

# AMS 5105

## Pressure sensor with one analog and two switching outputs

### FEATURES

- Combined pressure sensor and switch
- Calibrated and temperature compensated
- Analog voltage output of 0.5 to 4.5V (ratiometric)
- Two programmable logic switching outputs of 0/5 V, configurable as normally open, normally close or in window mode
- Threshold, hysteresis and delay can be set individually for each switching output
- Differential/relative, bidirectional differential, absolute and barometric versions
- High accuracy up to 0.5% at RT
- Small overall error within a temperature range of -25 ... 85°C
- Supply voltage range 4.75...5.25V
- High long term stability
- Small DIP package
- Ready to use
- RoHS compliant

### TYPICAL APPLICATIONS

- Pressure measurement/control
- Vacuum measurement/control
- Process control
- Gas flow
- Fluid level measurement
- Medical instrumentation
- Heating, Ventilation and Air Conditioning (HVAC)

### GENERAL DESCRIPTION

The pressure sensors/switches in the AMS 5105 series combine a high-precision OEM pressure sensor with a programmable pressure switch in one package. AMS 5105 has one analog voltage output and two independent logic switching outputs. The analog voltage output is ratiometric to the supply voltage of 5 V. The switching outputs are software configurable as normally open, normally closed or in window mode; thresholds and hysteresis can be set individually. The pressure sensors/switches are calibrated and compensated for across a temperature range of -25 to +85°C.

AMS 5105 comes in a dual in-line package (DIP) for assembly on printed circuit boards (PCBs). The electrical connection is made via the DIP solder pins; pressure is connected via two vertical metal tubes.

AMS 5105 is available for various applications and pressure ranges: differential (relative) devices in ranges from 0...5 mbar up to 0...7 bar, two absolute pressure variants for 0...1 bar and 0...2 bar and a barometric variant. Bidirectional differential devices are available in different ranges from -5...+5 mbar up to -1...+1 bar. Other pressure ranges or customized modifications are available on request.



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### PRESSURE RANGES

Sensor 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>Ultra low pressure</b>					
AMS 5105-0005-D	differential / relative	0 ... 5	>0.35	0 ... 0.0725	>5
AMS 5105-0010-D	differential / relative	0 ... 10	>0.35	0 ... 0.145	>5
AMS 5105-0005-D-B	bidirectional differential	-5 / +5	>0.35	-0.0725 / 0.0725	>5
AMS 5105-0010-D-B	bidirectional differential	-10 / +10	>0.35	-0.145 / +0.145	>5
<b>Low pressure</b>					
AMS 5105-0020-D	differential / relative	0 ... 20	>0.5	0 ... 0.290	>7.5
AMS 5105-0050-D	differential / relative	0 ... 50	>1	0 ... 0.725	>15
AMS 5105-0100-D	differential / relative	0 ... 100	>1	0 ... 1.450	>15
AMS 5105-0020-D-B	bidirectional differential	-20 / +20	>0.5	-0.290 / +0.290	>7.5
AMS 5105-0050-D-B	bidirectional differential	-50 / +50	>1	-0.725 / +0.725	>15
AMS 5105-0100-D-B	bidirectional differential	-100 / +100	>1	-1.450 / +1.450	>15
<b>Standard pressure</b>					
AMS 5105-0200-D	differential / relative	0 ... 200	5	0 ... 2.901	72
AMS 5105-0350-D	differential / relative	0 ... 350	5	0 ... 5.076	72
AMS 5105-1000-D	differential / relative	0 ... 1000	5	0 ... 14.50	72
AMS 5105-2000-D	differential / relative	0 ... 2000	15.5	0 ... 29.01	225
AMS 5105-4000-D	differential / relative	0 ... 4000	15.5	0 ... 58.02	225
AMS 5105-7000-D	differential / relative	0 ... 7000	15.5	0 ... 101.5	225
AMS 5105-0200-D-B	bidirectional differential	-200 / +200	5	-2.901 / +2.901	72
AMS 5105-0350-D-B	bidirectional differential	-350 / +350	5	-5.076 / +5.076	72
AMS 5105-1000-D-B	bidirectional differential	-1000 / +1000	5	-14.50 / +14.50	72
AMS 5105-1000-A	absolute	0 ... 1000	5	0 ... 14.5	72
AMS 5105-2000-A	absolute	0 ... 2000	5	0 ... 29.01	72
AMS 5105-1200-B	barometric	750 ... 1200	5	10.88 ... 17.4	72

**Table 1: AMS 5105 standard pressure ranges (other 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.

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## Pressure sensor with one analog and two switching outputs

### 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>			12	bar

**Table 2: Maximum ratings**

#### Notes:

- 1) The common mode pressure is defined as the maximum pressure that can be applied on both pressure ports of a differential pressure sensor simultaneously without damaging the sensors housing.

### SPECIFICATIONS

All parameters apply to  $V_S = 5.0V$  and  $T_{op} = 25^\circ C$ , unless otherwise stated.

Parameter	Minimum	Typical	Maximum	Units
<b>Analog output signal</b> <sup>1)</sup>				
@ specified minimum pressure (see Pressure range <sup>2)</sup> )		0.5		V
@ specified maximum pressure (see Pressure range <sup>2)</sup> )		4.5		V
Full span output (FSO) <sup>3)</sup>		4		V
without pressure (bidirectional differential)		2.5		V
<b>Logic switching outputs</b> <sup>4)</sup>				
Output-Low-Level <sup>5)</sup>	0		10	% $V_S$
Output-High-Level <sup>5)</sup>	90		100	% $V_S$
Max. output current (switching outputs)	4			mA
Adjustable threshold ( $p_{th}$ )	0		100	%p <sup>6)</sup>
Adjustable hysteresis ( $p_{hys}$ )	0		$p_{th}$	%p <sup>6)</sup>
Adjustable switching delay	1		500	ms
<b>Accuracy</b> <sup>7)</sup> (analog output) @ T= 25°C				
Ultra low pressure sensors (5, 10mbar)			±1.5	%FSO
Low pressure sensors (20, 50, 100 mbar)			±1.0	%FSO
Standard pressure sensors			±0.5	%FSO
<b>Overall error</b> <sup>8)</sup> (analog output) @ T= -25...85°C				
Ultra low pressure sensors (5, 10mbar)			±2.0	%FSO
Low pressure sensors (20, 50, 100 mbar)			±1.5	%FSO
Standard pressure sensors			±1.0	%FSO
<b>Accuracy (switching outputs) @ T = 25°C</b>				
Ultra low pressure sensors (5, 10 mbar)			±1.5	%FSO
Low pressure sensors (20, 50, 100 mbar)			±1.0	%FSO
Standard pressure sensors			±0.5	%FSO
<b>Overall error (switching outputs) @T = -25...85°C</b>				
Ultra low pressure sensors (5, 10 mbar)			±2.0	%FSO
Low pressure sensors (20, 50, 100 mbar)			±1.5	%FSO
Standard pressure sensors			±1.0	%FSO

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## Pressure sensor with one analog and two switching outputs

Parameter	Minimum	Typical	Maximum	Units
Long term stability			<0.5	%FSO/a
Supply voltage ( $V_S$ )	4.75	5	5.25	V
Current consumption (switching outputs open) <sup>9)</sup>			5	mA
Resolution A/D converter (analog output)	14			bits
Resolution D/A converter	11			bits
Resolution analog output signal	0.05			%FSO
Resolution of adjustment threshold <sup>10)</sup>			14	bit
Resolution of adjustment hysteresis <sup>10)</sup>			14	bit
Load resistance at analog output $R_L$	2k			$\Omega$
Capacitive load at analog output			50	nF
Ratiometricity error (@ $V_S = 4.75 \dots 5.25$ V)			500	ppm
Reaction time (10%...90% rise time)		1	2	ms
Load resistance at analog output $R_L$	2k			$\Omega$
Start-up time (after power on)			5	ms
Pressure changes	$10^6$			
Compensated temperature range	-25		85	$^{\circ}\text{C}$
Weight		3		g
Media compatibility	See "Specification notes" <sup>11) 12)</sup>			

**Table 3: Specifications**

### SPECIFICATION NOTES

- 1) The analog voltage output signal is ratiometric to the supply voltage
- 2) See *Table 1*
- 3) The Full Span Output (FSO) is the algebraic difference between the output signal at the specified minimum pressure and the output signal at the specified maximum pressure (see "Pressure ranges").
- 4) The two switching outputs (Switch 1 and Switch 2) are software configurable (with the AMS 5105 starter kit). The output modes can be set as normally open (NO), normally closed (NC) and to window mode. Thresholds and hysteresis can be set individually for each switching output. The default factory configuration of the two switching outputs is NO, with the thresholds set to 10% (Switch1) and 90% (Switch2). Hysteresis is set to 5% for both switching outputs.
- 5) Load resistance > 1 kOhm
- 6) 0%p refers to the specified minimum pressure and 100%p to the specified maximum pressure (see *Table 3*)
- 7) 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 this 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.
- 8) 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 $^{\circ}\text{C}$ ).
- 9) With active switching outputs the current consumption increases by the output currents of the switching outputs (see "Specifications/Logic switching outputs").
- 10) With the AMS 5105 starter kit software an adjustment of 0.1 %p (see note 6) is possible.
- 11) Media compatibility of pressure port 1 (for a description of port 1, see *Figure 3*): clean, dry gases, non-corrosive to silicon, RTV silicone rubber, gold (alkaline or acidic liquids can destroy the sensor).
- 12) Media compatibility of pressure port 2 (for a description of port 2, see *Figure 3*): fluids and gases non-corrosive to silicon, Pyrex, RTV silicone rubber.

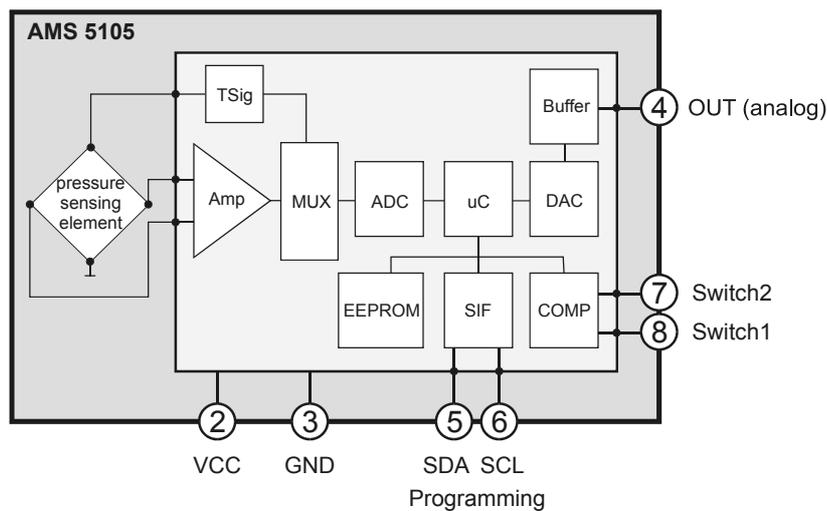
# AMS 5105

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### FUNCTIONAL DESCRIPTION

The pressure sensors/pressure switches in the AMS 5105 series combine a high-quality piezoresistive silicon sensing element with a modern, mixed-signal CMOS ASIC for signal conditioning with full digital correction on a ceramic substrate. This enables high-precision measurements and excellent drift and long-term stability.

The functional principle of the AMS 5105 is explained in *Figure 1*.



**Figure 1: Functional principle of AMS 5105**

The physical pressure is measured at AMS 5105's piezoresistive pressure sensing element where the pressure is converted into a differential voltage signal which is almost proportional to the pressure. This differential voltage signal is corrected and conditioned by the ASIC in multiple steps.

Firstly, the differential voltage signal from the sensing element is pre-amplified by the amplifier and transmitted by a multiplexer to the A/D converter (ADC). The ADC converts the signal into digital values with a resolution of 14 bits. The digitized signal is corrected and calibrated in the follow-on ASIC microcontroller.

Factory precision calibration of AMS 5105 sets the sensor-specific correction coefficients and stores these in the EEPROM for each sensor. 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 also measured at the piezoresistive measuring cell 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 values.

To generate the analog output signal the corrected digital pressure value is converted into an analog voltage by an 11-bit D/A converter (DAC). The standardized analog output voltage (0.5...4.5 V) at the sensor's PIN 4 (VOUT) is ratiometric to the supply voltage.

The logic output signals at the sensor's switching outputs PIN 8 (SWITCH 1) and PIN 7 (SWITCH 2) are generated by the ASIC's programmable comparator. This compares the corrected digital pressure value with the specific threshold and hysteresis values programmed and stored in the EEPROM. Depending on the selected configuration mode for the particular switching output the logic output signal is set to high or low.

The configuration setting (normally open, normally closed or window mode) and the settings of the particular thresholds, hysteresis and delay for the two switching outputs are stored in the EEPROM. These settings are changed by programming with the AMS 5105 starter kit via the sensor's programming interface at PIN 5 (SDA) and PIN 6 (SCL).

# AMS 5105

## Pressure sensor with one analog and two switching outputs

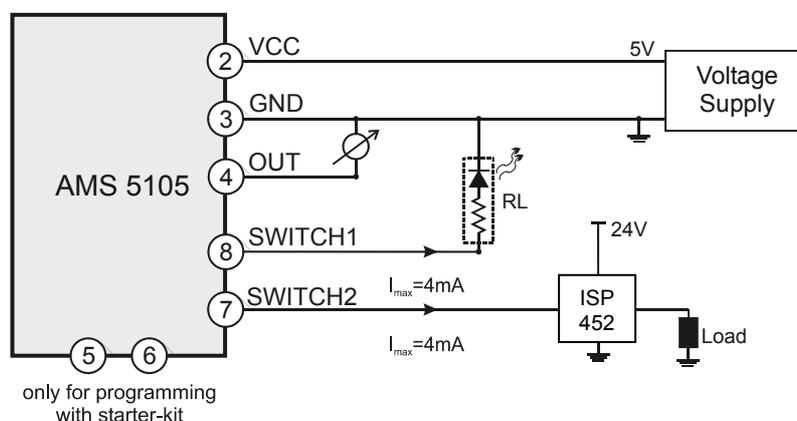
### INITIAL OPERATION

The sensors are connected up electrically by mounting them on a PCB. The principle electric circuitry of AMS 5105 with one analog and two switching outputs in use is shown in *Figure 2*.

For single use of the analog output it is sufficient to connect up PIN 2 (VCC), PIN 3 (GND) and PIN 4 (OUT).

In applications with a low switching current ( $< 4\text{mA}$ ) it is possible to connect the logic switching outputs PIN 8 (SWITCH1) and PIN 7 (SWITCH2) directly to the load (referenced to VCC or GND). For greater switching currents (i.e. when driving a relay) or if higher voltages are to be switched ( $> V_{cc}$ ), an external power transistor is necessary, such as an intelligent power FET (e.g. a PROFET ISP452 as shown in the example at PIN 7 in *Figure 2*) or a power Darlington transistor (i.e. a TIP121).

PIN 5 and PIN 6 are for programming AMS 5105 only (configuration of the switching outputs and adjustment of the thresholds and hysteresis) using the starter kit (see section "Additional Equipment").



**Figure 2: Principle electric circuitry (example)**

The pressure connection is made using the two metal pressure ports (hose connectors) on top of the AMS 5105. Depending on the type of AMS 5105 and the measuring pressure, either one or two of the pressure ports are connected up to the measuring media/volume.

For the pressures at port 1 and port 2 (for definition see *Figure 3*) the following requirements have to be fulfilled (according to the definition  $p_1$  = pressure at port 1 and  $p_2$  = pressure at port 2):

Differential/relative pressure sensors:	$p_1 > p_2$
Bidirectional differential sensors:	$p_1 > p_2$ or $p_1 < p_2$ possible.
Absolute pressure sensors, barometric sensors:	$p_1$ = measuring pressure.

#### Notes:

1. The guidelines governing media compatibility must be taken into account here (see "Specification notes").
2. For pressure connections up to 2 bar Analog Microelectronics recommends a silicone tubing (inner diameter  $\varnothing=2\text{mm}$ , outer diameter  $\varnothing=6\text{mm}$ ).
3. ESD precautions are necessary, it is essential to ground machines and personnel properly during assembly and handling of the device

### Configuring switching outputs

By factory programming the two switching outputs are set to standard configuration (see specification note 6). Using the relevant starter kit (see section Additional Equipment) the customer can select the basic switching function (off, normally open, normally closed, window mode) and adjust the specific threshold, hysteresis and a delay for each switching output. For a detailed description of the switching functions and the possible adjustments see the document "User Guide USB Starter Kit AMS 5105".

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## Pressure sensor with one analog and two switching outputs

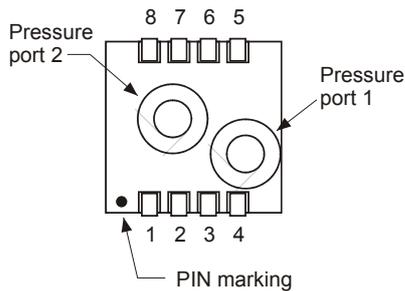
### DIMENSIONS AND PINOUT

AMS 5105 pressure sensors/switches come in a dual in-line package (DIP) for assembly on printed circuit boards.

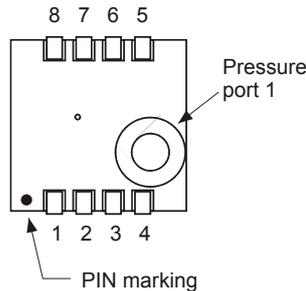
Figure 3 below gives the pinout and dimensions of the dual in-line package.

#### Pinout and pressure connection:

##### Differential types:



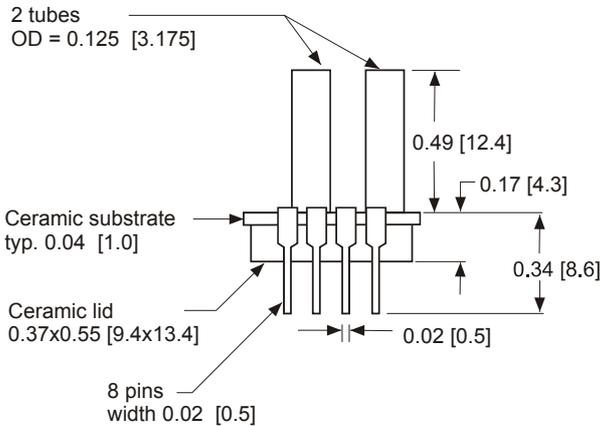
##### Absolute, barometric types:



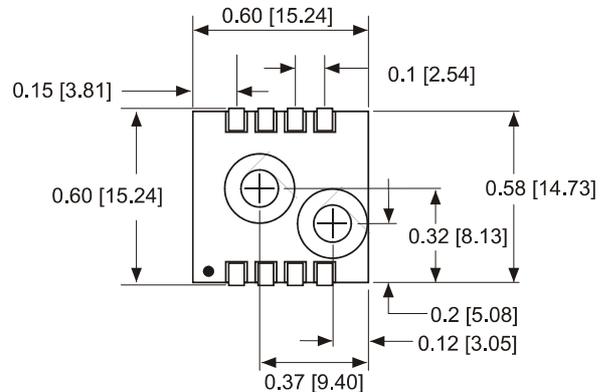
Pin	Description
1	N.C.
2	VCC
3	GND
4	OUT
5	SDA
6	SCL
7	SWITCH2
8	SWITCH1

#### Package dimensions:

##### Side view :



##### Top view :



All dimensions in inches [mm]

Figure 3: Dimensions

All pressure sensors/switches in the AMS 5105 series are maintenance free during their lifetime.

#### Notes:

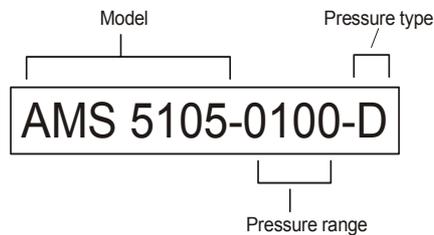
1. A package without tubes (for O-ring sealing) is also possible.
2. SMD Pins are available on request

# AMS 5105

## Pressure sensor with one analog and two switching outputs

### INFORMATION FOR ORDERING

Ordering code:



Pressure range:

Pressure range code	mbar	PSI	kPa
0005	5	0.073	0.5
0010	10	0.145	1.0
0020	20	0.290	2.0
0050	50	0.725	5.0
0100	100	1.450	10
0200	200	2.901	20
0350	350	5.076	35
1000	1000	14.50	100
1200	1200	17.40	120
2000	2000	29.01	200
4000	4000	58.02	400
7000	7000	101.5	700

Table 4: Pressure ranges

Pressure type:

Pressure type code	Available pressure ranges
D differential / relative (gage)	0...5 mbar to 0...7 bar
D-B bidirectional differential	-5 / +5 mbar to -1000 / +1000 mbar
A absolute	0...1000 mbar
B barometric (absolute)	700...1200 mbar

Table 5: Pressure types

### ADDITIONAL EQUIPMENT

A starter kit with software is available for AMS 5105 pressure sensors. Using a standard PC with an USB-port the starter kit permits easy configuration and adjustment of the two switching outputs. Together with the relevant software the customer can configure the two independent switching outputs of the AMS 5105 as normally open, normally close or in window mode and can adjust the specific thresholds, hysteresis and switching delays for both switching outputs individually.

Ordering code	Description
USB starter kit AMS 5105	AMS 5105 - starter kit (2 PCBs with software)

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