

AMS 5105

Pressure sensor/switch

with one analog and two switching outputs



Analog - Digitale
Mikromechanische
Sensorsysteme

GENERAL DESCRIPTION

The AMS 5105 series combines high-precision OEM pressure sensors with programmable pressure switches in one package. AMS 5105 has an 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 to 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 pressure ranges from 0...5 mbar up to 0...7 bar, an absolute pressure variant for 0...1 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.

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 NO, NC or in window mode
- Thresholds and hysteresis can be set individually
- Differential/relative, bidirectional and absolute (barometric) versions
- High accuracy at RT
- Small overall error within a temperature range of -25 to 85°C
- High overpressure reserve
- Small DIP package
- RoHS compliant

TYPICAL APPLICATIONS

- Pressure measurement/control
- Vacuum measurement/control
- Process control
- Fluid level measurement
- Gas flow
- Medical instrumentation
- HVAC

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PRESSURE RANGES

Sensor type (code)	Pressure type	Pressure range in mbar	Burst pressure in bar	Pressure range in PSI	Burst pressure in PSI
Ultra low pressure					
AMS 5105-0005-D	differential / relative	0 ... 5	5	0 ... 0.0725	72
AMS 5105-0010-D	differential / relative	0 ... 10	5	0 ... 0.145	72
AMS 5105-0005-D-B	bidirectional differential	-5 / +5	5	-0.0725 / +0.0725	72
AMS 5105-0010-D-B	bidirectional differential	-10 / +10	5	-0.145 / +0.145	72
Low pressure					
AMS 5105-0020-D	differential / relative	0 ... 20	5	0 ... 0.290	72
AMS 5105-0050-D	differential / relative	0 ... 50	5	0 ... 0.725	72
AMS 5105-0100-D	differential / relative	0 ... 100	5	0 ... 1.450	72
AMS 5105-0020-D-B	bidirectional differential	-20 / +20	5	-0.290 / +0.290	72
AMS 5105-0050-D-B	bidirectional differential	-50 / +50	5	-0.725 / +0.725	72
AMS 5105-0100-D-B	bidirectional differential	-100 / +100	5	-1.450 / +1.450	72
Standard pressure					
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 5105-1200-B	barometric	750 ... 1200	5	10.88 ... 17.4	72

Table 1: AMS 5105 standard pressure ranges (other ranges on request)

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BOUNDARY CONDITIONS

Parameter	Minimum	Typical	Maximum	Unit
Maximum supply voltage: V_S (max)			6.5	V
Operating temperature: T_{op}	-25		85	°C
Storage temperature: T_{amb}	-40		125	°C

SPECIFICATIONS

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

Parameter	Minimum	Typical	Maximum	Unit
Analog output signal ¹⁾				
@ specified minimum pressure (see Pressure range ²⁾)		0.5		V
@ specified maximum pressure (see Pressure range ²⁾)		4.5		V
Full span output (FSO) ³⁾		4		V
without pressure (bidirectional differential)		2.5		V
Logic switching outputs ⁴⁾				
Output-Low-Level ⁵⁾	0		10	% V_S
Output-High-Level ⁵⁾	90		100	% V_S
Max. output current (switching outputs)	4			mA
Adjustable threshold (p_{th})	0		100	%p ⁶⁾
Adjustable hysteresis	0		100	%p _{th}
Delay time		1		ms
Accuracy ⁷⁾ (analog output) @ $T = 25^\circ C$				
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
Total accuracy ⁸⁾ (analog output) @ $T = -25...85^\circ C$				
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
Accuracy (switching outputs) @ $T = 25^\circ C$				
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
Total accuracy (switching outputs) @ $T = -25...85^\circ C$				
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
Supply voltage (V_S)	4.75	5	5.25	V
Current consumption (switching outputs open) ⁹⁾			5	mA
Resolution of A/D converter	14		14	bit

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Resolution of D/A converter (analog output)	11		11	bit
Resolution of adjustment threshold ¹⁰⁾			14	bit
Resolution of adjustment hysteresis ¹⁰⁾			14	bit
Load resistance at analog output R _L	2k			Ω
Capacitive load at analog output			50	nF
Ratiometricity error (@ V _S = 4.75...5.25 V)			500	ppm
Reaction time (10%...90% rise time)		1	2	ms
Start-up time (after power on)			5	ms
Pressure changes	10 ⁶			
Compensated temperature range	-25		85	°C
Weight		3		g
Media compatibility	See "Specification notes" ¹¹⁾ ¹²⁾			

Table 2: 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 (cf. *Table 1*)
- 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 total accuracy is defined as the overall error, i.e. the maximum deviation of the measurement value from the ideal characteristic curve in %FSO across the entire temperature range (-25...85°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 01 %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.

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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*.

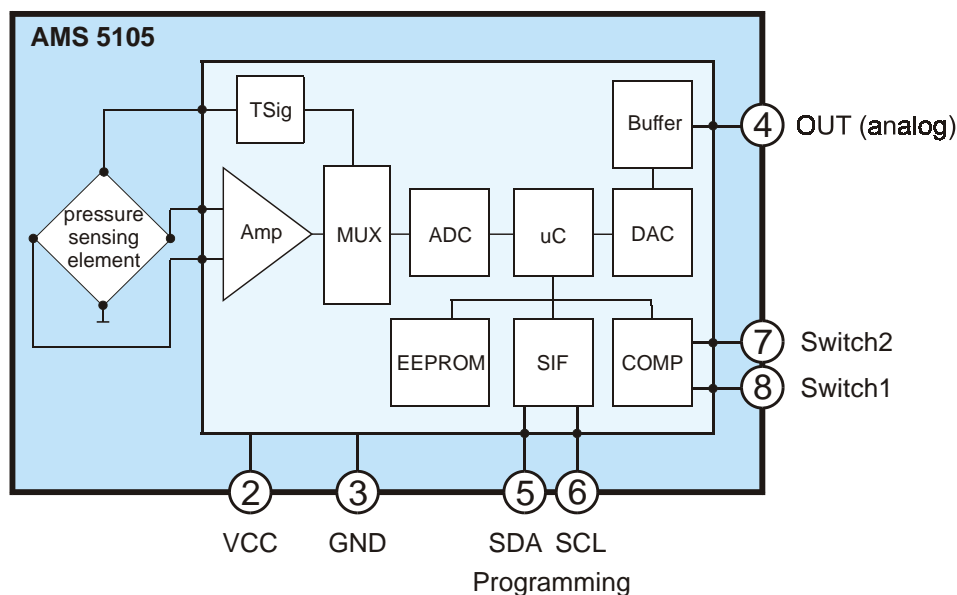


Figure 1: Functional principle of AMS 5105

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 in the EEPROM. Depending on the configuration mode for the particular switching output the logic output signal is set to high or low.

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

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 BSP452 as shown in the example at PIN 7 in *Figure 2*) or a power Darlington transistor (i.e. a TIP121).

In normal operating mode PIN 5 and PIN 6 are not used. 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 "Additional equipment").

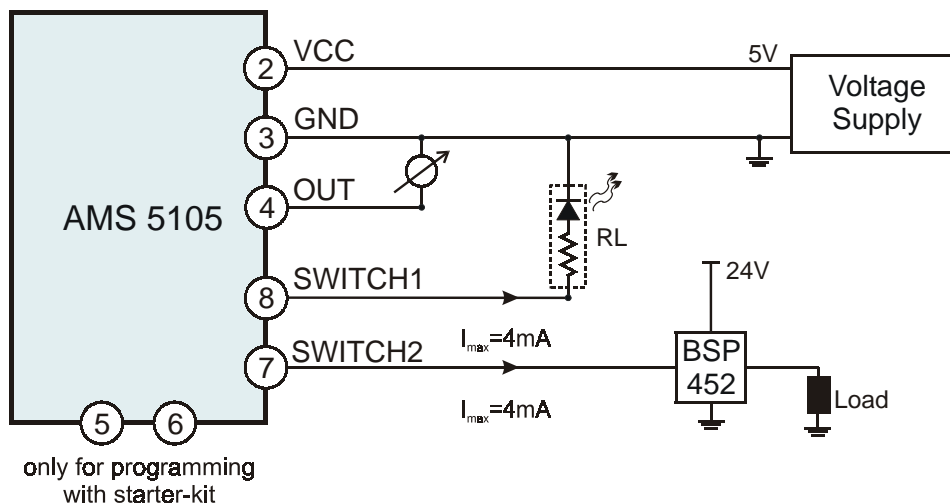


Figure 2: Principle electric circuitry (example)

The pressure connection is made using the two metal pressure ports (hose connectors) on the sensor. 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 (see definition in *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.

The guidelines governing media compatibility must be taken into account here (see "Specification notes").

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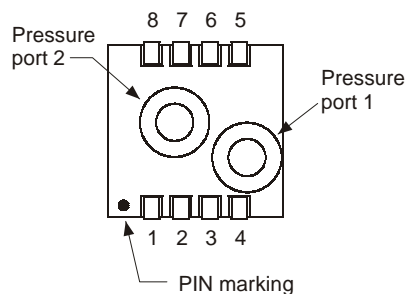
DIMENSIONS AND PINOUT

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

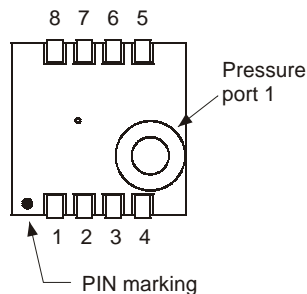
Figure 3 below gives the pinout and dimensions of the dual in-line package.

Pinout and pressure connection:

Differential types:



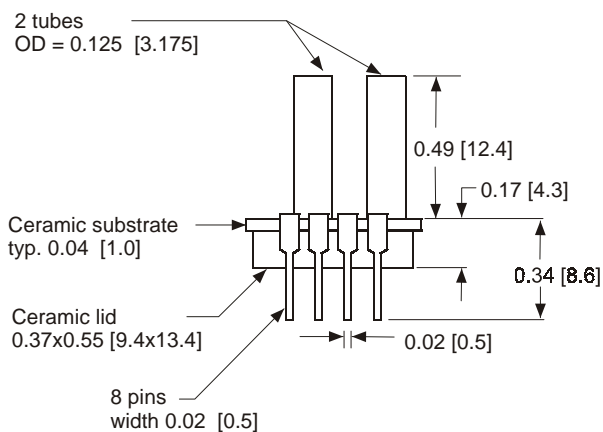
Absolute, barometric types:



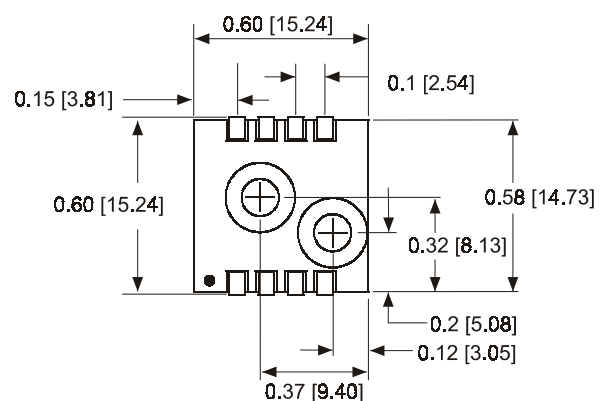
Pin	Description
1	N.C.
2	VCC
3	GND
4	OUT
5	SDA
6	SCL
7	SWITCH2
8	SWITCH1

Package dimensions:

Side view :



Top view :



All dimensions in inches [mm]

Figure 3: Dimensions

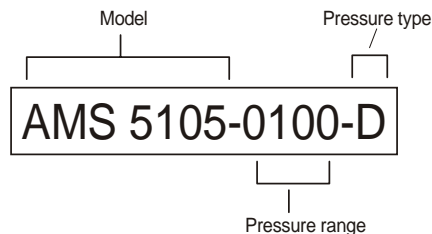
All pressure sensors/switches in the AMS 5105 series are maintenance free during their lifetime.

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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 3: 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 4: Pressure types

ADDITIONAL EQUIPMENT

A starter kit (with software) is available for AMS 5105 pressure sensors/switches. The starter kit permits easy customization of the switching ports using a standard PC via the PC's serial RS232 interface. It is thus possible to individually set the output mode of the two switching outputs (normally open, normally closed or window mode) and the specific thresholds and hysteresis.