



# AMS 3516 - Robust miniaturized metal pressure transmitter with 0 .. 5 V and Bluetooth 4.2 output

## FEATURES

- Calibrated and temperature compensated
- Amplified pressure sensor with standardized 0..5V output
- Bluetooth Low Energy 4.2 signal transmission
- Wide variety pressure ranges: 25 mbar up to 10 bar
- Differential / gage, bidirectional differential, absolute and barometric versions
- High precision digital signal conditioning
- Piezoresistive sensing element
- High accuracy at room temperature
- Low overall error within a temperature range of -25..85°C
- Supply voltage range 8..36V
- Compact and robust miniaturized metal package
- Pressure connection: M5 female thread
- Electrical connection: M5 sensor connector
- Dust- and waterproof (IP 67)
- Ready-to-use, simple and quick
- RoHS und REACH compliant

## TYPICAL APPLICATIONS

- Static pressure sensing
- Dynamic pressure sensing
- Barometric pressure sensing
- Level measurement
- Gas flow measurement
- Vacuum measurement
- Indoor and outdoor measurement
- Pneumatic system monitoring
- Test benches

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## GENERAL DESCRIPTION

The AMS 3516 is a series of robust pressure transmitters in a matchbox-sized IP67 metal package. This series is suitable for high precision measurements in industrial indoor and outdoor applications as well as in medical instrumentation. The sensor has a Bluetooth module integrated for wireless data transmission via Bluetooth Low Energy 4.2.

All sensors in this series provide an analog output signal of 0..5V and can be powered within a wide supply voltage range of  $V_S = 8..36V$ . They are calibrated and temperature compensated in a wide temperature range of -25..85°C.

AMS 3516 comes in a rugged metal package with M5 female threads for pressure connection. Using standard M5 pressure fittings like barbed ports, hose or push-in fittings a wide variety of pressure connections can be established. The sensor's electrical connection is realized with an M5 circular sensor connector. AMS 3516's package is dust- and water-tight conforming to IP67.

The pressure transmitters in the AMS 3516 series are available for various pressure types and ranges: differential (relative) devices in pressure ranges from 0..50mbar up to 0..10bar, absolute pressure variants for 0..1 bar and 0..2 bar as well as a barometric type for 0.7..1.2 bar. Bidirectional-differential devices for measurement of positive and negative differential pressure are available from  $\pm 25$  mbar up to  $\pm 1$  bar.

Customized pressure ranges and output voltage ranges are available on request. The signal transmission distance is about 100m in the open field.

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## PRESSURE RANGES

Pressure transmitter type (code)	Pressure type	Pressure range in mbar	Burst pressure <sup>1)</sup> in bar	Pressure range in PSI	Burst pressure <sup>1)</sup> in PSI
<b>Low pressure</b>					
AMS 3516-0050-D	differential / relative	0..50	>1	0..0.725	>15
AMS 3516-0100-D	differential / relative	0..100	>1	0..1.450	>15
AMS 3516-0025-D-B	bidirectional differential	±25	>1	±0.362	>15
AMS 3516-0050-D-B	bidirectional differential	±50	>1	±0.725	>15
AMS 3516-0100-D-B	bidirectional differential	±100	>1	±1.450	>15
<b>Standard pressure</b>					
AMS 3516-0200-D	differential / relative	0..200	>5	0..2.901	>72
AMS 3516-0350-D	differential / relative	0..350	>5	0..5.076	>72
AMS 3516-0500-D	differential / relative	0..500	>5	0..7.251	>72
AMS 3516-1000-D	differential / relative	0..1000	>5	0..14.50	>72
AMS 3516-0200-D-B	bidirectional differential	±200	>5	±2.901	>72
AMS 3516-0350-D-B	bidirectional differential	±350	>5	±5.076	>72
AMS 3516-1000-D-B	bidirectional differential	±1000	>5	±14.50	>72
AMS 3516-1000-A	absolute	0..1000	>5	0..14.50	>72
AMS 3516-1200-B	barometric	700..1200	>5	10.15..17.40	>72
<b>Medium pressure</b>					
AMS 3516-2000-D	differential / relative	0..2000	>16	0..29.01	>232
AMS 3516-4000-D	differential / relative	0..4000	>16	0..58.02	>232
AMS 3516-7000-D	differential / relative	0..7000	>16	0..101.52	>232
AMS 3516-10000-D	differential / relative	0..10000	>16	0..145	>232
AMS 3516-2000-A	absolute	0..2000	>5	0..29.01	>72

**Table 1: AMS 3516 standard pressure ranges (other ranges on request)**

## MAXIMUM RATINGS

Parameter	Symbol	Min.	Typ.	Max.	Units
Maximum supply voltage	$V_{cc}$	-25		36	V
Storage temperature	$T_{amb}$	-25		85	°C
Operating temperature	$T_{op}$	-25		85	
Common mode pressure:	$P_{cm}^{2)}$	-25		16	bar

**Table 2: Maximum ratings**

## NOTES

- 1) Burst pressure is defined as the maximum pressure, which can be applied to one pressure port relative to the other port (or while only one pressure port is connected) without causing damages / leaks.
- 2) Common mode pressure is defined as the maximum pressure, which can be applied simultaneously on both pressure ports of a differential or bidirectional transmitter without causing damages, while no differential pressure is applied.



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## ELECTRICAL SPECIFICATIONS (Operating range)

All Parameters apply to  $V_{cc} = 24\text{ V}$  and  $T_{op} = 25\text{ °C}$  and  $R_L = 10\text{ k}\Omega$ , unless otherwise stated.

Parameter	Minimum	Typical	Maximum	Units
<b>Analog output signal</b>				
@ specified minimum pressure (see "pressure ranges")		<0.025		V
@ specified maximum pressure (see "pressure ranges")	0	5	0.05	V
Full span output (FSO) <sup>1)</sup>		5		V
without pressure (only bidirectional differential types)		2.5		V
<b>Accuracy<sup>2)</sup> @ <math>T_{op} = 25\text{ °C}</math></b>				
Low pressure types (see "pressure ranges")		$\pm 0.5$	$\pm 1.0$	%FSO
Standard pressure types (see "pressure ranges")		$\pm 0.5$	$\pm 1.0$	%FSO
Medium pressure types (see "pressure ranges")		$\pm 0.5$	$\pm 1.0$	%FSO
<b>Overall Error<sup>3)</sup>: @ <math>T_{op} = -25 \dots 85\text{ °C}</math></b>				
Low pressure types (see "pressure ranges")		$\pm 1.0$	$\pm 2.0$	%FSO
Standard pressure types (see "pressure ranges")		$\pm 0.7$	$\pm 1.5$	%FSO
Medium pressure types (see "pressure ranges")		$\pm 0.7$	$\pm 1.5$	%FSO
Long term stability			<0.5	%FSO/year
Nonlinearity <sup>4)</sup>	-0.3	<0.1	+0.3	%FSO
Resolution analog output signal			0.05	%FSO
Supply voltage (VS to GND)	8	24	36	V
Current consumption			5	mA
Response time (10% .. 90% rise time)		1	2	ms
Load resistor $R_L$	2			k $\Omega$
Capacitive load			50	nF
Dependency of $V_{out}$ on $V_{cc}$ <sup>6)</sup>			<0.1	%FSO
Pressure Changes	$10^6$			
Compensated operating temperature range $T_{OP}$	-25		85	°C
Weight without cable		47		gram
Package material	standard: hard-eloxyd aluminum on request: stainless steel 316			
Media compatibility	see notes <sup>6) 7)</sup>			
Protection classification <sup>8)</sup>	IP67			

**Table 3: Specifications AMS 3516**

### SPECIFICATION NOTES

- 1) The Full Span Output (FSO) is the algebraic difference between the output signal at the specified maximum pressure and the output signal at the specified minimum pressure (nominal FSO = 5 V).
- 2) Accuracy is defined as the maximum deviation of the measurement value from the ideal characteristic curve at room temperature (RT) in %FSO including the adjustment error (offset and span), nonlinearity, pressure hysteresis and repeatability. Nonlinearity is the measured deviation from the best fit straight line (BFSL) across the entire pressure range. Pressure hysteresis is the maximum deviation of the output value at any pressure within the specified range when the pressure is cycled to and from the minimum or maximum rated pressure. Repeatability is the maximum deviation of the output value at any pressure within the specified range after 10 pressure cycles.



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- 3) The overall error is defined as the maximum deviation of the measurement value from the ideal characteristic curve in %FSO across the entire temperature range (-25 .. 85 °C).
- 4) Defined as best fit straight line (BFSL).
- 5) The given value is the maximum deviation from the output voltage at  $V_{cc} = 24V$  over the complete supply voltage range at any pressure in the specified range. It is normalized to the FSO.
- 6) Media compatibility of pressure port 1 (for a description of port 1, see Figure 3): fluids and gases non-corrosive to ceramics, silicon, Pyrex, RTV silicone rubber, NBR rubber and package material (aluminum or stainless steel).
- 7) Media compatibility of pressure port 2 (for a description of port 2, see Figure 3): clean, dry gases, non-corrosive to ceramics, silicon, Pyrex, RTV silicone rubber, gold, tin, silver palladium, NBR rubber and package material (alkaline or acidic liquids can destroy AMS 3516).
- 8) With pressure and electrical connection established.

## FUNCTIONAL DESCRIPTION

AMS 3516 combines a piezoresistive silicon chip and a mixed-signal integrated circuit (ASIC) on a ceramic substrate housed in a robust metal package. The piezoresistive silicon chip acts as pressure sensing element and the ASIC is used for amplification and signal-conditioning.

The physical pressure, which is applied to AMS 3516's pressure ports, is converted into a differential voltage signal by the sensing element. This differential voltage signal, which is almost proportional to the applied pressure, is converted into a standardized, temperature independent analog output voltage of  $V_{OUT} = 0 .. 5V$  by the signal conditioning ASIC.

The signal-conditioning is done in the following way (see Figure 1):

At first the sensing element's differential voltage signal is pre-amplified and converted into a digital signal using a 14-bit A/D converter (ADC). This digitized pressure signal is processed mathematically by the ASIC's integrated microcontroller unit. To achieve a calibrated and temperature compensated output signal the microcontroller unit uses individual correction coefficients and a mathematical correction algorithm, which are stored in the ASIC's EEPROM during AMS 3516's factory calibration process. The temperature value needed for the temperature compensation is measured directly at the piezoresistive sensing element, too. To obtain an analog output voltage the corrected digital signal is converted back into an analog voltage by an 11-bit D/A converter (DAC).

The standardized output voltage  $V_{OUT} = 0 .. 5V$  (or  $2.5V \pm 2.5V$  for bidirectional differential types) is a linear function of the applied pressure.<sup>1</sup> It is independent of the applied supply voltage.

Communication takes place via Bluetooth Low Energy 4.2 (2.4 Ghz bandwidth). After connecting the electrical cable, the name and the sensor data are sent to the client (advertising). For reconfiguring the displayed sensor, the user must click on "Sensor config" via the menu button. The sensor connects with the App and can now be adjusted individually. The measured values can be swapped out over the App and further processed at any time in a CSV file. The lifetime depends strongly on the transmission mode and the way of using the sensor.

In Connected Mode the sensor sends the data via Bluetooth Notifications to the client. The time can be determined via the configuration side in the App when these notifications are sent.

There are basically three possibilities of data processing:

- 1) Readout and configuration of the sensor via the AMS 3516 App.
- 2) Readout and configuration of the sensor via USB Bluetooth development dongle.
- 3) Readout and configuration of the sensor via the software manual.



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## GENERAL NOTES

The connection Interval can be changed by the manufacturer from 7,5 ms to 4 s.

Factory default data transmission rate is 5 s, which can be adjusted from 1 s to 65535 s in the an-droid smartphone AMS 3516 App or over a USB Bluetooth Development Dongle.

On request a software manual can be provided by the manufacturer, so a readout and configuration can be made without the AMS 3516 App

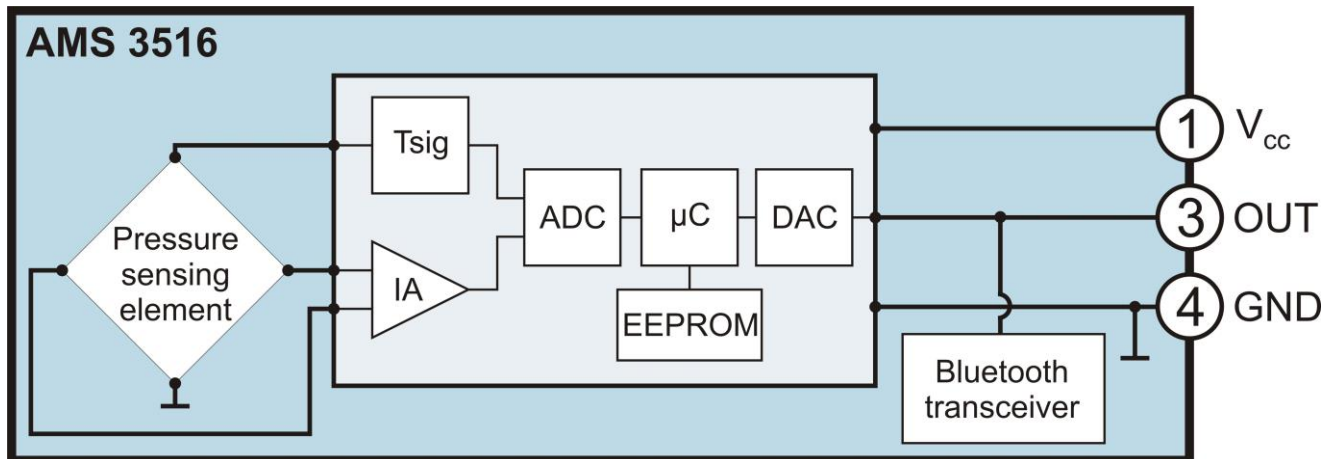


Figure 1: AMS 3516's block diagram

## NOTES

- 1) The applied pressure is the pressure difference between port 1 and port 2 for differential and bidirectional differential pressure transmitters. For relative pressure types it is the pressure difference between port 1 and ambient pressure and for absolute and barometric pressure types it is the pressure at port 2 (for the definition of ports see Figure 3).



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## GETTING STARTED

The pressure transmitters of the series AMS 3516 can be screw mounted in a fast and easy way using the two integrated through bores ( $\varnothing$  4.3 mm) at the sensor's metal package's edges.

The electrical connection is established using the integrated M5 circular sensor connector and a suitable cable with female M5 sensor connector (see "additional equipment"). Pin 1 ( $V_{CC}$ ) is directly connected to the power supply's positive output and pin 4 (GND) is connected to GND (see Figure 2). Pin 3 (OUT) can be connected to a voltmeter directly to measure the output signal voltage  $V_{OUT}$  (referenced to GND) or a load resistor  $R_L$  can be connected between pin 3 and GND and  $V_{OUT}$  can be measured parallel to  $R_L$ . The output voltage  $V_{OUT} = 0..5V$  at pin 3 is a linear function of the applied pressure and does not depend on the supply voltage. Please ensure that the supply voltage is in the specified range of 8 and 36 V and that the power supply is able to source at least 5 mA (for  $R_L \geq 10k\Omega$ ).

The pressure connection is made using the package's M5 female thread pressure ports, where a multitude of pressure fittings can be connected (see "additional equipment"). Depending on the type of pressure transmitter and the application one or two of the pressure ports have to be connected to the measuring media/volume. For the pressures at AMS 3516's pressure ports the following requirements have to be fulfilled, wherein  $p_1$  is the pressure at port 1 and  $p_2$  is the pressure at port 2 (for port definition see Figure 3):

- for differential pressure (type AMS 3516-XXXX-D):  $p_1 > p_2$
- for relative / gage pressure (type AMS 3516-XXXX-D):  $p_1 > p_{ambient}$ ,  $p_1$  = measuring pressure
- for bidirectional differential pressure (type AMS 3516-XXXX-D-B):  $p_1 > p_2$  or  $p_1 < p_2$  possible
- for absolute pressure (type AMS 3516-XXXX-A):  $p_2$  = measuring pressure
- for barometric pressure (type AMS 3516-XXXX-B):  $p_2$  = measuring pressure

The maximum pressures (see Table 1) and the guidelines concerning media compatibility (see specification notes 11) and 12)) have to be taken into account. AMS 3516's package is dust- and waterproof according to IP67.

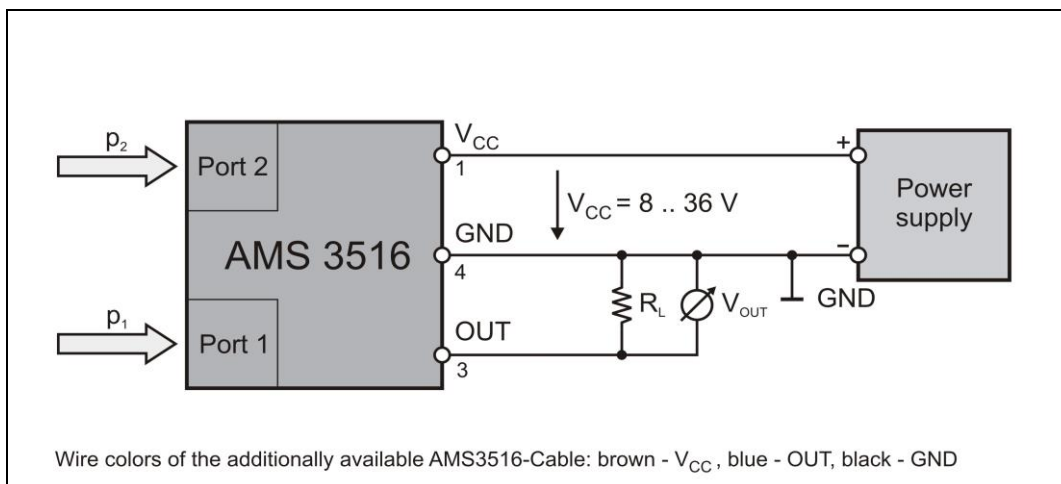


Figure 2: Electrical connection AMS 3516



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## DIMENSIONS AND PINOUT

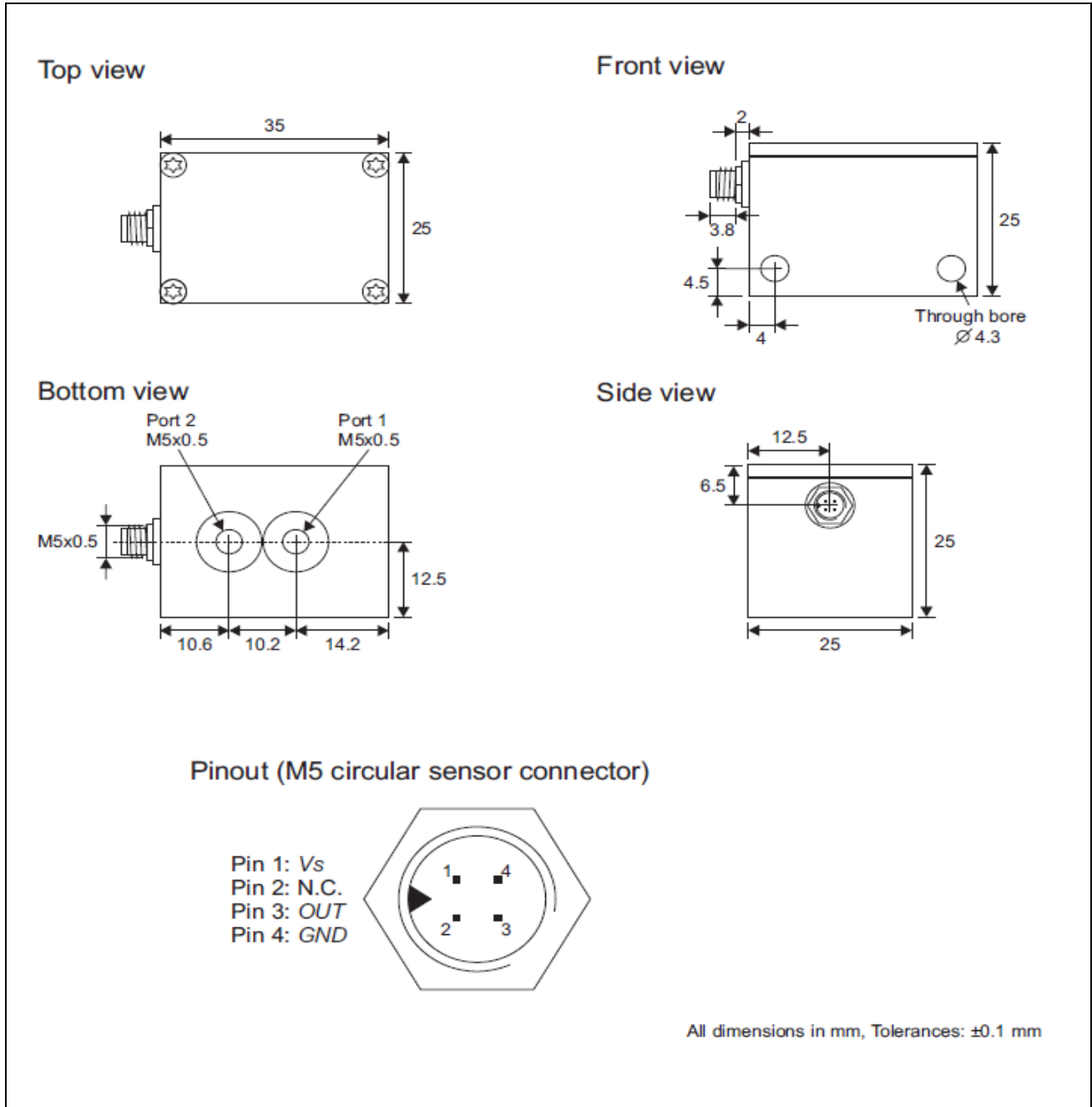


Figure 3: Dimensions and pinout of AMS 3516 package

## PACKAGE NOTES

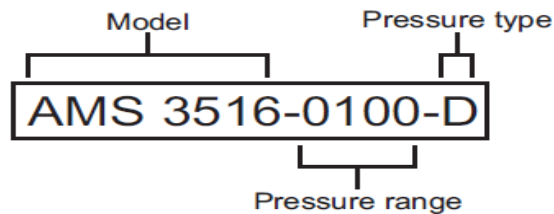
- 1) For absolute and barometric pressure transmitters only port 2 is available.
- 2) The electrical connection is established using an M5 sensor connector series 707 from Binder GmbH.
- 3) For pressure connection Analog Microelectronics recommends the pressure fittings listed in "additional equipment."



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## ORDERING INFORMATION

Ordering code:



## PRESSURE RANGE

Pressure range code	mbar	psi	kPa
0025	25	0.362	2.5
0050	50	0.725	5
0100	100	1.450	10
0200	200	2.901	20
0350	350	5.076	35
0500	500	7.251	50
1000	1000	14.50	100
1200	1200	17.50	120
2000	2000	29.01	200
4000	4000	58.02	400
7000	7000	101.52	700
10000	10000	145	1000

**Table 4: Pressure ranges**

## PRESSURE TYPE

Pressure type code	Available pressure ranges
D differential / relative	0 .. 5 mbar
D-B bidirectional differential	±5 mbar to ±1 bar
A absolute	0 .. 1000 mbar
B barometric	700 .. 1200 mbar

**Table 1: Pressure types**

## ADDITIONAL EQUIPMENT

Ordering code	Description
App	Android App for readout and configure of the sensors
Software Manual	For own software development
AMS 3516 Cable	3-wire cable with mating M5 sensor connector (2 m long) wiring: brown – Vs, blue – OUT, black – GND





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## MATCHING PRESSURE FITTINGS

ORDER NUMBER	DELIVERY FORM
AMS 3516-Barb-3	M5 barbed fitting with $\varnothing = 3$ mm, type: Festo CN-M5-PK-3
AMS 3516-Barb-4	M5 barbed fitting with $\varnothing = 4$ mm, type: SMC M-5AN-6
AMS 3516-Hose-4	M5 hose nipple with cap nut for tubing with $\varnothing = 2.4 / 4$ mm, type: SMC M-5H-4
AMS 3516-Hose-6	M5 hose nipple with cap nut for tubing with $\varnothing = 4 / 6$ mm, type: SMC M-5H-6
AMS 3516-PushIn-3	Push-In fitting for tubing with $\varnothing_{OD} = 3$ mm, type: Festo QSM-M5-3-I
AMS 3516-PushIn-4	Push-In fitting for tubing with $\varnothing_{OD} = 4$ mm, type: Festo QSM-M5-4-I
AMS 3516-PushIn-6	Push-In fitting for tubing with $\varnothing_{OD} = 6$ mm, type: Festo QSM-M5-6-I

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