AMS 6916
Board mount pressure sensor with ratiometric analog output

FEATURES

- **Piezoresistive pressure sensor with amplified analog output**

- **Calibrated and temperature compensated**

- **Ratiometric voltage output, 0.5 … 4.5 V**

- **Digital signal conditioning, 12 bit output resolution**

- **Differential, relative (gage), bidirectional differential, absolute and barometric versions**

- **Accuracy of 0.5 %FSO at room temperature (for pressure ranges > 10 mbar)**

- **Small overall error (TEB) within a temperature range of 0 … 60 °C**

- **Supply voltage range 4.75 … 5.25 V**

- **Operating temperature range -25 … 85 °C**

- **High long term stability**

- **Short circuit protected output and diagnostic functions**

- **Miniaturized DIL package for PCB assembly**

- **Horizontal and vertical pressure port configurations available**

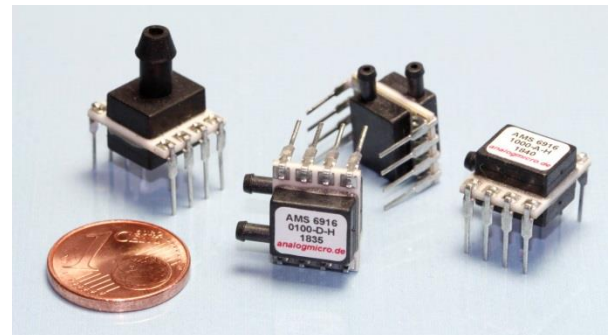- **Ready to use**

- **RoHS and REACH compliant**

GENERAL DESCRIPTION

AMS 6916 is an OEM pressure sensors series offering an analog voltage output in a compact DIL package for assembly on printed circuit boards (PCBs). The high-precision pressure sensors feature a short circuit protected ratiometric 0.5 … 4.5 V output and diagnostic functions indicating sensor errors.

The sensors in the AMS 6916 series are digitally calibrated, linearized and temperature compensated with an operating temperature range of -25 … 85 °C. Combining a high quality piezoresistive MEMS sensing element with a modern, mixed-signal conditioning ASIC on a ceramic substrate the AMS 6916 achieves a small total error band together with excellent long term stability.

AMS 6916 sensors are available for all pressure types in various pressure ranges: differential / relative pressure sensors in ranges from 0 … 5 mbar up to 0 … 1 bar, absolute pressure sensors for 0 … 500 mbar and 0 … 1 bar and a barometric type (700 … 1200 mbar). Bidirectional differential pressure sensors are offered in ranges from -5 … +5 mbar up to -1 … +1 bar. Custom specific pressure ranges or further modifications are available on request.

The robust AMS 6916 are especially suitable for precise low and medium differential pressure measurements in applications, where a consequent miniaturization is required.

TYPICAL APPLICATIONS

- Static and dynamic pressure measurement

- Industrial process control

- Medical instrumentation

- Heating, Ventilation and Air Conditioning (HVAC)

- Barometric pressure measurement

- Vacuum monitoring

- Gas flow measurement

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PRESSURE RANGES AND TYPES

Pressure sensor code	Pressure type	Pressure range in mbar	Burst pressure[1] in bar	Pressure range in PSI	Burst pressure in PSI
Ultra low pressure					
AMS 6916-0005-D-…	differential (relative)	0 … 5	> 0.2	0 … 0.0725	> 3
AMS 6916-0005-D-B-…	bidirectional differential	-5 … +5	> 0.2	-0.0725 … +0.0725	> 3
AMS 6916-0010-D-…	differential (relative)	0 … 10	> 0.2	0 … 0.145	> 3
AMS 6916-0010-D-B-…	bidirectional differential	-10 … +10	> 0.2	-0.145 … +0.145	> 3
Low pressure					
AMS 6916-0020-D-…	differential (relative)	0 … 20	> 0.4	0 … 0.29	> 6
AMS 6916-0020-D-B-…	bidirectional differential	-20 … +20	> 0.4	-0.29 … +0.29	> 6
AMS 6916-0050-D-…	differential (relative)	0 … 50	> 1	0 … 0.725	> 15
AMS 6916-0050-D-B-…	bidirectional differential	-50 … +50	> 1	-0.725 … +0.725	> 15
AMS 6916-0100-D-…	differential (relative)	0 … 100	> 1	0 … 1.450	> 15
Standard pressure					
AMS 6916-0200-D-…	differential (relative)	0 … 200	> 1.7	0 … 2.901	> 25
AMS 6916-0200-G-…	relative	0 … 200	> 1.7	0 … 2.901	> 25
AMS 6916-0200-D-B-…	bidirectional differential	-200 … +200	> 1.7	-2.901 … +2.901	> 25
AMS 6916-0350-D-…	differential (relative)	0 … 350	> 1.7	0 … 5.076	> 25
AMS 6916-0350-G-…	relative	0 … 350	> 1.7	0 … 5.076	> 25
AMS 6916-0350-D-B-…	bidirectional differential	-350 … +350	> 1.7	-5.076 … +5.076	> 25
AMS 6916-1000-D-…	differential (relative)	0 … 1000	> 5	0 … 14.50	> 72
AMS 6916-1000-G-…	relative	0 … 1000	> 5	0 … 14.50	> 72
AMS 6916-1000-D-B-…	bidirectional differential	-1000 … +1000	> 5	-14.50 … +14.50	> 72
AMS 6916-0500-A	absolute	0 … 500	> 5	0 … 7.25	> 72
AMS 6916-1000-A	absolute	0 … 1000	> 5	0 … 14.5	> 72
AMS 6916-1200-B	barometric	700 … 1200	> 5	10.88 … 17.4	> 72

Table 1: **AMS 6916 standard pressure ranges (other ranges on request)**

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}	-25		85	°C
Common mode pressure p_{CM} [2]			16	bar

Table 2: **Maximum ratings**

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) 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 further differential pressure is applied.

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SPECIFICATIONS

All parameters apply to T_{op} = 25 °C and V_S = 5.0 V unless otherwise stated.

Parameter	Minimum	Typical	Maximum	Units
Analog output signal [1]				
@ specified minimum pressure (see "pressure ranges") [2]		0.5		V
@ specified maximum pressure (see "pressure ranges") [2]		4.5		V
Full span output (FSO) [3]		4		V
without pressure (bidirectional differential types)		2.5		V
Accuracy [4] @ T = 25 °C				
Ultra low pressure sensors (5, 10 mbar)			± 1.0	%FSO
Low pressure sensors (20, 50, 100 mbar)			± 0.5	%FSO
Standard pressure sensors (> 100 mbar)			± 0.5	%FSO
Overall error [5] (TEB) @ T = 0 … 60 °C				
Ultra low pressure sensors (5, 10 mbar)			± 1.5	%FSO
Low pressure sensors (20, 50, 100 mbar)			± 1.0	%FSO
Standard pressure sensors (> 100 mbar)			± 1.0	%FSO
Long term stability		0.2 [6]	< 0.5	%FSO/a
Resolution A/D converter		14		bits
Resolution analog output signal		12		bits
Supply voltage range (V_S)	4.75	5.00	5.25	V
Overall ratiometricity error (@ V_S = 4.9 … 5.1 V) [7]			± 0.1	%FSO
Current consumption			3	mA
Reaction time (10 % … 90 % rise time)		1	2	ms
Start up time (Power up to data ready)			8	ms
Load resistance at output R_L to GND [8]	5			kΩ
Capacitive load			15	nF
Diagnostic output level	0 … 2.5 and 97.5 … 100			% V_S
Pressure changes	10^6			
Compensated temperature range	-25		85	°C
Weight		1.5		g
Media compatibility	See "Specification notes" [9] [10]			

***Table 3*: Specifications**

SPECIFICATION NOTES

1) The analog output signal is ratiometric to the supply voltage.

2) For pressure ranges see *Table 1*.

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 "Pressure ranges").

4) Accuracy is defined as the measurement value's maximum deviation 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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5) The overall error (TEB) is defined as the measurement value's maximum deviation from the ideal characteristic curve in %FSO in the temperature range of 0 … 60 °C.

6) The long term stability is tested on a sample base.

7) The ratiometricity error is defined as the maximum deviation of the measurement output voltage at a supply voltage V_S from the measurement output voltage at 5 V supply multiplied with $V_S / 5\,V$ at room temperature (RT) in %FSO at any pressure within the specified range. V_S has to be in the specified range.

8) A load resistor of $R_L = 10\,k\Omega$ is recommended, if the diagnostic feature is used to detect a power loss.

9) Media compatibility of pressure port 1 (for a description of port 1, see *Figure 3*): fluids and gases non-corrosive to LCP, silicon, Pyrex, RTV silicone rubber and epoxy.

10) Media compatibility of pressure port 2 (for a description of port 2, see *Figure 3*): clean, dry gases, non-corrosive to LCP, silicon, RTV silicone rubber, epoxy, gold (alkaline or acidic liquids can destroy the sensor).

FUNCTIONAL DESCRIPTION

The pressure sensors from the AMS 6916 series combine a high quality, piezoresistive MEMS silicon sensing element with a modern mixed-signal CMOS ASIC for digital signal-conditioning on a ceramic substrate. This combination enables high precision measurements and excellent drift and long-term stability.

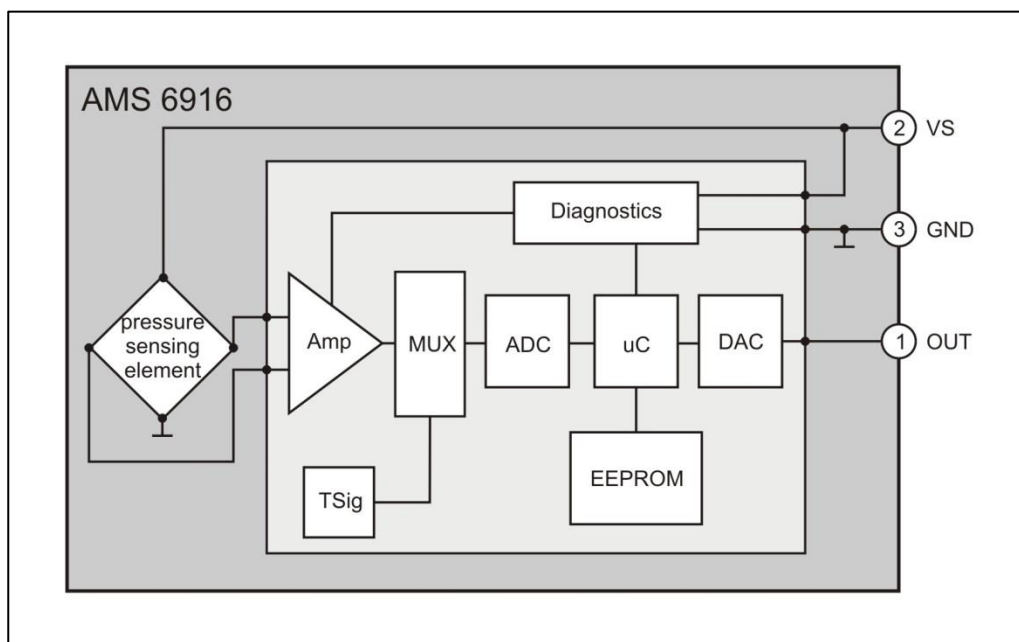The functional principle of the AMS 6916 sensors is explained using *Figure 1*.

Figure 1: Functional principle

The physical pressure measurement is done at AMS 6916's piezoresistive pressure sensing element, which converts the applied pressure into a differential voltage signal almost proportional to the applied pressure. This differential voltage signal is corrected and conditioned by the connected ASIC in multiple steps.

At first the differential voltage signal from the sensing element is pre-amplified by the ASIC's amplifier block (Amp) and transmitted to the integrated A/D converter (ADC) by the multiplexer stage (MUX). The ADC converts this voltage signal into a digital value with a resolution of 14 bit. This digitized pressure signal is corrected and calibrated in the subsequent ASIC microcontroller (uC) block.

During AMS 6916's factory calibration 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's temperature reference block (TSig) and is transmitted by the multiplexer to the ADC, where it is digitized. The ASIC's microcontroller block runs a cyclic program, which continuously calculates the current standardized and corrected digital pressure value using the current digitized pressure and temperature values as well as the stored correction coefficients.

Based on the linearized, temperature compensated and calibrated digital pressure value calculated by the microcontroller, the 12-bit D/A converter (DAC) block generates a ratiometric analog output voltage signal, which is factory calibrated to 0.5 … 4.5 V at 5 V supply voltage.

AMS 6916's ideal output voltage V_{OUT}^{rat} at pin 1 (OUT) is a linear function of the applied pressure p and the supply voltage V_S.

It can be calculated by:

$$V_{OUT}^{rat}(p,\ V_S) = \left(\frac{p - p_{min}}{p_{max} - p_{min}} \cdot 0.8 + 0.1 \right) \cdot V_S \tag{1}$$

Therein p_{min} and p_{max} are the sensor's specified minimum and maximum pressure, given by the sensor's pressure range in *Table 1*. The applied measurement pressure p is defined by

$p = p_1 - p_2$ for differential and bi-directional types

$p = p_1$ for relative types (with p_1 referenced to ambient pressure)

$p = p_2$ for absolute and barometric types (with p_2 referenced to vacuum)

with the definition p_1 = pressure at port 1 and p_2 = pressure at port 2 of AMS 6915 (for port definition see *Figure 3*).

Furthermore the output at pin 1 (OUT) is short circuit protected against GND and V_s.

AMS 6916's diagnostic function

The AMS 6916 series has integrated diagnostic features to ensure that the sensor is working properly. The proof of functionality is done by the signal conditioning ASIC's diagnostics block, which is able to detect the following errors:

- failures in EEPROM contents (checked after Power On)
- failures in the pressure sensing element's electrical connections (checked during measurement operation)
- failures in the sensor's power or ground connection (Vs or GND loss, checked during measurement operation).

If the diagnostics block detects an error, the output voltage is set to a value in the diagnostic range, with $V_{OUT} \leq 0.025 \cdot V_s$ or $V_{OUT} \geq 0.975 \cdot V_s$.

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INITIAL OPERATION

AMS 6916 is connected electrically by assembly on a PCB or by mounting it on a suitable socket[1]. Pins 1 to 3 have to be connected as shown in *Figure 2*, pins 4 to 8 are not connected internally, so they can be left open or shorted to GND.
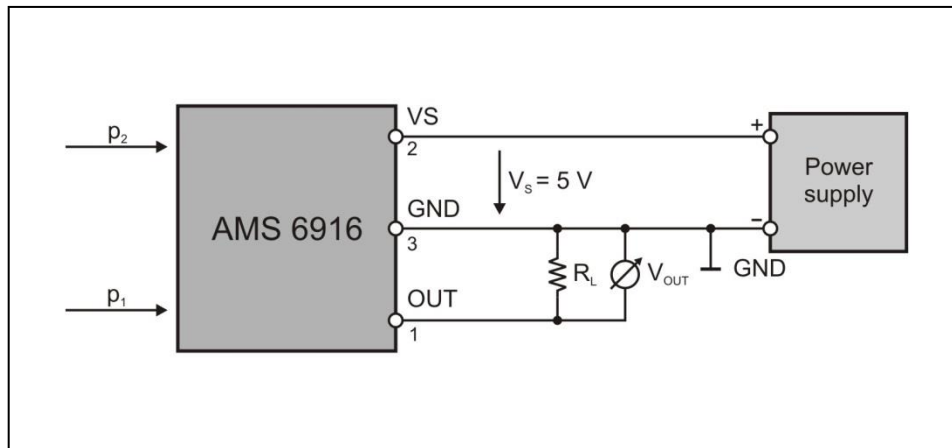

Figure 2: **Principle electrical circuit**

The pressure connection is established using suitable hoses[2] attached to AMS 6916's barbed pressure ports. Depending on the type of sensor and the type of pressure measurement one or two pressure ports have to be connected up to the measuring media / volumes.

For the pressures at port 1 and 2 (for port 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):

for differential pressure types[3] (AMS 6916-XXXX-D-…):	$p_1 > p_2$
for relative / gage pressure types (AMS 6916-XXXX-G-…):	$p_1 > p_{ambient}$, p_1 = measuring pressure
for bidirectional differential pressure types (AMS 6916-XXXX-D-B-…):	$p_1 > p_2$ and $p_1 < p_2$ possible
for absolute pressure types (AMS 6916-XXXX-A-…):	p_2 = measuring pressure
for barometric pressure types (AMS 6916-XXXX-B-…):	p_2 = measuring pressure

The guidelines on media compatibility have to be taken into account (see "Specification notes", 9) and 10)).

Notes:

1. ESD precautions are necessary, it is essential to ground machines and personnel properly during assembly and handling of the device
2. For horizontal pressure port configuration Analog Microelectronics recommends a silicone hose tubing with inner diameter Ø = 1.6 mm, outer diameter Ø = 3.2 mm and for vertical pressure port configuration a silicone hose tubing with inner diameter Ø = 2 mm, outer diameter Ø = 6 mm.
3. In general a differential pressure sensor can also be used for relative pressure measurements. In case of positive pressure relative to ambient pressure the measurement pressure has to be applied to port 1. For negative pressure relative to ambient pressure the measurement pressure is applied to port 2.

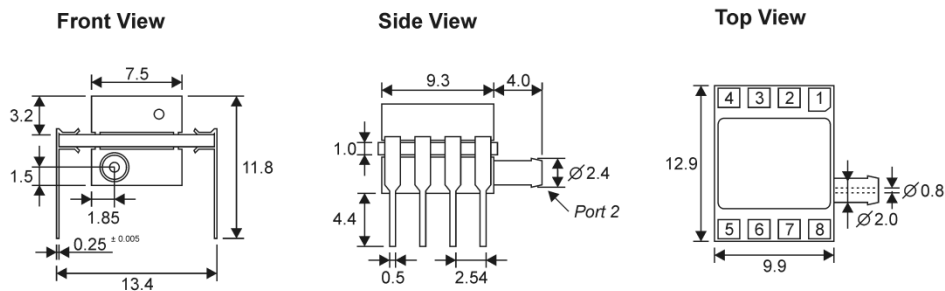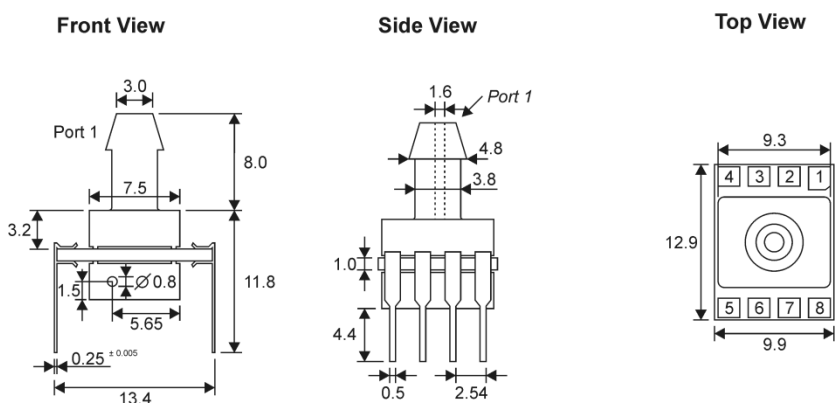## DIMENSIONS AND PINOUT

AMS 6916-xxxx-D-H-DIL & AMS 6916-xxxx-D-B-H-DIL (horizontal pressure port configuration):
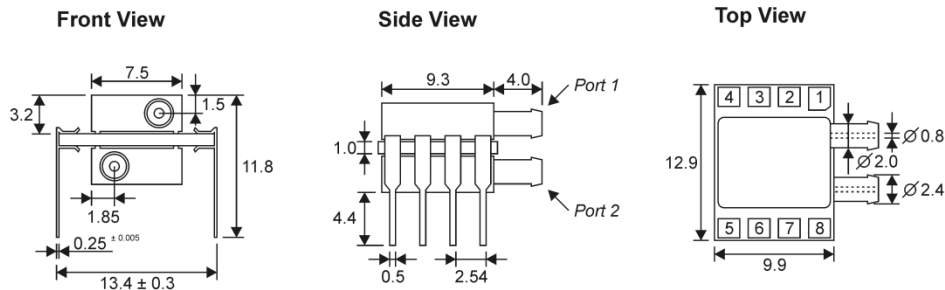
AMS 6916-xxxx-A-H-DIL & AMS 6916-1200-B-H-DIL (horizontal pressure port configuration):

AMS 6916-xxxx-G-V-DIL (vertical pressure port configuration):

Pinout:

Pin	Description
1	OUT
2	VS
3	GND
4 - 8	N.C.

All dimensions in mm, tolerances: ±0.1 mm unless otherwise noted

Figure 3: **AMS 6916 dimensions and pinout**

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ORDERING CODES

Horizontal pressure port configuration (DIL package)

Ordering Code	mbar	kPa	PSI
Differential pressure types (-D)			
AMS 6916-0005-D-H-DIL	0 .. 5	0 .. 0.5	0 .. 0.0725
AMS 6916-0010-D-H-DIL	0 .. 10	0 .. 1	0 .. 0.145
AMS 6916-0020-D-H-DIL	0 .. 20	0 .. 2	0 .. 0.290
AMS 6916-0050-D-H-DIL	0 .. 50	0 .. 5	0 .. 0.725
AMS 6916-0100-D-H-DIL	0 .. 100	0 .. 10	0 .. 1.450
AMS 6916-0200-D-H-DIL	0 .. 200	0 .. 20	0 .. 2.901
AMS 6916-0350-D-H-DIL	0 .. 350	0 .. 35	0 .. 5.076
AMS 6916-1000-D-H-DIL	0 .. 1000	0 .. 100	0 .. 14.50
Bidirectional differential pressure types (-D-B)			
AMS 6916-0005-D-B-H-DIL	-5 .. +5	-0.5 .. +0.5	-0.0725 .. +0.0725
AMS 6916-0010-D-B-H-DIL	-10 .. +10	-1 .. +1	-0.145 .. +0.145
AMS 6916-0020-D-B-H-DIL	-20 .. +20	-2 .. +2	-0.290 .. +0.290
AMS 6916-0050-D-B-H-DIL	-50 .. +50	-5 .. +5	-0.725 .. +0.725
AMS 6916-0100-D-B-H-DIL	-100 .. +100	-10 .. +10	-1.450 .. +1.450
AMS 6916-0200-D-B-H-DIL	-200 .. +200	-20 .. +20	-2.901 .. +2.901
AMS 6916-0350-D-B-H-DIL	-350 .. +350	-35 .. +35	-5.076 .. +5.076
AMS 6916-1000-D-B-H-DIL	-1000 .. +1000	-100 .. +100	-14.50 .. +14.50
Absolute pressure types (-A)			
AMS 6916-0500-A-H-DIL	0 .. 500	0 .. 50	0 .. 7.25
AMS 6916-1000-A-H-DIL	0 .. 1000	0 .. 100	0 .. 14.5
Barometric (absolute) pressure types (-B)			
AMS 6916-1200-B-H-DIL	700 .. 1200	70 .. 120	10.88 .. 17.4

Vertical pressure port configuration (DIL package)

Ordering Code	mbar	kPa	PSI
Relative (Gage) pressure types (-G)			
AMS 6916-0200-G-V-DIL	0 .. 200	0 .. 20	0 .. 2.901
AMS 6916-0350-G-V-DIL	0 .. 350	0 .. 35	0 .. 5.076
AMS 6916-1000-G-V-DIL	0 .. 1000	0 .. 100	0 .. 14.50

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