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Function Description

SSI

APCIe-1711, CPCIs-1711, APCI-1710 and CPCI-1710
Multifunction counter board, optically isolated

DIN EN ISO 9001:2015 certified

Edition: 02.09-04/2022

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Warning!

The following risks result from the improper implementation of the board and from use contrary to the regulations:

Personal injury

Damage to the board, the PC and peripherals

Pollution of the environment.

- Protect yourself, others and the environment!
- Read the safety precautions (yellow leaflet) carefully!

  If this leaflet is not enclosed with the documentation, please contact us and ask for it.
- Observe the instructions of this manual!

  Make sure that you do not forget or skip any step!
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- Pay attention to the following symbols:

NOTICE!
Designates hints and other useful information.

NOTICE!
Designates a possibly dangerous situation.
If the instructions are ignored, the board, the PC and/or peripherals may be **destroyed**.

WARNING!
Designates a possibly dangerous situation.
If the instructions are ignored, the board, the PC and/or peripherals may be **destroyed** and persons may be **endangered**.

Contents

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Tables

Chapter overview

In this manual, you will find the following information:

Chapter	Content
1	Function description including block diagram and pin assignment
2	Standard software: Information on the API software functions
3	Appendix with index
4	Contact and support address

This document solely describes the function “SSI”.

For general information on the **APCIe-/CPCIs-1711** or **APCI-/CPCI-1710**, please read the respective Technical Description of these boards (see PDF links). It contains, for example, the chapter “Inserting and installing the board” that supports you in commissioning.

1 Function description

The “SSI” function is a synchronous serial interface for absolute SSI sensors. The serial data transfer allows you to get information about the absolute position.

Features:

- 4 function modules per board, up to 3 SSI sensors per function module
- Optical isolation of the inputs and outputs through opto-couplers to prevent ground loops
- Serial data transfer
- Common clock for all three sensor interfaces of one function module
- Clock frequency and number of data bits are software-selectable
- Gray-binary conversion possible
- For each function module, 3 digital inputs and 1 digital output for an additional function are available (without impact on the SSI function).

1.1 Board versions with “SSI” function

NOTICE!
The “SSI” function cannot be used with the 24 V version of the **APCIe-1711, CPCIs-1711** or **APCI-1710**.

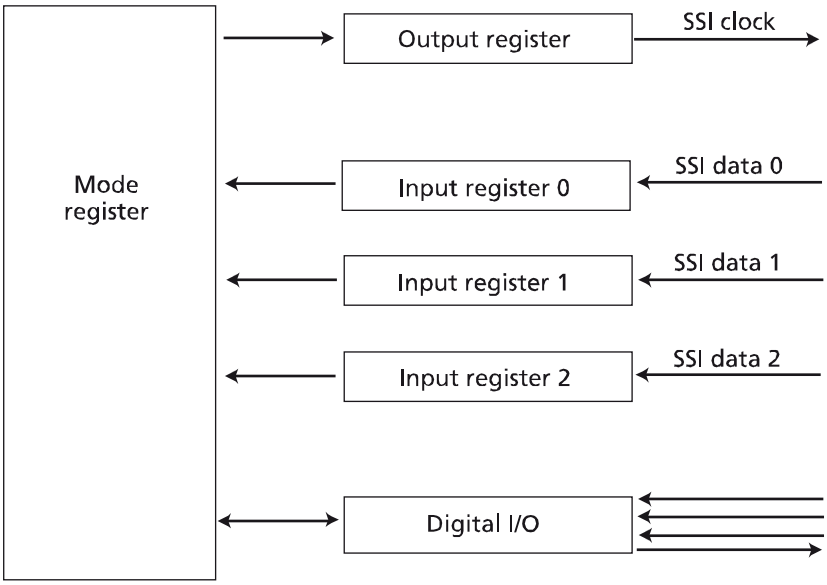
Table 1-1: Board versions with “SSI” function

Board version	“SSI” function
APCIe-1711	x
APCIe-1711-24V	-
APCIe-1711-5V-I	x
CPCIs-1711	x
CPCIs-1711-24V	-
CPCIs-1711-5V-I	x
APCI-1710	x
APCI-1710-24V	-
APCI-1710-5V-I	x
APCI-1710-5V-I-O	x
CPCI-1710	x

The I/O specifications of the different board versions are available in the Technical Description of the **APCIe-/CPCIs-1711** or **APCI-/CPCI-1710** (see PDF links).

1.2 Block diagram

Fig. 1-1: Block diagram: SSI function



1.3 Used signals

A maximum of twelve SSI sensors can be operated on the board, i.e. a maximum of three sensors per function module.

NOTICE!
Operating three SSI sensors on one clock line of the board is only possible with RS422 input drivers of the SSI sensors.
Input drivers of the SSI sensors with too low impedance may overload the outputs of the board so that potentially, no more than two SSI sensors can be connected to one function module.

With each function module, the SSI function uses six inputs (B to G) and two outputs (A and H).

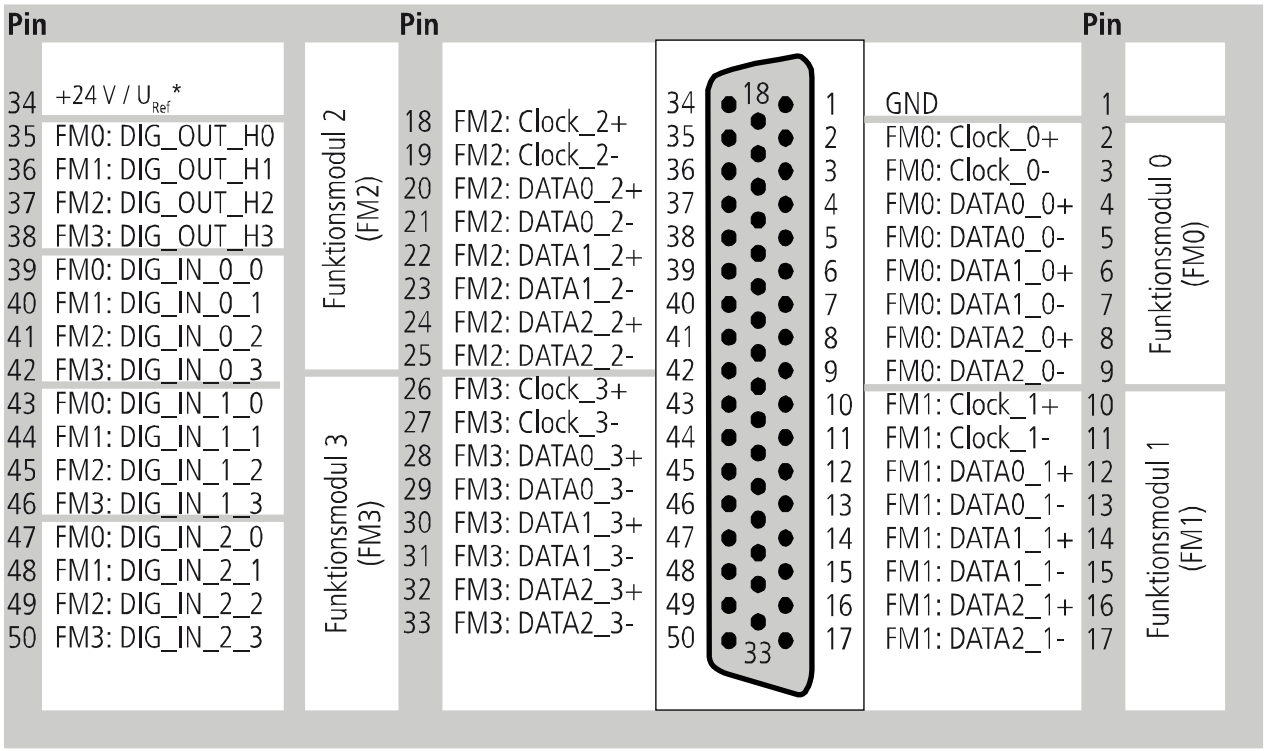
Table 1-2: Used signals

Signal name	Pin name	Signal type	Function
Clock_x+/-	Ax+/-	RS422/TTL output	Clock output for the SSI sensors
DATA0_x+/-	Bx+/-	RS422/TTL input	Data input of SSI sensor 0
DATA1_x+/-	Cx+/-	RS422/TTL input	Data input of SSI sensor 1
DATA2_x+/-	Dx+/-	RS422/TTL input	Data input of SSI sensor 2
DIG_IN_0_x	Ex	24 V input/optional 5 V	Digital input 0
DIG_IN_1_x	Fx	24 V input/optional 5 V	Digital input 1
DIG_IN_2_x	Gx	24 V input/optional 5 V	Digital input 2
DIG_OUT_Hx	Hx	24 V output/optional 5 V	Digital output

x = Number of the function module (0-3)

1.4 Pin assignment: Function modules

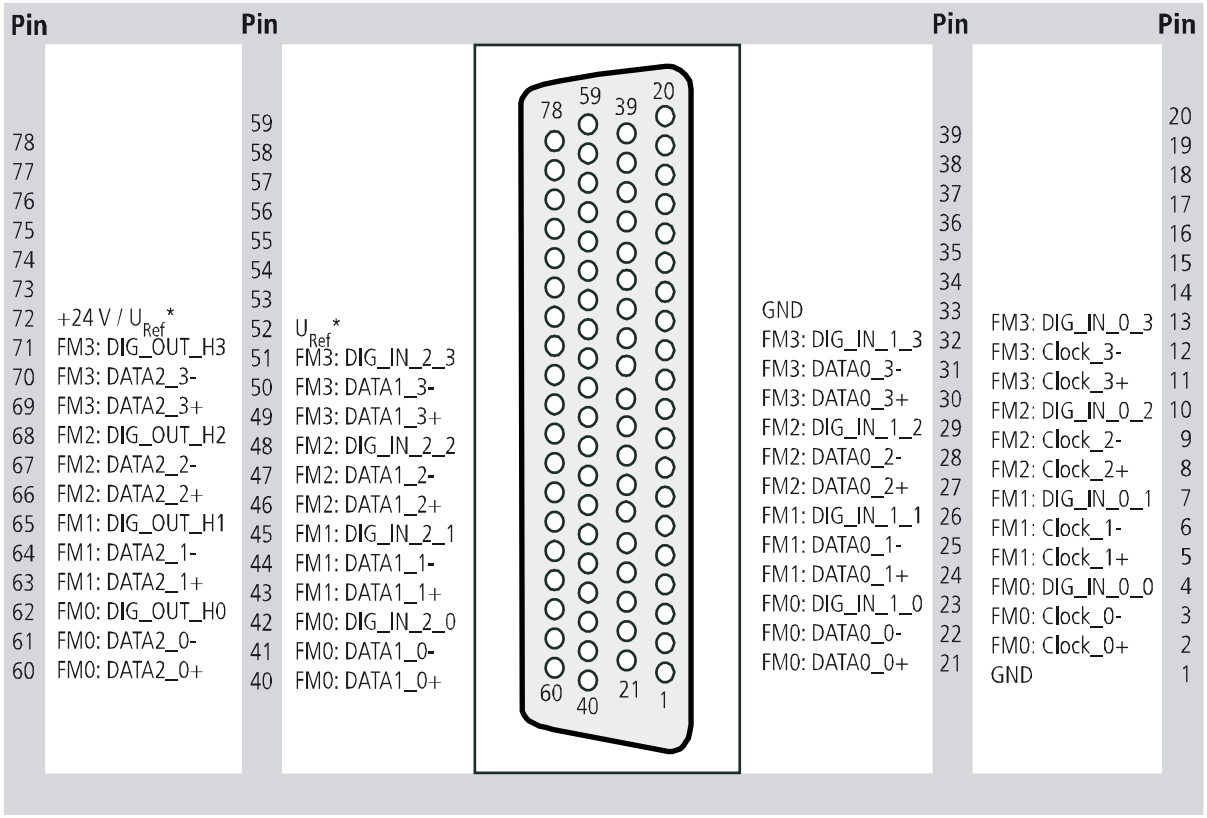
Fig. 1-2: Pin assignment: 50-pin D-Sub male connector (4 SSI modules)



* Pin 34: see Technical Description of the board

This pin assignment also applies to the **APCIe-1711** or **CPCIs-1711** if the cable **ST1711-50** is connected to the 78-pin D-Sub female connector of the board. For further information on this, please refer to the Technical Description of the **APCIe-1711** and **CPCIs-1711** (see PDF link).

Fig. 1-3: Pin assignment: 78-pin D-Sub female connector (APCIe-1711 and CPCIs-1711)



FM = Function module
* Pins 52 and 72: see Technical Description of the board

1.5 Connecting the sensors

1.5.1 Connection to the screw terminal panel

On the screw terminal panel **PX8001**, the pins of the 50 pin D-Sub female connector and the terminals connected to them are numbered in the same way. Thus, the terminal assignment of the screw terminal panel is identical with the pin assignment of the 50-pin D-Sub male connector of the **APCI-/CPCI-1710** or with that of the 50-pin D-Sub male connector on the **ST1711-50** cable **(APCIe-/CPCIs-1711)**.

The following table is to serve as a help for you when connecting the sensors to the screw terminal panel. The blank fields in the “Sensor” column can be filled in on the basis of the selected sensor type.

Table 1-1: Connection of the sensors to the screw terminal panel

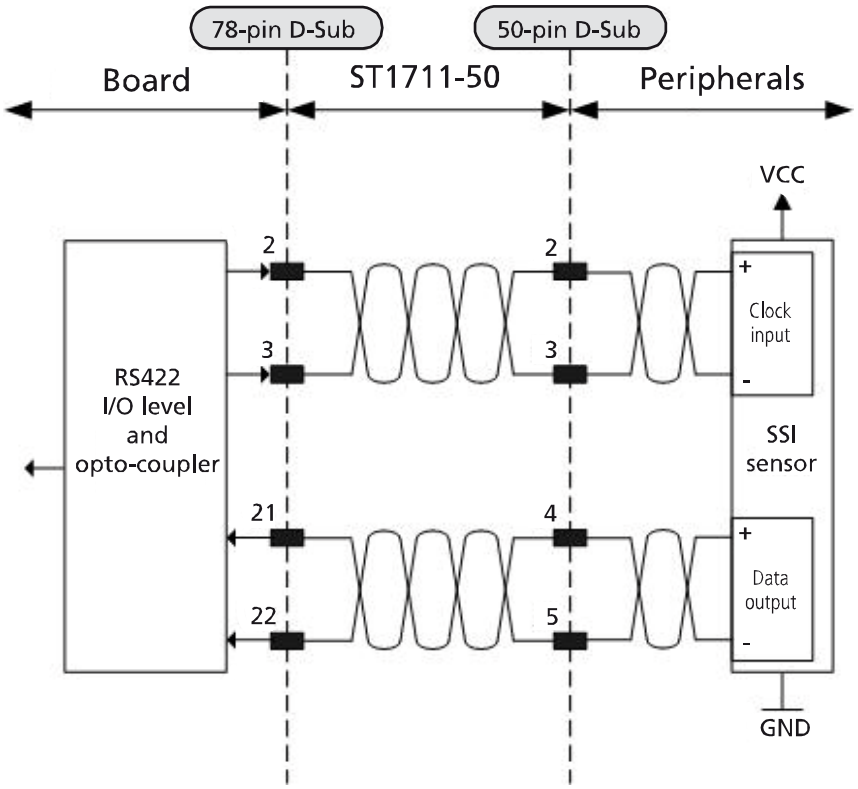
Sensor			Screw terminal panel PX8001 (50-pin)							
Pin No.	Pin name	Lead colour (cable)	Signal name	Terminal name	Signal type	Terminal No.				Terminal function
						FM0	FM1	FM2	FM3	
	+24 V / U_{Ref}		+24 V / U_{Ref}	+24 V / U_{Ref}	-	34	34	34	34	see Technical Description of the board
	GND		GND	GND	-	1	1	1	1	Ground
			Clock_x+	Ax+	RS422/TTL	2	10	18	26	Clock output for the SSI sensors
			Clock_x-	Ax-	RS422/TTL	3	11	19	27	
			DATA0_x+	Bx+	RS422/TTL	4	12	20	28	Data input of SSI sensor 0
			DATA0_x-	Bx-	RS422/TTL	5	13	21	29	
			DATA1_x+	Cx+	RS422/TTL	6	14	22	30	Data input of SSI sensor 1
			DATA1_x-	Cx-	RS422/TTL	7	15	23	31	
			DATA2_x+	Dx+	RS422/TTL	8	16	24	32	Data input of SSI sensor 2
			DATA2_x-	Dx-	RS422/TTL	9	17	25	33	
			DIG_IN_0_x	Ex	24 V / opt. 5 V	39	40	41	42	Digital input 0
			DIG_IN_1_x	Fx	24 V / opt. 5 V	43	44	45	46	Digital input 1
			DIG_IN_2_x	Gx	24 V / opt. 5 V	47	48	49	50	Digital input 2
			DIG_OUT_Hx	Hx	24 V / opt. 5 V	35	36	37	38	Digital output
			-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-

x = Number of the function module (0-3)

1.5.2 Connection example

One SSI sensor is connected to the function module 0 of the board.

Fig. 1-4: Connection example



1.6 Functioning principle

An internal parallel/serial converter (shift register) converts the parallel absolute information in the SSI sensor into serial information. This information is transferred in synchronisation with the clock emitted by the board.

The synchronous transfer of the data word is started and controlled by a clock signal.
The length of the clock sequence is defined through an internal register in the board so that the length of the data word to be transferred can be changed as required in the range from 2 to 48 bits.

The clock frequency determines the rate of the data transfer. This frequency is also defined through an internal register.

1.6.1 Transfer protocol

In standby or rest state of the SSI sensor, the signal of the clock line (Clock +) and that of the data line (Data +) correspond to the level “logic 1”.
The SSI function starts the data transfer when the clock signal switches from “logic 1” to “logic 0”. This change causes a retriggerable monoflop to be set in the SSI sensor. The parallel data of the SSI sensor is saved in a serial shift register.
With the following change when the clock signal switches from “logic 0” to “logic 1”, the most significant bit from the serial shift register is set to the data output of the SSI sensor. Every further positive edge sets the following bit (ranging down to the least significant bit) to the output.

The monoflop time (e.g. 20 µs, see data sheet from the sensor manufacturer) determines the minimum interval between two transfers and the minimum clock frequency. If the interval time is shorter than the monoflop time, the same value is always read out from the sensor.

1.6.2 Transfer rate and transmission line

An SSI transmission line basically consists of SSI sensor, transfer cable and board.
Usually, the signals are delayed (propagation time) in these units. As a consequence of this, the data reaches the receiver side of the board in synchronisation with the emitted clock, but with a delay according to this propagation time.
The propagation time varies with the length of the transmission line. Therefore, the rate of the clock signal (clock frequency) needs to be adjusted to the transmission line.

1.7 Clock frequency

The clock frequency, whose maximum value is 5 MHz, can be selected through software.

NOTICE!
Please note that with the **APCI-1710** and **CPCI-1710**, the maximum input or output frequency is limited to 2.5 MHz.

When selecting the clock frequency, the maximum frequency of the sensor, the type of transmission line and the number of sensors per clock line have to be considered. For standard use, clock frequencies of up to a maximum of 1.5 MHz are reasonable.

Due to the reference clock of the board, the clock frequency can be output only in specific steps (period duration steps of 50 ns). If the frequency selected through software cannot be implemented, the next higher frequency is automatically output.

Table 1-3: Possible clock frequencies (examples)

Period duration (ns)	Clock frequency (kHz)
200	5000
250	4000
300	3333,333
350	2857,143
400	2500
450	2222,222
500	2000
2000	500
2050	487,805
2100	476,190
10000	100
10050	99,502
10100	99,010

The number of clock pulses to be output is set through software.
For a 25-bit sensor, for example, 25 clock pulses are preset. To trigger the sensor, the board always generates one more clock pulse, i.e. in this example a total of 26 clock pulses.

1.8 Transfer example

1.8.1 SSI sensor with 18 bits (fir tree format)

In this example, an SSI sensor with 1024 steps/revolution (10 bits in the single-turn part) and 256 revolutions (8 bits in the multi-turn part) is used.

By default, the transfer protocol is configured for a data word of 25 bits, i.e. 13 bits for the resolution (steps/revolution) and 12 bits for the revolutions.
As the transfer always starts with the multi-turn bit 12, but in this example, the multi-turn part is configured for 8 bits only, 4 vacancies with “logic 0” are transferred at first and after that the used 8 bits from the multi-turn part. Then the bits from the single-turn part follow, starting from S10 to S1. The 3 bits that are not used are also transferred with “logic 0” here.

Fig. 1-5: Data transfer according to the fir tree format

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		
4096	12	M12	M11	M10	M9	M8	M7	M6	M5	M4	M3	M2	M1	S13	S12	S11	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1	8192	13
2048	11	0	M11	M10	M9	M8	M7	M6	M5	M4	M3	M2	M1	S12	S11	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1	0	4096	12
1024	10	0	0	M10	M9	M8	M7	M6	M5	M4	M3	M2	M1	S11	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1	0	0	2048	110
512	9	0	0	0	M9	M8	M7	M6	M5	M4	M3	M2	M1	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1	0	0	0	1024	10
256	8	0	0	0	0	M8	M7	M6	M5	M4	M3	M2	M1	S9	S8	S7	S6	S5	S4	S3	S2	S1	0	0	0	0	512	9
128	7	0	0	0	0	0	M7	M6	M5	M4	M3	M2	M1	S8	S7	S6	S5	S4	S3	S2	S1	0	0	0	0	0	256	8
64	6	0	0	0	0	0	0	M6	M5	M4	M3	M2	M1	S7	S6	S5	S4	S3	S2	S1	0	0	0	0	0	0	128	7
32	5	0	0	0	0	0	0	0	M5	M4	M3	M2	M1	S6	S5	S4	S3	S2	S1	0	0	0	0	0	0	0	64	6
16	4	0	0	0	0	0	0	0	0	M4	M3	M2	M1	S5	S4	S3	S2	S1	0	0	0	0	0	0	0	0	32	5
8	3	0	0	0	0	0	0	0	0	0	M3	M2	M1	S4	S3	S2	S1	0	0	0	0	0	0	0	0	0	16	4
4	2	0	0	0	0	0	0	0	0	0	0	M2	M1	S3	S2	S1	0	0	0	0	0	0	0	0	0	0	8	3
2	1	0	0	0	0	0	0	0	0	0	0	0	M1	S2	S1	0	0	0	0	0	0	0	0	0	0	0	4	2
		Multi-turn bit												Single-turn bit														

Number of revolutions / Bits/ revolution / Steps/ revolution / Bits/ revolution

1.9 Reading data

The data from the SSI sensors can be read in two ways.
As there is only one clock line for up to three sensors available in each function module, the initialisation has to be carried out only once. The data format must be identical for all three sensors.

1.9.1 Option 1: Fir tree format

a) Reading data with one software function

The sensor is initialised with the following software function:

Software function
i_PCIe1711_InitSSI (…)

The total number of bits, the number of single-turn bits, the number of multi-turn bits, the clock frequency and the counting mode (binary or gray) are passed.

With the following function, the data from one sensor is read:

Software function
i_PCIe1711_Read1SSIValue (…)

The data from up to three sensors is read with this function:

Software function
i_PCIe1711_ReadAllSSIValue (…)

b) Reading data with several software functions

The function “i_APCI1710_Read1SSIValue” from paragraph a) is split here.

The sensor is initialised with the following software function:

Software function
i_PCIe1711_InitSSI (…)

The total number of bits, the number of single-turn bits, the number of multi-turn bits, the clock frequency and the counting mode (binary or gray) are passed.

To start the data transfer, the following function is used:

Software function
i_PCIe1711_StartSSIAcquisition (…)

The status of the data transfer can be read with this function:

Software function
i_PCIe1711_GetSSIAcquisitionStatus (…)

After that, the data from one sensor is read with the following function:

Software function
i_PCIe1711_GetSSIValue (…)

1.9.2 Option 2: Reading the raw data

This option allows SSI sensors to be read out with a different format than the original fir tree format. The read data is not formatted and corresponds to the raw data from the sensor. The single-turn part, the multi-turn part and potentially other sensor-typical information (e.g. parity bit) have to be evaluated by the user.

The sensor is initialised with the following software function:

Software function
i_PCIe1711_InitSSIRawData (…)

The total number of bits and the clock frequency are passed.
With the following function, the raw data from one sensor is read:

Software function
i_PCIe1711_Read1SSIRawDataValue (…)

The raw data from up to three sensors is read with this function:

Software function
i_PCIe1711_ReadAllSSIRawDataValue (…)

2 Standard software

The API software functions supported by the board are listed in an HTML document. A description of how to access the respective file can be found in the document “Quick installation PC boards” (see PDF link), in the chapter “Standard software”.

3 Appendix

3.1 Index

4 Contact and support

Do you have any questions? Write or call us:

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