50 Hz, 1 min
7.5 V supply (bus logic) / 24 V supply U_{ANA} / functional earth ground	500 V AC, 50 Hz, 1 min
24 V supply (I/O) / functional earth ground	500 V AC, 50 Hz, 1 min

Error Messages to the Higher-Level Control or Computer System

Failure or insufficient communications power U_L	Yes, I/O error message to the bus terminal

Approvals

For the latest approvals, please visit www.download.phoenixcontact.com.

Local Diagnostic/Status Indicators and Terminal Point Assignment

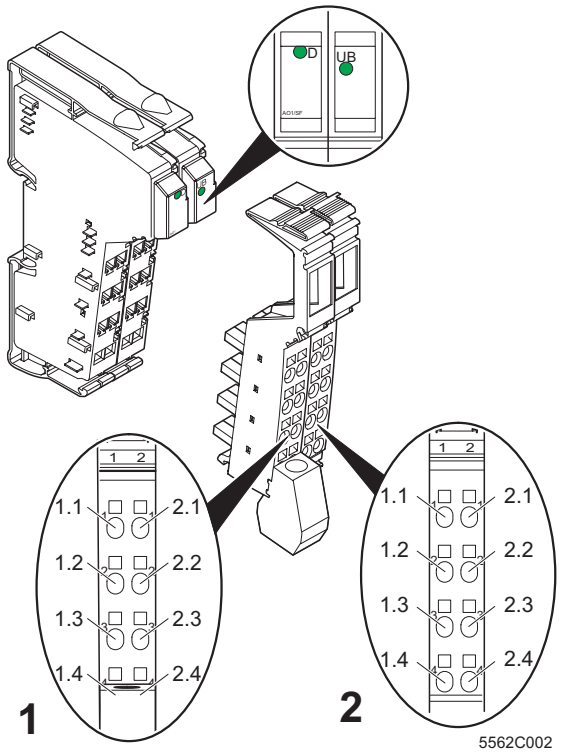


Figure 1 The terminal with appropriate connectors

Local Diagnostic and Status Indicators

Des.	Color	Meaning
D	Green	Diagnostics
UB	Green	I/O voltage for analog terminals present (current level)

Function Identification

Yellow

Terminal Point Assignment

Connec-tor	Terminal Point	Signal	Assignment
1	**1.1**	**U**	Voltage output 0 V to 10 V
	2.1	**–**	Not used
2	**1.1**	**I**	Current output 0 mA to 20 mA
	2.1	**I**	Current output 4 mA to 20 mA
1 and 2	**1.2, 2.2**	**–**	Not used
	1.3, 2.3	**GND**	Ground
	1.4, 2.4	**Shield**	Shield connection

Installation Instructions

High current flowing through potential jumpers U_M and U_S increases the temperature of the potential jumpers and the inside of the terminal. Note the following instructions to keep the current flowing through the potential jumpers of the analog terminals as low as possible:

Create a separate main circuit for each analog terminal.

If this is not possible in your application and if you are using analog terminals in a main circuit together with other terminals, place the analog terminals behind all the other terminals at the end of the main circuit.

Please note the derating curve shown on page 4.

Internal Circuit Diagram

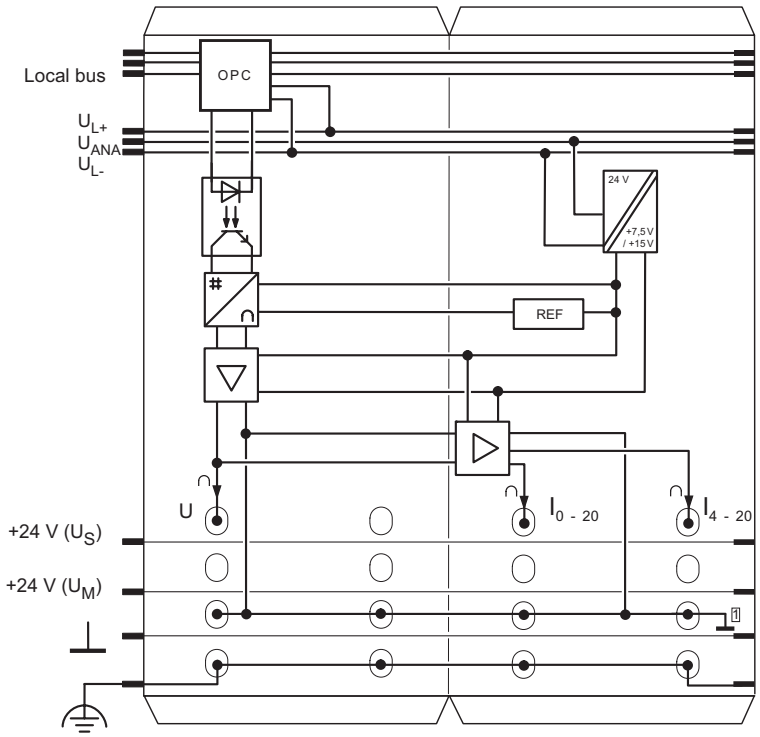


Figure 2 Internal wiring of the terminal points

Key:

OPC	Protocol chip		Amplifier
	Optocoupler		Digital/analog converter
	DC/DC converter with electrical isolation		Analog output
REF	Reference voltage		Analog ground, electrically isolated from ground of the potential jumper

Other symbols used are explained in the IL SYS INST UM E user manual or in the Inline systems manual for your bus system.

Electrical Isolation

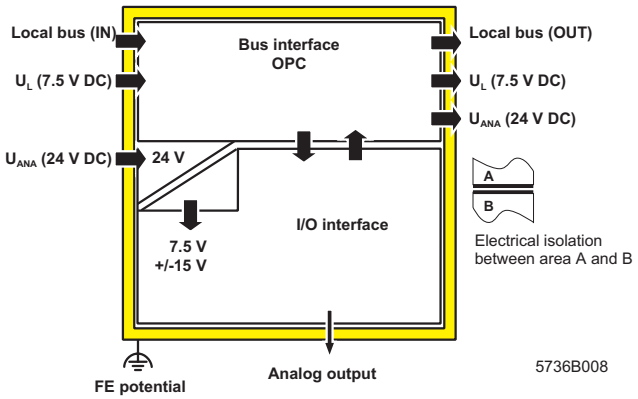


Figure 3 Electrical isolation of the individual function areas

Connection Notes

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

Connect one end of the shielding to PE. At the module, fold the outer cable sheath back and connect the shield to the terminal via the shield connection clamp. The clamp connects the shield directly to FE on the terminal side.

When using cables longer than 10 m (32.81 ft.) in environments prone to interference, we recommend connecting the shield on the actuator to the FE potential via an RC element. Typically, the capacitor C should be rated between 1 nF and 15 nF. The resistor R should be at least 10 MΩ.

Use an I/O connector with shield connection when installing the actuator. On the base side that is not used to connect an actuator, you may use one of the connectors listed in the ordering data. The appearance of the module differs depending on the output used. This is shown in Figure 4 and Figure 5 in the top left corner.

Connection Examples

Use a connector with shield connection when installing the actuator. Figure 4 and Figure 5 show the connection schematically (without shield connector).

Voltage Output

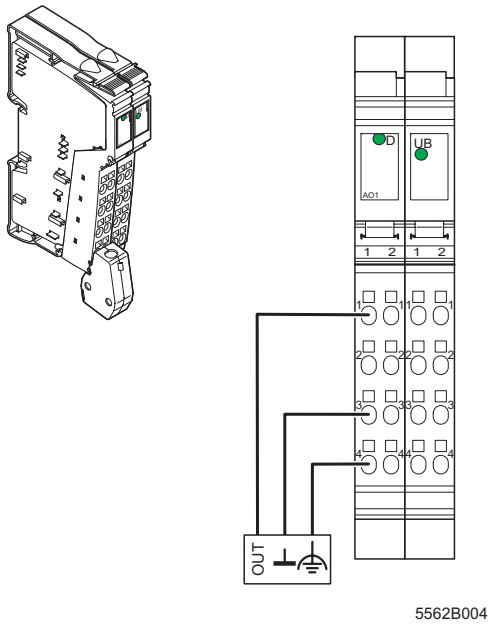


Figure 4 Actuator connected to the voltage output 0 V to 10 V in 2-wire technology with shield connection

Current Output

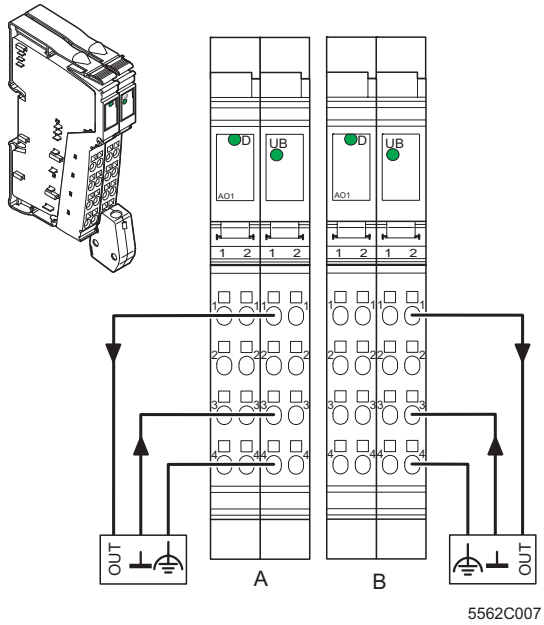


Figure 5 Actuator connected to the current outputs in 2-wire technology with shield connection

A Signals for actuator at the current output 0 mA to 20 mA

B Signals for actuator at the current output 4 mA to 20 mA

Notes on Using the Terminal in Potentially Explosive Areas

Approval in Acc. With EG-RL 94/9 (ATEX) II 3G EEx nAC IIC T4 U

This Inline terminal conforms to standard EN 50021 and can be installed in a Zone 2 potentially explosive area. These Inline terminals are Category 3 items of equipment.

UL Approval

These Inline terminals for the indicated hardware version or later are suitable for use in Class I, Division 2, Groups A, B, C, D.

Before using an Inline terminal in a Zone 2 potentially explosive area, check that the terminal has been approved for installation in this area.

For a list of terminals that are approved for the potentially explosive areas of Zone 2, please refer to the AH EN IL EX ZONE 2 application note.

Check the labeling on the Inline terminal and the packaging (see Figure 6).

Figure 6 Example labeling of terminals for use in potentially explosive areas

Before startup, ensure that the following points and instructions are observed.

1. When working on the Inline terminal, always switch off the supply voltage.
2. The Inline terminal must only be installed, started up, and maintained by qualified specialist personnel.
3. Install the Inline terminals in a control cabinet or metal housing. The minimum requirement for both items is IP54 protection according to EN 60529.
4. The Inline terminal must not be subjected to any mechanical or thermal strain, which exceeds the limits specified in the product documentation.
5. The Inline terminal must not be repaired by the user. Repairs may only be carried out by the manufacturer. The Inline terminal is to be replaced by an approved terminal of the same type.
6. During operation, only Category 3G equipment must be connected to Inline terminals in Zone 2.
7. Observe all applicable standards (e.g., EN 60079) and national safety and accident prevention regulations for installing and operating equipment.

Restrictions

When using terminals in potentially explosive areas, observe the technical data and limit values specified in the corresponding documentation (user manual, data sheet, package slip).

Restrictions regarding the Inline system

The **maximum permissible current** flowing through potential jumpers U_M and U_S (total current) is limited to **4 A** when using the Inline terminals in potentially explosive areas.

Programming Data/Configuration Data

Local Bus (INTERBUS)

ID code	$7D_{hex}$ (125_{dec})
Length code	01_{hex}
Input address area	0 bytes
Output address area	2 bytes
Parameter channel (PCP)	0 bytes
Register length (bus)	2 bytes

Other Bus Systems

For the programming data/configuration data of other bus systems, please refer to the corresponding electronic device data sheet (e.g., GSD, EDS).

Process Data Words

For the assignment of the illustrated (byte.bit) view to your INTERBUS control or computer system, please refer to data sheet DB GB IBS SYS ADDRESS, Order No. 9000990.

Assignment of the Terminal Points to the OUT Process Data Word

(Word.bit) view	Word	Word x															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Terminal points Slot 1	Signal	Terminal point 1.1: Voltage output															
	Signal reference	Terminal point 1.3, 2.3															
	Shielding (FE)	Terminal point 1.4, 2.4															
Terminal points Slot 2	Signal	Terminal point 1.1: Current output 0 to 20 mA Terminal point 2.1: Current output 4 to 20 mA															
	Signal reference	Terminal point 1.3, 2.3															
	Shielding (FE)	Terminal point 1.4, 2.4															

OUT Process Data Word

The **OUT process data word** specifies the output value in each cycle.

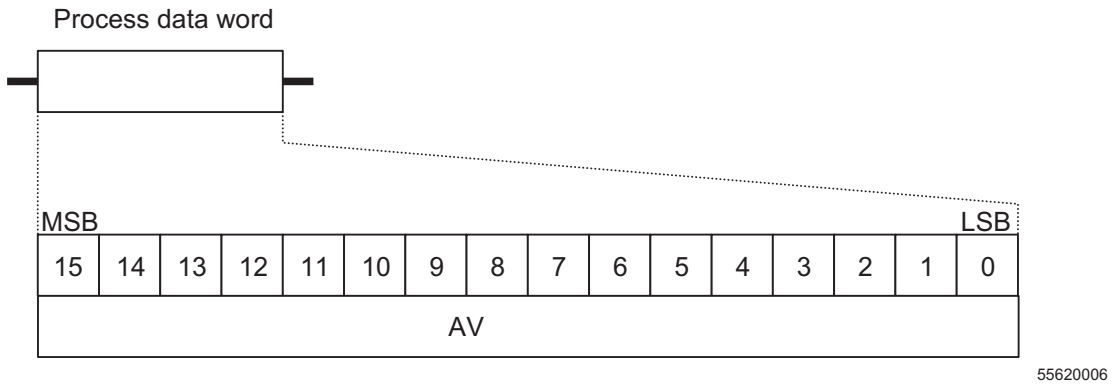


Figure 7 OUT Process Data Word

AV Analog value
MSB Most significant bit
LSB Least significant bit

All output values are represented in 16 bits.

For significant values in the process data word, refer to the following tables.

Abbreviations used in the following tables:

QS Quantization step(s)
MSB Most significant bit
ORF Output range final value
LSB Least significant bit

OUT Process Data Word for the Voltage Output 0 V to 10 V (Example)																		
Voltage output **0 V to 10 V**	Analog Value (V)	OUT Process Data Word																
		hex.	Binary (Two's Complement) MSB LSB															
			15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
10 V minus 1 QS	9.99985	FFFF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10 V minus 2 QS	9.99969	FFFE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Half ORF	5.0000	8000	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 QS	0.153 mV	0001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Zero	0.0000	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

OUT Process Data Word for the Current Output 0 mA to 20 mA (Example)																		
Current Output **0 mA to 20 mA**	Analog Value (mA)	OUT Process Data Word																
		hex.	Binary (Two's Complement) MSB LSB															
			15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
20 mA minus 1 QS	19.9997	FFFF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20 mA minus 2 QS	19.9994	FFFE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Half ORF	10.000	8000	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 QS	0.305 µA	0001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Zero	0.0000	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

OUT Process Data Word for the Current Output 4 mA to 20 mA (Example)																		
Current Output **4 mA to 20 mA**	Analog Value (mA)	OUT Process Data Word																
		hex.	Binary (Two's Complement) MSB LSB															
			15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
20 mA minus 1 QS	19.99998	FFFF	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20 mA minus 2 QS	19.99995	FFFE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Half ORF	12.0000	8000	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 mA plus 1 QS	4.000244	0001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Output range start	4.0000	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Output Behavior of the Voltage or Current Output

Take output behavior (in the event of an error) into account when configuring your system!

Switching Operation/State of the Supply Voltage	Marginal Condition	OUT Process Data Word (hex)	Behavior/Status of the Analog Output		
			0 V to 10 V	0 mA to 20 mA	4 mA to 20 mA
U_{ANA} of 0 V to 24 V	U_L = 0 V	xxxx	0 V	0 mA	4 mA
U_{ANA} of 24 V to 0 V	U_L = 7.5 V	xxxx	0 V	0 mA	0 mA
Bus in stop state	U_{ANA} = 0 V	xxxx	0 V	0 mA	0 mA
Bus in stop state	U_{ANA} = 24 V	xxxx	Maintain last value		

U_{ANA} Analog supply voltage of the terminal

U_L Supply voltage of the module electronics (communications logic)

xxxx Any value in the range of 0000_{hex} up to $FFFF_{hex}$.

The behavior and status of the output depend on the output used.

Response of the Control System or Computer to a Hardware Signal for Different Control or Computer Systems

Signal	Control or Computer System	State After the Switching Process		
		OUT Process Data Output Word	Analog Output	
			U_{out}	I_{out}
NORM*	AEG-Schneider Automation	0000	0 V	0 mA/4 mA
BASP	Siemens S5	0000	0 V	0 mA/4 mA
CLAB	Bosch	0000	0 V	0 mA/4 mA
SYSFAIL	VME	0000	0 V	0 mA/4 mA
SYSFAIL	PC	0000	0 V	0 mA/4 mA
CLEAR OUT	Moeller IPC	0000	0 V	0 mA/4 mA

* On controller boards for AEG Schneider Automation control systems it is possible to set the NORM signal so that the OUT process data output word and the analog output maintain the last value.

The status of the current output depends on the range selected.

Response of the Voltage and Current Output to a Control Command of the Controller Board

Command	State After the Switching Process		
	Process Data Output Word OUT	Analog Output	
		U_{out}	I_{out}
STOP	Maintains last value	Maintains last value	Maintains last value
ALARM STOP (reset)	Maintains last value	Maintains last value	Maintains last value