AI 040

S-DIAS Analog Input Module

Instruction Manual

Date of creation: 16.01.2015 | Version date: 26.07.2023 | Article number: 20-009-040-E

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Translation of the Original Instructions

S-DIAS Analog Input Module AI 040

with 4 inputs for vibration sensors with IEPE interface

The S-DIAS AI 040 analog input module has four constant current sources, which can be set independently of one another. The sensor signals converted to a broad frequency range with a 16-bit resolution.

Contents

1 Introduction

1.1 Target Group/Purpose of this Operating Manual

This operating manual contains all information required for the operation of the product.

This operating manual is intended for:

- Project planners
- Technicians
- Commissioning engineers
- Machine operators
- Maintenance/test technicians

General knowledge of automation technology is required.

Further help and training information, as well as the appropriate accessories can be found on our website www.sigmatek-automation.com.

Our support team is happily available to answer your questions.
Please see our website for our hotline number and business hours.

1.2 Important Reference Documentation

This and additional documents can be downloaded from our website or obtained through support.

1.3 Contents of Delivery

1x AI 040

2 Basic Safety Directives

2.1 Symbols Used

The following symbols are used in the operator documentation for warning and danger messages, as well as informational notes:

DANGER

Danger indicates that death or serious injury **will occur**, if the specified measures are not taken.

⇨ To avoid death or serious injuries, observe all guidelines.

Danger indique une situation dangereuse qui, faute de prendre les mesures adéquates, **entraînera** des blessures graves, voire mortelles.

⇨ Respectez toutes les consignes pour éviter des blessures graves, voire mortelles.

WARNING

Warning indicates that death or serious injury **can** occur, if the specified measures are not taken.

⇨ To avoid death or serious injuries, observe all guidelines.

Avertissement d'une situation dangereuse qui, faute de prendre les mesures adéquates, **entraînera** des blessures graves, voire mortelles.

⇨ Respectez toutes les consignes pour éviter des blessures graves, voire mortelles.

CAUTION

Caution indicates that moderate to slight injury **can** occur, if the specified measures are not taken.

⇨ To avoid moderate to slight injuries, observe all guidelines.

Attention indique une situation dangereuse qui, faute de prendre les mesures adéquates, **peut** entraîner des blessures assez graves ou légères.

⇨ Respectez toutes les consignes pour éviter des blessures graves, voire mortelles.

INFORMATION

Information

⇨ Provides important information on the product, handling or relevant sections of the documentation, which require attention.

2.2 Disclaimer

INFORMATION

The contents of this operating manual were prepared with the greatest care. However, deviations cannot be ruled out. This operating manual is regularly checked and required corrections are included in the subsequent versions. The machine manufacturer is responsible for the proper assembly, as well as device configuration. The machine operator is responsible for safe handling, as well as proper operation.

The current operating manual can be found on our website. If necessary, contact our support.

Subject to technical changes, which improve the performance of the devices. The following operating manual is purely a product description. It does not guarantee properties under the warranty.

Please thoroughly read the corresponding documents and this operating manual before handling a product.

SIGMATEK GmbH & Co KG is not liable for damages caused through, non-compliance with these instructions or applicable regulations.

2.3 General Safety Directives

The Safety Directives in the other sections of this operating manual must be observed. These instructions are visually emphasized by symbols.

INFORMATION

According to EU Directives, the operating manual is a component of a product.

This operating manual must therefore be accessible in the vicinity of the machine since it contains important instructions.

This operating manual should be included in the sale, rental or transfer of the product, or its online availability indicated.

Regarding the requirements for Safety and health connected to the use of machines, the manufacturer must perform a risk assessment in accordance with machine directives 2006/42/EG before introducing a machine to the market.

Operate the unit with devices and accessories approved by SIGMATEK only.

CAUTION

Handle the device with care and do not drop or let fall.

Prevent foreign bodies and fluids from entering the device.

The device must not be opened!

Manipulez l'appareil avec précaution et ne le laissez pas tomber.

Empêchez les corps étrangers et les liquides de pénétrer dans l'appareil.

L'appareil ne doit pas être ouvert!

If the device does not function as intended or has damage that could pose a danger, it must be replaced!

En cas de fonctionnement non conforme ou de dommages pouvant entraîner des risques, l'appareil doit être remplacé!

The module complies with EN 61131-2.

In combination with a facility, the system integrator must comply with EN 60204-1 standards.

For your own safety and that of others, compliance with the environmental conditions is essential.

Le module est conforme à la norme EN 61131-2.

En combinaison avec une équipement, l'intégrateur de système doit respecter la norme EN 60204-1.

Pour votre propre sécurité et celle des autres, le respect des conditions environnementales est essential.

2.4 Software/Training

The application is created with the software LASAL CLASS 2 and LASAL SCREEN Editor.

Training for the LASAL development environment, with which the product can be configured, is provided. Information on our training schedule can be found on our website.

3 Standards and Directives

3.1 Directives

The product was constructed in compliance with the following European Union directives and tested for conformity.

3.1.1 EU Conformity Declaration

EU Declaration of Conformity

The product AI 040 conforms to the following European directives:

- **2014/35/EU** Low-voltage Directive
- **2014/30/EU** Electromagnetic Compatibility (EMC Directive)
- **2011/65/EU** “Restricted use of certain hazardous substances in electrical and electronic equipment” (RoHS Directive)

The EU Conformity Declarations are provided on the SIGMATEK website. See Products/Downloads or use the search function and the keyword “EU Declaration of Conformity”.

4 Type Plate

Exemplary nameplate (symbol image)

HW: Hardware version
SW: Software version

5 Technical Data

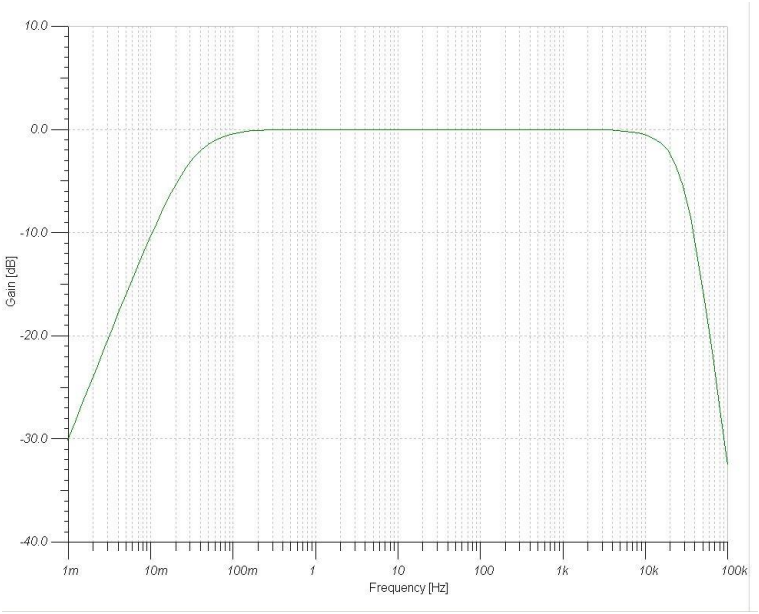
5.1 IEPE Interface Specifications

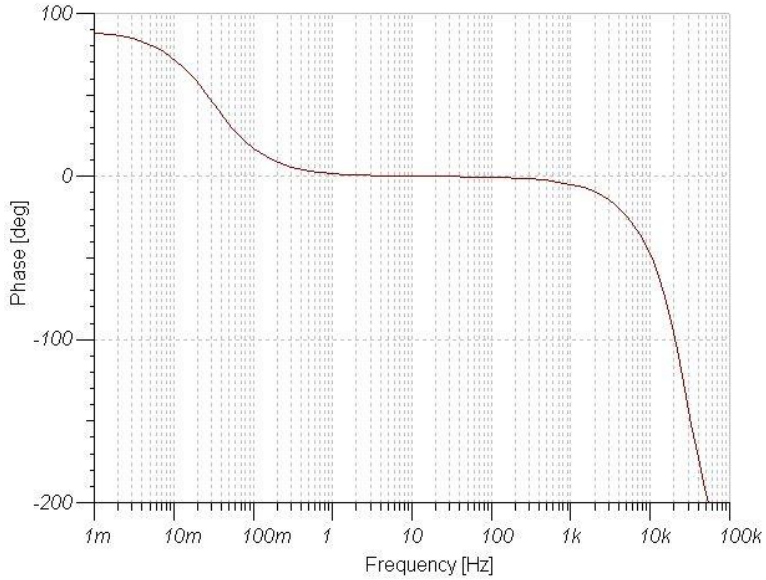
Number of channels	4					
Measurement Range	±5.500 V AC	±2.750 V AC	±1.375 V AC	±0.688 V AC	±0.344 V AC	±0.172 V AC
Adjustable amplification	1	2	4	8	16	32
Measurement value	±30000					
	An open or shorted input returns -2147483632 in the hardware class.					
AD converter resolution	16-bit					
Conversion rate per channel	≥ 5 µs (adjustable, default setting 5 µs)					
Data recording per channel	maximum 64 word					
Short circuit monitoring	yes					
Cable break monitor	yes					
Input filter hardware	typically 31 mHz (1)			high pass 1st order system (1)		
	typically 20 kHz			low pass 3rd order system		
Measurement precision (amplification 1 to 8)	±0.5 %					
Measurement precision (amplification 16 to 32)	±2 % (2)					

(1) Due to the 31 mHz 1st order high-pass filter, a hardware-induced settling process with a time constant τ of 5.13 seconds occurs when the current sources for the IEPE sensors are switched on/configured. After $5*\tau$ the final value has settled to ≥ 99 %.

(2) When connecting the shield to the component and with strong electromagnetic disturbances, the measurement error can be increased by an additional ±2 %.

5.2 Input Filter Hardware





5.3 Software Band Pass Filter Specifications

Lower frequency limit	adjustable (min 0.1 Hz)
Upper frequency limit	adjustable (max. 10 kHz)
Measurement values processed per cycle	configurable
Output parameters	average value minimum value maximum value time stamp minimum value time stamp maximal value

The filter block can be used for every channel, as well as several times per channel.

5.4 Measuring and Bus Transmission

In the module, values are measured continuously. Data is transferred isochronously. All recorded values are therefore available in every bus cycle.

The following data is generated with a bus time of 1 ms.

	S-DIAS (CP 111)	VARAN (over VI 021)
Read:		
100-byte data/channel	4 * ~6 µs = ~24 µs	3*128 bytes =~46.2 µs
2-byte status	~2.1 µs	18 bytes = ~4.2 µs
Write:		
2-byte control	~2.1 µs	2 bytes = ~2.8 µs
Total (1st participant on bus)	ca. 28.2 µsec	ca. 53.2 µsec
Total (2nd participant)	+ 0.2 µsec	+ 0.94 µsec

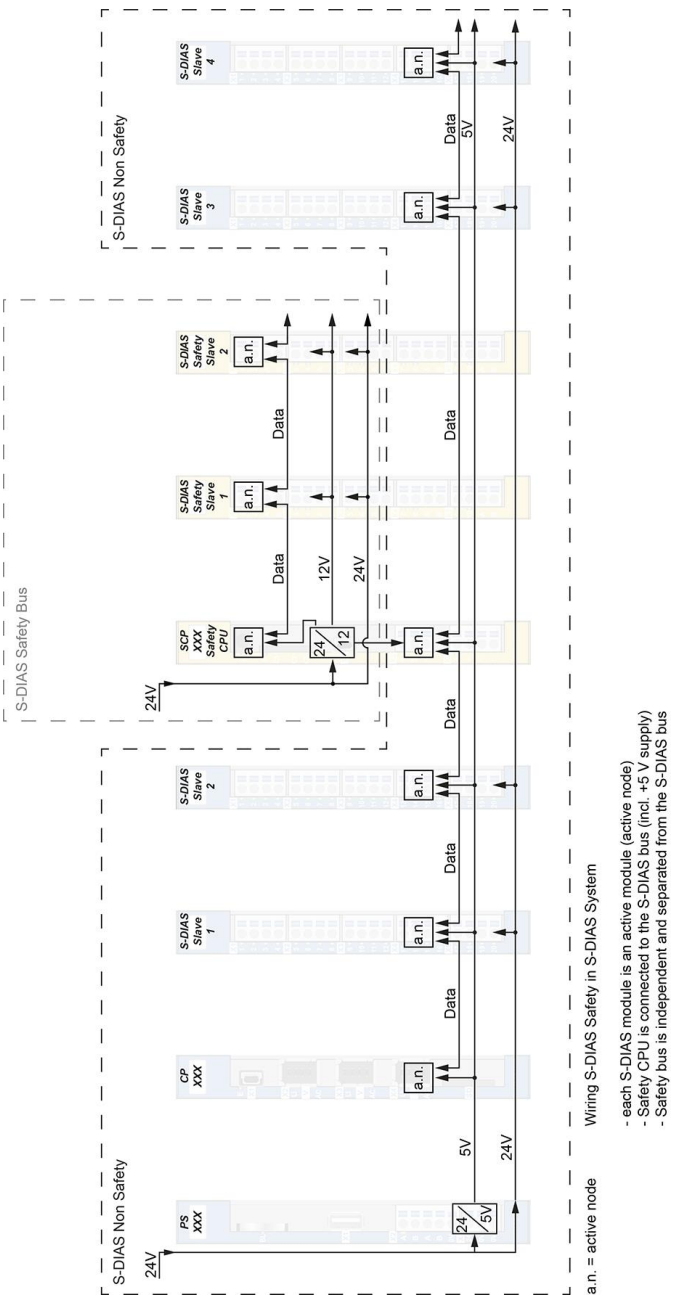
5.5 Supply Voltage Specifications

Adjustable current	0, 4, 8, 12 mA separately adjustable for each channel	
Setting tolerance	maximum ±5 %	
Supply voltage (1)	+18-30 V DC	
Current consumption	typically 20 mA plus constant current setting	
Sensor voltage at 12 mA supply current (1)	minimal 18.5 V	typically 19.1 V

(1) Additionally:
1. The sensor voltage has at least: [supply voltage]-[0.5 V].
2. With supply voltages under 20.5 V, the noise suppression of the supply voltage can be minimized.

5.6 Electrical Requirements

Voltage supply from S-DIAS bus	+24 V	
Current consumption on the S-DIAS bus (+24 V power supply)	typically 30 mA	maximum 40 mA


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

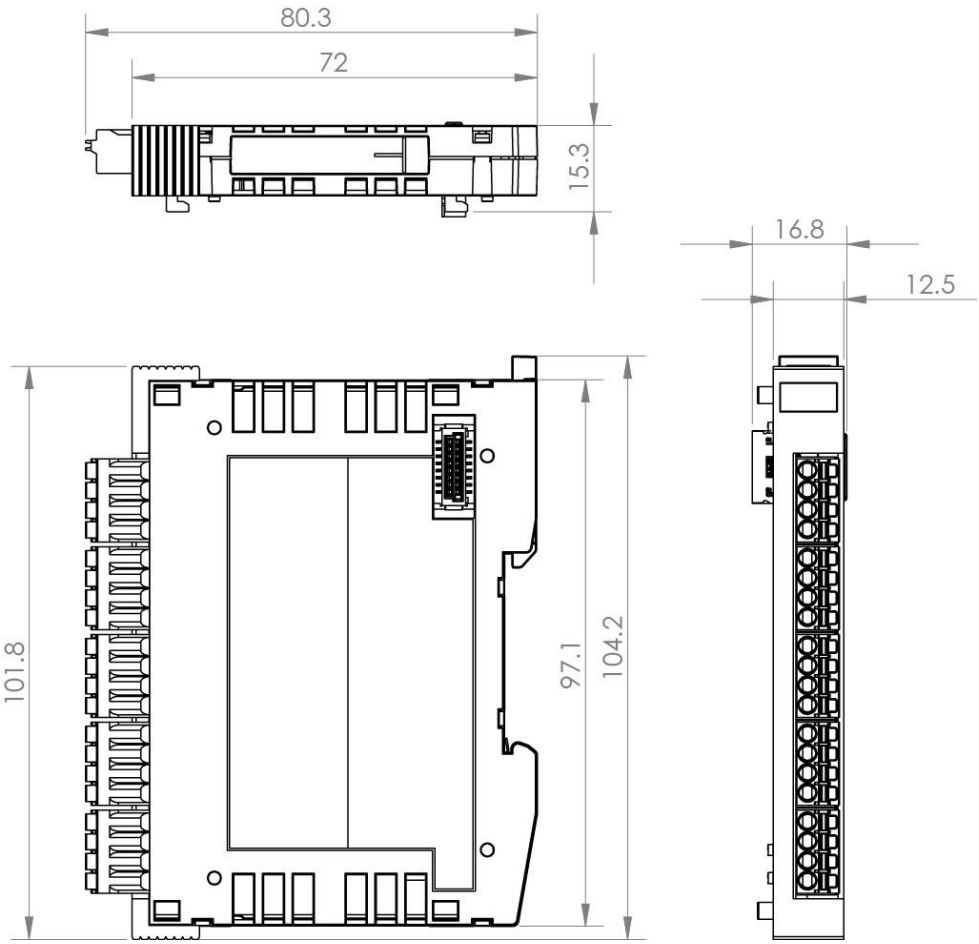
5.7 Miscellaneous

Article number	20-009-040
Standard	UL 508 (E247993)
Approbations	UL, cUL, CE, UKCA

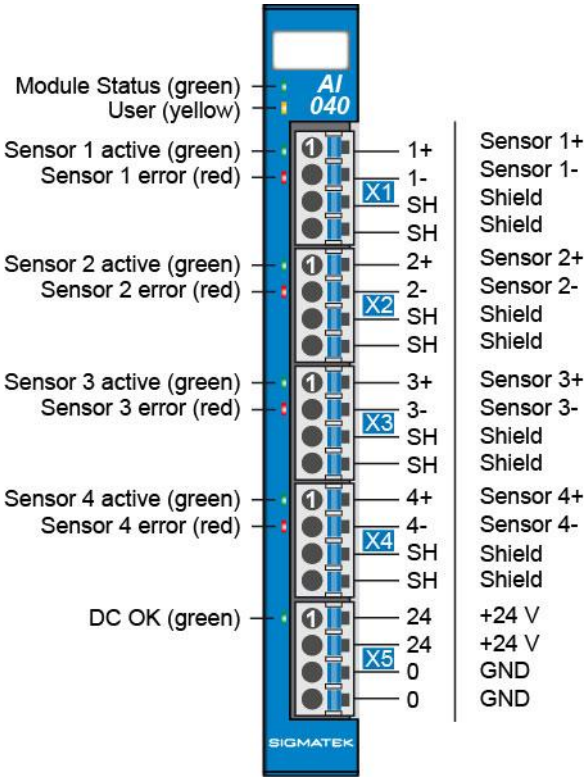
5.8 Environmental Conditions

Storage temperature	-20 ... +85 °C	
Environmental temperature	0 ... +60 °C	
Humidity	0-95 %, non-condensing	
Installation altitude above sea level	0-2000 m without derating > 2000 m up to a maximum of 5000 m with derating of the maximum environmental temperature by 0.5 °C per 100 m	
Operating conditions	Pollution degree 2	
EMC resistance	in accordance with EN 61000-6-2 (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

6 Mechanical Dimensions



7 Connector Layout



INFORMATION

The connections of the +24 V supply (X5: pin 1 and pin 2) or the GND supply (X5: pin 3 and pin 4) are internally bridged. To supply the module, only one connection to a +24 V pin (pin 1 or pin 2) and a GND pin (pin 3 or pin 4) is required. The bridged connections may be used for further looping of the +24 V supply and the GND supply. However, it must be taken into account that a total current of 6 A per connection is not exceeded by the forward looping!

7.1 Status LEDs

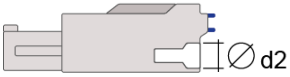
Module Status	green	ON	module active
		OFF	no supply available
		BLINKING (5 Hz)	no communication
User	yellow	ON	can be set from the application (e.g. the module LED can be set to blinking through the visualization so that the module is easily found in the control cabinet)
		OFF	
		BLINKING (2 Hz)	
		BLINKING (4 Hz)	
Sensor 1	green	ON	active, sensor energized
	red	ON	error, cable break
		BLINKING (1 Hz)	error short circuit
Sensor 2	green	ON	active, sensor energized
	red	ON	error, cable break
		BLINKING (1 Hz)	error short circuit
Sensor 3	green	ON	active, sensor energized
	red	ON	error, cable break
		BLINKING (1 Hz)	error short circuit
Sensor 4	green	ON	active, sensor energized
	red	ON	error, cable break
		BLINKING (1 Hz)	error short circuit
DC OK	green	ON	module is supplied with a voltage > 18 V

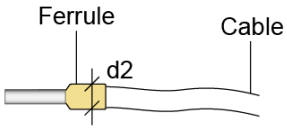
7.2 Applicable Connectors

Connectors:
X1-X5: Connectors with spring terminals (included in delivery)
The spring terminals are suitable connecting ultrasonically compacted (ultrasonically welded) strands.

Connections:

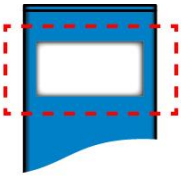
Stripping length/Sleeve length:	10 mm
Mating direction:	parallel to the lead axis or circuit board
Conductor cross section, rigid:	0.2-1.5 mm^2
Conductor cross section, flexible:	0.2-1.5 mm^2
Conductor cross section, ultrasonically compacted:	0.2-1.5 mm^2
Conductor cross section AWG/kcmil:	24-16
Conductor cross section flexible, with ferrule without plastic sleeve:	0.25-1.5 mm^2
Conductor cross section flexible with ferrule with plastic sleeve:	0.25-0.75 mm^2 (reason for reduction d2 of the ferrule)





d2 = max. 2.8 mm

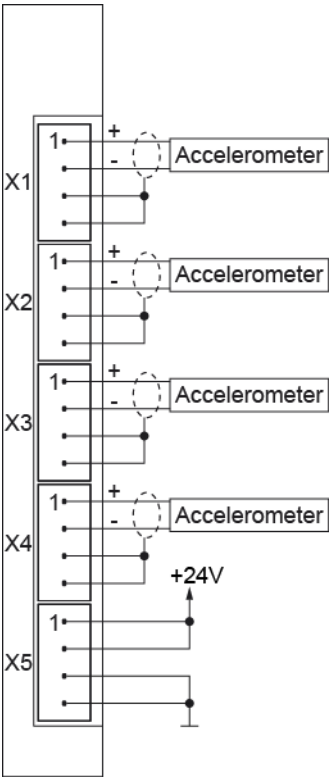
7.3 Label Field



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

8 Wiring

8.1 Wiring Example



8.2 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:

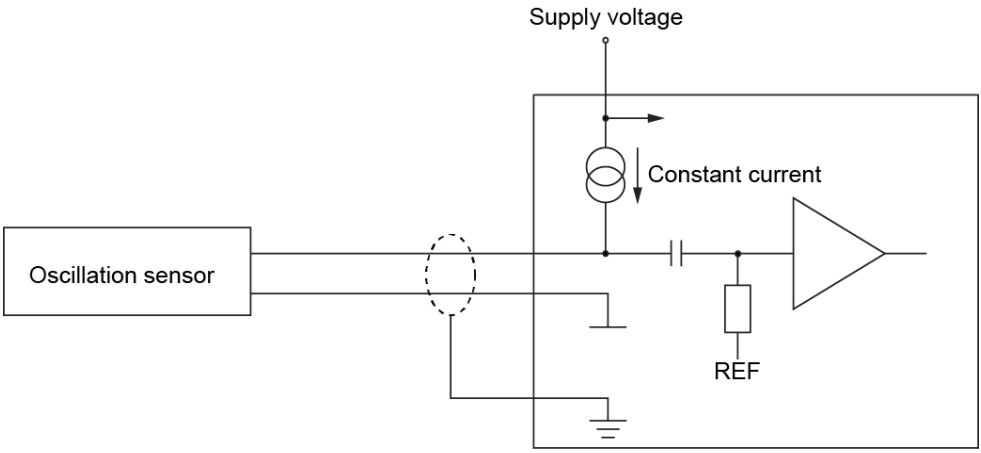
- The DIN rail must have an adequate mass connection.
- The lines connected to the source of the analog signals must be as short as possible and parallel wiring to digital signal lines must be avoided.
- The signal lines must be shielded.
- The shielding must be connected to a shielding bus.
- Avoid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

INFORMATION

Connect the ground bus to the control cabinet.

The S-DIAS module CANNOT be connected/disconnected while voltage is applied!

8.3 Schematic Diagram



9 Assembly/Installation

9.1 Check Contents of Delivery

Ensure that the contents of the delivery are complete and intact. See chapter Contents of Delivery.

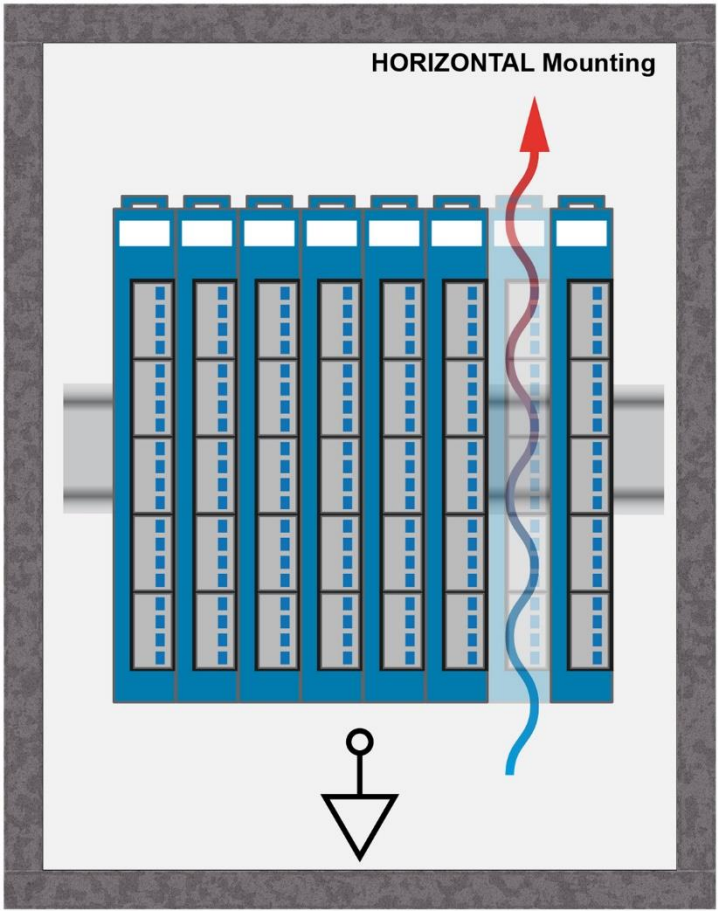
INFORMATION

On receipt and before initial use, check the device for damage. If the device is damaged, contact our customer service and do not install the device in your system.

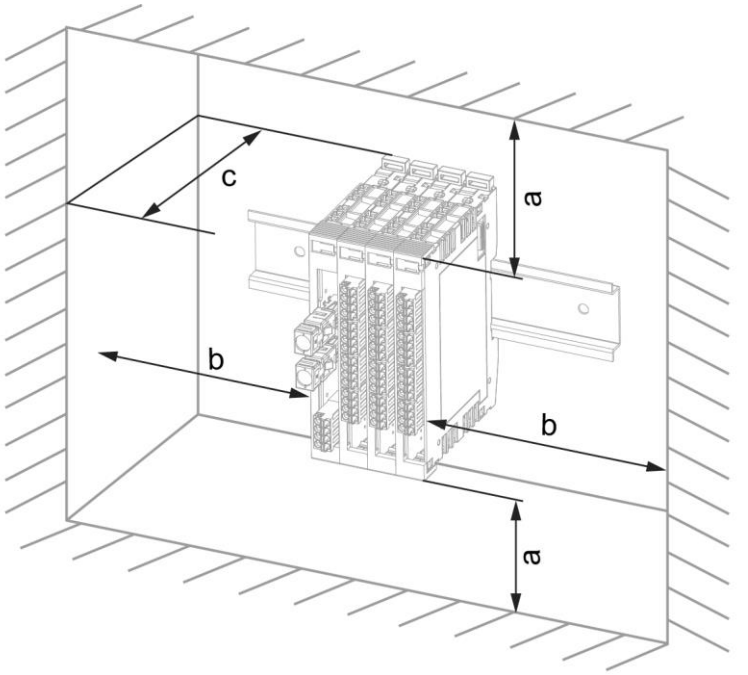
Damaged components can disrupt or damage the system.

9.2 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 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 operating 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)

10 Addressing

10.1 Address Mapping Overview

Address (hex)	Size (bytes)	Device ID (thex)	Description	Software Access
Control				
0000	265	0138	SPI Master	yes
0140	32	0E07	S-DIAS Sync Generator	yes
0180	32	0907	S-DIAS configuration register	yes
Memory				
0000	523	3 m	Register data FiFo	yes
0240	40	0A42	Calibration	yes

10.2 Detailed Address Mapping

Address (hex)	Size (bytes)	Access Type	Description	Reset value
PDO Read				
0000	128	r16	FiFo data channel 1	0000
0080	128	r16	FiFo data channel 2	0000
0100	128	r16	FiFo data channel 3	0000
0180	128	r16	FiFo data channel 4	0000
0200	1	r/w	Buffer Status Register (buffer is set to full when the current write buffer is full) Bit 0 Channel 1 buffer full Bit 1 Channel 2 buffer full Bit 2 Channel 3 buffer full Bit 3 Channel 4 buffer full (buffer is set to empty when the current read buffer is empty) Bit 4 Channel 1 buffer empty Bit 5 Channel 2 buffer empty Bit 6 Channel 3 buffer empty Bit 7 Channel 4 buffer empty	00

0201	1	r/w	DC OK Register Bit 0 DC 5 V ok Bit 1 DC 24 V ok Bit 2 DC 5 V not ok latched Bit 3 DC 24 V not ok latched Bit 4-7 Reserved	00
0202	2	r	Hardware status register channel Bit 0 Channel 1 short circuit Bit 1 Channel 2 cable break Bit 2 Channel 2 short circuit Bit 3 Channel 2 cable break Bit 4 Channel 3 short circuit Bit 5 Channel 3 cable break Bit 6 Channel 4 short circuit Bit 7 Channel 4 cable break Bit 8 Channel 1 short circuit latched Bit 9 Channel 2 cable break latched Bit 10 Channel 2 short circuit latched Bit 11 Channel 2 cable break latched Bit 12 Channel 3 short circuit latched Bit 13 Channel 3 cable break latched Bit 14 Channel 4 short circuit latched Bit 15 Channel 4 cable break latched	0000
SDO				
0204	1	r/w	Control register Bit 0 Channel 1 enable (1 = enable) Bit 1 Channel 2 enable (1 = enable) Bit 2 Channel 3 enable (1 = enable) Bit 3 Channel 4 enable (1 = enable) Bit 4-7 Reserved	00
0205	1	r/w	Status register Bit 0 Channel 1 start (1 = start) Bit 1 Channel 2 start (1 = start) Bit 2 Channel 3 start (1 = start) Bit 3 Channel 4 start (1 = start) Bit 4 Channel 1 synchronous start (1 = start) Bit 5 Channel 2 synchronous start (1 = start) Bit 6 Channel 3 synchronous start (1 = start) Bit 7 Channel 4 synchronous start (1 = start)	00
0206	1	r/w	Conversion time [µs] The shortest conversion time is defined with 5 µs	05
0207	1	r/w	Hardware control register channel 1 Bit 0-2 Current amplifier Bit 3 Reserved Bit 4-5 Constant current source Bit 6-7 Reserved	00

0208	1	r/w	Hardware control register channel 2 Bit 0-2 Current amplifier Bit 3 Reserved Bit 4-5 Constant current source Bit 6-7 Reserved	00
0209	1	r/w	Hardware control register channel 3 Bit 0-2 Current amplifier Bit 3 Reserved Bit 4-5 Constant current source Bit 6-7 Reserved	00
020A	1	r/w	Hardware control register channel 4 Bit 0-2 Current amplifier Bit 3 Reserved Bit 4-5 Constant current source Bit 6-7 Reserved	00
020B	55	r/w	Reserved	00
Calibration				
0240	2	r16/w16	Channel 1 calibrated data (16-bit signed)	0000
0242	2	r16/w16	Channel 2 calibrated data (16-bit signed)	0000
0244	2	r16/w16	Channel 3 calibrated data (16-bit signed)	0000
0246	2	r16/w16	Channel 4 calibrated data (16-bit signed)	0000
0248	2	r16/w16	Channel 1 binary data (16-bit signed)	0000
024A	2	r16/w16	Channel 2 binary data (16-bit signed)	0000
024C	2	r16/w16	Channel 3 binary data (16-bit signed)	0000
024E	2	r16/w16	Channel 4 binary data (16-bit signed)	0000
0250	2	r16/w16	Channel 1 offset	0000
0252	2	r16/w16	Channel 2 offset	0000
0254	2	r16/w16	Channel 3 offset	0000
0256	2	r16/w16	Channel 4 offset	0000
0258	2	r16/w16	Channel 1 multiplicand	0000
025A	2	r16/w16	Channel 2 multiplicand	0000
025C	2	r16/w16	Channel 3 multiplicand	0000
025E	2	r16/w16	Channel 4 multiplicand	0000
0260	2	r16/w16	Channel 1 divisor	0000
0262	2	r16/w16	Channel 2 divisor	0000
0264	2	r16/w16	Channel 3 divisor	0000
0266	2	r16/w16	Channel 4 divisor	0000

11 Supported Cycle Times

11.1 Cycle Times below 1 ms (in µs)

50	100	125	200	250	500
x	x	x	x	x	x

x= supported

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

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

x= supported

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

x= supported

12 Transport/Storage

INFORMATION

This device contains sensitive electronics. During transport and storage, high mechanical stress must therefore be avoided.

For storage and transport, the same values for humidity and vibration as for operation must be maintained!

Temperature and humidity fluctuations may occur during transport. Ensure that no moisture condenses in or on the device, by allowing the device to acclimate to the room temperature while turned off.

When sent, the device should be transported in the original packaging if possible. Otherwise, packaging should be selected that sufficiently protects the product from external mechanical influences. Such as cardboard filled with air cushioning.

13 Storage

INFORMATION

When not in use, store the operating panel according to the storage conditions. See chapter 12.

During storage, ensure that all protective covers (if available) are placed correctly, so that no contamination, foreign bodies or fluids enter the device.

14 Maintenance

INFORMATION

During maintenance as well as servicing, observe the safety instructions from chapter 2 Basic Safety Directives.

14.1 Service

This product was constructed for low-maintenance operation.

14.2 Repair

INFORMATION

In the event of a defect/repair, send the device with a detailed error description to the address listed at the beginning of this document.

For transport conditions, see chapter 12 Transport/Storage.

15 Disposal

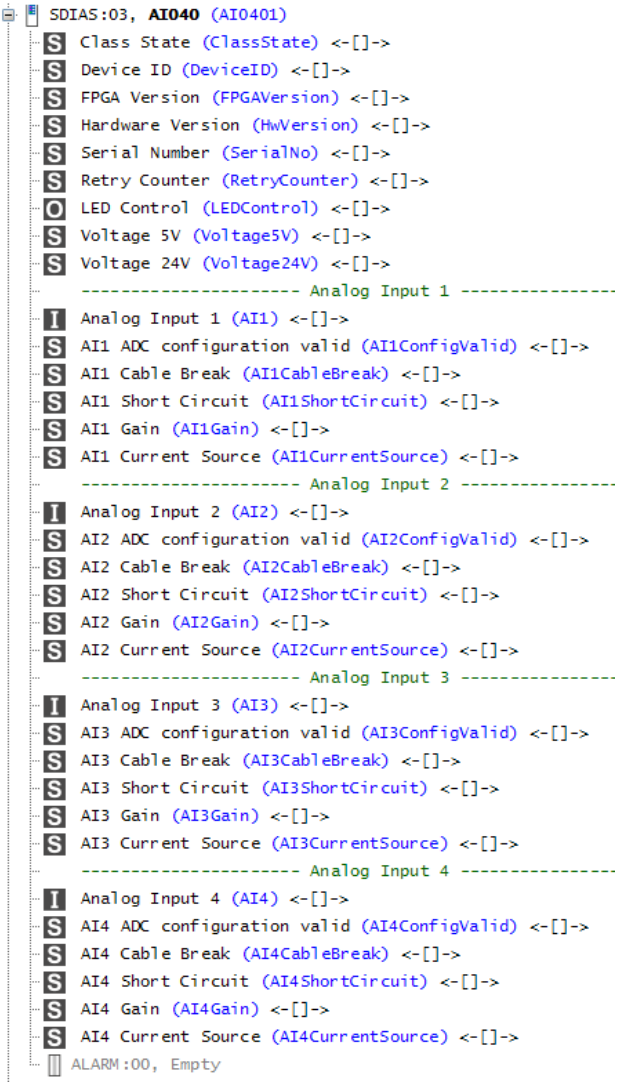
INFORMATION

Should you need to dispose of the device, the national regulations for disposal must be followed.

The device appliance must not be disposed of as household waste.

16 Hardware Class AI040

Hardware Class AI040 for the S-DIAS AI040 analog module



This hardware class is used to control the AI 040 hardware module. The module has four analog inputs and four 1024-byte Fifo buffers. The measurement value of each analog input is written into the corresponding Fifo buffer. To evaluate the Fifo buffer, the AI 040 band pass filter hardware class can be used. More information on the hardware can be found in the module documentation. When this hardware class is used, the FPU (Floating Point Unit) for the CPU in the project must be activated!

16.1 General

ClassState	State	This server shows the actual status of the hardware class.
DeviceID	State	The device ID of the hardware module is shown in this server.
FPGAVersion	State	FPGA version of the module in 16#XY (e.g. 16#10 = version 1.0).
HardwareVersion	State	Hardware version of the module in format 16#XXYY (e.g. 16#0120 = Version 1.20).
SerialNumber	State	The serial number of the hardware module is shown in this server.
RetryCounter	State	This server increments when a transfer fails.
LEDControl	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 statuses are possible: 0 LED off 1 LED on 2 blinks slowly 3 blinks rapidly
Required	Property	This client is active by default, which means that the S-DIAS hardware module at this position is mandatory for the system and can under no circumstances be disconnected or return an error. Otherwise, the entire hardware deactivated. If the hardware module is missing or removed, an S-DIAS error is triggered. If his client is initialized with 0, the hardware module located in this position is not mandatory. This means that it can be inserted or removed at any time. However, which components identified as "not required" should be selected with regard to the safety of the system.
ValuesPerCylce	Property	Used to create the values that should be sent per cycle and analog input. Set as initial value! The shortest conversion time for the ADC defined with 5 µs. This results in a maximum of 200 values, which can sent in one millisecond when only one analog input is activated. 0 Default setting, the maximum number of values is entered automatically.
Voltage5V	State	Shows whether the 5 V supply is OK. 0 not OK 1 OK
Voltage24V	State	Shows whether the 24 V supply is OK. 0 not OK 1 OK

16.2 Analog Inputs [1-4]

AnalogInput	Input	Analog input. Here, the first value from the Fifo buffer is displayed. The value displayed is dependent on State Gain and the properties MaxValue and MinValue. An open or shorted input returns -2147483632 in the hardware class.
ConfigValid	State	Shows whether the configuration of analog input 1-4 is valid. 1 Configuration is valid 0 Configuration currently being written -1 Configuration is invalid
CableBreak	State	Shows whether a cable has broken in analog input 1-4. 1 Cable break at input 0 OK
ShortCircuit	State	Shows whether a short circuit has occurred in input 1-4. 1 Short circuit at input 0 OK
Gain	State	Amplification setting. Possible values: 0 amplification of 1 1 amplification of 2 2 amplification of 4 4 amplification of 8 6 amplification of 16 7 amplification of 32
CurrentSource	State	Constant current source setting. Possible values: 0 0 mA 1 4 mA 2 8 mA 3 12 mA
ChannelActive	Property	For activating the analog input. Set as an initial value! 0 analog input is deactivated 1 analog input is activated
MaximumValue	Property	To set the upper scale range as an initial value! The largest settable value is 327675000. The value entered must be higher than MinValue. Otherwise, both the Max and MinValue properties are set to +/-16#FFFF/2.
MinimumValue	Property	To set the lower scale range as an initial value! The smallest settable value is -327675000. Generated from (2-byte value (65535)*Multiplier(10000))/2 The value entered must be lower than MaxValue. Otherwise, both the Max and MinValue properties are set to +/-16#FFFF/2.

16.2.1 Communication Interfaces

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

16.3 Global Methods

The following methods can be called via the ClassState server.

16.3.1 GetData

Transfer parameters	Type	Description
usChannelNr	USINT	Indicates analog input, from which the data should be read.
uiDataLength	UINT	Indicates the required data length in bytes. Per value, 2 bytes are required.
pBufferData	^INT	Pointer to the data to copy from the Fifo buffer.
Return parameters	**Type**	**Description**
dRetCode	DINT	0 Data were copied -1 selected analog input is inactive -2 selected analog input is not available -3 Data length is invalid -4 Data of the analog input are invalid

This function is used to copy data from the Fifo buffer.

16.3.2 GetSettings

This function is used to read the module settings.

Transfer parameters	Type	Description
usChannelNr	USINT	Indicates the analog input, from which the multiplier and divisor must be used.
pSampleRate	^LREAL	Pointer to which the scan rate of the analog input is written.
pMaxValuesCycle	^UINT	Pointer to which the number of measurement values per cycle is written.
pChannelsActive	^USINT	Pointer to which the number of active analog inputs is written.
pBusCycleTime	^UDINT	Pointer to which the bus cycle time in ns is written.
pMultiplier	^DINT	Pointer to which the multiplier for the channel selected with usChannelNr is written.
pDivisor	^DINT	Pointer to which the divisor for the channel selected with usChannelNr is written.
pOffset	^DINT	Pointer to which the offset for the channel selected with usChannelNr is written.
Return parameters	**Type**	**Description**
dRetCode	DINT	1 data are valid -2 selected analog input is not available

16.4 Internal Properties

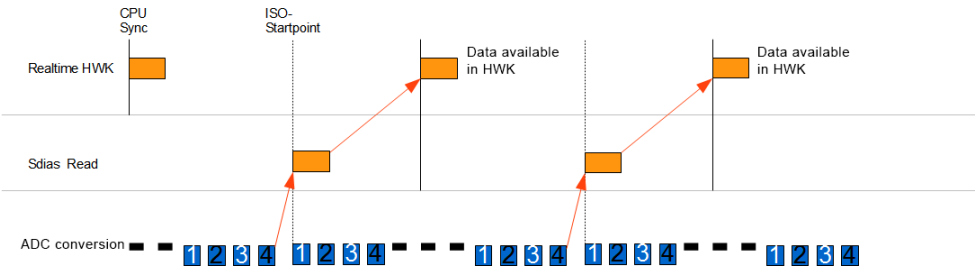
The shortest conversion time of the ADC is 5 microseconds. In one millisecond, a maximum of 200 values can be thereby converted. If all 4 analog inputs are active, then 50 measurement values per channel per cycle are processed.

If less values are used, the conversion time is adjusted. An example: 25 values should be measured per cycle with 4 active inputs. With a bus cycle time of 1 ms, this results in a conversion time of 10 µs.

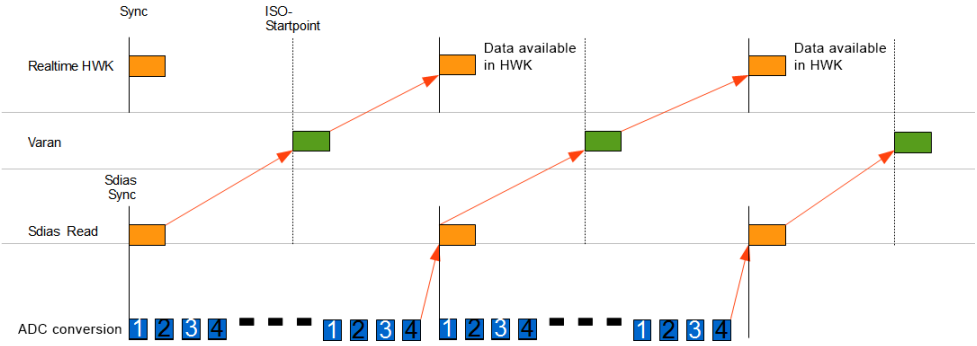
Measurement values per cycle = bus cycle time / (conversion time*active analog inputs)

The Fifo buffer is always read after the sync. The maximum buffer size is 1024 bytes. Theoretically, 512 measurement values can be stored in one cycle.

16.4.1 Timing on the local S-DIAS

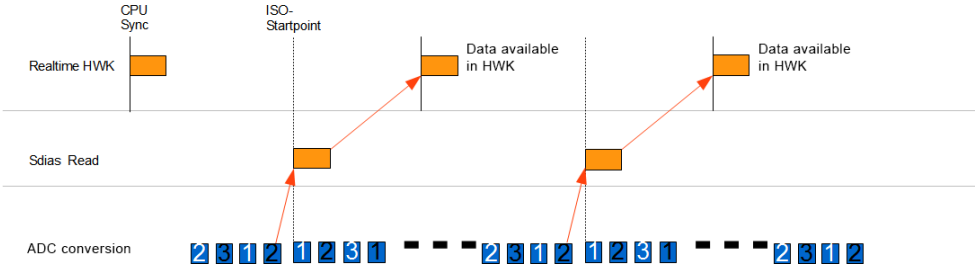


16.4.2 Timing behind VI 021



16.4.3 Special case: 3 analog inputs activated

With a cycle time of 1 ms, 66.67 measurement values are generated per cycle. In this case, a warning is triggered and the timing changes.



In this case, the last value in the buffer is discarded.

17 Hardware Class AI040BandpassFilter

AI040BandpassFilter Hardware Class for the AI 040 module

This hardware class is used for calculating the band pass filter in the measurement values from the FIFO buffer of the AI 040 module. The real-time task of the object is thereby automatically set to the bus cycle time.

17.1 Interfaces

17.1.1 Clients

toAI040	This client must be connected to the AI040 object.
toTaskObjectControl	This client is automatically connected to the OS interface.
ChannelNr	With this client, the desired analog input is selected. as initialization value
LowCutOffFrequ	The lower cutoff frequency is set in 1/10 Hz with this client. as initialization value
UppCutOffFrequ	The upper cutoff frequency is set in 1/10 Hz with this client. as initialization value
Gain	This client is used to set 1/10 amplification.as initialization value
FilterIterations	Specifies the number filter cycles.as initialization value
PreRTWorkTrigger	The write method of this client is called at the beginning of the RtWork of the class.
PostRTWorkTrigger	The write method of this client is called at the end of the RtWork of the class.

17.1.2 Servers

ClassState	This server shows the actual status of the hardware class.
ResonanceFrequ	This server shows the resonance frequency in 1/10 Hz.
qFactor	This server shows the quality factor in 1/1000.
Maximum	This server shows the current maximum of the filtered values.
Minimum	This server shows the current minimum of the filtered values.
Average	This server shows the current average value of the filtered values.
MaxTimeStamp	This server shows the time of the current maximum in µs.
MinTimeStamp	This server shows the time point of current minimum in µs.
FilterValuesPerCycle	With this server, the number of measurement values calculated per cycle is set. This setting is only possible when there are no active measuring. No more measurement values can be filtered than those provided from the AI 040 class. In the event an error, an error code is displayed in the server. -1 measuring is active -2 the number of values entered is invalid
StartMeasure	With this server, the filter calculation is started via the write() method. In the event an error, an error code is displayed in the server. -1 the set analog input is inactive -2 the set analog input is not available -4 the data from the analog input are invalid

17.2 Global Methods

The following methods can be called via the ClassState server.

17.2.1 GetValues

This function is used to retrieve the filtered and unfiltered values.

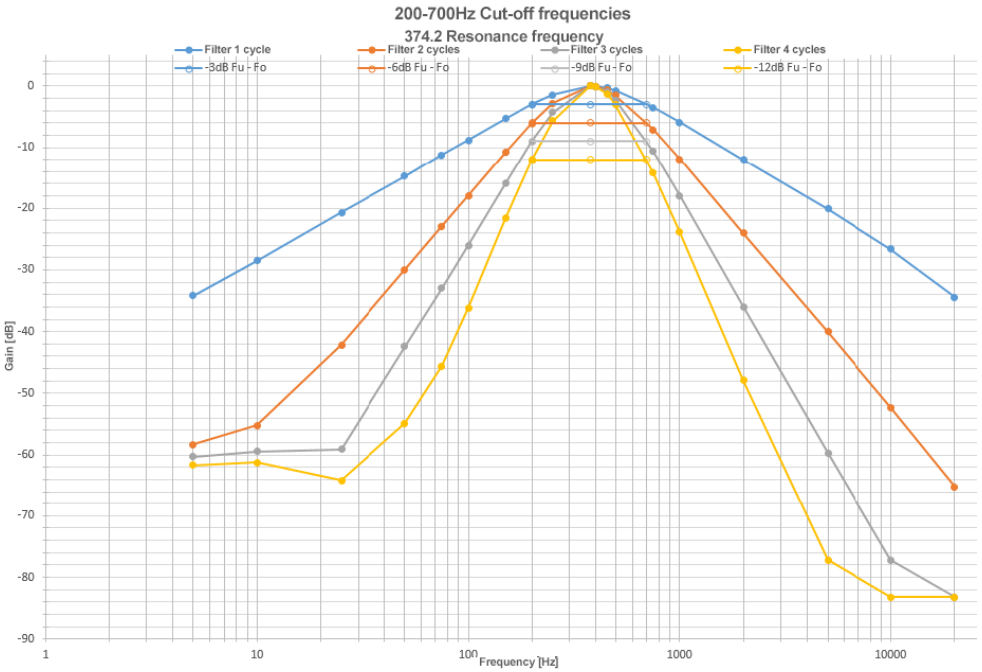
Transfer parameters	Type	Description
pRawValues	^INT	Pointer to the unfiltered value to copy. Only used when a valid pointer is entered. An unfiltered value consists of 2 bytes.
pFilterValues	^DINT	Pointer to the filtered values to copy. Only used when a valid pointer is entered. A filtered value consists of 4 bytes.
NrValues	UDINT	Indicates the number of required values.
Return parameters	**Type**	**Description**
dRetCode	DINT	1 filter currently active 0 data are valid -1 number of values required is invalid

17.3 Internal Properties

With the number of filter cycles, the desired damping outside of the band pass can be specified.

If the filter is run one time, a damping of -3 dB is generated in the upper and lower frequency limit. This corresponds to the 2nd order bandpass filter. With each cycle, the damping increases by -3 dB at the upper and lower frequency limit.

In the example below, a Bode diagram is shown in which the various filter settings and frequencies are recorded.



With the multiple filter cycles, the real-time also increases. In the diagram below, the real-time load was recorded in µs with 50, 100 and 200 measurement values and 1-4 filter cycles. The CP 111 was used as the CPU.

Filter values	1 cycle	2 cycles	3 cycles	4 cycles
200	114	157	226	257 µs
100	65	84	124	139 µs
50	43	52	72	80 µs

Documentation Changes

Change date	Affected page(s)	Chapter	Note
30.01.2015	12	4.2 note	Note regarding connecting/disconnecting the S-DIAS module under voltage.
26.03.2015	11	3.2 Applicable Connectors	Connections expanded
30.03.2015	3	1.1 IEPE Interface Specifications	Measurement range, adjustable amplification, measurement values, conversion time per channel, data recording per channel and input filter hardware added.
	5	1.3 Software Band Pass Filter Specifications	Time offset between channels deleted
	14	4.3 Schematic diagram	software cycle time deleted Schematic diagram added
19.01.2016	8	1.7 Miscellaneous	Norms changed
22.01.2016	8	1.6 Electrical Requirements	New page, graphic added
28.04.2016	18	5 Mounting	Graphics distances
27.03.2017	4	1.1 IEPE Interface Specifications	Added value for cable break and short circuit detection.
17.08.2017	9	1.8 Environmental Conditions	Added operating conditions
	13	3.2 Applicable Connectors	Added sleeve length Added info regarding ultrasonically welded strands
18.10.2017	14	3.3 Label Field	Added chapter
	19	5 Mounting	Graphic replaced
28.05.2018	4	1.1 IEPE Interface Specifications	Note for settling procedure added
20.09.2018		3 Connector Layout	Note added
14.11.2019		7 Supported Cycle Times	Chapter added
28.02.2020	23	7 Supported Cycle Times	Text adapted
08.09.2020	25	8 Hardware Class AI040	Chapter added
	32	9 Hardware Class AI040BandpassFilter	Chapter added
04.11.05	19	5 Mounting	Expansion functional ground connection

06.12.2022	9	1.7 Miscellaneous	UKCA conformity
26.07.2023		Document	General chapters added, design