Introduction to Analog Value Processing

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

Bit No.	min. units		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Bit Value	Dec.	Hex.	Sign	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}
Reso-lution in bits + sign	8	128	80	*	*	*	*	*	*	*	*	*	0	0	0	0	0	0	0
	9	64	40	*	*	*	*	*	*	*	*	*	*	0	0	0	0	0	0
	10	32	20	*	*	*	*	*	*	*	*	*	*	*	0	0	0	0	0
	11	16	10	*	*	*	*	*	*	*	*	*	*	*	*	0	0	0	0
	12	8	8	*	*	*	*	*	*	*	*	*	*	*	*	*	0	0	0
	13	4	4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	0	0
	14	2	2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	0
	15	1	1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

* = **0** or **1**

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

Range	Voltage such as:		Current such as:		Resistance such as:		Temperature e.g. Pt100 (Standard)	
	Meas.range ± 10V	Units	Meas.range 4 to 20mA	Units	Meas.range 0...300Ohm	Units	Meas.range -200...+850ºC	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 : : : -200.0	8500 : : : -2000
Underrange	- 10.0004 : - 11.759	- 27649 : - 32512	3.9995 : 1.1852	-1 : - 4864	Negative values not possible	-1 : - 4864		
Underflow	≤ - 11.76	- 32768	≤ 1.1845	- 32768		- 32768	- 200.1 : - 243.0	- 2001 : - 2430

Voltage, Current (Symmetrical)

Encoding the symmetrical voltage or current ranges

- ± 80mV
- ± 250 mV
- ± 500 mV
- ± 1 V
- ± 2,5 V
- ± 5V
- ± 10V
- ± 3,2 mA
- ± 10 mA
- ± 20 mA

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

Voltage, Current (Asymmetrical)

Encoding the asymmetrical voltage or current ranges

- 0 ... 2 V
- 1 ... 5 V
- 0 ... 20 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 range:	Rated range when encoded:
• Pt 100	-200 to + 850 ºC	-2000 to + 8500
• Ni 100	-60 to + 250 ºC	-600 to + 2500
• Thermocouple Type K	-270 to + 1372 ºC	-2700 to + 13720
• Thermocouple Type N	-270 to + 1300 ºC	-2700 to + 13000
• Thermocouple Type J	-210 to + 1200 ºC	-2100 to + 12000
• Thermocouple Type E	-270 to + 1000 ºC	-2700 to + 10000.

Analog Value Representation for the Analog Output

		Voltage			Current		
		Output ranges:			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 : 27649	11.7589 : 10.0004	5.8794 : 5.0002	11.7589 : 10.0004	23.515 : 20.0007	22.81 : 20.005	23.515 : 20.0007
Rated range	27648 : 0 : - 6912 - 6913 : : : - 27648	10.0000 : 0 0	5.0000 : 1.0000 0.9999 0 0	10.0000 : 0 : : : : : : -10.0000	20.000 : 0 0	20.000 : 4.000 3.9995 0 0	20.000 : 0 : : : : : : -20.000
Underrange	- 27649 : - 32512			- 10.0004 : - 11.7589			- 20.007 : - 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
- ± 20mA.

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)