AI 022-1

S-DIAS Strain Gauge Input Module

Operating Manual

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Publisher: SIGMATEK GmbH & Co KG
A-5112 Lamprechtshausen
Tel.: +43/6274/4321
Fax: +43/6274/4321-18
Email: office@sigmatek.at
WWW.SIGMATEK-AUTOMATION.COM

Translation from German

S-DIAS Strain Gauge Input Module AI 022-1

with 2 analog inputs

The S-DIAS AI 022-1 strain gauge input module is used to analyze measuring bridges (i.e. strain gauge load cells). With a 24-bit resolution, measurement values are provided with an overall accuracy of 0.035 %.

The AI 022-1 differs from the AI 022 in the following technical data:

- the resolution of the measurement range is increased to a maximum of 100 %, the reduction in the expanded measurement range of 100-150 % for evaluating overstretching of the load cell by 50 % was eliminated.
- For increased noise suppression, the hardware input filter has a lower limiting frequency of 8 Hz instead of 180 Hz.
- the support of lower impedance load cells (e.g. via the parallel connection of several load cells) – loads of at least 60 Ω / channel from the AI 022-1 are now supported; lower load cell loads lead to a higher current consumption of the module on the S-DIAS bus

Contents

1 Technical Data

1.1 Analog Channel Specifications

Number of channels	2					
Bridge supply voltage	+5 V					
Load cell rated values	0.25 mV/V	0.5 mV/V	1 mV/V	2 mV/V	16 mV/V	
Measurement range [1]	±1.25 mV	±2.5 mV	±5 mV	±10 mV	±80 mV	
Measurement value	±8388608 d					
	The hardware class returns -2147483632 with an open input.					
Resolution	24 bits					
Hardware filter	8 Hz, 1st order					
Filter setting, conversion time and noise-free resolution.	filter word	2	...	5	...	1023
	filter type	Sinc4	...	Sinc4	...	Sinc4
	cutoff frequency (-3 dB)	144 Hz	...	57.7 Hz	...	0.282 Hz
	conversion time	4 ms	...	9 ms	...	1702 ms
	noise-free resolution [2]	15.5 bits	...	16 bits	...	20-bit
Sensor break detection	yes					
Load per channel	60-5000 Ω					
Noise [3]	±0.0031 % referred to the full scale value for filter Word 2					
Temperature drift [3]	±0.001 % / °C referred to the full scale value of the measuring range					
Overall accuracy [3]	±0.035 % referred to the full scale value of the measuring range					
Calibration data Null-voltage protected	yes					
Calibratable	no					

[1] the measurement ranges are not designed for overstretching of the load cell

[2] These are typical values with an active Sinc4 filter and measurement range of 2 mV/V

[3] To maintain the accuracy of the analog channel measurement, a system calibration with the sensor is required. Whereby the null point and full-scale deflection are calibrated. The system must be re-calibrated when a sensor is replaced or the measurement range changed. Generally, the zero point is first calibrated and then the full deflection. The calibration of the full deflection is only possible between 50 and 100 % of the positive measurement range.

1.2 Electrical Requirements

Voltage supply from S-DIAS bus	+5 V	
Current consumption on the S-DIAS bus (+5 V power supply)	typically 50 mA	maximum 55 mA
Voltage supply from S-DIAS bus	+24 V	
Current consumption on the S-DIAS bus (+24 V supply) without a load on the measurement bridge supply	typically 17 mA at +18 V typically 15 mA at +24 V typically 14 mA at +30 V	maximum 20 mA at +18 V maximum 18 mA at +24 V maximum 17 mA at +30 V
Current consumption on the S-DIAS bus (+24 V supply) with maximum load on both measurement bridge supplies	typically 92 mA at +18 V typically 71 mA at +24 V typically 59 mA at +30 V	maximum 110 mA at +18 V maximum 85 mA at +24 V maximum 71 mA at +30 V

If this S-DIAS module is connected to an S-DIAS supply module with several other S-DIAS modules, the total current of the modules used must be determined and checked.

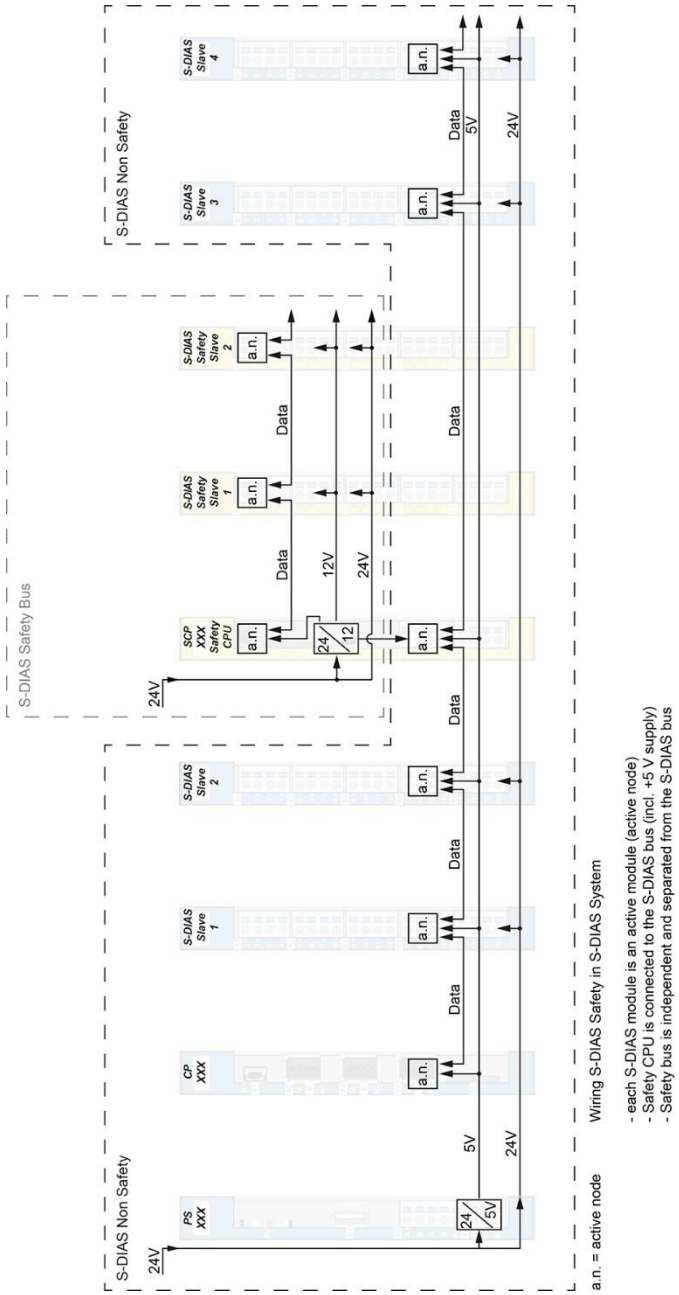
The total current of the +24 V supply cannot exceed 1.6 A!
The total current of the +5 V supply cannot exceed 1.6 A!

The specification for the current can be found in the module-specific documentation under "Electrical Requirements".

Si ce module S-DIAS est connecté à un module d'alimentation S-DIAS suivi de plusieurs modules S-DIAS, le courant total des modules utilisés doit être déterminé et vérifié.

Le courant total de l'alimentation +24 V ne peut pas dépasser 1,6 A!
Le courant total de l'alimentation +5 V ne peut pas dépasser 1,6 A!

Le cahier des charges pour le courant peut être trouvé dans la documentation spécifique au module sous "Spécifications électriques".


S-DIAS Non Safety
S-DIAS Safety Bus
S-DIAS Non Safety
24V
PS XXX
CP XXX
S-DIAS Slave 1
S-DIAS Slave 2
SCP XXX Safety CPU
S-DIAS Safety Slave 1
S-DIAS Safety Slave 2
S-DIAS Slave 3
S-DIAS Slave 4
a.n.
Data
5V
12V
24V
24/5V
24/12
a.n. = active node
Wiring S-DIAS Safety in S-DIAS System
- each S-DIAS module is an active module (active node)
- Safety CPU is connected to the S-DIAS bus (incl. +5 V supply)
- Safety bus is independent and separated from the S-DIAS bus

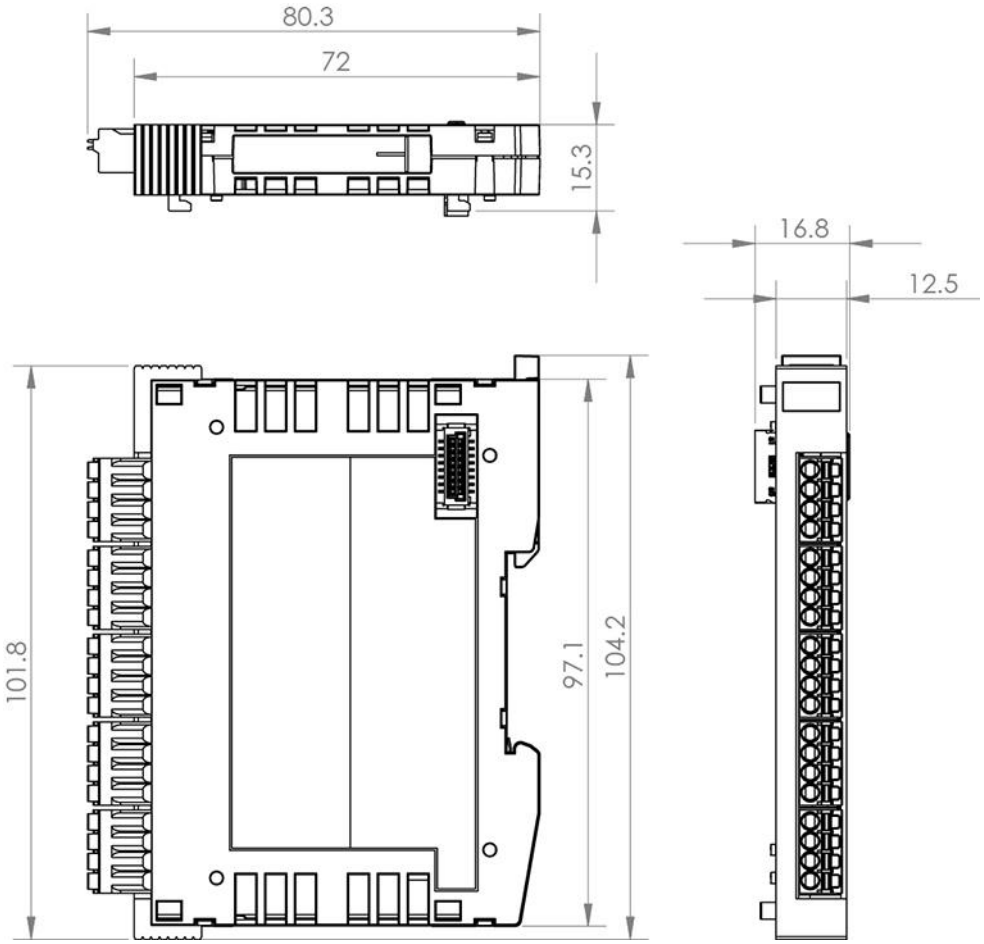
1.3 Miscellaneous

Article number	20-009-022-1
Hardware version	1.x
Standard	UL 508 (E247993)
Approvals	UL, cUL, CE

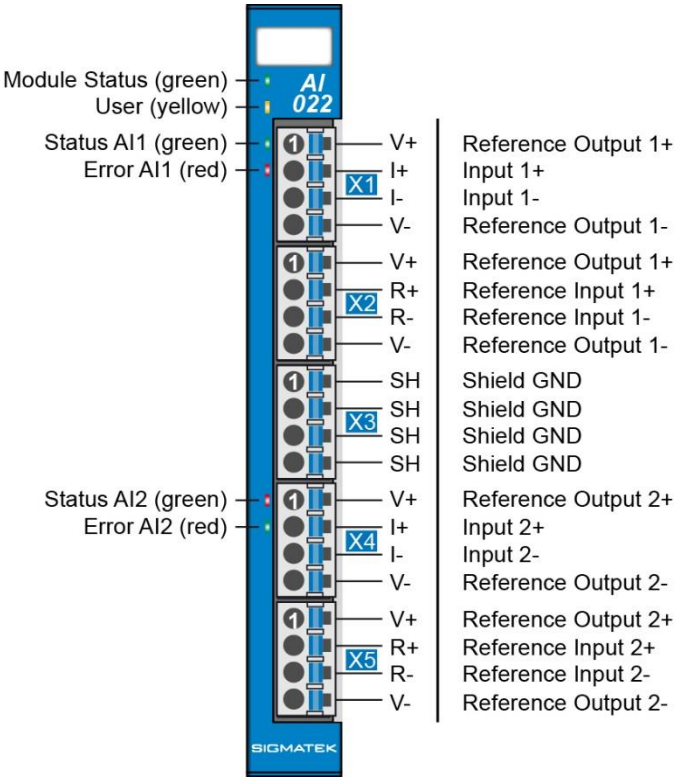
1.4 Environmental Conditions

Storage temperature	-20 ... +85 °C	
Environmental temperature	0 ... +55 °C	
Humidity	0-95 %, non-condensing	
Installation altitude above sea level	0-2000 m without derating > 2000 m with derating of the maximum environmental temperature by 0.5 °C per 100 m	
EMC resistance	in accordance with EN 61000-6-2:2007 (industrial area)	
EMC noise generation	in accordance with EN 61000-6-4 (industrial area)	
Vibration resistance	EN 60068-2-6	3.5 mm from 5-8.4 Hz 1 g from 8.4-150 Hz
Shock resistance	EN 60068-2-27	15 g
Protection type	EN 60529	IP20

2 Mechanical Dimensions



3 Connector Layout



3.1 Status LEDs

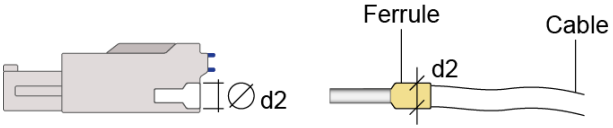
Module status	green	ON	module active
		OFF	no supply available
		BLINKING (5 Hz)	no communication
User	yellow	ON	can be set from the application (e.g. the module LED can be set to blinking through the visualization, so that it is easily found in the control cabinet)
		OFF	
		BLINKING (2 Hz)	
		BLINKING (4 Hz)	
Status AI1/AI2	green	BLINKING (3 Hz)	A/D converter active
		OFF	A/D converter inactive
Error AI1/AI2	red	ON	sensor break or overload/short circuit of the bridge supply.
		OFF	no errors
		BLINKING (1 Hz)	input initialization error

3.2 Applicable Connectors

Connectors:
X1-X5: Connectors with spring terminals (included in delivery)
The spring terminals are suited for the connection of ultrasonically compacted (ultrasonically welded) stranded wire.

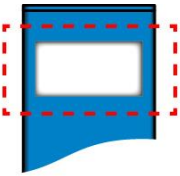
Connections

Stripping length/sleeve length:	10 mm
Mating direction:	parallel to the conductor axis or circuit board
Conductor cross section rigid:	0.2-1.5 mm^2
Conductor cross section flexible:	0.2-1.5 mm^2
Conductor cross-section strands ultrasonically compacted:	0.2-1.5 mm^2
Conductor cross section AWG/kcmil:	24-16
Conductor cross section flexible with ferrule:	0.25-1.5 mm^2
Conductor cross section flexible with ferrule and plastic sleeve:	0.25-0.75 mm^2 (reason for reduction d2 of the ferrule)



d2 = max. 2.8 mm

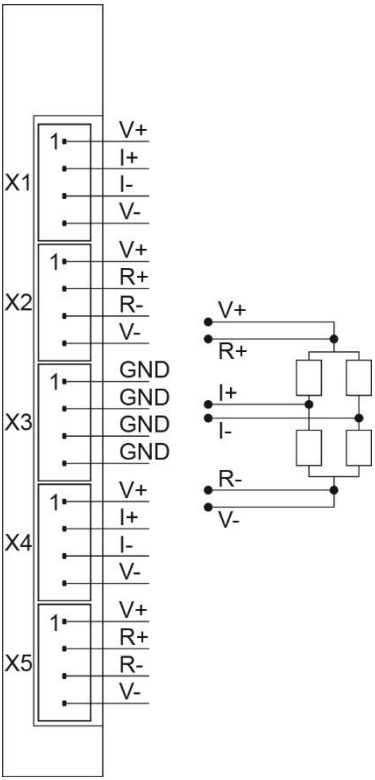
3.3 Labeling Field



Manufacturer	Weidmüller
Type	MF 10/5 CABUR MC NE WS
Article number Weidmüller	1854510000
Compatible printer	Weidmüller
Type	Printjet Advanced 230V
Article number Weidmüller	1324380000

4 Wiring

4.1 Wiring Example



4.2 Note

The signals recorded by the analog modules are very small, as compared to the digital signals. To ensure error-free operation, a careful wiring method must be followed:

- The DIN rail must have an adequate connection to mass.
- The lines connected to the source of the analog signals must be as short as possible and parallel wiring to digital signal lines must be avoided.
- The signal lines must be shielded.
- The shielding must be connected to a shielding bus.
- Avoid parallel connections between input lines and load-bearing circuits.
- Protective circuits for all relays (RC networks or free-wheeling diodes).

The ground bus should be connected to the control cabinet when possible!

Si possible la terre doit être connectée à l'armoire de commande!

IMPORTANT:
The S-DIAS module CANNOT be connected or disconnected while voltage is applied!

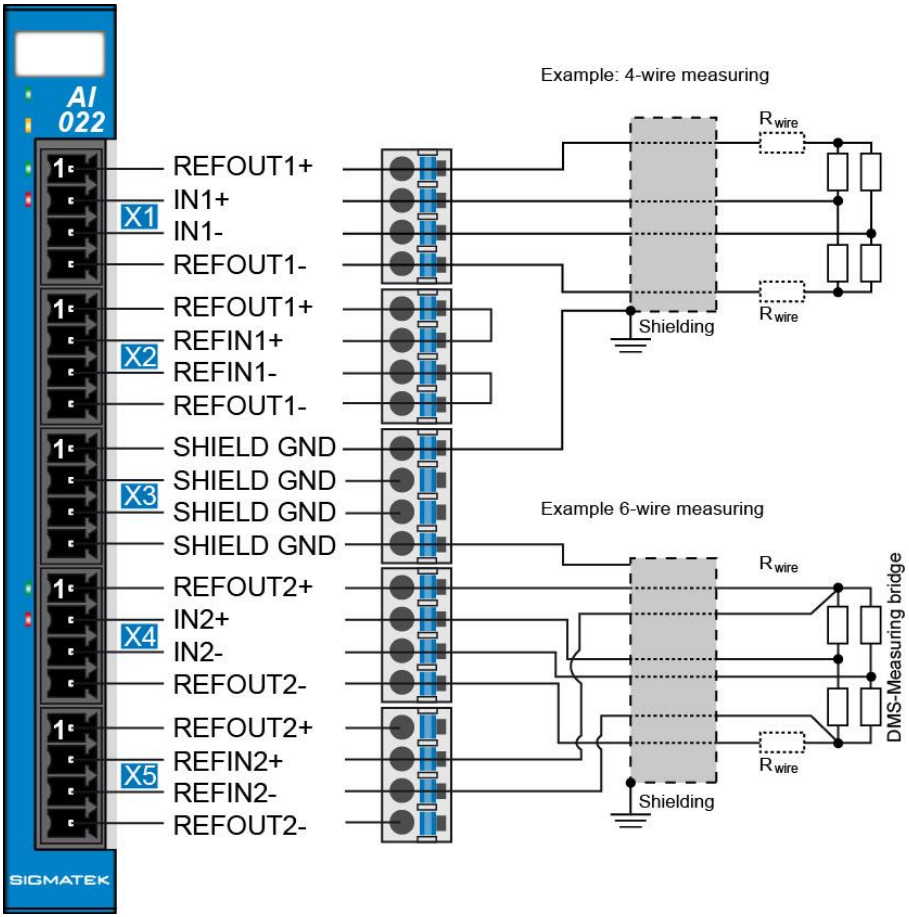
IMPORTANT:
Le module S-Dias NE PEUT PAS être inséré ou retiré sous tension.

4.3 Connection Variants

Two connection Types can be used when measuring with strain gauges:

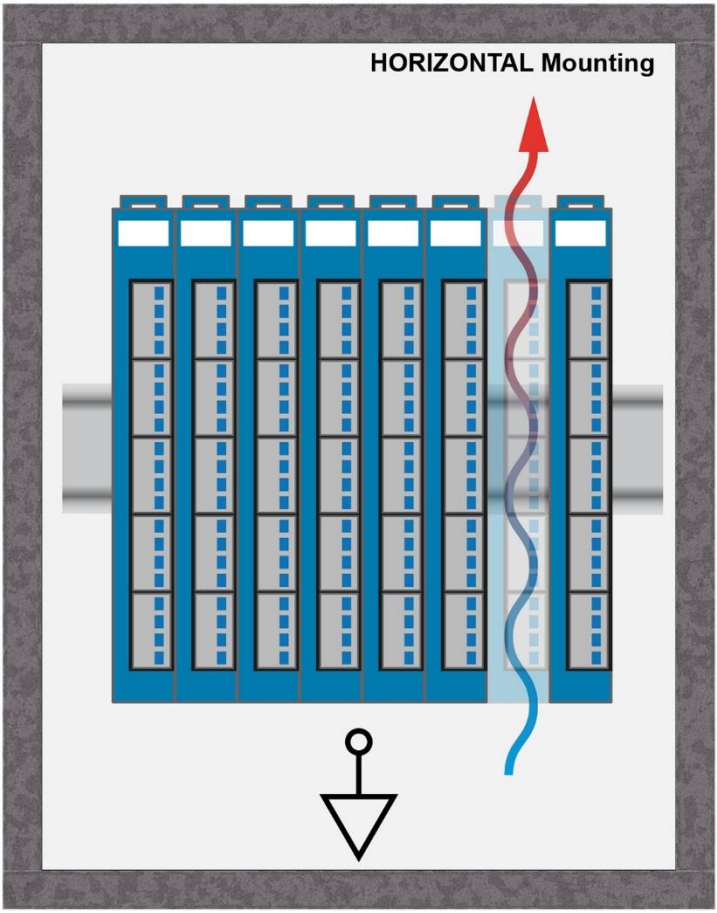
4-wire measurement:
The advantage of this variant is that a 4-pin connector cable can be used for the strain gauge. The voltage drop over the circuit for the bridge voltage supply however, cannot be compensated.

6-wire measurement:
This configuration provides the advantage of voltage compensation using the bridge voltage supply measurement on the strain gauge directly.

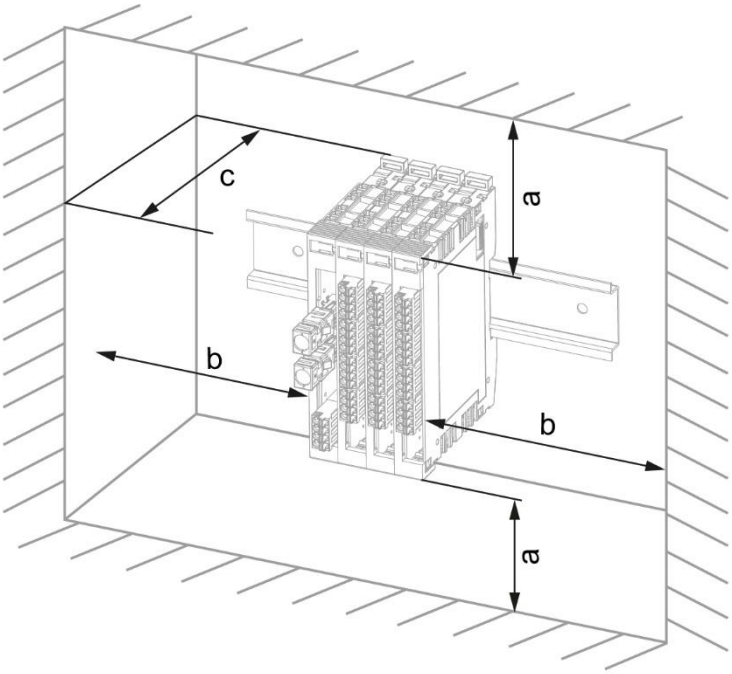


5 Mounting

The S-DIAS modules are designed for installation into the control cabinet. To mount the modules, a DIN-rail is required. The DIN rail must establish a conductive connection with the back wall of the control cabinet. The individual S-DIAS modules are mounted on the DIN rail as a block and secured with latches. The functional ground connection from the module to the DIN rail is made via the grounding clamp on the back of the S-DIAS modules.The modules must be mounted horizontally (module label facing up) with sufficient clearance between the ventilation slots of the S-DIAS module blocks and nearby components and/or the control cabinet wall. This is necessary for optimal cooling and air circulation, so that proper function up to the maximum ambient temperature is ensured.



Recommended minimum distances of the S-DIAS modules to the surrounding components or control cabinet wall:



a	b	c
30 mm (1.18″)	**30 mm** (1.18″)	**100 mm** (3.94″)

a, b, c … distances in mm (inches)

6 Supported Cycle Times

6.1 Cycle Times below 1 ms (in µs)

FW	50	100	125	200	250	500
V3.00		x	x	x	x	x

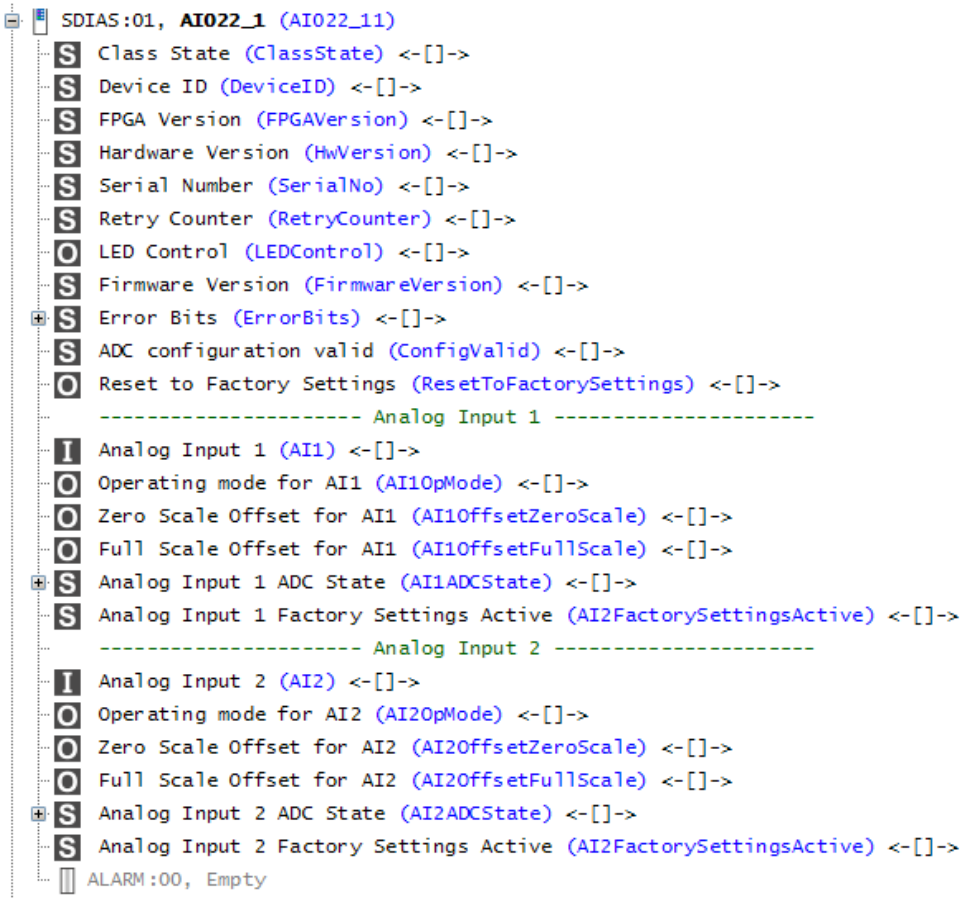
6.2 Cycle Times equal to or higher than 1 ms (in ms)

FW	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
V3.00	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

FW	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
V3.00	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

7 Hardware Class AI022_1

Hardware Class AI022_1 for the S-DIAS AI022-1 analog module



This hardware class is used to control the AI022-1 hardware module. The module has two analog inputs for resistance bridges (e.g. DMS weighing cells). More information on the hardware can be found in the module documentation.

7.1 General

Class State	State	This server shows the actual status of the hardware class.
Device ID	State	This server shows the device ID of the hardware module.
FPGA Version	State	FPGA version of the module in 16#XY (e.g. 16#10 = version 1.0).
Hardware Version	State	Hardware version of the module in format 16#XXYY (e.g. 16#0120 = version 1.20)
Serial Number	State	The serial number of the hardware module is shown in this server.
Retry Counter	State	This server increments when a transfer fails.
LED Control	Output	With this server, the application LED of the S-DIAS module can be activated to find the module in the network more quickly. The following status are possible: 0 LED off 1 LED on 2 blinks slowly 3 blinks rapidly
Required	Property	This client is activated by default, i.e. this S-DIAS hardware module at this position is absolutely necessary for the system and may under no circumstances be missing, disconnected or deliver an error, otherwise the entire hardware is switched off. If the hardware module is missing, it returns an error or if it is removed, this triggers an S-DIAS error. If this client is initialized with 0, this hardware module is not mandatory at the position. This means that it can be removed at any time. However, which components identified as "not required" should be selected with regard to the safety of the system.
Firmware Version	State	The firmware version of the hardware module is shown in this server.
Error Bits	State	In this server, the error bits of the module are shown. The respective bits mean the following: Bit 0 Not used Bit 1 no Sync available Bit 2 Flash Data CRC Error Bit 3 Ram Data CRC Error Bit 4 invalid EEProm version Bit 5 Bridge 1 DC not OK Bit 6 Bridge 2 DC not OK Bit 7 incorrect gain setting of ADC1 – current setting does not match the calibrated data Bit 8 incorrect gain setting of ADC2 – current setting does not match the calibrated data Bit 9 Bridge1 filter is not yet filled Bit 10 Bridge2 filter is not yet filled The error bits 7 and 8 go to null as soon as the gain setting matches the defined values. The application must ensure that the correct gain (as well as filter type and filter depth) is set correctly after each restart. This is necessary, since the calibration data no longer matches when the gain is changed and the measurement results are thereby incorrect. If the gain must be changed, a new calibration must be performed.

7.2 Analog Inputs

ADC configuration valid	State	1: The configuration of the ADCs is valid => the analog values can be used in the application 0: The configuration of the ADCs is invalid -1: Error while sending the configuration to the ADCs
Analog Input [1-4]	Input	Current value of the respective analog channel (if AI1[1-2]ConfigValid, as well as the Ready bit of the AI[1-2]ADCState is set) Displays the value 16#80000010 if the ErrorBit on the server AI[1-2]ADCState is set.
Zero Scale Offset for AI [1-2]	Output	Scale null point according to the last calibration (updated with each change in the FilterDepth, SincSetting, Gain or OpMode settings)
Full Scale Offset for AI [1-2]	Output	Scale end value according to the last calibration (updated with each change in the FilterDepth, SincSetting, Gain or OpMode settings)
AI[1-2]ADCState	State	Shows the status of the respective input: Bit 0-4: Not used Bit 5: No reference (set if the reference voltage is too low) Bit 6: error The ADC error bit is set when all bits in the analog value were referenced to 0 or 1. The bit is cleared when the error no longer exists and the analog value valid again. Possible Causes: -Value outside of the valid measurement range - No reference voltage Bit 7: Not Ready Indicates when newly converted values are available (for valid values, it is always set to 0 in Continuous mode)
AI[1-2]FilterDepth	Property	Value setting for the filter depth of the respective ADC (as a default 2) Valid range of values: 2-1023
AI[1-2]SincSetting	Property	Selection of the sinc filter type of the respective ADC: 0: sinc 4 Filter is used (default) 1: sinc 3 Filter is used (default) The advantage of the sinc 3 filter, as compared with sinc 4 filter, is the lower settling time. The sinc 4 filter however, provides better 50 / 60 Hz suppression.
AI[1-2] Gain	Property	Gain selection to select the input range of the respective ADC: 0: Gain 1 (± 80 mV) 1: Not used (if selected, the default value is used) 2: Not used (if selected, the default value is used) 3: Gain 8 (± 10 mV) (default) 4: Gain 16 (± 5 mV) 5: Gain 32 (± 2,5 mV) 6: Gain 64 (± 1,25 mV)
Operating mode for AI[1-2]	Output	Selection of operating mode for the respective ADC: 0: Continuous conversion mode (default) 6: System zero-scale calibration 7: System full-scale calibration
Reset to Factory Settings	Output	-1: Function not available (available starting with FW version 1.80)

Analog Input [1-2]Factory Settings Active		-2 Invalid CRC in the factory settings -3 Invalid input parameters (must be 1, 2 or 3) 0 Reset successful, if ConfigValid goes to 1
	State	Shows whether the ADC for the respective channel is set to factory settings. 0 ADC configuration is different to factory settings 1 ADC configuration matches with factory settings -1 Factory settings are not available (too old FW version (at least 1.80 or higher) or invalid CRC in the factory settings data (can occur with firmware update with update stick)

7.3 Communication Interfaces

ALARM	Downlink	With this downlink the corresponding alarm class can be placed via the hardware editor.

7.4 Setting the FilterDepth

When setting the filter depth it has to be cared, that also the conversion time depends on it.

Calculating the ADC data rate fADC (with fCLK = 4.92 MHz) for the sinc 4 filter:
fADC = fCLK / (4 * 1024 * AI[1-2]FilterDepth)

Calculating the ADC data rate fADC (with fCLK = 4.92 MHz) for the sinc 3 filter:
fADC = fCLK / (3 * 1024 * AI[1-2]FilterDepth)

This results in the conversion time tSETTLE: tSETTLE = 2/ fADC

Calculation of the cut-off frequency f3DB: f3DB = 0,24 * fADC

Ex.: Sync 4, filter depth 5 : Conversion time = 9 ms; cut-off frequency = 57.7 Hz

7.5 Setting the Force Sensor

1. The gain of the ADC is set correctly according to the data sheet of the sensor. The module should be set in such a way that the range of the force transducer used makes the most of the value range of the ADC without exceeding it.
2. Zero point calibration (tare) of the sensor with AI[1-2]OpMode - 6. This sets AI[1-2]OffsetZeroScale.
3. Final deflection calibration: The sensor is loaded with the maximum force used and with AI[1-2]OpMode - 7 the full scale value in register AI[1-2]OffsetFullScale is defined. The calibration of the full deflection is only possible between 50 and 100 % of the positive measurement range.

Documentation Changes

Change date	Affected page(s)	Chapter	Note
21.03.2019	3	1.1 Analog Channel Specification	Noise, Temperature drift and overall accuracy appended
18.12.2019		6 Supported Cycle Times	Chapter added
08.09.2020	18	7 Hardware Class AI022_1	Chapter added
04.11.2020	15	5 Mounting	Expansion functional ground connection