AMS 4516
Miniaturized wireless Bluetooth Low Energy 5.1 Pressure Transmitter

FEATURES

- **Calibrated and temperature compensated**
- **Mobile wireless operations**
- **Bluetooth Low Energy 5.1 signal transmission**
- **Wide variety pressure ranges: 5 mbar up to 1 bar**
- **Differential, bidirectional differential, versions**
- **Logger function (256 Kbit EEPROM)**
- **High accuracy at room temperature**
- **Low overall error within a temperature range of 0 .. 60 °C**
- **Supply voltage range 2,7 .. 3,6 V**
- **Battery powered (CR2032)**
- **Compact package**
- **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**
- **Heating, Ventilation and Air Conditioning (HVAC)**

GENERAL DESCRIPTION

The miniaturized sensors of the AMS 4516 series are ready-to-use, high precision pressure transmitters. The sensor has a Bluetooth module integrated for wireless data transmission via Bluetooth Low Energy 5.1. The sensors are operated with a coin cell battery (CR2032) and are temperature compensated, linearized and calibrated. AMS 4516 comes in a robust plastic package and is ready to use. The sensors can be read out and configured via an Android App provided by AMSYS for free via Google Play Store. The software specifications are provided by AMSYS on request.

The pressure transmitters in the AMS 4516 series are available for various applications and pressure ranges: differential (relative) devices in pressure ranges from 0 .. 5 mbar up to 0 .. 1 bar. Bidirectional-differential devices are available from ±5 mbar up to ±1 bar for measurement of positive and negative differential pressure. Other pressure ranges and customized output voltage ranges are available on request. The signal transmission distance is about 100 m in the open field.

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PRESSURE RANGES

Pressure transmitter type (code)	Pressure type	Pressure range in mbar	Burst pressure[1] in bar	Pressure range in PSI	Burst pressure[1] in PSI
Ultra low pressure					
AMS 4516-0005-D	differential / relative	0..5	>0.35	0..0.073	>5
AMS 4516-0010-D	differential / relative	0..10	>0.35	0..0.145	>5
AMS 4516-0005-D-B	bidirectional differential	±5	>0.35	±0.073	>5
AMS 4516-0010-D-B	bidirectional differential	±10	>0.35	±0.145	>5
Low pressure					
AMS 4516-0050-D	differential / relative	0..50	>1	0..0.725	>15
AMS 4516-0100-D	differential / relative	0..100	>1	0..1.450	>15
AMS 4516-0025-D-B	bidirectional differential	±25	>1	±0.363	>15
AMS 4516-0050-D-B	bidirectional differential	±50	>1	±0.725	>15
AMS 4516-0100-D-B	bidirectional differential	±100	>1	±1.450	>15
Standard pressure					
AMS 4516-0200-D	differential / relative	0..200	5	0..2.901	72
AMS 4516-0350-D	differential / relative	0..350	5	0..5.076	72
AMS 4516-0500-D	differential / relative	0..500	5	0..7.251	72
AMS 4516-1000-D	differential / relative	0..1000	5	0..14.50	72
AMS 4516-0200-D-B	bidirectional differential	±200	5	±2.901	72
AMS 4516-0350-D-B	bidirectional differential	±350	5	±5.076	72
AMS 4516-0500-D-B	bidirectional differential	±500	5	±7.251	72
AMS 4516-1000-D-B	bidirectional differential	±1000	5	±14.50	72

Table 1: AMS 4516 standard pressure ranges (other ranges on request)

MAXIMUM RATINGS

Parameter	Symbol	Min.	Typ.	Max.	Units
Maximum supply voltage	V_{cc}	2.7	3	3.6	V
Storage temperature (without battery)	T_{amb}	-25		85	°C
Operating temperature	T_{op}	0		60	°C
Common mode pressure:	P_{cm}[2]			5	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} = 3 V and T_{op} = 25 °C, unless stated otherwise.

Parameter	Minimum	Typical	Maximum	Units
Accuracy[1] @ T_{op} = 25 °C				
Ultra low pressure types			±1.5	%FSO[2]
Low pressure types			±1.0	%FSO
Standard pressure types			±0.5	%FSO
Overall Error @ T_{op} = 0 .. 60 °C				
Ultra low pressure types			±2.0	%FSO
Low pressure types			±1.5	%FSO
Standard pressure types			±1.0	%FSO
Resolution A/D converter		14		bits
Resolution pressure signal		12		bits
Resolution temperature signal			11	bits
Long term stability			<0.5	%FSO/year
Supply voltage (V_{cc})	2.7	3.0	3.6	V
Overall ratiometricity error		±0.025	±0.1	%FSO
Wireless protocol	Bluetooth Low Energy 5.1			
Receiver operating system	Android™ 8.0 and above			
Signal transmission distance	Ca. 40 m[4]			
Current consumption in Advertising Mode[5]		25		µA
Current consumption in Advertising Mode[6]		5	7	µA
Current consumption in Connected Mode[7]		0.5	0.6	mA
Battery Life CR2032 (210 mAh)	ca. 1 year[8]			
Battery Life CR2032 (210 mAh)	ca. 3 years[9]			
Response time (10 % .. 90 % rise time)		0.5	1	ms
Response time (Power up to data ready)			10	ms
Pressure changes	10^6			
Operating temperature range	0		60	°C
Storage temperature range (without battery)	-25		85	°C
Weight		20		gram
Media compatibility	See "Specification notes[10] [11]			
Protection classification[12]	IP44			

Table 3: Electrical Specifications

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SPECIFICATION NOTES

1) 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.

2) 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 (see "Pressure range").

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 (0 .. 60 °C).

4) Affected by receiver antenna and blocking objects.

5) At an advertising interval of 1 s and a measurement interval of 1 s without enabling EEPROM.

6) At an advertising interval of 5 s and a measurement interval of 120 s without enabling EEPROM.

7) At a min. connection interval of 500 ms and max. 1000 ms and a measurement interval of 1 s without enabling EEPROM.

8) Only in Advertising Mode considering point 5 and without enabling EEPROM Mode.

9) Only in Advertising Mode considering point 6 and without enabling EEPROM Mode.

10) Media compatibility of pressure port 1: fluids and gases non-corrosive to ceramics, silicon, Pyrex, RTV silicone rubber and Zytel PA66.

11) Media compatibility of pressure port 2: clean, dry gases, non-corrosive to ceramics, silicon, RTV silicone rubber, gold, tin and Zytel PA66 (alkaline or acidic liquids can destroy AMS 4516).

12) With tubes connected to port 1 and port 2 for differential and bidirectional differential pressure transmitters and with a tube connected to port 2 for absolute and barometric pressure transmitters.

GENERAL NOTES

The connection interval can be changed in ms by the manufacturer from 7,5 ms to 4 s (default minimum connection interval: 100 ms and maximum connection interval: 200 ms).

Default data sampling rate is set to 5 s, which can be adjusted in ms from 100 ms to 500 s in the android smartphone AMS 4516 App.

Default battery sampling rate is set to 60 s, which can be adjusted in sec from 1 s to 500 s in the android smartphone AMS 4516 App.

The advertising interval can be changed in ms from 20 ms to 10 s in the android smartphone AMS 4516 App (default 2 s).

On request a software manual can be provided by the manufacturer, so a sensor readout and configuration can be made without the AMS 4516 App.

Battery life depends on its capacity, operating temperature and signal transmission interval.
Temperature can impact battery capacity retention even in idle. Check battery specifications for more details.

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FUNCTIONAL DESCRIPTION

AMS 4516 uses a piezoresistive high quality silicon chip as sensing element and a modern mixed-signal integrated circuit CMOS ASIC with full digital correction for signal conditioning, which are assembled together on a ceramic substrate and housed in a robust plastic package. The physical pressure, which is applied to the transmitter's pressure ports is measured at AMS 4516's piezoresistive pressure sensing element where the pressure is converted into a differential voltage signal which is almost proportional to the pressure (see figure 1).

This enables high precision measurements and excellent drift and long-term stability.
This differential voltage signal is corrected and conditioned by the ASIC in multiple steps.
At first the differential voltage signal from the sensing element is pre-amplified by the ASIC amplifier stage and transmitted to the A/D converter (ADC) by a multiplexer. The ADC converts this voltage signal into digital values with a resolution of 14 bits. The digitized signal is corrected and calibrated in the follow-on ASIC microcontroller.

During the factory calibration of AMS 4516 sensor-specific correction coefficients are determined and stored in each sensor's EEPROM. This permits sensor-specific calibration and correction (i.e. temperature compensation and linearization) of the digitized pressure signal. The temperature signal necessary for temperature compensation is generated at the ASIC temperature reference block and is transmitted by the multiplexer to the ADC, where it is digitized. The ASIC microcontroller runs a cyclic program which continuously calculates the current standardized and corrected digital pressure value using the actual digitized pressure and temperature values and the stored correction coefficients. In addition, a standardized current digital temperature value is calculated. These calculated and corrected digital values (14 bit pressure value and 11 bit temperature value) are written to the ASIC output registers and are continuously updated (typically every 0.5 ms).

The temperature compensation extends over the entire operating temperature range of 0..60 °C. The specified overall error in the range of 0..60 °C can therefore also be referred to as Total Error Band, TEB.

The sensors values are written into a 256 Kbit EEPROM. If the memory is full, the oldest data will be deleted and gradually replaced by new ones. Communication takes place via Bluetooth Low Energy 5.1 (2.4 GHz band). After inserting the batteries, the name and the sensor data are continuously sent to the client (advertising). For reconfiguring the displayed sensor, the user must click on "Sensor Configuration" 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 battery 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 frequency (sampling rate) can be determined via the configuration tab inside the app.
There are basically three possibilities of data processing:

1) Readout and configuration of the sensor via the AMS 4516 App.

2) Reading out the sensor via the BLE gateway with firmware.

3) Readout and configuration of the sensor via the software manual.

4) Readout and configuration of the sensor via a windows desktop app.

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GETTING STARTED

AMS 4516's package provides a dust and water tight protection is maintenance free except from the occasional battery change. The package can be screw mounted in a fast and easy way using the two through holes (Ø 3.1 mm) at the package's edges.

The supply voltage is ensured by a CR2032 coin cell battery (230 mAh). The battery holder is located directly under the lid. For an exchange of the battery, the housing must be opened and the battery pushed into the battery holder. It is important to pay attention to the correct polarity of the battery.

The pressure connection is made using the package's pressure ports (barbed hose connectors). Depending on the type of pressure transmitter and measured pressure one or two pressure ports are connected to the measuring media/volume. For the pressures connected at port 1 and port 2 (for port definition see figure 2) the following requirements have to be fulfilled, where p_1 is the pressure at port 1 and p_2 is the pressure at port 2:

differential pressure (type AMS 4516-XXXX-D): $\quad\quad\quad\quad\quad\quad$ $p_1 > p_2$

relative / gage pressure (type AMS 4516-XXXX-D): $\quad\quad\quad$ $p_1 > p_{ambient}$, $p_1 =$ measured pressure

bidirectional differential pressure (type AMS 4516-XXXX-D-B): $\quad$ $p_1 > p_2$ or $p_1 < p_2$ possible
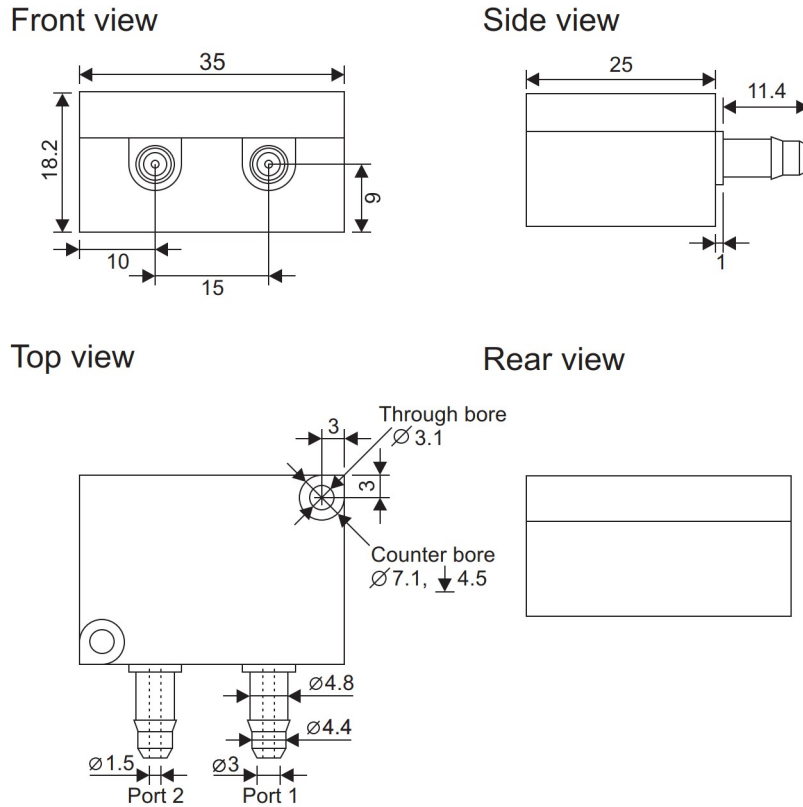
The maximum pressures (see table 3) and the guidelines concerning media compatibility (see specification notes 10) and 11)) have to be taken into account.

PACKAGE DIMENSIONS

Front view

Side view

Top view

Rear view

Through bore ∅ 3.1

Counter bore ∅ 7.1, ↧ 4.5

∅4.8

∅4.4

∅1.5 Port 2

∅3 Port 1

All dimensions in mm, Tolerances: ±0.1 mm

Figure 2: Dimensions and pinout of AMS 4516 package

NOTES

1) For absolute and barometric pressure transmitters only port 2 is available.
2) Package material is Zytel PA66.
3) For pressure connections AMSYS recommends a silicone tubing (inner diameter $\emptyset_{ID}$ = 3.2 mm, outer diameter $\emptyset_{OD}$ = 6.4 mm) or a soft PU tubing ($\emptyset_{ID}$ = 4 mm, $\emptyset_{OD}$ = 6 mm).
4) If silicone tubing is used, it is recommended to use hose clamps to reduce the risk of leaks.
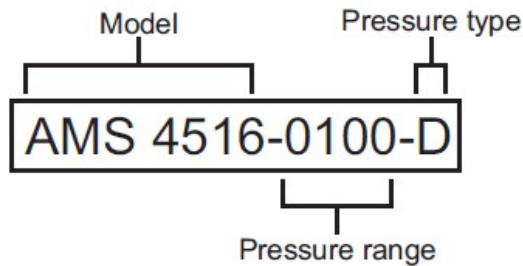
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ORDERING INFORMATION

Ordering code:

PRESSURE RANGE

Pressure range code	mbar	psi	hPa
0005	5	0.073	5
0010	10	0.145	10
0025	25	0.363	25
0050	50	0.725	50
0100	100	1.450	100
0200	200	2.901	200
0350	350	5.076	350
0500	500	7.251	500
1000	1000	14.51	1000

PRESSURE TYPE

Pressure type code	Available pressure ranges
D differential / relative	0 .. 5 mbar to 0 .. 1 bar
D-B bidirectional differential	±5 mbar to ±1 bar

ADDITIONAL EQUIPMENT

Name	Description
App	Android app for readout and configuring the sensors
Desktop software	Windows software for readout and configuring the sensors
BLE Gateway	(W)LAN gateway with web interface for readout and configuring the sensors
Software Manual	On demand for own software development

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