

## FEATURES

- Board mount pressure sensor series with digital I2C output
- Calibrated and temperature compensated
- Differential/relative, bidirectional differential, absolute and barometric sensor versions
- Wide variety of pressure ranges: from 2.5 mbar (250 Pa) up to 16 bar full scale
- Piezoresistive sensor with high precision digital signal conditioning
- Total accuracy < 0.5 %FSO at room temperature for standard pressure ranges
- TEB < 1.0 %FSO (-25 ... 85 °C) for standard pressure ranges
- High long term stability
- Fast response time (typ. < 1 ms)
- Supply voltage: 3.3 V and 5 V models available
- Digital output via I<sup>2</sup>C interface: 14 bit for pressure and 11 bit for temperature values
- Programmable I<sup>2</sup>C-address
- Ceramic DIP-8 package (width: 0.6 inch)
- Package options for tubing or manifold mount (O-Ring sealing)
- RoHS compliant

## TYPICAL APPLICATIONS

- Static and dynamic pressure measurement
- Barometric pressure measurement
- Vacuum monitoring
- Gas flow measurement
- Fluid level measurement
- Medical instrumentation
- Heating, Ventilation and Air Conditioning (HVAC)

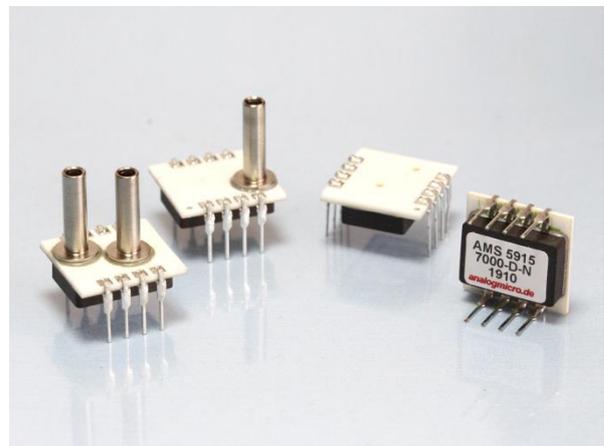
## GENERAL DESCRIPTION

The pressure sensors in the AMS 5915 series are high-precision board mount sensors with a digital I<sup>2</sup>C-interface. They combine a micromachined, high quality piezoresistive pressure sensing element with a modern, mixed-signal CMOS-ASIC used for signal conditioning on a ceramic substrate. AMS 5915 sensors are extensively calibrated and compensated across a wide temperature range of -25 to 85 °C.

The AMS 5915 come in a compact and robust ceramic dual in-line package (DIP) for assembly on printed circuit boards (PCBs). Two package variants are available: one with vertical pressure ports for hose connection and one for O-ring sealing (N-package type for manifold mount). The sensors are operational without any additional components. The electrical connection is established via DIP solder pins and pressure is connected either by using flexible tubing on the metal tubes or a suitable flange.

The sensors in the AMS 5915 series are available in various pressure ranges for all pressure types: differential (relative) pressure sensors in ranges from 0 ... 5 mbar up to 0 ... 16 bar, absolute pressure types from 0 ... 500 mbar up to 0 ... 2 bar and 700 ... 1200 mbar for barometric measurements. Bidirectional differential sensors are available in pressure ranges from -2.5 ... +2.5 mbar up to -1 ... +1 bar.

Custom specific pressure ranges or modifications are available on request.



## PRESSURE RANGES

### Sensor types with vertical pressure ports (metal tubes for hose connection)

Sensor type (code)	Pressure type	Pressure range in mbar	Burst pressure <sup>1)</sup> in bar	Pressure range in PSI	Burst pressure in PSI
<b>Ultra low pressure ranges</b>					
AMS 5915-0005-D-...	differential / relative	0 ... 5	> 0.2	0 ... 0.0725	> 3
AMS 5915-0010-D-...	differential / relative	0 ... 10	> 0.2	0 ... 0.145	> 3
AMS 5915-0002-D-B-...	bidirectional differential	-2.5 ... +2.5	> 0.2	-0.0362 ... +0.0362	> 3
AMS 5915-0005-D-B-...	bidirectional differential	-5 ... +5	> 0.2	-0.0725 ... +0.0725	> 3
AMS 5915-0010-D-B-...	bidirectional differential	-10 ... +10	> 0.2	-0.145 ... +0.145	> 3
<b>Low pressure ranges</b>					
AMS 5915-0020-D-...	differential / relative	0 ... 20	> 0.4	0 ... 0.290	> 6
AMS 5915-0035-D-...	differential / relative	0 ... 35	> 0.4	0 ... 0.508	> 6
AMS 5915-0050-D-...	differential / relative	0 ... 50	> 1	0 ... 0.725	> 15
AMS 5915-0100-D-...	differential / relative	0 ... 100	> 1	0 ... 1.450	> 15
AMS 5915-0020-D-B-...	bidirectional differential	-20 ... +20	> 0.4	-0.290 ... +0.290	> 6
AMS 5915-0035-D-B-...	bidirectional differential	-35 ... +35	> 0.4	-0.508 ... +0.508	> 6
AMS 5915-0050-D-B-...	bidirectional differential	-50 ... +50	> 1	-0.725 ... +0.725	> 15
AMS 5915-0100-D-B-...	bidirectional differential	-100 ... +100	> 1	-1.450 ... +1.450	> 15
<b>Standard pressure ranges</b>					
AMS 5915-0200-D-...	differential / relative	0 ... 200	> 1.7	0 ... 2.901	> 24.6
AMS 5915-0350-D-...	differential / relative	0 ... 350	> 5	0 ... 5.076	> 72
AMS 5915-0500-D-...	differential / relative	0 ... 500	> 5	0 ... 7.250	> 72
AMS 5915-1000-D-...	differential / relative	0 ... 1000	> 5	0 ... 14.50	> 72
AMS 5915-2000-D-...	differential / relative	0 ... 2000	> 16	0 ... 29.01	> 232
AMS 5915-4000-D-...	differential / relative	0 ... 4000	> 16	0 ... 58.02	> 232
AMS 5915-7000-D-...	differential / relative	0 ... 7000	> 16	0 ... 101.5	> 232
AMS 5915-10000-D-...	differential / relative	0 ... 10000	> 16	0 ... 145.0	> 232
AMS 5915-0200-D-B-...	bidirectional differential	-200 ... +200	> 5	-2.901 ... +2.901	> 72
AMS 5915-0350-D-B-...	bidirectional differential	-350 ... +350	> 5	-5.076 ... +5.076	> 72
AMS 5915-0500-D-B-...	bidirectional differential	-500 ... +500	> 5	-7.250 ... +7.250	> 72
AMS 5915-1000-D-B-...	bidirectional differential	-1000 ... +1000	> 5	-14.50 ... +14.50	> 72
AMS 5915-0500-A-...	absolute	0 ... 500	> 5	0 ... 7.250	> 72
AMS 5915-1000-A-...	absolute	0 ... 1000	> 5	0 ... 14.50	> 72
AMS 5915-1500-A-...	absolute	0 ... 1500	> 5	0 ... 21.75	> 72
AMS 5915-2000-A-...	absolute	0 ... 2000	> 5	0 ... 29.01	> 72
AMS 5915-1200-B-...	absolute (barometric)	700 ... 1200	> 5	10.88 ... 17.4	> 72

**Table 1: AMS 5915 standard pressure ranges (other pressure ranges on request)**

**Notes:**

- 1) Burst pressure is defined as the maximum pressure which may be applied to one pressure port relative to the other port (or while only one pressure port is connected) without causing leaks in the sensor.
- 2) All differential pressure sensors with vertical metal tubes can be ordered with inverted pressure direction for enhanced media compatibility in relative pressure measurements (option -I, for more information on ordering codes see page 14)
- 3) Relative pressure is the difference between applied pressure and atmospheric pressure. It is often also called gage or gauge pressure.

## PRESSURE RANGES continued

### Sensor types for manifold assembly (-N package option without tubes for O-ring sealing)

Sensor type (code)	Pressure type	Pressure range in mbar	Burst pressure <sup>1)</sup> in bar	Pressure range in PSI	Burst pressure in PSI
<b>Ultra low pressure ranges</b>					
AMS 5915-0005-D-N-...	differential / relative	0 ... 5	> 0.2	0 ... 0.0725	> 3
AMS 5915-0010-D-N-...	differential / relative	0 ... 10	> 0.2	0 ... 0.145	> 3
AMS 5915-0002-D-B-N-...	bidirectional differential	-2.5 ... +2.5	> 0.2	-0.0362 ... +0.0362	> 3
AMS 5915-0005-D-B-N-...	bidirectional differential	-5 ... +5	> 0.2	-0.0725 ... +0.0725	> 3
AMS 5915-0010-D-B-N-...	bidirectional differential	-10 ... +10	> 0.2	-0.145 ... +0.145	> 3
<b>Low pressure ranges</b>					
AMS 5915-0020-D-N-...	differential / relative	0 ... 20	> 0.4	0 ... 0.290	> 6
AMS 5915-0050-D-N-...	differential / relative	0 ... 50	> 1	0 ... 0.725	> 15
AMS 5915-0100-D-N-...	differential / relative	0 ... 100	> 1	0 ... 1.450	> 15
AMS 5915-0020-D-B-N-...	bidirectional differential	-20 ... +20	> 0.4	-0.290 ... +0.290	> 6
AMS 5915-0050-D-B-N-...	bidirectional differential	-50 ... +50	> 1	-0.725 ... +0.725	> 15
AMS 5915-0100-D-B-N-...	bidirectional differential	-100 ... +100	> 1	-1.450 ... +1.450	> 15
<b>Standard pressure ranges</b>					
AMS 5915-0200-D-N-...	differential / relative	0 ... 200	> 1.7	0 ... 2.901	> 24.6
AMS 5915-0350-D-N-...	differential / relative	0 ... 350	> 5	0 ... 5.076	> 72
AMS 5915-1000-D-N-...	differential / relative	0 ... 1000	> 5	0 ... 14.50	> 72
AMS 5915-2000-D-N-...	differential / relative	0 ... 2000	> 16	0 ... 29.01	> 232
AMS 5915-4000-D-N-...	differential / relative	0 ... 4000	> 16	0 ... 58.02	> 232
AMS 5915-7000-D-N-...	differential / relative	0 ... 7000	> 16	0 ... 101.5	> 232
AMS 5915-10000-D-N-...	differential / relative	0 ... 10000	> 16	0 ... 145.0	> 232
AMS 5915-0200-D-B-N-...	bidirectional differential	-200 ... +200	> 5	-2.901 ... +2.901	> 72
AMS 5915-0350-D-B-N-...	bidirectional differential	-350 ... +350	> 5	-5.076 ... +5.076	> 72
AMS 5915-1000-D-B-N-...	bidirectional differential	-1000 ... +1000	> 5	-14.50 ... +14.50	> 72
<b>Pneumatic ranges<sup>2)</sup></b>					
AMS 5915-4000-D-I-N-...	inverted differential / relative	0 ... 4000	> 30	0 ... 58.02	> 435
AMS 5915-7000-D-I-N-...	inverted differential / relative	0 ... 7000	> 30	0 ... 101.5	> 435
AMS 5915-10000-D-I-N-...	inverted differential / relative	0 ... 10000	> 30	0 ... 145.0	> 435
AMS 5915-12000-D-I-N-...	inverted differential / relative	0 ... 12000	> 30	0 ... 174.0	> 435
AMS 5915-16000-D-I-N-...	inverted differential / relative	0 ... 16000	> 30	0 ... 232.1	> 435

**Table 2: AMS 5915 standard pressure ranges for manifold assembly (-N option, other ranges on request)**

**Note:**

- 1) Burst pressure is defined as the maximum pressure which may be applied to one pressure port relative to the other port (or while only one pressure port is connected) without causing leaks in the sensor.
- 2) Pneumatic ranges are built with a special sensing element adhesive to increase the burst pressure.
- 3) Differential sensor types for manifold assembly (option -N, without tubes) can be ordered with inverted pressure direction for pressure ranges up to 1 bar, too (option -I, for more information on ordering codes see page 14).
- 4) Relative pressure is the difference between applied pressure and atmospheric pressure. It is often also called gage or gauge pressure.

## MAXIMUM RATINGS

Parameter	Minimum	Typical	Maximum	Units
Maximum supply voltage: $V_{S,max}$			6.0	V
Operating temperature: $T_{op}$	-25		85	°C
Storage temperature: $T_{amb}$	-40		125	°C
Common mode pressure $p_{CM}$ <sup>1)</sup>			16	bar

**Table 3: Maximum ratings**

**Note:**

- 1) Common mode pressure is defined as the maximum pressure, which can be applied simultaneously on both pressure ports of a differential or bidirectional pressure sensor without causing damages, while no differential pressure is applied.

## SPECIFICATIONS

All parameters apply to  $T_{op} = 25\text{ °C}$  and  $V_S = 3.3\text{ V}$  (3.3 V models) or  $V_S = 5.0\text{ V}$  (5 V models), unless otherwise stated.

Parameter	Minimum	Typical	Maximum	Units
<b>Digital output signal (pressure)</b> <sup>1)</sup>				
@ specified minimum pressure (see "pressure range") <sup>2)</sup>		1638		counts
@ specified maximum pressure (see "pressure range") <sup>2)</sup>		14745		counts
Full span output (FSO) <sup>3)</sup>		13107		counts
without pressure (bidirectional differential)		8192		counts
<b>Digital output signal (temperature)</b> <sup>4)</sup>				
@ minimum temperature $T = -25\text{ °C}$		256		counts
@ maximum temperature $T = 85\text{ °C}$		1382		counts
<b>Total accuracy</b> <sup>5)</sup> (pressure measurement) @ $T = 25\text{ °C}$				
Ultra low pressure ranges ( $\leq 10\text{ mbar}$ )			$\pm 1.5$	%FSO
Low pressure ranges ( $10\text{ mbar} < p \leq 100\text{ mbar}$ )			$\pm 1.0$	%FSO
Standard pressure ranges / pneumatic ranges ( $> 100\text{ mbar}$ )			$\pm 0.5$	%FSO
<b>TEB/Overall error</b> <sup>6)</sup> (pressure meas.) @ $T = -25 \dots 85\text{ °C}$				
Ultra low pressure ranges ( $\leq 10\text{ mbar}$ )			$\pm 2.0$	%FSO
Low pressure ranges ( $10\text{ mbar} < p \leq 100\text{ mbar}$ )			$\pm 1.5$	%FSO
Standard pressure ranges / pneumatic ranges ( $> 100\text{ mbar}$ )			$\pm 1.0$	%FSO
<b>Total error for temperature measurement</b>				
All types of AMS 5915 $T = -25 \dots 85\text{ °C}$			$\pm 3.0$	%FSO
Long term stability		0.2	$< 0.5$	%FSO/a
Resolution A/D converter		14		bits
Resolution pressure signal		12		bits
Resolution temperature signal			11	bits
Supply voltage range ( $V_S$ ) for 3.3 V model	3.0	3.3	3.6	V
Supply voltage range ( $V_S$ ) for 5 V model	4.75	5.00	5.25	V
Overall ratiometricity error (@ supply voltage range)		$\pm 0.025$	$\pm 0.1$	%FSO
Current consumption			4	mA
Reaction time (10 % ... 90 % rise time)		0.5	1	ms
Start-up time (Power up to data ready)			10	ms

Parameter	Minimum	Typical	Maximum	Units
<b>I<sup>2</sup>C-interface</b>				
Input high level	80		100	% V <sub>S</sub>
Input low level	0		20	% V <sub>S</sub>
Output low level	0		10	% V <sub>S</sub>
Load capacitance @ SDA			200	pF
Clock frequency SCL		100	400	kHz
Pull-up resistor	500			Ω
Pressure changes	10 <sup>6</sup>			
Compensated temperature range	-25		85	°C
Weight		3		g
Media compatibility	See "Specification notes" <sup>7), 8)</sup>			

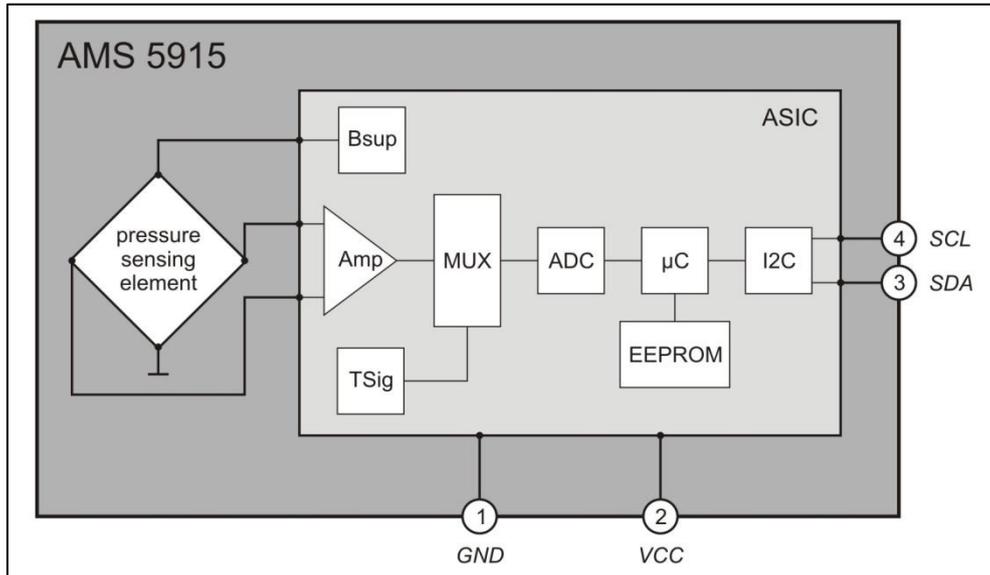
**Table 4: Specifications****SPECIFICATION NOTES**

- 1) The digital pressure output signal is not ratiometric to the supply voltage.
- 2) The pressure ranges with specified minimum and maximum pressure are listed in *Table 1* and *Table 2*.
- 3) 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 *Table 1* and *Table 2*).
- 4) The digital temperature output signal is not ratiometric to the supply voltage. The temperature output value is the overall sensor temperature. It is measured at the sensor's signal conditioning ASIC and is influenced by the measurement media's temperature, the ambient temperature, the sensor's self-heating and the thermal conductivity of the material in contact to the sensor (e.g. PCB, mounting assembly, pressure hoses).
- 5) Total 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.
- 6) The TEB (total error band or 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).
- 7) Media compatibility of pressure port 1 (for a description of port 1 see *Figure 5* and *Figure 6*): clean, dry gases, non-corrosive to silicon, RTV silicone rubber, epoxy, gold (alkaline or acidic liquids can destroy the sensor). For standard packages with tubes the media compatibility of the nickel-plated steel tubes has to be considered, too.
- 8) Media compatibility of pressure port 2 (for a description of port 2 see *Figure 5* and *Figure 6*): fluids and gases non-corrosive to silicon, Pyrex, RTV silicone rubber. For standard packages with tubes the media compatibility of the nickel-plated steel tubes and its epoxy adhesive has to be considered, too.

## FUNCTIONAL DESCRIPTION

The pressure sensors in the AMS 5915 series combine a high quality, membrane-based piezoresistive silicon sensing element with a modern mixed-signal CMOS ASIC for signal-conditioning on a ceramic substrate. This enables a low total error band, an excellent temperature behavior and long-term stability.

AMS 5915's functional principle is explained using *Figure 1*.



**Figure 1: Functional principle**

The physical pressure applied to AMS 5915's pressure port(s) is converted into a differential voltage signal at AMS 5915's piezoresistive pressure sensing element. This differential voltage is signal-conditioned and converted into a standardized digital voltage output signal in the following way:

At first the sensing element's differential voltage signal is pre-amplified, transmitted to the A/D converter block (ADC) by the multiplexer block and converted into a digital signal with 14-bit resolution. This digitized signal is processed mathematically by the ASIC's integrated microcontroller unit ( $\mu\text{C}$ ) to achieve a calibrated and temperature compensated output signal. For this purpose the  $\mu\text{C}$  uses a correction algorithm and individual correction coefficients stored in the ASIC's EEPROM during AMS 5915's factory calibration process. This permits sensor-specific calibration and correction (i.e. linearization and temperature compensation) of the digitized pressure signal. The temperature signal necessary for temperature compensation is generated at the ASIC's temperature reference block and is transmitted by the multiplexer to the ADC, where it is digitized, too.

The ASIC's microcontroller runs a cyclic program, which continuously calculates the current standardized and corrected digital pressure value using the present digitized pressure and temperature measurement values and the stored correction coefficients. In addition, a standardized digital value of the current temperature is calculated. These calculated and corrected digital values (14-bit pressure value and 11-bit temperature value) are written to the ASIC's output registers and are continuously updated (typically every 0.5 ms).

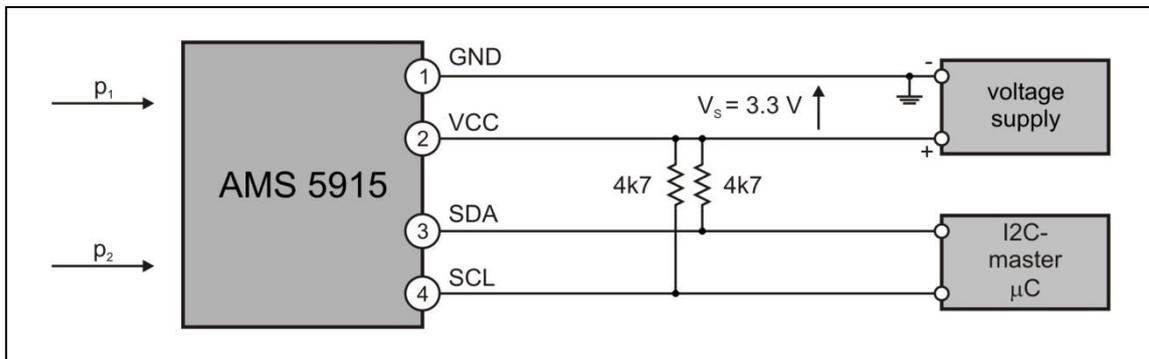
The readout of the standardized digital output values for pressure and temperature from the output registers is done via the sensor's I<sup>2</sup>C interface at PIN3 (SDA) and PIN4 (SCL). The AMS 5915's digital output values (for pressure and temperature) are not ratiometric to the supply voltage.

## INITIAL OPERATION

### Electrical Connection

The electrical connection of AMS 5915 sensors is typically made by soldering them directly on a printed circuit board or by mounting them on a suitable socket. The basic circuit of the AMS 5915 sensor is shown in *Figure 2*. To read data from the digital output, it is enough to connect PIN1 (GND), PIN2 (VCC) and the I2C-bus lines to PIN3 (SDA) and PIN4 (SCL). Pins 5 to 8 are internally not connected and can be left unconnected.

**Important:** For I2C-bus communication, each bus line (SCL and SDA) has to be connected to the positive supply voltage (pin Vcc or +3.3 V) via a pull-up resistor. Please add pull-up resistors (4.7 kΩ are recommended) to your bus line if they are not integrated in the I2C-master.



**Figure 2: Principle electric circuitry**

### Pressure Connection

The pressure connection is established by mounting hoses / flexible tubing on the sensor’s metal pressure ports or by sealing the pressure ports of the N-type package via O-rings to a suitable flange. Depending on the sensor type and the type of measuring pressure, one or two of the pressure ports are connected to the measuring medium / volume, as described in the table below:

Sensor type	Pressure type to measure	Port 1	Port 2	Requirement
AMS 5915-xxxx-D	differential	connected to p <sub>1</sub>	connected to p <sub>2</sub>	p <sub>1</sub> ≥ p <sub>2</sub>
	positive gage	connected to p <sub>1</sub>	open	p <sub>1</sub> ≥ p <sub>ambient</sub>
	negative gage (vacuum)	open	connected to p <sub>2</sub>	p <sub>2</sub> ≤ p <sub>ambient</sub>
AMS 5915-xxxx-D-I	differential	connected to p <sub>1</sub>	connected to p <sub>2</sub>	p <sub>1</sub> ≤ p <sub>2</sub>
	positive gage	open	connected to p <sub>2</sub>	p <sub>2</sub> ≥ p <sub>ambient</sub>
	negative gage (vacuum)	connected to p <sub>1</sub>	open	p <sub>1</sub> ≤ p <sub>ambient</sub>
AMS 5915-xxxx-D-B	differential (bidirectional)	connected to p <sub>1</sub>	connected to p <sub>2</sub>	p <sub>1</sub> ≥ p <sub>2</sub> or p <sub>1</sub> ≤ p <sub>2</sub>
AMS 5915-xxxx-A	absolute pressure	connected to p <sub>1</sub>	not connected	p <sub>1</sub> = meas. pressure
AMS 5915-xxxx-B	barometric pressure	connected to p <sub>1</sub>	not connected	p <sub>1</sub> = meas. pressure

wherein p<sub>1</sub> = pressure at port 1 and p<sub>2</sub> = pressure at port 2. For port declaration see *Figure 5* and *Figure 6*. The media compatibility of pressure port 1 and port 2 can be found in “Specification notes”, 7 and 8.

#### Notes:

- For pressure connections up to 2 bar we recommend a silicone tubing (inner diameter Ø = 2 mm, outer diameter Ø = 6 mm) and above 2 bar PU or PA tubing. Suitable tubing can be found on [AMS 5915's product page](#).
- ESD precautions are necessary, it is essential to ground machines and personnel properly during assembly and handling of the device.

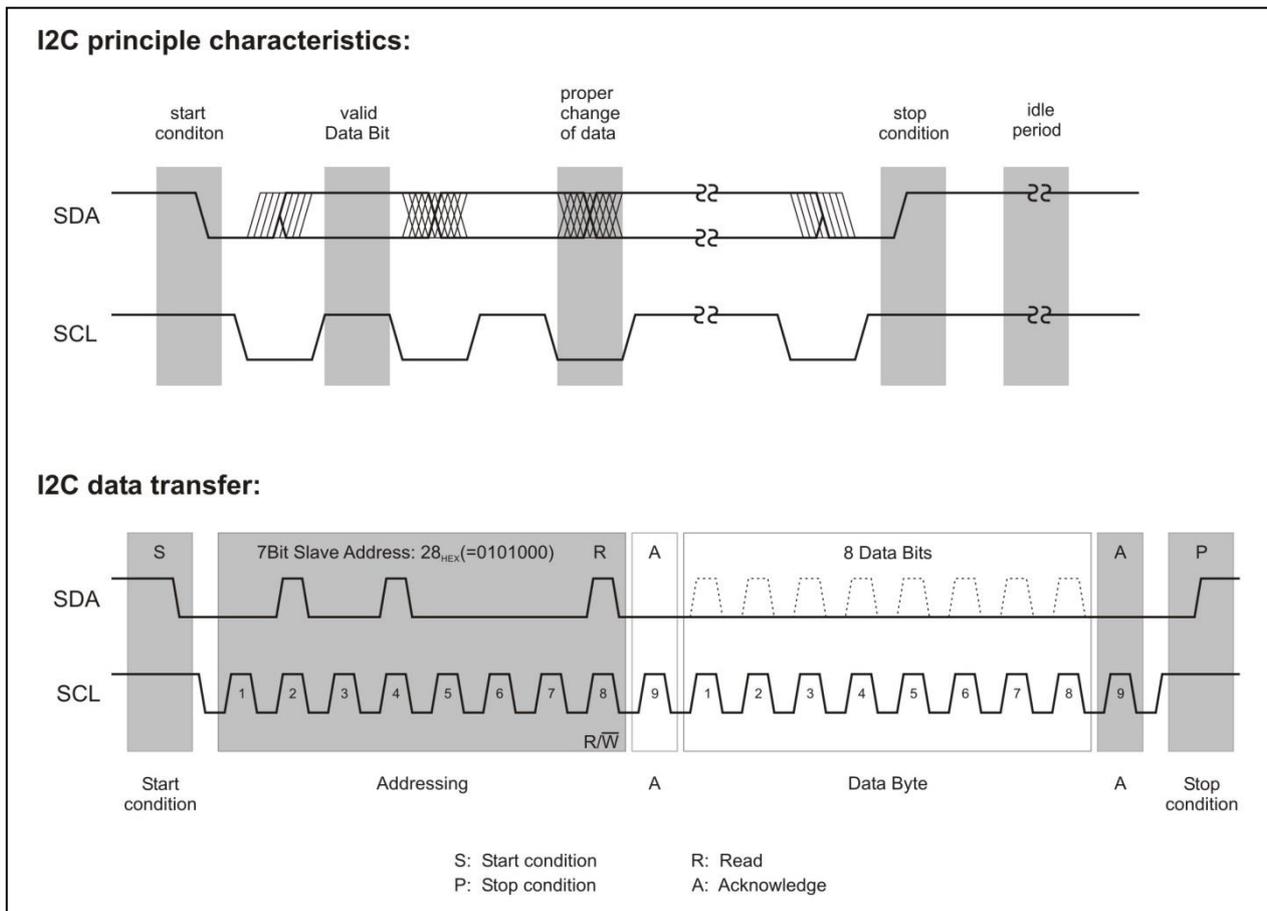
## I<sup>2</sup>C-INTERFACE

AMS 5915 pressure sensors have a digital output (I<sup>2</sup>C-interface). When connected to a bidirectional I<sup>2</sup>C-bus, the current corrected digital pressure and temperature values can be read from AMS 5915's output register via the I<sup>2</sup>C-interface.

Communication via the I<sup>2</sup>C-bus follows a simple master-slave principle. Data transfer is always initialized by a master (such as a microcontroller), which sends a data request to the sensor; the AMS 5915 sensor – which always operates as slave – answers then.

The I<sup>2</sup>C-bus requires just two bus lines: a serial data line (SDA) and a serial clock line (SDL). SDA and SCL are bidirectional lines, which are connected to the positive supply voltage using pull-up resistors.

AMS 5915 communication protocol adheres to a standard I<sup>2</sup>C communication protocol (given in *Figure 3*)<sup>1</sup>.



**Figure 3: Standard I<sup>2</sup>C protocol**

<sup>1</sup> There are three differences of AMS 5915's communication protocol compared to the original I<sup>2</sup>C communication protocol:

1. A stop condition directly after a start condition without clock pulses in between is not allowed. This creates a communication error for the next communication.
2. A second start condition (restart) during data transmission when SCL is still high is not allowed.
3. Between the start condition and the first rising SCL edge a falling SDA edge is not allowed.

The I<sup>2</sup>C communication phases are as follows:

**Idle period** (bus is free)

When the bus is free, both I<sup>2</sup>C-bus lines (SDA and SCL) are pulled up to supply voltage level ("high level").

**Start S** (start condition)

Prior to any data transfer on the bus a start condition has to be generated. The start condition is always sent by the I<sup>2</sup>C-master. The start condition is defined as a transition from "high level" to "low level" on the SDA line while the SCL line is still on "high level". The digital data readout from the AMS 5915 is always initiated by a start condition.

**Stop P** (stop condition)

The stop condition is always generated by the I<sup>2</sup>C-master after a data transfer has been completed. The stop condition is defined as a transition from "low level" to "high level" on the SDA line while the SCL line is still on "high level". The digital data readout from the AMS 5915 is always terminated by a stop condition.

**Valid data**

Data is transmitted in bytes (8 bits), starting with the most significant bit (MSB). One data bit is transmitted with each clock pulse. The transmitted bits are only valid when, following a start condition, the level on the SDA line is constant as long as the SCL line is on "high level". Changes to the SDA level must be made while the SCL line is on "low level".

**Acknowledge A**

After a byte has been transmitted the respective receiver (master or slave) has to send an acknowledge (additional acknowledge bit) confirming the correct receipt of the data. For this purpose the master generates an extra acknowledge-related clock pulse. The receiver sends the acknowledge bit by pulling the SDA line down to "low level" during the additional clock pulse.

**Addressing / Slave address (I<sup>2</sup>C-address AMS 5915)**

After the start condition the master sends an addressing byte (the first byte after the start condition) which determines which slave is selected. The addressing byte contains the individual 7-bit slave address of the selected slave (AMS 5915) and a data direction bit ( $R/\overline{W}$ ). A "0" for the  $R/\overline{W}$  bit indicates a transmission from master to slave ( $\overline{W}$ : write; the master wishes to transmit data to the selected slave), a "1" a data request ( $R$ : read; the master requests data from the slave).

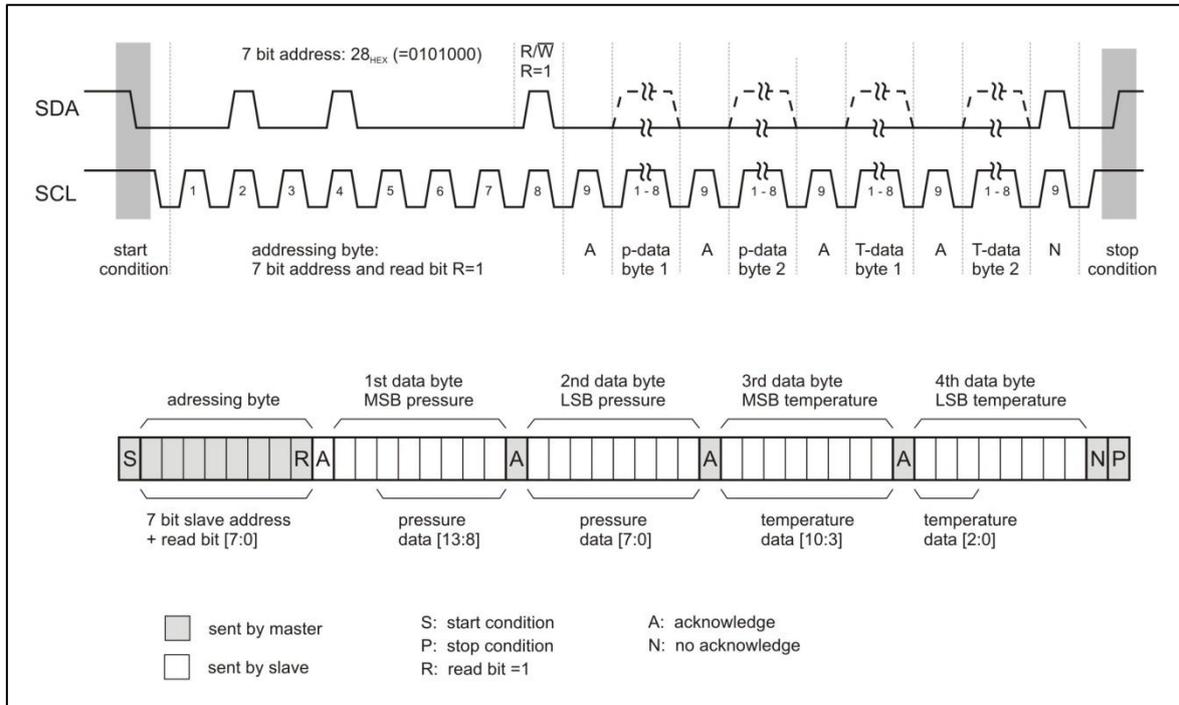
The pressure sensors in the AMS 5915 series have a factory-programmed 7-bit slave address of  $0x28_{Hex}$  ( $0101000_{bin}$ ), which is stored in the sensor's EEPROM.

On request each AMS 5915 can be ordered with an individual 7-bit slave address programmed at the factory. Using [AMS 5915's USB starter kit](#) the customer can program the individual slave address himself.

In general 7-bit addressing allows 128 different addresses. If more than one AMS 5915 should be connected to the same I<sup>2</sup>C-bus, each pressure sensor requires an individual slave address.

### DATA READOUT VIA THE I2C-INTERFACE

The digital output values for pressure (14-bit value) and temperature (11-bit value) are read from AMS 5915's output register via AMS 5915's I<sup>2</sup>C-interface. The data readout, which is illustrated in *Figure 4*, is done byte by byte.



**Figure 4: Data readout of the digital pressure and temperature values**

A data request from the I<sup>2</sup>C-master always initializes the data transfer via the I<sup>2</sup>C-bus. For this purpose the I<sup>2</sup>C-master generates a start condition on the I<sup>2</sup>C-bus lines. Following the start condition the I<sup>2</sup>C-master then sends the addressing byte containing the 7-bit slave address of the AMS 5915 (programmed to 0x28<sub>Hex</sub> = 0101000<sub>bin</sub> at the factory) and the data direction bit R = 1 which indicates a data request. The selected pressure sensor first answers with an acknowledge bit. The selected sensor then starts the data transfer from the output register.

For pressure and temperature value readout four data bytes are transmitted from the pressure sensor to the I<sup>2</sup>C-master. The two bytes for the current digital pressure value are sent first, followed by the two bytes for the current digital temperature value, always beginning with the most significant byte. On each transferred data byte the I<sup>2</sup>C-master sends an acknowledge bit confirming the correct receipt of data. After the fourth data byte, the receiving master generates a no acknowledge bit and the pressure sensor is set to inactive. The I<sup>2</sup>C-master shuts down the data transfer by sending a stop condition.

The last 6 bits of the first data byte and the 8 bits of the second data byte always beginning with the most significant bit give the 14-bit pressure value. The 8 bits of the third data byte and the first 3 bits of the fourth data byte give the 11-bit temperature value.

For pressure value readout only it is possible to stop the data transfer after two data bytes. In this case the I<sup>2</sup>C-master sends a no acknowledge bit after the second data byte and shuts down the data transfer by sending a stop condition.

## Calculating the current pressure and temperature value

The digital output values for pressure (14-bit value) and temperature (11-bit value) have to be converted in order to generate the desired information on pressure and temperature in physical units.

The current pressure in mbar (or PSI) is calculated from the digital pressure value using the following equations:

$$p = \frac{Digoutp(p) - Digoutp_{min}}{Sensp} + p_{min} \quad \text{with} \quad Sensp = \frac{Digoutp_{max} - Digoutp_{min}}{p_{max} - p_{min}} \quad (1)$$

wherein  $p$  is the current pressure in mbar<sup>2</sup>,  $p_{min}$  is the specified minimum pressure and  $p_{max}$  is the specific maximum pressure in mbar; depending on the specified pressure range,  $Digoutp(p)$  is the current digital 14-bit pressure value in counts,  $Digoutp_{min}$  and  $Digoutp_{max}$  are the digital pressure values at minimum and maximum specified pressure in counts and  $Sensp$  is the sensitivity of the pressure sensor in counts/mbar.

The current sensor temperature in °C is calculated from the digital temperature output value using the following equation:

$$T = \frac{DigoutT(T)}{2048} * 200 \text{ °C} - 50 \text{ °C} \quad (2)$$

Therein  $T$  is the current sensor temperature in °C and  $DigoutT(T)$  is the current 11-bit digital temperature output value in counts.

### Example:

At the digital output of an AMS 5915-0005-D-B (-5 ... 5 mbar bidirectional differential sensor) the following data bytes 1 ... 4 are read:

Byte 1: 00101100      Byte 2: 11001101      Byte 3: 01011100      Byte 4: 11100000

Taking the last 14 bits of byte 1 and byte 2 the current 14 bit digital pressure value is:

$$Digoutp(p) = 10110011001101_{bin} \text{ counts} = 2CCD_{Hex} \text{ counts} = 11469_{Dec} \text{ counts}$$

and with the first 11 bits of byte 3 and byte 4 the digital temperature value is:

$$DigoutT(T) = 01011100111_{bin} \text{ counts} = 2E7_{Hex} \text{ counts} = 743_{Dec} \text{ counts.}$$

For AMS 5915-0005-D-B the following values are specified:

$p_{min} = -5$  mbar,  $p_{max} = 5$  mbar and  $Digoutp_{min} = 1638$ ,  $Digoutp_{max} = 14745$

Using these values and equation (1) the current pressure in mbar can be calculated:

$$p = \frac{(11469 - 1638) \text{ counts}}{(13107 / 10) \text{ counts / mbar}} + (-5) \text{ mbar} = 2.501 \text{ mbar}$$

Using equation (2), the current sensor temperature in °C is calculated as:

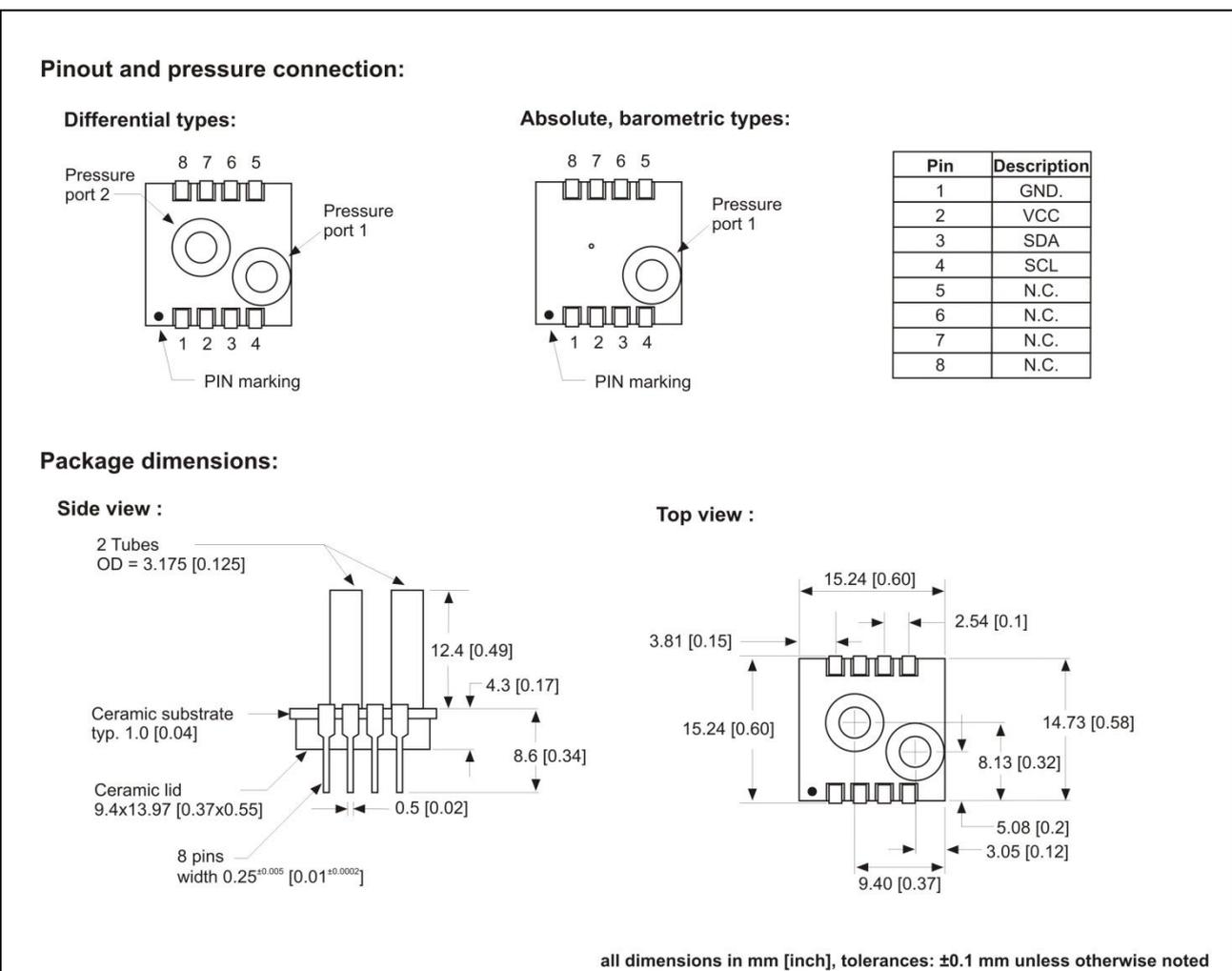
$$T = \frac{(743 \cdot 200) \text{ counts} \cdot \text{°C}}{2048 \text{ counts}} - 50 \text{ °C} = 22.6 \text{ °C}$$

<sup>2</sup> If the current pressure is required in another physical unit, we suggest calculating the current pressure value in mbar as described above and converting the value into the required physical unit then.

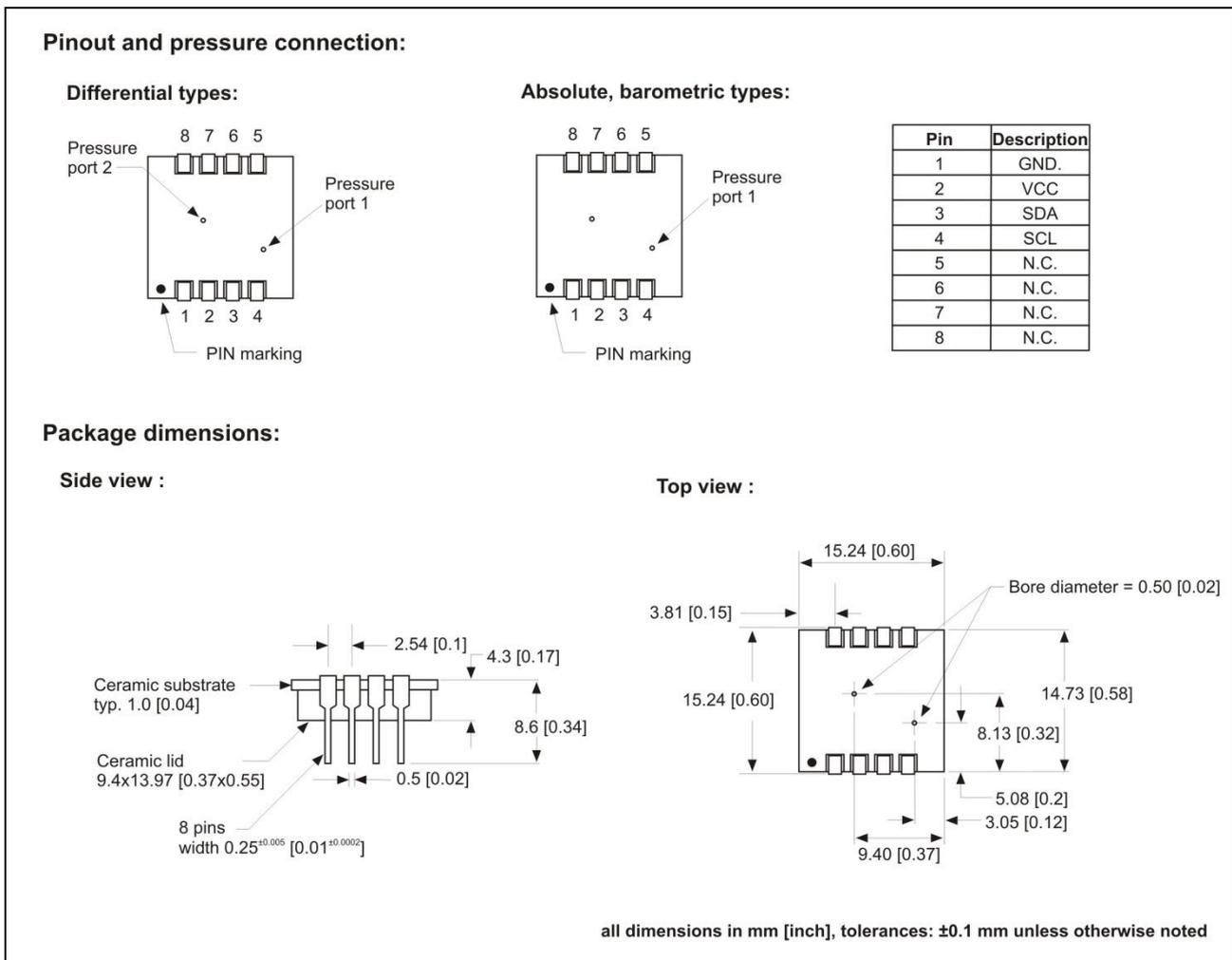
**DIMENSIONS AND PINOUT**

AMS 5915 pressure sensors come in a dual-in-line package (DIP-08, width: 600 mil) for assembly on printed circuit boards (PCB).

The pinout and dimensions of AMS5915's dual-in-line package are shown in *Figure 5* for sensor types with vertical metal tubes (for connection with pressure hoses) and in *Figure 6* for sensor types for manifold assembly (-N option without tubes).



**Figure 5: Dimensions of sensor types with vertical metal tubes**



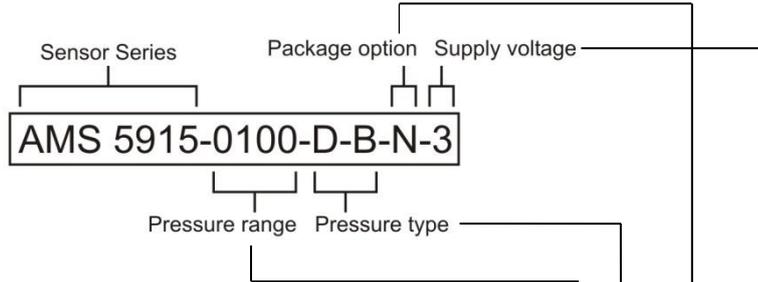
**Figure 6: Dimensions and pinout of AMS 5915 for manifold assembly (-N option without tubes)**

**Notes on “Dimensions and Pinout” (Figure 5 and Figure 6):**

1. Packages with SMT Pins (J-Lead) are available on request
2. Relative / gage variants with one single tube are available on request.
3. Pressure port 2 applies pressure to the piezoresistive silicon sensing element’s backside and is therefore compatible with non-corrosive liquids. For media compatibility of pressure port 1 and port 2 see "Specification notes", 7 and 8.
4. For automatic soldering (lead-free wave or reflow soldering) of AMS 5915 a peak temperature of 250°C for a maximum of 20 to 30 seconds is recommended. A typical temperature profile for Pb-free assembly is given by IPC/JEDEC J-STD-020D, Table 5-2.

## INFORMATION FOR ORDERING

Ordering code:



Pressure range code	mbar	PSI	kPa
0002	2.5	0.036	0.25
0005	5	0.073	0.5
0010	10	0.145	1.0
0020	20	0.290	2.0
0035	35	0.507	3.5
0050	50	0.725	5.0
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	17.40	120
1500	1500	21.75	150
2000	2000	29.01	200
4000	4000	58.02	400
7000	7000	101.5	700
10000	10000	145.0	1000
12000	12000	174.0	1200
16000	16000	232.0	1600

Code	Pressure type	Available pressure ranges
D	Differential / relative (gage)	0 ... 5 mbar to 0 ... 10 bar
D-I	Inverted differential / relative (gage)	0 ... 5 mbar to 0 ... 16 bar
D-B	Bidirectional differential	-2.5 ... +2.5 mbar to -1 ... 1 bar
A	Absolute	0 ... 500 mbar to 0 ... 2000 mbar
B	Barometric (absolute)	700 ... 1200 mbar

Code	Package option	Available pressure ranges
	Standard package	-2.5 ... +2.5 mbar to 0 ... 10 bar
N	Manifold mount package	-2.5 ... +2.5 mbar to 0 ... 16 bar

Code	Supply Voltage Range	Available pressure ranges
3	3.0 ... 3.6 V, typ. 3.3 V	all pressure ranges
5	4.75 ... 5.25 V, typ. 5.0 V	all pressure ranges

**ADDITIONAL EQUIPMENT**

Ordering code	Description
USB starter kit AMS 5915	A USB starter kit interfacing AMS 5915 to a Windows PC (Windows XP, 7 or 10) via a USB port. It consists of two PCBs and software. The kit can be used for quick and easy evaluation of AMS 5915, data readout, data logging and to change AMS 5915's I2C address.
AMS 5915 – Arduino PCB	An adapter PCB board, which can be used to interface AMS 5915 with an Arduino Uno. A library and example code for Arduino's IDE is available for download at <a href="http://www.analog-micro.com">www.analog-micro.com</a> .
AMS 5915 Arduino Nano Kit	A kit used to interface AMS 5915 to an Arduino Nano directly. It consists of two PCBs, an AMS Arduino Nano Shield and an AMS 5915 Mini PCB, as well as a matching ribbon cable. A library and example code for Arduino's IDE is available for download at <a href="http://www.analog-micro.com">www.analog-micro.com</a> .

For more information on additional equipment see [AMS 5915's product page](#)

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