

## PCD2/3.W380

User Manual

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**0.1 Document revisions**

Revision	Modified	Published	Comments
EN06	2015-03-04	2015-03-04	Text replacement: version 'B' replaced by version 'A2'.
EN05	2014-11-11	2014-11-11	Modifications of the RC filter value in chapter Input Wiring. Chapter deleted about active protections for diode and resistance measurements. Auto reconfiguration feature added in chapter "Protection mode". Modification of table 1, "Technical data". Over current limit modified to +/-30mA.
EN04	2014-08-20	2014-08-20	Modifications in chapters 1.1, 1.2, 1.3.1 and 1.4 about protective ground connection.
EN03	2014-06-13	2014-06-13	Modifications in chapter 1.7 about input protections.
EN02	2014-04-24	2014-04-24	Global update of the document
EN01	2013-09-27	2013-09-27	New document

# 1 PCD2/3.W380, 8 analog configurable inputs

This new module is a universal analog input module with improved embedded features. This is an intelligent module with a very comfortable utilization. It is able to measure voltages, currents, resistances and temperatures with the common sensors available in the market and with a precision of 0.3% or better (based on the full range). The inputs can be easily configured directly with PG5 and the Device Configurator. Every channel can be configured individually. This module can be used in applications where the data acquisition speed is important. Each channel value is updated in internal buffer each 680us that means each input value is refreshed at 1.5 kHz.

## 1.1 Module overview

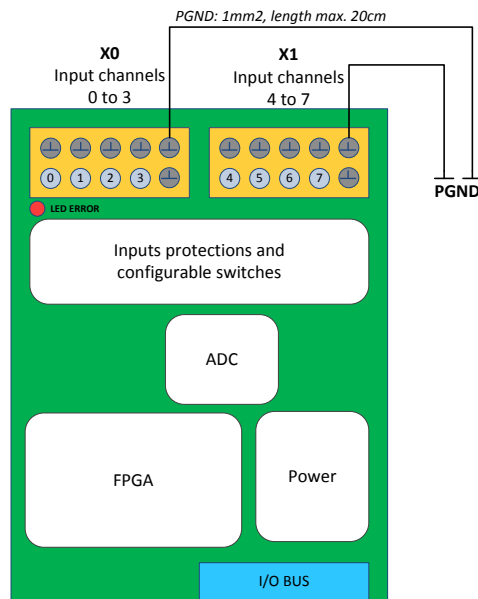


Figure 1: Module overview

## 1.2 Inputs connection

X0	1: GND	3: GND	5: GND	7: GND	9: GND
X1	0: CH0	2: CH1	4: CH2	6: CH3	8: GND
	1: GND	3: GND	5: GND	7: GND	9: GND
	0: CH4	2: CH5	4: CH6	6: CH7	8: GND

Figure 2: Inputs connections

- 2 connections per channel (signal and ground). All the ground pins are internally connected together.
- 4 channels per connector.
- In supplement, 2 ground connections per connector (pins 8 and 9). One of this pin should be used for a protective ground connection.
- Wires up to 1mm<sup>2</sup>.

## 1.3 Specifications

### 1.3.1 General data

<b>Technical data</b>																																									
<b>COMPATIBILITY</b>	PCD1, PCD2, PCD3																																								
<b>POWER</b>																																									
Module power supply voltage	+5V and V+ IOBUS																																								
Current consumption	25mA on +5V and 25mA on V+																																								
Galvanic separation	No																																								
<b>INPUTS</b>																																									
Number of inputs	8																																								
Input ranges of each mode	<table border="0"> <tr> <td>Voltage</td> <td>-10V</td> <td>...</td> <td>+10V</td> </tr> <tr> <td>Current</td> <td>-20mA</td> <td>...</td> <td>+20mA</td> </tr> <tr> <td>Resistance</td> <td>0Ω</td> <td>...</td> <td>2'500Ω</td> </tr> <tr> <td></td> <td>0Ω</td> <td>...</td> <td>300kΩ</td> </tr> <tr> <td>Diode</td> <td>0V</td> <td>...</td> <td>5V</td> </tr> <tr> <td>Pt1000</td> <td>-50°C</td> <td>...</td> <td>+400°C</td> </tr> <tr> <td>Ni1000</td> <td>-50°C</td> <td>...</td> <td>+200°C</td> </tr> <tr> <td>Ni1000L&amp;S</td> <td>-30°C</td> <td>...</td> <td>+130°C</td> </tr> <tr> <td>NTC10k</td> <td colspan="3"><i>used in range 0 ... 300kΩ</i></td> </tr> <tr> <td>NTC20k</td> <td colspan="3"><i>used in range 0 ... 300kΩ</i></td> </tr> </table>	Voltage	-10V	...	+10V	Current	-20mA	...	+20mA	Resistance	0Ω	...	2'500Ω		0Ω	...	300kΩ	Diode	0V	...	5V	Pt1000	-50°C	...	+400°C	Ni1000	-50°C	...	+200°C	Ni1000L&S	-30°C	...	+130°C	NTC10k	<i>used in range 0 ... 300kΩ</i>			NTC20k	<i>used in range 0 ... 300kΩ</i>		
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NTC20k	<i>used in range 0 ... 300kΩ</i>																																								
Absolute maximum input voltage	+/- 20V (independent of the inputs configuration)																																								
Temperature error (0°C .. +55°C)	+/- 0.2%																																								
Inputs configuration	Each input can be configured individually in 5 modes (ranges above)																																								
Configuration method	Software (PG5, Device Configurator)																																								
User connector	Per channel: 1 pin for input and 1 pin for ground. 2 pins for protective ground and 2 pins for ground in supplement.																																								
Inputs wiring	Up to 1mm <sup>2</sup>																																								
<b>TIMING</b>																																									
Refresh of each channel	680us (all channels are updated during this time)																																								
Hardware input filter time constant	<table border="0"> <tr> <td>Voltage</td> <td></td> <td><math>\tau = 2.5\text{ms}</math></td> </tr> <tr> <td>Current</td> <td></td> <td><math>\tau = 2.5\text{ms}</math></td> </tr> <tr> <td>Resistance</td> <td>( &lt; 2'500Ω)<sup>1</sup></td> <td><math>\tau &lt; 4.4\text{ms}</math></td> </tr> <tr> <td></td> <td>(typ. for R&lt;300kΩ)<sup>2</sup></td> <td><math>\tau \approx 8\text{ms}</math></td> </tr> <tr> <td>Diode</td> <td>(typ. for U&lt;5V)</td> <td><math>\tau \approx 4.4\text{ms}</math></td> </tr> </table>	Voltage		$\tau = 2.5\text{ms}$	Current		$\tau = 2.5\text{ms}$	Resistance	( < 2'500Ω) <sup>1</sup>	$\tau < 4.4\text{ms}$		(typ. for R<300kΩ) <sup>2</sup>	$\tau \approx 8\text{ms}$	Diode	(typ. for U<5V)	$\tau \approx 4.4\text{ms}$																									
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Digital input filter available	<table border="0"> <tr> <td>No Filter</td> <td>One value per cycle</td> <td><math>\tau = 680\text{ us}</math></td> </tr> <tr> <td>Filter 1:</td> <td>Mean of 4 cycles</td> <td><math>\tau = 2.72\text{ ms}</math></td> </tr> <tr> <td>Filter 2:</td> <td>Mean of 8 cycles</td> <td><math>\tau = 5.44\text{ ms}</math></td> </tr> <tr> <td>Filter 3<sup>3</sup>:</td> <td>Mean of 16 cycles</td> <td><math>\tau = 10.88\text{ ms}</math></td> </tr> </table>	No Filter	One value per cycle	$\tau = 680\text{ us}$	Filter 1:	Mean of 4 cycles	$\tau = 2.72\text{ ms}$	Filter 2:	Mean of 8 cycles	$\tau = 5.44\text{ ms}$	Filter 3 <sup>3</sup> :	Mean of 16 cycles	$\tau = 10.88\text{ ms}$																												
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Filter 3 <sup>3</sup> :	Mean of 16 cycles	$\tau = 10.88\text{ ms}$																																							
Min. number of I/O Bus accesses to read one channel	28 (~28us)																																								

Table 1: Technical data of the module

<sup>1</sup> Temperature sensors Pt1000, Ni1000 and Ni1000L&S

<sup>2</sup> Temperature sensors NTC10k and NTC20k.

<sup>3</sup> Recommended filter, configured by default in Device Configurator

### 1.3.2 Technical data of inputs

Each input can be configured to be used in the following modes:

Mode	Resolution [Bit]	Resolution [measure]	Accuracy (@ T <sub>Ambient</sub> = 25°C)	Display
Voltage -10V ... +10V	12 + Sign	2.44 mV (linear) $R_{IN} = 330k\Omega$	0.2% of measured value +/- 10mV	-10'000...+10'000
Current -20mA...+20mA	12 + Sign	5.39 uA (linear) $R_{SHUNT} = 225\Omega$	0.2% of measured value +/- 20uA	-20'000...+20'000
Resistance 0...2'500 $\Omega$	12 bit	0.50... 0.80 $\Omega$ <i>Measuring current: 1.0 .. 1.3 mA</i>	0.2% of measured value +/- 3 $\Omega$	0...25'000
Resistance 0...300 k $\Omega$	13 bit	0...10k $\Omega$ : 1...10 $\Omega$ 10k...40k $\Omega$ : 10..40 $\Omega$ 40k...70k $\Omega$ : 40..100 $\Omega$ 70k...100k $\Omega$ : 100...200 $\Omega$ 100k...300k $\Omega$ : 0.2...1.5 k $\Omega$ <i>Measuring current: 30<math>\mu</math>A..1.3 mA</i>	0.2% of measured value +/- 40 $\Omega$ 0.2% of measured value +/- 160 $\Omega$ 0.5% of measured value +/- 400 $\Omega$ 1.0% of measured value +/- 800 $\Omega$ 2.5% of measured value +/- 5.0k $\Omega$	0..300'000
Pt 1000	12 bit	-50...+400°C: 0.15 ... 0.25°C <i>Measuring current: 1.0 .. 1.3 mA</i>	0.2% of measured value +/- 0.5°C	-500...4000
Ni 1000	12 bit	-50 ... +200°C: 0.09 ... 0.11°C <i>Measuring current: 1.0 .. 1.3 mA</i>	0.2% of measured value +/- 0.5°C	-500...2000
Ni 1000 L&S	12 bit	-30 ... +130°C: 0.12 ... 0.15°C <i>Measuring current: 1.0 .. 1.3 mA</i>	0.2% of measured value +/- 0.5°C	-300...1300
Diode 0...5'000mV	12 bit	1.22mV (linear) <i>Measuring current: 0.7...1.3mA</i>	0.2% of measured value +/- 10mV	0...5'000

Table 2: Inputs specifications for each mode

The measuring current was chosen to be the best compromise between the resolution and the sensors self-heating effect, which is negligible for most of the sensors and applications. Even in bad measuring conditions with Pt/Ni1000 sensors with a low thermal coupling as 4mW/K, the maximal error produced by the sensors self-heating is lower than 0.3°C.

The module offers the possibility to use NTC temperature sensors. The corresponding input must be configured in mode "Resistance 0...300k $\Omega$ ".

Mode Resistance 0...300k $\Omega$	Resolution [Bit]	Resolution [measure]	Accuracy (@ T <sub>Ambient</sub> = 25°C)	Display
NTC10k <sup>1</sup>	13 bit	-40...+120°C: 0.05 ... 0.1°C	-20..+60°C: +/- 0.6°C -30...+80°C: +/- 1.0°C -40...+120°C: +/-2.8°C	-400...1200 <sup>2</sup>
NTC20k <sup>3</sup>	13 bit	-10...+80°C: 0.02...0.05°C -20...+150°C: < 0.15°C	-15...+75°C: +/- 0.6°C -20...+95°C: +/- 1.0°C +95...+120°C: +/-2.5°C +120...+150°C: +/-5.8°C	-200...1500 <sup>4</sup>

Table 3: Inputs specifications for NTC10k and NTC20k

For an example of the utilization of a NTC sensor, please see the chapter 4 "Example of linearization".

<sup>1</sup> The temperature curves for the NTC10k are not standardized and may be different for each manufacturer. For this reason, the curves can be loaded by the user program using the linearization FBox. The curve of the NTC10k from Produal is available in a CSV file and can be downloaded from the Support Website.

<sup>2</sup> This is the output value of the FBox for linearization. The module gives a resistance 0 ... 300'000 $\Omega$ .

<sup>3</sup> For the same reason of NTC10k, the curve of the NTC20k from Honeywell can be downloaded from the Support Website.

<sup>4</sup> This is the output value of the FBox for linearization. The module gives a resistance 0 ... 300'000 $\Omega$ .

With an input configured in “Diode 0...5000mV”, it is possible to use integrated circuit temperature sensors operating as a 2-terminal zener. A typical sensor for this measurement is the LM235 for example.

Mode Resistance 0...2500Ω	Resolution [Bit]	Resolution [measure]	Accuracy (@ T <sub>Ambient</sub> = 25°C)	Display
LM235	12 bit	-40..+125°C: 0.12°C	0.2% of measured value +/- 1.0°C	-400...1250 <sup>1</sup>

Table 4: Inputs specifications for LM235

For an example of the utilization of a LM235 sensor, please see the chapter 4 “Example of linearization”.

### 1.4 Input wiring

The module is connected with the PCD by the I/O Bus connector. It can be plugged with all the PCD versions PCD1, PCD2, PCD3. The module is completely powered from the PCD bus, no external power supply is needed.

The inputs are connected with the module by two 10-pins connectors for cables up to 1mm<sup>2</sup>. These connectors are very reliable and providing 2 pins per channel, one for the input and the other connected to the ground. In each connector, 2 pins are connected to the ground and can be used by user. In each connector, one of these pins should be used as protective ground connection to avoid immunity problems against external perturbations. A wire with a section of 1mm<sup>2</sup> and a maximum length of 20cm is recommended for a good PGND connection.

Every measurement mode has an equivalent input stage. For resistance measurements (temperature sensors), 10V are provided through a 7.5kΩ resistor to the input.

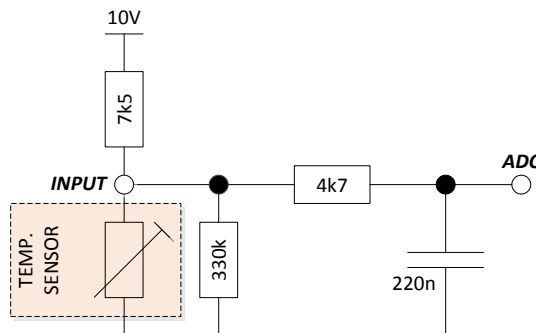


Figure 3: Equivalent schematic of input in temperature and resistance mode

<sup>1</sup> This is the output value of the FBox for linearization. The module gives a voltage 0 ... 5'000mV.

For current measurements, a shunt of 225Ω is connected to the ground.

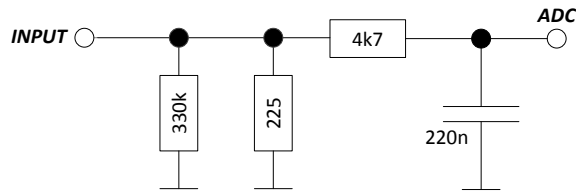


Figure 4: Equivalent schematic of input in "current" mode

In voltage measurements, the input is “directly” connected to the ADC.

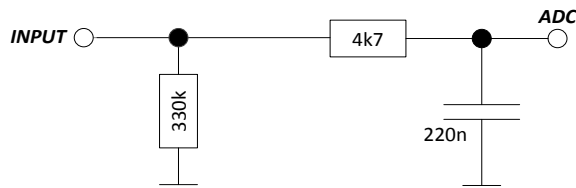


Figure 5: Equivalent schematic of input in "voltage" mode

In “Diode” mode, the module measures voltages in an “active” way. The schematic is the same as the mode for resistance measurements. The output values are given in [mV]. This mode is useful for temperature sensors as LM235.

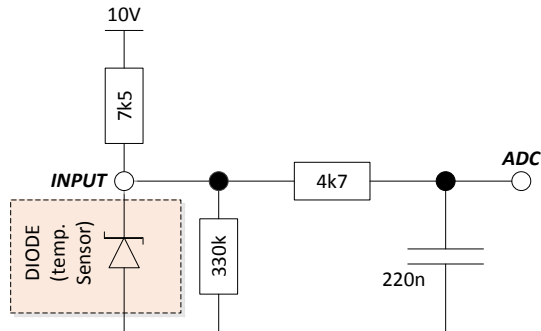
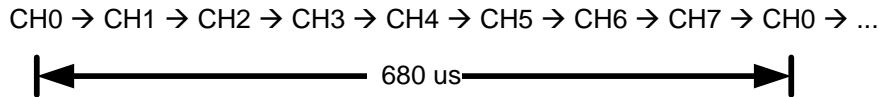


Figure 6: Equivalent schematic of input in "diode" mode



## 1.5 Input values acquisition

The module is able to acquire and convert the each channel one by one, with a total cycle time of 680µs:



## 1.6 Configurable digital filters

Each channel can be configured with a digital filter. Four possibilities are available:

- Disabled: Each channel value is updated in buffer every 680µs  
(f = 1.47kHz)
- 3 ms: Mean of 4 cycles, value updated every 2.72ms (f = 367Hz)
- 6 ms: Mean of 8 cycles, value updated every 5.44ms (f = 184Hz)
- 12 ms: Mean of 16 cycles, value updated every 10.88ms (f = 92Hz)

## 1.7 Out of range indication

The module has an out of range indication. This information can be read in the registers “OutOfRange”.

The table below shows the values setting the bits “Out Of Range”.

N/A means not available.

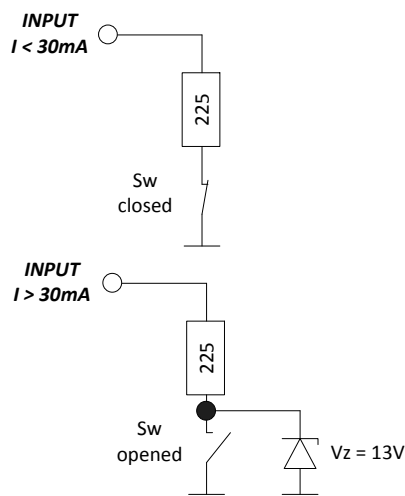
Mode	Out of range bit set...	
	Limit min	Limit max
Voltage -10V ... +10V	N/A	N/A
Current -20mA...+20mA	-20'002 uA	+20'002uA
Resistance 0...2'500 Ω	N/A	2518.7Ω
Resistance 0...300 kΩ	N/A	302'010Ω
Pt 1000	-50.0°C	+408.7°C
Ni 1000	-50.0°C	+210.3°C
Ni 1000 L&S	-30.0°C	+130°C
Diode 0...5'000mV	N/A	4'999 mV

Table 5: Limits for Out Of Range

## 1.8 Input protections

The design supports an input voltage between -20V to +20V in all the modes of measurement. It can be considered a passive protection. Higher values can damage the module. For voltages higher than +/-13V a current passes through the circuit. It can be calculated approximately:  $I_{\text{overvoltage}} = (V_{\text{in}} - 13V) / 225\Omega$ . In this situation, the values measured on the other channels can be falsified.

Active protections are implemented for current measurements, but in all conditions the input voltage must be lower than +/-20V. The bit corresponding to the channel is set to '1' in the register "ModuleErrors" when the protection is enabled.



If current mode is chosen the measuring shunt is connected to ground through the switch as shown in the picture on the left.

In case the current is higher than 30mA<sup>1</sup> the switch opens to protect the measuring shunt. For voltage lower than +/-13V on the opened input the current will be kept lower than 1mA. If the voltage on the opened input rises above +/-13V the current can be approximately calculated using the formula:  
 $I_{\text{overvoltage}} = (V_{\text{in}} - 13V) / 225\Omega$   
 Care should be taken to keep input voltage below +/-20V.

## 1.9 Protection mode

The input stage configuration (switch) is automatically modified when the module enters in protection mode. The input values of the others channels could be out of the specified tolerances when a channel is in protection mode.

The modules from version 'A2' have an automatic reconfiguration mechanism after the active protection has become active. Once triggered, the input will remain for 10 seconds in protection mode. After 10 seconds, the input will switch back to normal operating configuration. If the input is still in overload condition, protection will again be activated. This feature is available only with firmware version greater than 1.24.10.

For Modules with version 'A' or 'A1' the protection will also be activated when an overload occurs, but to switch back to normal operation mode the PCD has to be restarted.

<sup>1</sup> HW version 'A' and 'A1' : Limit = +/-24mA

## 1.10 LED signalization

One red LED is placed near the channel 0. The LED is enabled when an error occurs on the module. This is a general indication and the details of the error must be read in the specific register of the module.

The signaled errors are:

- Configuration error: The desired inputs configuration is not applied correctly.
- ADC error: A/D converter doesn't respond.
- Calibration error: Module not calibrated.
- Protection mode: An input channel has been automatically put in protection mode, because the module detects a situation which can cause important damages to hardware.

## 1.11 Bloc diagram

The PLC communicates with the module through the I/O Bus.  
The data acquisition is independent of the rest. The input values are continuously updated into the internal buffer. One value is stored per channel. The values are sent to the PLC when the user program sends a defined request to the module.

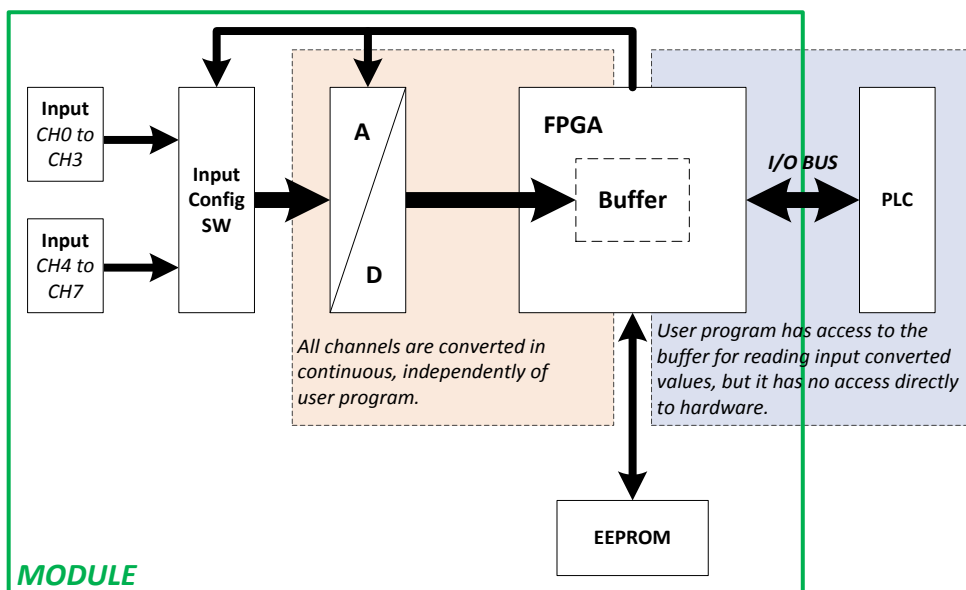


Figure 7: Global diagram of module structure conception

The configuration of the module is done in PG5 Device Configurator. The user program can read the input values or input configurations by specific registers.

## 2 Preparing the PLC system

The PCD used for the module PCDx.W380 must be updated with a firmware version 1.22.28 or higher. Please, download the last firmware version from the support website and load it in the PCD with the PG5 Firmware Downloader Tool.

## 3 Module in PG5 environment

### 3.1 Preparing PG5

This module can only be used with the software version PG5 2.1.300 or higher. Please, verify if your system is up-to-date. You find the last PG5 version on the support Website [www.sbc-controls.com](http://www.sbc-controls.com).

### 3.2 Choosing the module



Figure 8: List of modules in PG5

### 3.3 Inputs configuration

Slot 0 : PCD2.W380, 8 Analogue Inputs, -10..+10V, -20..+20mA, Pt 1000, Ni 1000, 2500 Ohms or 300 kOhms	
<b>General</b>	
Base Address	0
<b>Power Consumption</b>	
Power Consumption 5V [mA]	25
Power Consumption V+ [mA]	25
<b>Media Mapping</b>	
Media Mapping Enabled	Yes
Media Type	Register
Number Of Media	8
<b>Media Mapping Status/Diagnostic</b>	
Media Type For Status/Diagnostic	Flag
Number Of Media For Status/Diagnostic	24
<b>Analogue Input 0</b>	
Digital Filter Input 0	Disabled
Input 0 Range	-10..10V in mV resolution
Minimum Value Input 0	-10000
Maximum Value Input 0	10000
<b>Analogue Input 1</b>	
Digital Filter Input 1	Disabled
Input 1 Range	-20..20mA in uA resolution
Minimum Value Input 1	-20000
Maximum Value Input 1	20000
<b>Analogue Input 2</b>	
Digital Filter Input 2	Disabled
Input 2 Range	User defined range for current input -20..20mA
Minimum Value Input 2	-1000
Maximum Value Input 2	1000
<b>Analogue Input 3</b>	
Digital Filter Input 3	3 ms
Input 3 Range	0..2500Ohms
Minimum Value Input 3	0
Maximum Value Input 3	25000
<b>Analogue Input 4</b>	
Digital Filter Input 4	6 ms
Input 4 Range	Pt 1000 (-50..400°C)
Minimum Value Input 4	-500
Maximum Value Input 4	4000
<b>Analogue Input 5</b>	
Digital Filter Input 5	12 ms
Input 5 Range	0..300kOhms
Minimum Value Input 5	0
Maximum Value Input 5	300000
<b>Analogue Input 6</b>	
Digital Filter Input 6	Disabled

Figure 9: PG5, inputs configuration (1)

The module can be used by two ways:

- With media mapping
- With direct access

The two possibilities are described in the next chapter.

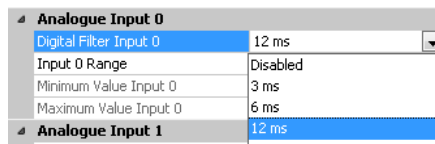


Figure 10: PG5, inputs configuration (2)

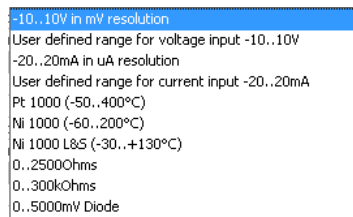


Figure 11: PG5, inputs configuration (3)

### 3.4 Data acquisition

The format of the values is directly linked with the corresponding input configuration. For example, the value is a temperature if the input is configured for a Ni1000 sensor.

#### 3.4.1 With media mapping

With the media mapping enabled, each module has these following registers:

Slots / Symbols	Type	Address	Comments	Scope	Tags
PCD1.M2120, CPU with 512 KBytes code/text/DB flash memory and 128 KBytes extension memory (RAM for Text/DB from ad...					
I/O 0, 16 Digital In-/Outputs, 4 digital inputs, 4 digital outputs, 4 configurable in- or outputs, 2 interrupts, 1 PWM, 1 watchdog...					
I/O 1, 2 Analogue Inputs, 2 analogue inputs, -10...+10VDC, 0...20mA, Pt/Ni 1000 or resistance, connector X1.					
Slot 0, PCD2.W380, 8 analogue inputs, -10...+10V, -20...20mA, Pt 1000 for -50...+400°C, Ni 1000 for -50...+200°C, resistor 250...					
S.IO.Slot0.AnalogueInput	R [8]			Public	S_IO
IO.Slot0.AnalogueInput0	R	S.IO.Slot0.AnalogueInput + 0	Analogue input 0	Public	S_IO
IO.Slot0.AnalogueInput1	R	S.IO.Slot0.AnalogueInput + 1	Analogue input 1	Public	S_IO
IO.Slot0.AnalogueInput2	R	S.IO.Slot0.AnalogueInput + 2	Analogue input 2	Public	S_IO
IO.Slot0.AnalogueInput3	R	S.IO.Slot0.AnalogueInput + 3	Analogue input 3	Public	S_IO
IO.Slot0.AnalogueInput4	R	S.IO.Slot0.AnalogueInput + 4	Analogue input 4	Public	S_IO
IO.Slot0.AnalogueInput5	R	S.IO.Slot0.AnalogueInput + 5	Analogue input 5	Public	S_IO
IO.Slot0.AnalogueInput6	R	S.IO.Slot0.AnalogueInput + 6	Analogue input 6	Public	S_IO
IO.Slot0.AnalogueInput7	R	S.IO.Slot0.AnalogueInput + 7	Analogue input 7	Public	S_IO
S.IO.Slot0.AnalogueInputStatus	R [2]			Public	S_IO
IO.Slot0.ModuleErrors	R	S.IO.Slot0.AnalogueInputSta...	Analogue input modul...	Public	S_IO
IO.Slot0.OutOfRange	R	S.IO.Slot0.AnalogueInputSta...	Analogue inputs out of...	Public	S_IO

Figure 12: PG5, media mapping

##### 3.4.1.1 Inputs values

In a Fupla or IL program, the input values are saved in registers and can be read with the names:

- **IO.Slot0.AnalogueInput0** for channel 0
- **IO.Slot0.AnalogueInput1** for channel 1
- **IO.Slot0.AnalogueInput2** for channel 2
- **IO.Slot0.AnalogueInput3** for channel 3
- **IO.Slot0.AnalogueInput4** for channel 4
- **IO.Slot0.AnalogueInput5** for channel 5
- **IO.Slot0.AnalogueInput6** for channel 6
- **IO.Slot0.AnalogueInput7** for channel 7

##### 3.4.1.2 Status and errors

Two registers are implemented for the status of the module:

- IO.Slot0.ModuleErrors
- IO.Slot0.OutOfRange

This information can be read as registers or flags. It can be configured in the device configurator:



Figure 13: Media type for diagnostic

The behavior of the diagnostic bits is the same for the two types.

3.4.1.2.1 Module Errors

With flag type configuration, one flag per channel is created for the protection state and three flags for Calibration, ADC and Configuration errors.

Slots / Symbols	Ty...	Address	Comments	Scope	Ta
PCD1.M2120, CPU with 512 KBytes code/text/DB flash memory and 128 KBytes extension memory (RAM for Text/DB from address 4000), 8/6 digit					
I/O 0, 16 Digital In-/Outputs, 4 digital inputs, 4 digital outputs, 4 configurable in- or outputs, 2 interrupts, 1 PWM, 1 watchdog, connector X0, X1 and					
I/O 1, 2 Analogue Inputs, 2 analogue inputs, -10..+10VDC, 0..20mA, Pt/Ni 1000 or resistance, connector X1.					
Slot 0, PCD2.W380, 8 analogue inputs, -10..+10V, -20..20mA, Pt 1000 for -50..+400°C, Ni 1000 for -50..+200°C, resistor 2500 Ohms or 300 kOhm					
S.IO.Slot0.AnalogueInput	R [8]			Public	S_
I0.Slot0.AnalogueInput0	R	S.IO.Slot0.AnalogueInput + 0	Analogue input 0	Public	S_
I0.Slot0.AnalogueInput1	R	S.IO.Slot0.AnalogueInput + 1	Analogue input 1	Public	S_
I0.Slot0.AnalogueInput2	R	S.IO.Slot0.AnalogueInput + 2	Analogue input 2	Public	S_
I0.Slot0.AnalogueInput3	R	S.IO.Slot0.AnalogueInput + 3	Analogue input 3	Public	S_
I0.Slot0.AnalogueInput4	R	S.IO.Slot0.AnalogueInput + 4	Analogue input 4	Public	S_
I0.Slot0.AnalogueInput5	R	S.IO.Slot0.AnalogueInput + 5	Analogue input 5	Public	S_
I0.Slot0.AnalogueInput6	R	S.IO.Slot0.AnalogueInput + 6	Analogue input 6	Public	S_
I0.Slot0.AnalogueInput7	R	S.IO.Slot0.AnalogueInput + 7	Analogue input 7	Public	S_
S.IO.Slot0.AnalogueInputStatus	F [2...			Public	S_
I0.Slot0.AnalogueInput0ProtectionState	F	S.IO.Slot0.AnalogueInputStatus + 0	Analogue input 0 is in protection state	Public	S_
I0.Slot0.AnalogueInput1ProtectionState	F	S.IO.Slot0.AnalogueInputStatus + 1	Analogue input 1 is in protection state	Public	S_
I0.Slot0.AnalogueInput2ProtectionState	F	S.IO.Slot0.AnalogueInputStatus + 2	Analogue input 2 is in protection state	Public	S_
I0.Slot0.AnalogueInput3ProtectionState	F	S.IO.Slot0.AnalogueInputStatus + 3	Analogue input 3 is in protection state	Public	S_
I0.Slot0.AnalogueInput4ProtectionState	F	S.IO.Slot0.AnalogueInputStatus + 4	Analogue input 4 is in protection state	Public	S_
I0.Slot0.AnalogueInput5ProtectionState	F	S.IO.Slot0.AnalogueInputStatus + 5	Analogue input 5 is in protection state	Public	S_
I0.Slot0.AnalogueInput6ProtectionState	F	S.IO.Slot0.AnalogueInputStatus + 6	Analogue input 6 is in protection state	Public	S_
I0.Slot0.AnalogueInput7ProtectionState	F	S.IO.Slot0.AnalogueInputStatus + 7	Analogue input 7 is in protection state	Public	S_
I0.Slot0.AnalogueInputCalibrationError	F	S.IO.Slot0.AnalogueInputStatus + 8	Analogue input calibration error	Public	S_
I0.Slot0.AnalogueInputADCErr	F	S.IO.Slot0.AnalogueInputStatus + 9	Analogue input ADC error	Public	S_
I0.Slot0.AnalogueInputConfigurationError	F	S.IO.Slot0.AnalogueInputStatus + 10	Analogue input configuration error	Public	S_

Figure 14: Flags for module errors

In register type, the following register is created:

Bit	Description
11 .. 15	Reserved
10	Configuration error
9	ADC error
8	Calibration error
7	CH7 protection
6	CH6 protection
5	CH5 protection
4	CH4 protection
3	CH3 protection
2	CH2 protection
1	CH1 protection
0	CH0 protection

Table 6: Description of ModuleErrors register

- Configuration error: The desired inputs configuration is not applied correctly.
- ADC error: A/D converter doesn't respond.
- Calibration error: Module not calibrated.
- Protection mode: An input channel has been automatically put in protection mode, because the module detects a situation which can cause important damages to hardware.

## 3.4.1.2.2 Out Of Range

One flag per channel is created to signalize when the input values are out of range:

IO.Slot0.AnalogueInput0OutOfRange	F	S.IO.Slot0.AnalogueInputStatus + 16	Analogue input 0 out of range	Public	S_
IO.Slot0.AnalogueInput1OutOfRange	F	S.IO.Slot0.AnalogueInputStatus + 17	Analogue input 1 out of range	Public	S_
IO.Slot0.AnalogueInput2OutOfRange	F	S.IO.Slot0.AnalogueInputStatus + 18	Analogue input 2 out of range	Public	S_
IO.Slot0.AnalogueInput3OutOfRange	F	S.IO.Slot0.AnalogueInputStatus + 19	Analogue input 3 out of range	Public	S_
IO.Slot0.AnalogueInput4OutOfRange	F	S.IO.Slot0.AnalogueInputStatus + 20	Analogue input 4 out of range	Public	S_
IO.Slot0.AnalogueInput5OutOfRange	F	S.IO.Slot0.AnalogueInputStatus + 21	Analogue input 5 out of range	Public	S_
IO.Slot0.AnalogueInput6OutOfRange	F	S.IO.Slot0.AnalogueInputStatus + 22	Analogue input 6 out of range	Public	S_
IO.Slot0.AnalogueInput7OutOfRange	F	S.IO.Slot0.AnalogueInputStatus + 23	Analogue input 7 out of range	Public	S_

If the configuration is done in “register type”, an 8-bit register is created:

Bit	Description
7	CH7 out of range
6	CH6 out of range
5	CH5 out of range
4	CH4 out of range
3	CH3 out of range
2	CH2 out of range
1	CH1 out of range
0	CH0 out of range

Table 7: Description of OutOfRange register

The “out of range” status bit means that the converted value is out of the specified range. The input value stay at the minimum or other maximum value allowed.

The mode “VOLTAGE” hasn’t out of range detection.



### 3.4.2 With direct access

The module allows direct access with RDP commands.

Symbol Name	Type	Address/Value	Comment	Tags	Scope
AllPublics	ROOT				
IO	GROUP				
IOAccess	GROUP				
Slot0	GROUP				
IOAccess	GROUP				
ANALOGUE_INPUT_0	CONST	8	Address of analogue input 0 in memory input range - used for direct access		Public
ANALOGUE_INPUT_1	CONST	12	Address of analogue input 1 in memory input range - used for direct access		Public
ANALOGUE_INPUT_2	CONST	16	Address of analogue input 2 in memory input range - used for direct access		Public
ANALOGUE_INPUT_3	CONST	20	Address of analogue input 3 in memory input range - used for direct access		Public
ANALOGUE_INPUT_4	CONST	24	Address of analogue input 4 in memory input range - used for direct access		Public
ANALOGUE_INPUT_5	CONST	28	Address of analogue input 5 in memory input range - used for direct access		Public
ANALOGUE_INPUT_6	CONST	32	Address of analogue input 6 in memory input range - used for direct access		Public
ANALOGUE_INPUT_7	CONST	36	Address of analogue input 7 in memory input range - used for direct access		Public
MODULE_ERRORS	CONST	40	Address of module errors in memory input range - used for direct access		Public
OUT_OF_RANGE	CONST	42	Address of out of range status in memory input range - used for direct access		Public

Here an IL program example to read the input values, the module errors and the out of range status:

Declaration of a mask:

```

; Mask declaration (top of the file)
Mask1Byte EQU R
; Load the value 255 in the mask to keep only
; the least significant byte (in X0B16 or in COB)
LD Mask1Byte
255

```

Commands for reading module data:

```

; 4 bytes (dword) : RDP command for ANALOGUE_INPUT_x
RDP IO.Slot0.IOAccess.ANALOGUE_INPUT_0
R 0
RDP IO.Slot0.IOAccess.ANALOGUE_INPUT_1
R 1
RDP IO.Slot0.IOAccess.ANALOGUE_INPUT_2
R 2
RDP IO.Slot0.IOAccess.ANALOGUE_INPUT_3
R 3
RDP IO.Slot0.IOAccess.ANALOGUE_INPUT_4
R 4
RDP IO.Slot0.IOAccess.ANALOGUE_INPUT_5
R 5
RDP IO.Slot0.IOAccess.ANALOGUE_INPUT_6
R 6
RDP IO.Slot0.IOAccess.ANALOGUE_INPUT_7
R 7

; 2 bytes (word) : RDPW command for MODULE_ERRORS
RDPW IO.Slot0.IOAccess.MODULE_ERRORS
R 8

; 1 byte : RDPB command with mask for OUT_OF_RANGE
RDPB IO.Slot0.IOAccess.OUT_OF_RANGE
R 9
AND R 9
Mask1Byte
R 9

```

The type of read data for each “register” is the same than using media mapping. The mask after the command RDPB is only for the comfort. The RDPB command has an integrated 2-complement conversion. If the channel 7 is out of range, the bits 8 to 31 of the register R 9 are setting to ‘1’. To avoid this phenomenon, a mask can be placed to keep only the desired data on R 9 and the bits 8 to 31 stay ‘0’.

The register MODULE\_ERRORS must be read cyclically even if they are not used in the user program.

## 4 Example of linearization

The choice of NTC sensors is not available in the Device Configurator because these sensors are not standardized. To use a NTC with the module PCD2/3.W380, please configure the desired channel in mode "0..300k $\Omega$ " and use the linearization FBox available in PG5 environment.

This FBox can be used to enter the own tables for the conversion of a resistance value in a temperature value.

A project example can be downloaded from the SBC Support Website at this location:

<http://www.sbc-support.com>

This project example can be used for temperature measurements with integrated circuits operating as a 2-terminal zener too. This FBox can be used to enter the own tables for the conversion of a voltage value in a temperature value. The desired channel must be configured in mode "Diode 0...5000mV".

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## 6 Contact

**Saia-Burgess Controls AG**

Bahnhofstrasse 18  
CH-3280 Murten / Switzerland

Telephon: ..... +41 26 672 72 72

Fax: ..... +41 26 672 74 99

E-Mail Support: ..... [support@saia-pcd.com](mailto:support@saia-pcd.com)

Supportseite: ..... [www.sbc-support.com](http://www.sbc-support.com)

SBC Seite: ..... [www.saia-pcd.com](http://www.saia-pcd.com)

Internationale Vertretungen &

SBC Verkaufsgesellschaften: ... [www.saia-pcd.com/contact](http://www.saia-pcd.com/contact)