

ASTD Series

Digital pressure sensors

FEATURES

- Pressure ranges from 1 mbar to 10 bar
- Single 3 V or 5 V supply
- Max. output current 1 mA
- Digital SPI or I²C output
- Total pressure accuracy down to max. 0.5 %FS
- 15 bit A/D resolution
- Outstanding offset stability
- Small footprint, low profile
- Pressure ports for direct manifold assembly

**SERVICE**

Wetted Materials:

Pressure port P1: silicon, RTV, ceramics Al2O3, Pyrex, LCP plastics

Pressure port P2: silicon, RTV, ceramics Al2O3, Pyrex, epoxy, FR4

SPECIFICATIONS**Maximum Ratings**

Supply voltage

ASTD 5V	4.75...5.25 V _S
ASTD 3V	2.70...3.30 V _S

Output Current	max. 1 mA
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Common Mode Pressure	25 bar
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Lead Specifications

Average preheating temp. gradient	2.5 K/s
Soak time	approx. 3 min
Time above 217 °C	50 s
Time above 230 °C	40 s
Time above 250 °C	15 s
Peak temperature	260 °C
Cooling temp. gradient	-3.5 K/s

Temperature ranges

Storage	-40...125 °C
Operating	-25...85 °C
Compensated	0...70 °C



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PRESSURE SENSOR CHARACTERISTICS

Part Number	Operating Pressure	Over Pressure ¹	Burst Pressure ²
ASTD-M001	1 mbar	100 mbar	150 mbar
ASTD-MF02	2.5 mbar	100 mbar	150 mbar
ASTD-M005	5 mbar	150 mbar	200 mbar
ASTD-M010	10 mbar	150 mbar	200 mbar
ASTD-M020	20 mbar	200 mbar	300 mbar
ASTD-M050	50 mbar	500 mbar	750 mbar
ASTD-M100	100 mbar	1 bar	1.5 bar
ASTD-M350	350 mbar	1 bar	1.7 bar
ASTD-B001	1 bar	3 bar	5 bar
ASTD-B002	2 bar	6 bar	10 bar
ASTD-B005	5 bar	15 bar	25 bar
ASTD-B007	7 bar	21 bar	25 bar
ASTD-B010	10 bar	25 bar	25 bar

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■ PERFORMANCE CHARACTERISTICS

TA=25 °C

Parameter		Min.	Typ.	Max.	Unit
Accuracy (@ 25 °C) ⁴	Up to 5 mbar		±2.0	±4.0	
	10 to 100 mbar		±0.5	±1.0	%FSS
	All others		±0.1	±0.3	
Total accuracy (0...70 °C) ⁵	Up to 5 mbar		±2.5	±5.0	
	10 to 100 mbar		±0.75	±1.25	%FSS
	All others		±0.25	±0.5	
Non-linearity (BFSL) ⁶			±0.1	±0.3	%FSS
Repeatability ⁷	Up to 5 mbar		±0.1		
	10 to 100 mbar		±0.05		%FSS
	All others		±0.01		
Position sensitivity	1 mbar		±0.25		
	All others		±0.05		%FSS
Long term drift (one year)	Up to 5 mbar		±0.5		
	10 to 100 mbar		±0.1		%FSS
	All others		±0.05		
Response time @15 bit			2.2		ms
A/D resolution			15		Bit
D/A resolution			11		
Load resistance		2		∞	kΩ
Current consumption			4.0	6.5	mA

Specification notes:

- Over pressure is the maximum pressure which may be applied without causing damage to the sensing element.
- Burst pressure is the maximum pressure which may be applied without causing leakage damage to the sensing element.
- Full Scale Span (FSS) is the algebraic difference between the output signal for the highest and lowest specified pressure
- Accuracy includes all effects (offset, span, non-linearity, pressure hysteresis and repeatability) at room temperature and represents maximum deviation of transducer signal from ideal characteristic.
- Total accuracy includes all effects (offset, span, non-linearity, pressure hysteresis and repeatability) included with all temperature effects of offset and span. It describes overall error and represents maximum deviation of transducer signal from ideal characteristic in compensated temperature range from 0...70 °C.
- Non-linearity is defined as the BFSL (best fit straight line) across entire pressure range.
- Repeatability is defined as typical deviation of the output signal after 10 pressure cycles.
- Analogue output signal is ratiometric to power supply V_S , digital signal is not ratiometric to the power supply.

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■ PERFORMANCE CHARACTERISTICS

3 V devices ($V_S = 3$ V, $T_A = 25$ °C)Analogue output⁸

Unidirectional pressure devices

Parameter		Min.	Typ.	Max.	Unit
Zero pressure offset			0.3		
Full scale span (FSS) ³			2.4		V
Full scale output (FSO)			2.7		

Bidirectional pressure devices

Parameter		Min.	Typ.	Max.	Unit
Zero pressure offset			1.5		
Full scale span (FSS) ³			2.4		V
Output	At min. specified pressure		0.3		
	At max. specified pressure		2.7		

Digital output (15 bit)

Unidirectional pressure devices

Parameter		Min.	Typ.	Max.	Unit
Zero pressure offset		3277			
Full scale span (FSS) ³		26214			counts
Full scale output (FSO)		29491			

Bidirectional pressure devices

Parameter		Min.	Typ.	Max.	Unit
Zero pressure offset		16384			
Full scale span (FSS) ³		26214			counts
Output	At min. specified pressure	3277			
	At max. specified pressure	29491			

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Digital pressure sensors

■ PERFORMANCE CHARACTERISTICS

5 V devices ($V_S = 5$ V, $T_A = 25$ °C)Analogue output⁸

Unidirectional pressure devices

Parameter		Min.	Typ.	Max.	Unit
Zero pressure offset			0.5		
Full scale span (FSS) ³			4.0		V
Full scale output (FSO)			4.5		

Bidirectional pressure devices

Parameter		Min.	Typ.	Max.	Unit
Zero pressure offset			2.5		
Full scale span (FSS) ³			4.0		V
Output	At min. specified pressure		0.5		
	At max. specified pressure		4.5		

Digital output (15 bit)

Unidirectional pressure devices

Parameter		Min.	Typ.	Max.	Unit
Zero pressure offset		3277			
Full scale span (FSS) ³		26214			counts
Full scale output (FSO)		29491			

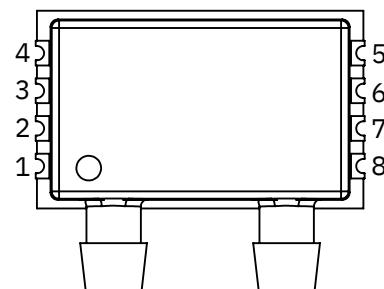
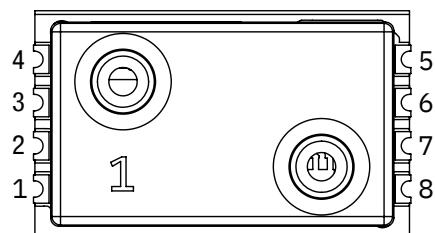
Bidirectional pressure devices

Parameter		Min.	Typ.	Max.	Unit
Zero pressure offset		16384			
Full scale span (FSS) ³		26214			counts
Output	At min. specified pressure	3277			
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■ ELECTRICAL CONNECTION



SPI bus

Pin	Name	Function
1	V _{OUT}	Analogue output
2	GND	Ground
3	MOSI	Data IN for SPI
4	CLK	SPI clock
5	SS	SPI slave select
6	MISO	Data OUT for SPI
7	NC*	Not connected
8	+V _S	Positive power supply

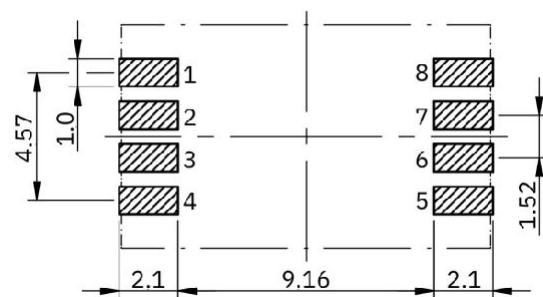
I2C bus

Pin	Name	Function
1	V _{OUT}	Analogue output
2	GND	Ground
3	SDA	Data I/O
4	SLK	I ² C clock
5	I/C	Internal connection
6	I/C	Internal connection
7	NC*	Not connected
8	+V _S	Positive power supply

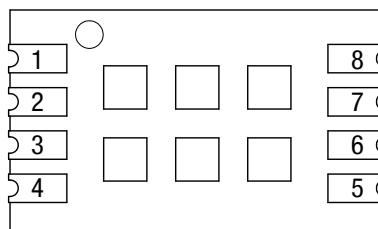
* For future developments of the ASTD sensor pin 7 might be used for SDA data I/O instead of pin 3. Please consider this for your PCB design.

■ SOLDERING FOOTPRINT AND BOTTOM VIEW

Recommended soldering footprint



Bottom View



Note:
Do not connect leadless grid array in centre area.

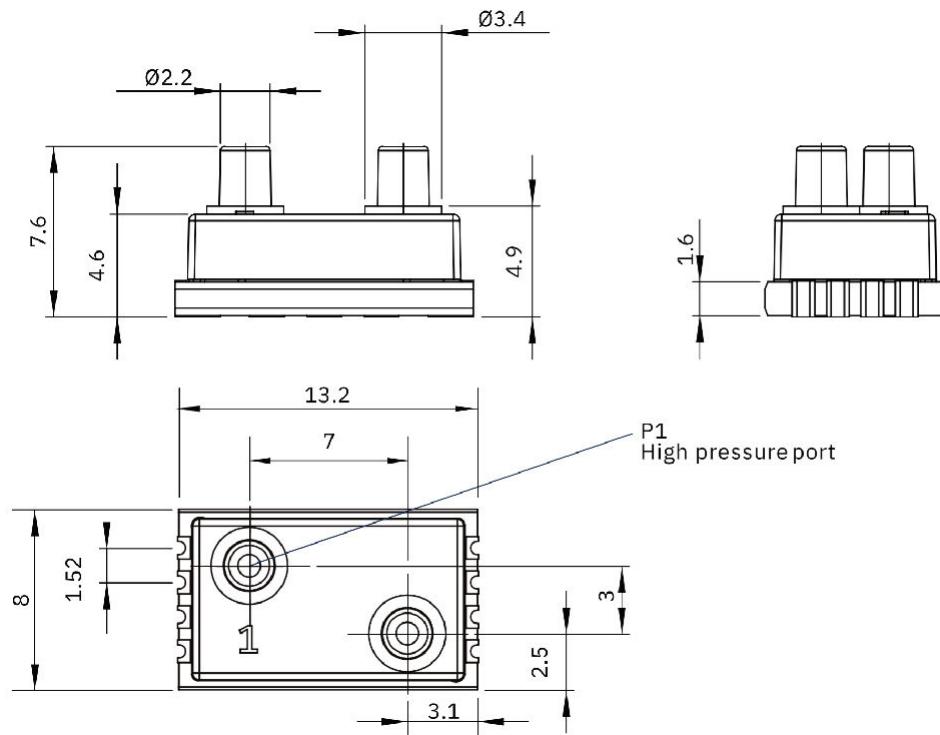
Dimension in mm

ASTD Series

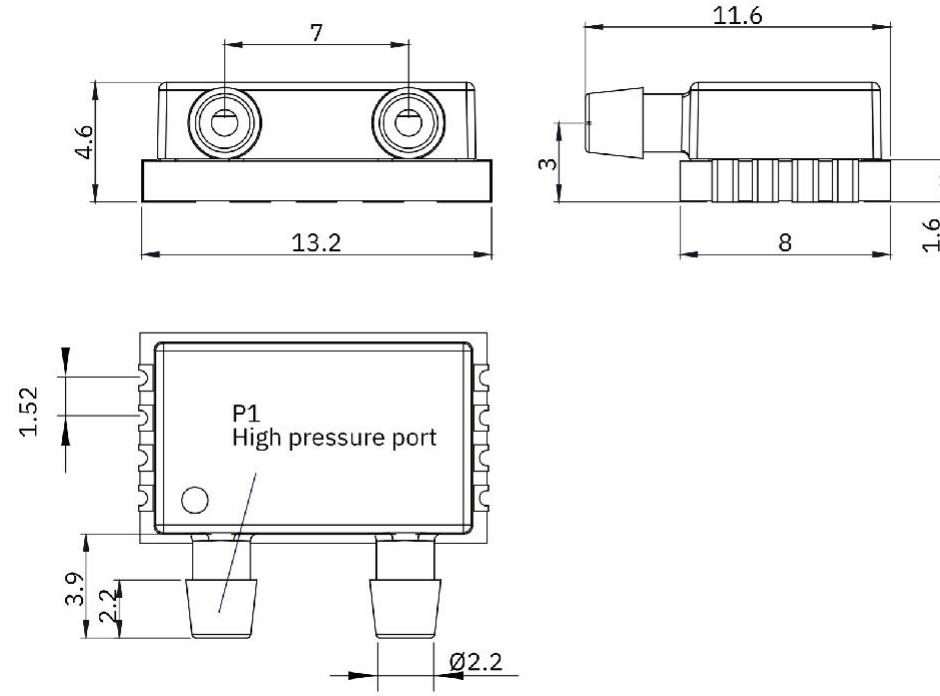
Digital pressure sensors

■ DIMENSIONAL DRAWINGS

A- axial (SMD, 2 straight vertical ports)



H- horizontal (SMD, 2 barbed horizontal ports)

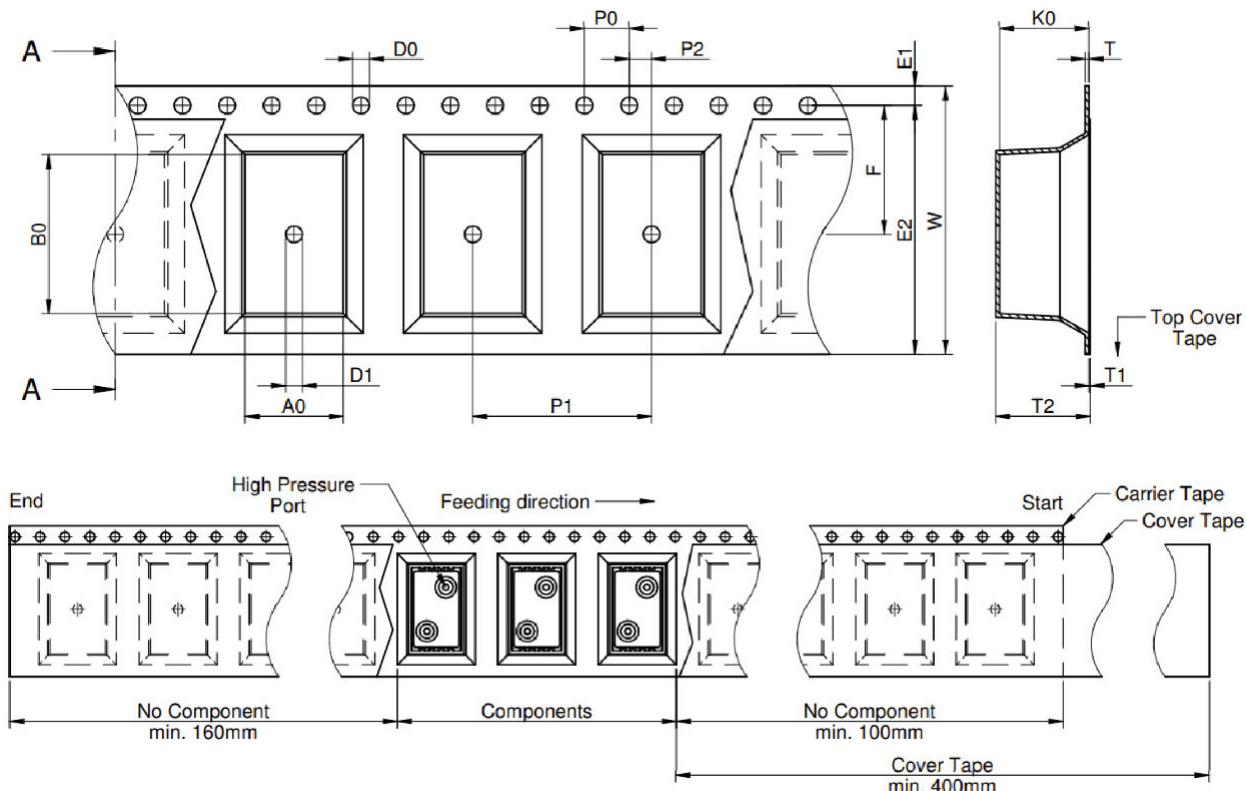


Dimension in mm

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■ PACKING SPECIFICATION - VERTICAL PRESSURE PORT



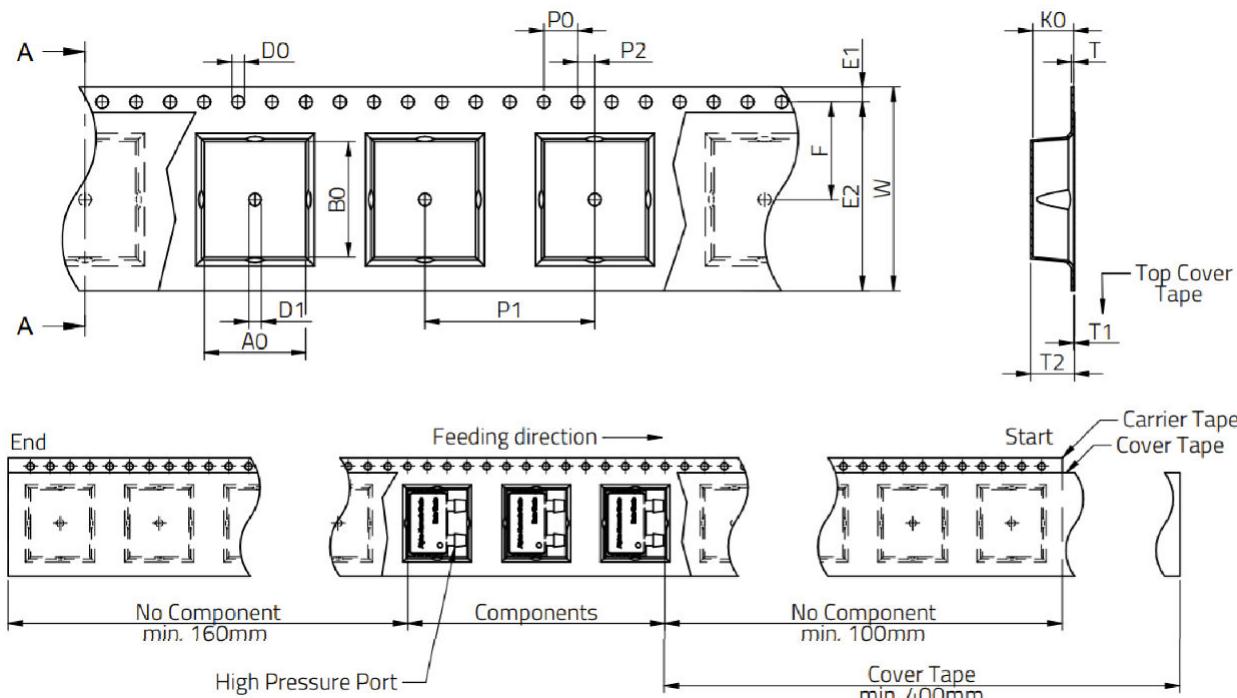
[mm]	A0	B0	W	T	T1	K0	P0
Value	8,8	14,2	24,0	0,35	0,10	8,22	8,0
Tolerance	typ.	typ.	+0,3/-0,1	ref.	ref.	typ.	±0,1

[mm]	P1	P2	D0	D1	E1	E2	F
Value	16,0	2,0	1,5	1,5	1,75	22,25	11,5
Tolerance	±0,1	±0,1	+0,1/-0,0	min.	±0,1	min.	±0,1

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■ PACKING SPECIFICATION - HORIZONTAL PRESSURE PORT



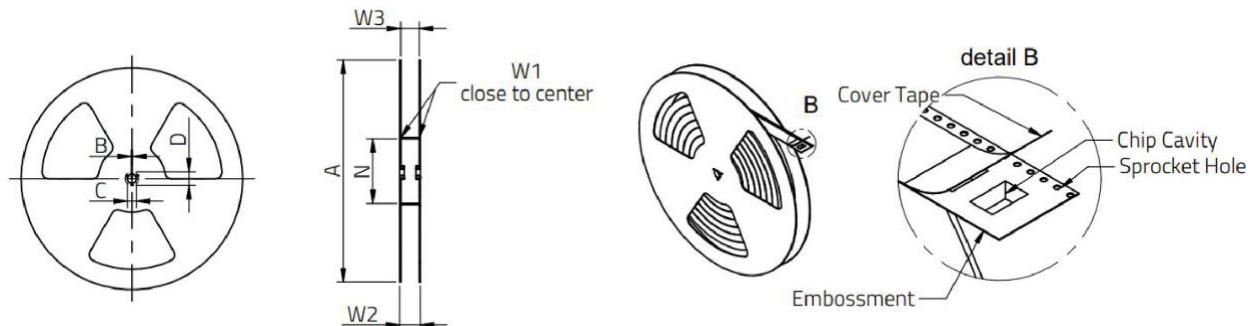
[mm]	A0	B0	W	T	T1	T2	K0	P0
Value	11,9	13,6	24,0	0,4	0,1	5,2	4,8	4,0
Tolerance	typ.	typ.	+0,3/-0,1	ref.	ref.	typ.	typ.	±0,1

[mm]	P1	P2	D0	D1	E1	E2	F
Value	20,0	2,0	1,5	1,5	1,75	22,25	11,5
Tolerance	±0,1	±0,1	+0,1/-0,0	min.	±0,1	min.	±0,1

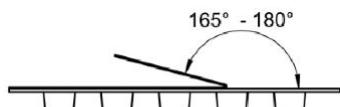
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■ PACKING SPECIFICATION - TAPE AND REEL PACKAGING

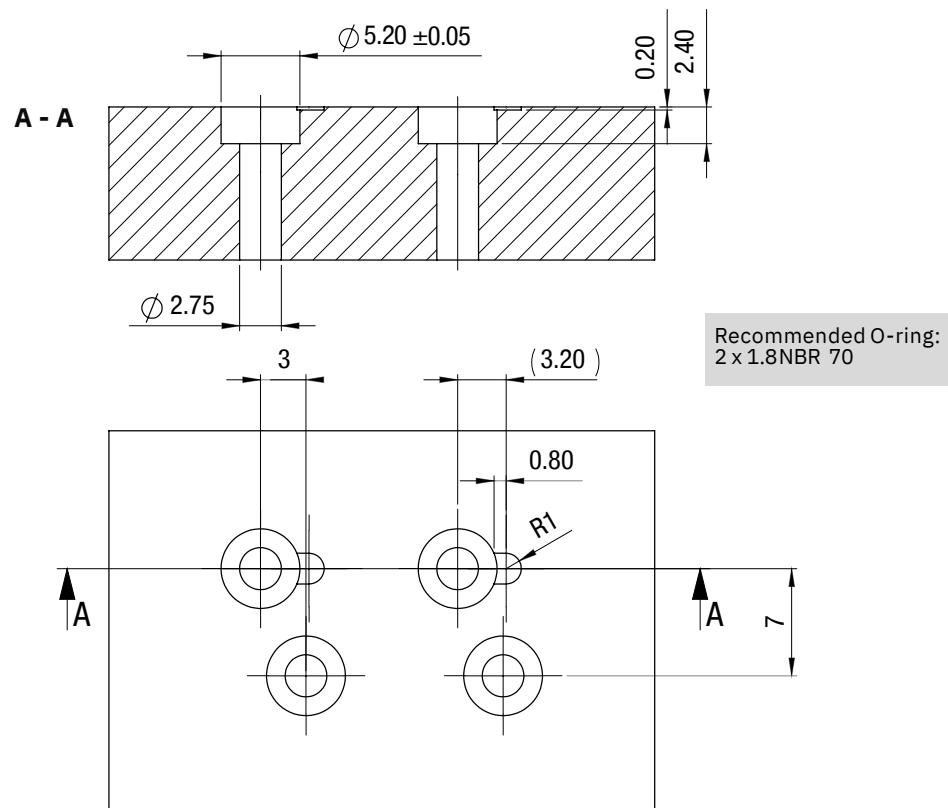


[mm]	A	B	C	D	N	W1	W2	W3	Quantity
Value	330,0	1,5	12,8	20,2	60,0	24,4	30,4	25,65	500
Tolerance	$\pm 2,0$	min.	min.	min.	min.	$+2,0$	max.	$\pm 1,75$	pcs/reel



Pull-off force: 0.1 - 1.3

■ MANIFOLD DIAGRAM



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■ I²C BUS**Introduction**

The sensor is capable to generate a digital output signal. The device runs a cyclic program, which will store a corrected pressure value with 12 bit resolution about every 250 µs (typ) within the output registers of the internal ASIC. In order to use the sensor for digital signal readout, it should be connected to a bidirectional I²C-bus.

According to the I²C-bus specification, the bus is controlled by a master device, which generates the clock signal, controls the bus access and generates START and STOP conditions. The sensor is designed to work as a slave, hence it will only respond to requests from a master device.

Digital I²C interface

The sensor complies with the following protocol (Fig. 4):

Bus not busy: During idle periods both data line (SDA) and clock line (SCL) remain HIGH.

START condition (S): HIGH to LOW transition of SDA line while clock (SCL) is HIGH is interpreted as START condition. START conditions are always generated by the master. Each initial request for a pressure value has to begin with a START condition.

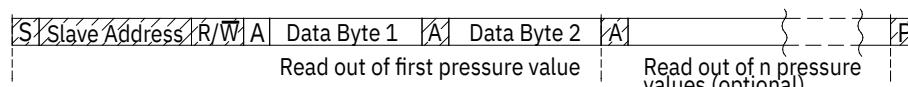
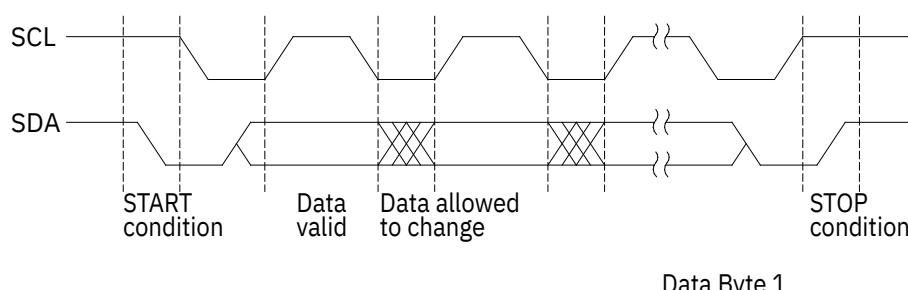
STOP condition (P): LOW to HIGH transition of SDA line while clock (SCL) is HIGH determines STOP condition. STOP conditions are always generated by the master. More than one request for the current pressure value can be transmitted without generation of intermediate STOP condition.

DATA valid (D): State of data line represents valid data when, after START condition, data line is stable for duration of HIGH period of clock signal. Data on line must be changed during LOW period of clock signal. There is one clock pulse per bit of data.

Acknowledge (A): Data is transferred in pieces of 8 bits (1 byte) on serial bus, MSB first. After each byte receiving device – whether master or slave – is obliged to pull data line LOW as acknowledge for reception of data. Master must generate an extra clock pulse for this purpose. When acknowledge is missed, slave transmitter becomes inactive. It is on master either to send last command again or to generate STOP condition in that case.

Slave address: The I²C-bus master-slave concept requires a unique address for each device. The sensor has a preconfigured slave address (1111000xb) By factory programming it is possible to define a secondary slave address additional to the general one. According to I²C specification 127 different addresses are available. The sensor will then listen to both slave addresses. After generating a START condition the master sends the address byte containing a 7 bit address followed by a data direction bit (R/W). A "0" indicates a transmission from master to slave (WRITE), a "1" indicates a data request (READ).

DATA operation: The sensor starts to send 2 data bytes containing the current pressure value as a 15 bit information placed in the output registers.



generated by master
 generated by slave

S = START condition
A = Acknowledge
P = STOP condition

Data Byte 1 = High Byte (MSB first)
Data Byte 2 = Low Byte (LSB last)

Fig. 4: I²C bus protocol

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■ I²C INTERFACE PARAMETERS

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input high level		90		100	
Input low level		0		10	% of Vs
Output low level				10	
Pull-up resistor		500			Ω
Load capacitance @ SDA	C _{SDA}			400	
Input capacitance @ SDA/SCL	C _{I²C_IN}			10	pF
SCL clock frequency	F _{SCL}	100*		400	kHz
Bus free time between STOP and START cond.	t _{BUF}	1.3			
Hold time (repeated) START condition, to first clock pulse	t _{HD.STA}	0.8			
LOW period of SCL	t _{LOW}	1.3			
HIGH period of SCL	t _{HIGH}	0.6			
Setup time repeated START condition	t _{SU.STA}	1			
Data hold time	t _{HD.DAT}	0			
Data setup time	t _{SU.DAT}	0.2			
Rise time of both SDA and SCL	t _R			0.3	
Fall time of both SDA and SCL	t _F			0.3	
Setup time for STOP condition	t _{SU.STO}	0.6			

* recommended

Note:
All Sensors recommends communication speeds of at least 100 kHz (max. 400 kHz).
Please contact All Sensors for further information.

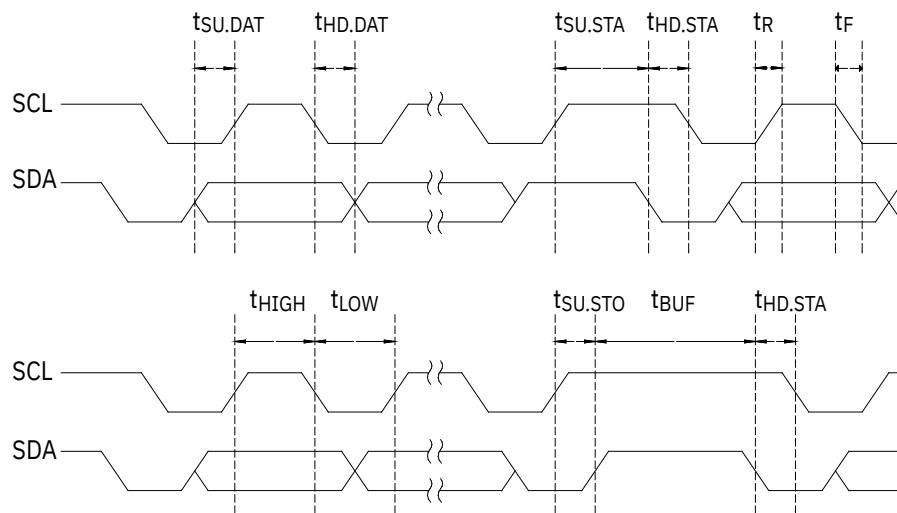


Fig. 5: Timing characteristics

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■ SPI – SERIAL PERIPHERAL INTERFACE

Introduction

The sensor is capable to generate a digital output signal. The device runs a cyclic program, which will store a corrected sensor value with 15 bit resolution about every 1.1 ms (typ) within the output registers of the internal ASIC. This cyclic program runs independent from the bus communication. In order to use the pressure sensor for digital signal readout, it should be connected to a SPI Master device. SPI specifies four signals: The clock (CLK) is generated by the master and input to all slaves. MOSI carries data from master to slave. MISO carries data from slave back to master. A slave select line (SS) allows individual selection of a slave device.

SPI Modes

A pair of parameters called clock polarity (CPOL) and clock phase (CPHA) determine the edges of the clock signal on which the data are driven and sampled. Each of the two parameters has two

possible states, which allows for four possible combinations, all of which are incompatible with one another. In general the sensor supports all combinations of clock phase (CPHA) and polarity (CPOL). By default it is programmed to CPHA = 0 and CPOL = 0, which means that data transmission starts with the rising first clock edge (see Fig 1).

Slave select

The falling edge of the SS line indicates the beginning of the transfer. Additionally the SS line must not be negated and reasserted between the three bytes to be transmitted.

Data operation

The MOSI line should always be set to high level. So there is no data transmission from master to slave. Because of internal configuration the slave will answer the first byte with an FF_h. The second and third byte contain the 15 bit pressure information (see Fig. 2).

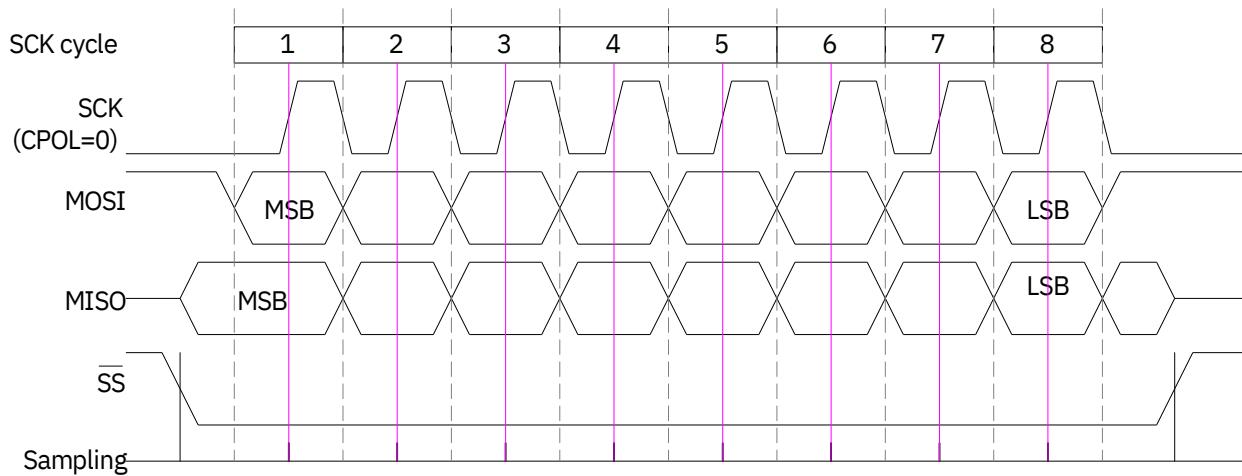


Fig. 1: Example of a standard 1 byte SPI data transfer for CPHA=0 and CPOL=0

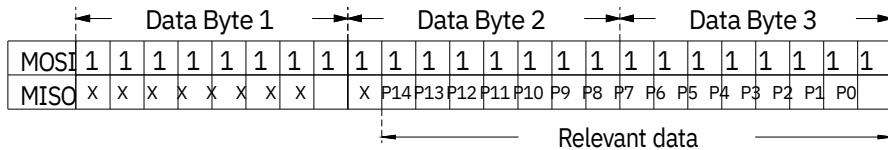


Fig. 2: 3 byte data stream between sensor and master containing the pressure value as a 15 bit information

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■ SPI PARAMETERS

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input high level		90		100	
Input low level		0		10	% of Vs
Output low level				10	
Load capacitance @ MISO	C _{MISO}			400	
Input capacitance @ ach pin	C _{SPI_IN}			10	pF
Signal clock frequency	F _{SCK}	100*		640	kHz
MISO hold time after SCK sample slope	t _{SPI_HD_MISO}	200			ns
MOSI setup time before SCK sample slope	t _{SPI_SU_MOSI}	2/f _{clk}			
/SS setup time before SCK sample slope	t _{SPI_SU_SS}	10			ns
/SS hold time after SCK sample slope	t _{SPI_HD_SS}	1/f _{clk}			

* recommended

Note:

All Sensors recommends communication speeds of at least 100kHz (max. 640kHz).
Please contact All Sensors GmbH for further information.

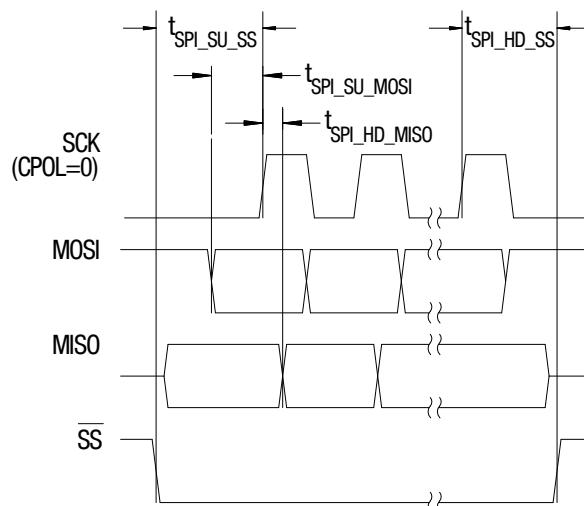


Fig. 3: Timing characteristics

ASTD Series

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■ ORDERING INFORMATION

Series	Pressure Range	Calibration	Housing	Parylene	Communication	Voltage
ASTD-	M001 1 mbar	D- Bidirectional *	A- axial	N No	I I2C	3T 3 V
	MF02 2.5 mbar	G- Unidirectional	H- horizontal		S SPI	5T 5 V
	M005 5 mbar	A- Absolute **				
	M010 10 mbar					
	M020 20 mbar					
	M050 50 mbar					
	M100 100 mbar					
	M350 350 mbar					
	B001 1 bar					
	B002 2 bar					
	B005 5 bar					
	B007 7 bar	* Only up to 1bar				
	B010 5 bar	** Only from 1 bar				

Please note:

Products are laser-marked with a shortened version of the order code. For example, ASTD-M001D-A-NI3T will appear as D-M001D-ANI3.

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