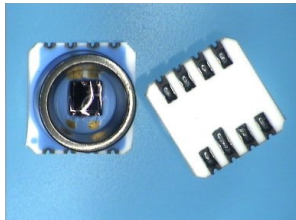


MS54xx

MINIATURE SMD PRESSURE SENSOR



- 1, 7, 12, and 70 bar absolute pressure range
- Uncompensated
- Piezoresistive silicon micromachined sensor
- Miniature surface mount
- Ceramic or PCB carrier
- Low noise, high sensitivity, high linearity
- RoHS-compatible & Pb-free*

DESCRIPTION

The MS54xx SMD pressure sensor series is designed for pressure sensor systems with highest demands on resolution and accuracy. The device consists of a silicon micromachined pressure sensor die mounted on a 6.2 x 6.4 mm ceramic carrier or a 6.1 x 6.3 mm PCB protected by a metal or plastic cap. The MS54xx can be delivered in a high sensitivity version giving a maximal output voltage or in a high linearity version. Both versions provide an output voltage directly proportional to the applied pressure.

Carrier	Full Scale Pressure	High Sensitivity Versions		High Linearity Versions	
		Product Code	Full Scale Span / Linearity	Product Code	Full Scale Span / Linearity
Ceramic	1 bar	MS5401-AM	240 mV / $\pm 0.2\%$ FS	MS5401-BM	150 mV / $\pm 0.05\%$ FS
	7 bar	MS5407-AM	392 mV / $\pm 0.2\%$ FS		
	12 bar			MS5412-BM	150 mV / $\pm 0.05\%$ FS
	70 bar	MS5470-AM	310 mV / $\pm 0.25\%$ FS		
PCB	1 bar	MS5401-APF	240 mV / $\pm 0.2\%$ FS	MS5401-BPF	150 mV / $\pm 0.05\%$ FS

FEATURES

- Low cost SMD package
- Small size
- High reliability, low drift
- -40 °C to +125 °C operation range
- Gel protection against humidity and water

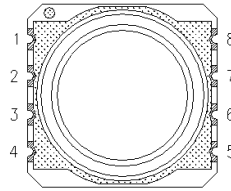
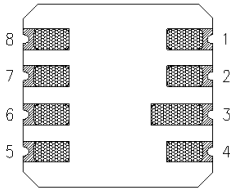
APPLICATIONS

- Brake systems
- High resolution altimeters, variometers
- Barometers
- Engine management
- Water proof watches and diving computers
- Tire pressure monitoring systems (TPMS)

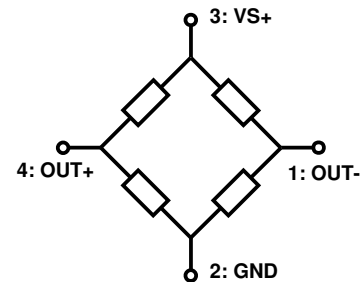
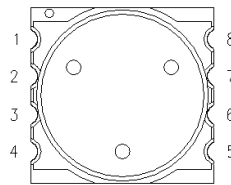
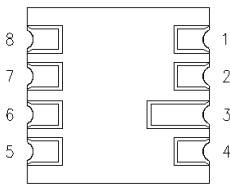
* The European RoHS directive 2002/95/EC (Restriction of the use of certain Hazardous Substances in electrical and electronic equipment) bans the use of lead, mercury, cadmium, hexavalent chromium and polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE).

PIN CONFIGURATION

VERSION WITH CERAMIC CARRIER AND METAL CAP



VERSION WITH PCB CARRIER AND PLASTIC CAP



PIN DESCRIPTION

Pin Name	Pin No.	Function
OUT-	1	Negative output voltage of Wheatstone bridge
GND	2	Ground
VS+	3	Supply voltage of Wheatstone bridge
OUT+	4	Positive output voltage of Wheatstone bridge

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Conditions	Min	Max	Unit	Notes
Supply voltage	VS+	Ta = 25 °C	-	20	V	
Storage temperature	T _s		-40	+125	°C	
Overpressure	MS5401-AM MS5401-APF MS5401-BPF MS5401-BM MS5407-AM MS5412-BM MS5470-AM	P Ta = 25 °C	-	5 5 5 10 21 30 180	bar	- - - (1) (2) - -

NOTES

- 1) The MS5401-BM is qualified referring to ISO Standard 2281 and can withstand an absolute pressure of 11 bar in salt water or 100 m water respectively.
- 2) The MS5407-AM is qualified referring to ISO Standard 2281 and can withstand an absolute pressure of 21 bar in salt water or 200 m water respectively.

ELECTRICAL CHARACTERISTICS

HIGH SENSITIVITY VERSIONS

(VS+ = 5 V; Ta = 25°C)

	Parameter	Min	Typ	Max	Unit	Notes
MS5401-AM MS5401-APF	Operating pressure range	0	-	1	bar	
	Full-scale span (FS)	190	240	290	mV	
	Sensitivity	190	240	290	mV/bar	
	Linearity	-	±0.15	±0.4	% FS	1, 6
MS5407-AM	Operating pressure range	0	-	7	bar	
	Full-scale span (FS)	322	392	462	mV	
	Sensitivity	46	56	66	mV/bar	
	Linearity	-	±0.15	±0.4	% FS	1, 6
MS5470-AM	Operating pressure range	0	-	70	bar	
	Full-scale span (FS)	250	310	370	mV	
	Sensitivity	3.6	4.4	5.3	mV/bar	
	Linearity	-	±0.25	±0.50	% FS	1, 6
All Ranges	Operating temperature range	-40	-	125	°C	
	Zero pressure offset	-40	0	40	mV	
	Pressure hysteresis	-	-	±0.20	% FS	2, 6
	Temperature hysteresis	-	0.3	0.8	% FS	3, 6
	Repeatability	-	-	±0.20	% FS	4, 6
	Bridge resistance	3.0	3.4	3.8	kΩ	
	Temperature coefficient of resistance	+2 400	2 900	+3 300	ppm/°C	5, 6
Temperature coefficient of span	-1 500	-1 900	-2 300	ppm/°C	5, 6	
Temperature coefficient of offset	-80	-	+80	μV/°C	5, 6	

NOTES

- 1) Deviation at one half full-scale pressure from the least squares best line fit over pressure range.
- 2) Maximum difference of output voltage after 1 pressure cycle at any pressure within the operating pressure range.
- 3) Maximum difference in offset after one thermal cycle from -40°C to +125°C.
- 4) Same as 2) after 10 pressure cycles.
- 5) Slope of the end-point straight line from 25°C to 60°C.
- 6) Not 100% tested.

ELECTRICAL CHARACTERISTICS (CONT.)

HIGH LINEARITY VERSIONS

(VS+ = 5 V; Ta = 25 °C)

	Parameter	Min	Type	Max	Unit	Notes
MS5401-BM MS5401-BPF	Operating pressure range	0	-	1	bar	8
	Full-scale span (FS)	120	150	180	mV	
	Sensitivity	120	150	180	mV/bar	
	Linearity	-	±0.05	±0.2	% FS	1, 6
MS5412-BM	Operating pressure range	0	-	12	bar	8
	Full-scale span (FS)	120	150	180	mV	
	Sensitivity	10	12.5	15	mV/bar	
	Linearity		±0.05	±0.15	% FS	1, 6
All Ranges	Operating temperature range	-40	-	125	°C	
	Zero pressure offset	-40	0	40	mV	
	Pressure hysteresis	-	-	±0.20	% FS	2, 6
	Temperature hysteresis	-	0.3	0.8	% FS	3, 6
	Repeatability	-	-	±0.20	% FS	4, 6, 7
	Bridge resistance	3.0	3.4	3.8	kΩ	
	Temperature coefficient of resistance	+2 400	2 900	+3 300	ppm/°C	5, 6
Temperature coefficient of span	-1 500	-1 900	-2 300	ppm/°C	5, 6	
Temperature coefficient of offset	-80	-	+80	µV/°C	5, 6	

NOTES

- 1) Deviation at one half full-scale pressure from the least squares best line fit over pressure range.
- 2) Maximum difference of output voltage after 1 pressure cycle at any pressure within the operating pressure range.
- 3) Maximum difference in offset after one thermal cycle from -40 °C to +125 °C.
- 4) Same as 2) after 10 pressure cycles.
- 5) Slope of the end-point straight line from 25 °C to 60 °C.
- 6) Not 100% tested.
- 7) MS5412-BM: Max. 0.3% FS
- 8) This sensor family is optimised for the linearity; it is suitable for applications with higher pressure where the linearity requirement is less critical.

APPLICATION INFORMATION

GENERAL

The MS54xx is a miniaturised absolute pressure sensor series which has been designed as a surface mount device (SMD). Its main advantages are the high performance of the semiconductor sensor and a design which makes it suitable for applications requiring small dimensions and cost efficiency.

The sensor element of the MS54xx consists of a micromachined silicone membrane with Pyrex glass wafer-bonded under vacuum to the back side for reference pressure. Implanted resistors make use of the piezo-resistive effect to sense pressure applied to the membrane. The sensor is mounted using a special process allowing best offset stability making the device suitable for direct PCB assembly.

Typical applications for this miniaturised pressure sensor MS54xx are altitude measurements and the measurement of atmospheric reference pressure in medical and industrial equipment as well as in automotive and household applications, consumer electronics and pneumatics.

Full Scale Pressure	High Sensitivity Versions (MS54xx-Axx)	High Linearity Versions (MS54xx-Bxx)
1 bar	Variometer, Altimeter, Barometer	High End Altimeter, Medical Instrumentation
7 bar	Divers Watch, Tire Pressure, Electronic Scale	High End Electronic Scale
12 bar		Pneumatic Brake, Diving Computer
70 bar	Engine Control, Diving Computer	

HUMIDITY, WATER PROTECTION

MS54xx-xM with METAL CAP:

The MS54xx-AM / -BM has an anticorrosive and antimagnetic metallic protection cap filled with silicone gel for enhanced protection against humidity. The properties of this gel ensure function of the sensor even when in direct water contact. This feature can be useful for waterproof watches or other applications, where direct water contact cannot be avoided. Nevertheless the user should avoid drying of hard materials like for example salt particles on the silicone gel surface. In this case it is advisable to rinse with clean water afterwards. Special care has to be taken not to mechanically damage the gel. Damaged gel may lead to air entrapment and consequently to unstable sensor signal, especially if the damage is close to the sensor surface.

The metal cap is fabricated of special anticorrosive alloy in order to avoid any galvanic effects within the end product. The MS5401-BM is qualified referring to the ISO Standard 2281 and can withstand a pressure of 11 bar in salt water. The concentration of the sea water used for the qualification is 41 g of sea salt per 1 litre of DI water. The MS5407-AM satisfies salt-water testing with a pressure capability of 21 bar.

For underwater operations as specified in ISO Standard 2281 it is important to seal the sensor with a rubber O-ring around the metal cap. Any salt water reaching the contact side (ceramic and pads) of the sensor could lead to permanent damage. Especially for "water-resistant 100 m" watches and for diving computers, it is recommended to provide a stable mechanical pusher from the backside of the sensor; otherwise the overpressure may push the sensor backwards and even deform the electronic board on which the sensor is mounted.

MS54xx-xPx with PLASTIC CAP:

The sensor die of the MS54xx-xPx is protected by a drop of silicone gel. The properties of this gel ensure function of the sensor even in a humid environment.

LIGHT SENSITIVITY

The MS54xx is sensitive to sunlight (visible and near-infrared spectrum). This is due to the strong photo effect of silicon. As the effect is reversible there will be no damage, but the user has to take care that in the final product the sensor cannot be exposed to direct light during operation as it effects the measurement. This can be achieved for instance by placing mechanical parts with holes in such that light cannot pass.

CONNECTION TO PCB

The package outline of the module enables the use of a flexible PCB to connect it. This can be important for applications in watches and other special devices, and will also reduce mechanical stress on the device. For applications subjected to mechanical shock, it is recommended to enhance the mechanical reliability of the solder junctions by covering the rim or the corners of MS54xx ceramic substrate with glue or globtop-like material.

SOLDERING

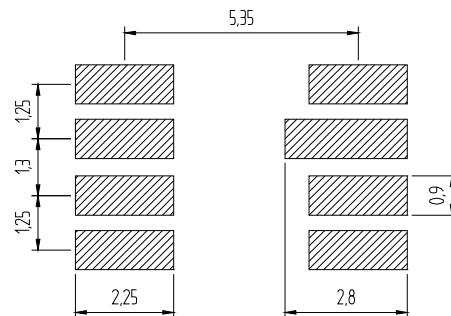
Please refer to the application note AN808 for all soldering issues.

CLEANING

The MS54xx has been manufactured under clean-room conditions. Each device is inspected for homogeneity and cleanness of the silicone gel. It is therefore recommended to assemble the sensor under class 10 000 or better conditions. Should this not be possible, it is recommended to protect the sensor opening during assembly from entering particles and dust. To avoid cleaning of the PCB, solder paste of type “no-clean” must be used. **Cleaning might damage the sensor.**

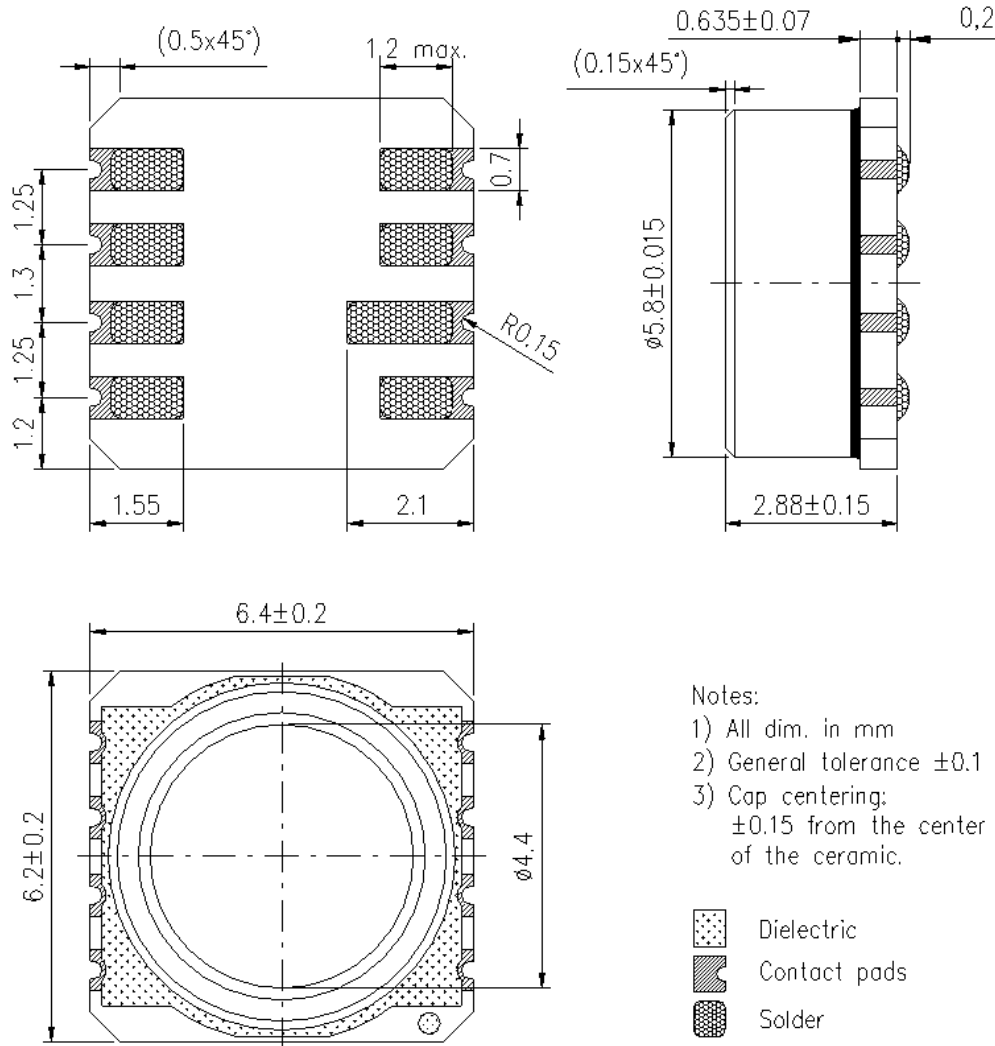
RECOMMENDED PAD LAYOUT

Recommended pad layout for soldering of the MS54xx on a printed circuit board



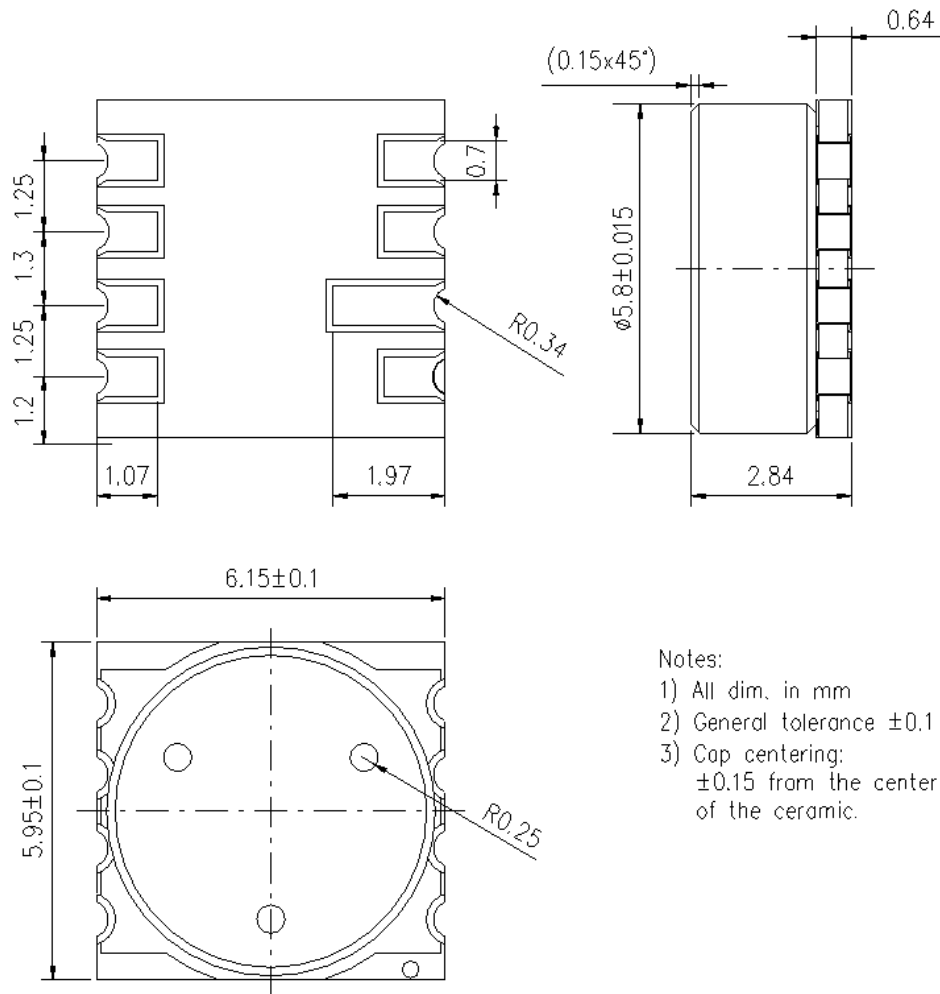
PACKAGE OUTLINES

VERSIONS WITH CERAMIC CARRIER AND METAL CAP



Device package outlines of **MS54xx-AM** and **MS54xx-BM**
(M = anticorrosive and antimagnetic stainless steel cap)

VERSIONS WITH PCB CARRIER AND PLASTIC CAP

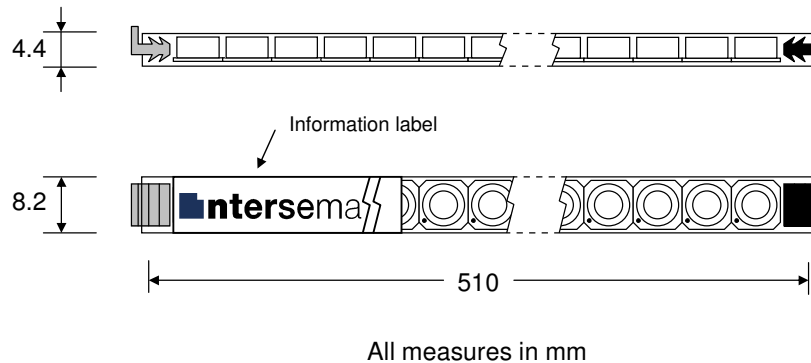


Device package outlines of **MS54xx-APF** and **MS54xx-BPF**

PACKING

The MS54xx is packed in 51 cm (20-inch) antistatic plastic tubes with rubber end-plugs of different colours: one green and one black. The dot on the carrier next to Pin 1 is facing the green end-plug. Each tube contains 80 sensors. The tubes are marked "ANTISTATIC" and have an information label. See the drawings below for more details.

PACKING TUBE OUTLINES



ORDERING INFORMATION

MS5401-AM	Miniature Pressure Sensor 1 bar, high sensitivity, ceramic carrier	Art.-Nr. 325401001
MS5401-APF	Miniature Pressure Sensor 1 bar, high sensitivity, PCB carrier	Art.-Nr. 325401004
MS5401-BM	Miniature Pressure Sensor 1 bar, high linearity, ceramic carrier	Art.-Nr. 325401000
MS5401-BPF	Miniature Pressure Sensor 1 bar, high linearity, PCB carrier	Art.-Nr. 325401005
MS5407-AM	Miniature Pressure Sensor 7 bar, high sensitivity, ceramic carrier	Art.-Nr. 325407000
MS5412-BM	Miniature Pressure Sensor 12 bar, high linearity, ceramic carrier	Art.-Nr. 325412000
MS5470-AM	Miniature Pressure Sensor 70 bar, high sensitivity, ceramic carrier	Art.-Nr. 325470000

A x x = high sensitivity
 B x x = high linearity
 x M x = anticorrosive and antimagnetic metallic cap
 x P x = plastic cap
 x x F = PCB carrier

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