



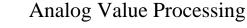


**Introduction to Analog Value Processing** 









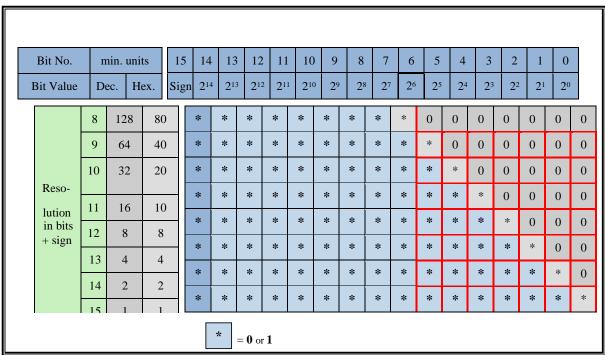
# The participant should

- .....be familiar with the principle of analog value processing
- ...be able to parameterize an analog module
- ...be able to address an analog module...be able to interpret the resolution (capability) of a module
- ...be familiar with the operations for the analog value conversion
- ...be able to program a simple analog value conversion
- ...be able to evaluate the diagnostics interrupt of the analog module
- ...be familiar with the principle of interrupt processing
- ...be able to generate and program a cyclic interrupt

### **Objectives**

In this chapter, the principle of analog value processing is presented. The goal is that the participant is capable of parameterizing an analog module and of interpreting the resolution. Furthermore, the necessary conversion operations are presented in order to be able to process an analog value. The participant should be able to program a simple analog value conversion and be able to interpret a diagnostics interrupt of an analog module.

### **Analog Value Representation and Measured Value Resolution**





#### Representation

Negative analog values are represented as the two's complement. The value is positive if bit No. 15=0 and negative if bit No.15=1.





#### Resolution

If the resolution of an analog module is less than 16 bits, the analog value is written into the accumulator left-justified. The unused less significant bit positions are filled with "0"s.

#### Accuracy

Resolutions of between 8 and 16 bits are possible, depending on the type of module.

## **Analog Value Representation of Different Measuring Ranges**

	Voltage such as:		Current such as:		Resistance such as:		Temperature e.g. Pt100 (Standard)	
Range	Meas.range ± 10V	Units	Meas.range 4 to 20mA	Units	Meas.range 0300Ohm	Units	Meas.range -200+850°C	Units
Overflow	≥ 11.759	32767	≥ 22.815	32767	≥ 352.778	32767	≥ 1000.1	32767
Overrange	11.7589 : 10.0004	32511 : 27649	22.810 : 20.0005	32511 : 27649	352.767 : 300.011	32511 : 27649	1000.0 : 850.1	10000 : 8501
Rated range	10.00 7.50 : -7.5 -10.00	27648 20736 : -20736 -27648	20.000 16.000 : : 4.000	27648 20736 : : 0	300.000 225.000 : : : 0.000	27648 20736 : : 0	850.0 : :	8500 : :
Underrange	- 10.0004 :	- 27649 :	3.9995 : 1.1852	-1 : - 4864	Negative values	-1 : - 4864	-200.0	-2000
Underflow	- 11.759 ≤- 11.76	- 32512 - 32768	≤ 1.1845	- 32768	not possible	- 32768	- 200.1 : - 243.0	- 2001 : - 2430

Voltage, Current (Symmetrical)

Encoding the symmetrical voltage or current ranges

- $\pm 80 \text{mV}$

 $\pm$  3,2 mA

- $\pm 250 \ mV$
- $\pm 5\dot{V}$

 $\pm 10 \,\mathrm{mA}$ 

- $\pm 500 \text{ mV}$  $\pm 1 V$
- $\pm 10V$

 $\pm 20 \,\mathrm{mA}$ 

results in a rated range of -27648 to +27648.

Voltage, Current (Asymmetrical)

Encoding the asymmetrical voltage or current ranges

- $0 \dots 20 \text{ mA}$ 4 ... 20 mA

results in a rated range of 0 to +27648.





#### Resistance

Encoding the resistance ranges

0 ... 150 Ohm
0 ... 300 Ohm
0 ... 600 Ohm

results in a rated range of 0 to +27648.

### Temperature

Temperatures are measured with resistance thermometers or thermocouples. Encoding results in a rated range of ten times the temperature range:

Sensor:		Temperature	Rated range when		
		range:	encoded:		
•	Pt 100	$-200 \text{ to} + 850 ^{\circ}\text{C}$	-2000  to + 8500		
•	Ni 100	$-60 \text{ to} + 250 ^{\circ}\text{C}$	-600  to + 2500		
•	Thermocouple Type K	$-270 \text{ to} + 1372 ^{\circ}\text{C}$	-2700  to + 13720		
•	Thermocouple Type N	-270 to + 1300 °C	-2700  to + 13000		
•	Thermocouple Type J	$-210 \text{ to} + 1200 ^{\circ}\text{C}$	-2100  to + 12000		
•	Thermocouple Type E	$-270 \text{ to} + 1000 ^{\circ}\text{C}$	-2700  to + 10000.		

# **Analog Value Representation for the Analog Output**

		Voltage				Current			
		Output ranges:			Ī	Output ranges:			
		0 to 10V	1 to 5V	± 10V		0 to 20mA	4 to 20mA	± 20mA	
Overflow	≥ 32512	0	0	0		0	0	0	
Overrange	32511	11.7589	5.8794	11.7589		23.515	22.81	23.515	
	: 27649	: 10.0004	5.0002	: 10.0004		: 20.0007	: 20.005	: 20.0007	
Rated range	27648 : 0 : - 6912 - 6913 : : :	10.0000	5.0000 : 1.0000 0.9999 0	10.0000 : 0 : : : : : : : : : : : : : : : :		20.000 : 0	20.000 : 4.000 3.9995 0	20.000	
	- 27648			-10.0000				-20.000	
Underrange	- 27649 :			-10.0004				- 20.007	
	- 32512			-11.7589				-23.515	
Underflow	≤ -32513			0				0	





#### Voltage, Current (Symmetrical)

For symmetrical voltage or current ranges, a rated range of -27648 to +27648 is converted to:

- ± 10V
- $\pm 20$ mA.

#### Voltage, Current (Asymmetrical)

For asymmetrical voltage or current ranges, a rated range of 0 to +27648 is converted to:

- 0 to 10V
- 1 to 5V
- 0 to 20mA
- 4 to 20mA.

#### Overflow

If the value to be converted reaches the overflow range, the analog output module is disabled (0V, 0mA)