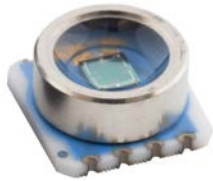


## MS54XX Miniature SMD Pressure Sensor



- 1, 7, 12, and 70 bar absolute pressure range
- Uncompensated
- Piezoresistive silicon micromachined sensor
- Miniature surface mount
- Ceramic carrier
- Low noise, high sensitivity, high linearity

### 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. 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          | ±0.20 % FS | MS5401-BM               | 150 mV          | ±0.05 % FS |
|         | 7 bar               | MS5407-AM                 | 392 mV          | ±0.20 % FS |                         |                 |            |
|         | 12 bar              |                           |                 |            | MS5412-BM               | 150 mV          | ±0.05 % FS |
|         | 70 bar              | MS5470-AM                 | 310 mV          | ±0.25 % 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

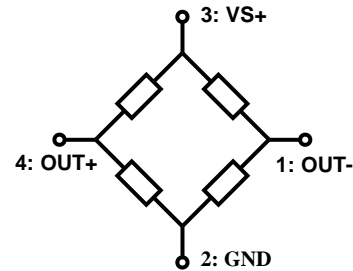
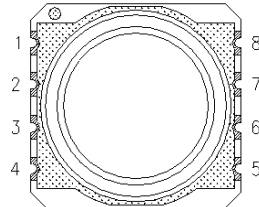
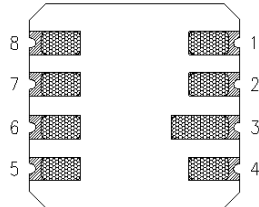
### APPLICATIONS

- Brake systems
- High resolution altimeters, variometers
- Barometers
- Engine management
- Waterproof watches and diving computers

## MS54XX Miniature SMD Pressure Sensor

### PIN CONFIGURATION

VERSION WITH CERAMIC CARRIER AND METAL 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 |
|------------------------|----------------|------------|-----|------|------|
| Supply voltage         | VS+            | Ta = 25 °C | -   | 20   | V    |
| Storage temperature    | T <sub>s</sub> |            | -40 | +125 | °C   |
| Overpressure MS5401-AM | P              | Ta = 25 °C | -   | 5    | bar  |
| MS5401-BM (1)          |                |            | -   | 10   |      |
| MS5407-AM (2)          |                |            | -   | 21   |      |
| MS5412-BM              |                |            | -   | 30   |      |
| MS5470-AM              |                |            | -   | 180  |      |

### 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 specifically.

# MS54XX Miniature SMD Pressure Sensor

## ELECTRICAL CHARACTERISTICS

### HIGH SENSITIVITY VERSIONS

(Vs+ = 5 V; Ta = 25 °C)

|            | Parameter                             | Min    | Typ    | Max    | Unit   | Notes |
|------------|---------------------------------------|--------|--------|--------|--------|-------|
| MS5401-AM  | Operating pressure range              | 0      | -      | 1      | bar    |       |
|            | Full-scale span (FS)                  | 190    | 240    | 290    | mV     |       |
|            | Sensitivity                           | 190    | 240    | 290    | mV/bar |       |
|            | Linearity                             | -      | ±0.15  | ±0.40  | % 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  | ±0.40  | % 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.

# MS54XX Miniature SMD Pressure Sensor

## ELECTRICAL CHARACTERISTICS (CONT.)

### HIGH LINEARITY VERSIONS

(Vs+ = 5 V; Ta = 25 °C)

|            | Parameter                             | Min    | Typ    | Max    | Unit   | Notes   |
|------------|---------------------------------------|--------|--------|--------|--------|---------|
| MS5401-BM  | Operating pressure range              | 0      | -      | 1      | bar    | 8       |
|            | Full-scale span (FS)                  | 120    | 150    | 180    | mV     |         |
|            | Sensitivity                           | 120    | 150    | 180    | mV/bar |         |
|            | Linearity                             | -      | ±0.05  | ±0.20  | % 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 optimized for the linearity; it is suitable for applications with higher pressure where the linearity requirement is less critical.

# MS54XX Miniature SMD Pressure Sensor

## APPLICATION INFORMATION

### GENERAL

The MS54XX is a miniaturized 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 silicon membrane with borosilicate 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 miniaturized 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-AX)         | High Linearity Versions (MS54XX-BX)         |
|---------------------|---|---|
| 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 / - BMXXBA 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-BM 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.

### 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 affects the measurement. This can be achieved for instance by placing mechanical parts with holes in such that light cannot pass.

## MS54XX Miniature SMD Pressure Sensor

### 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.

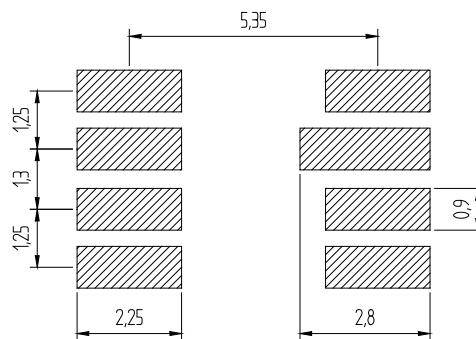
### CLEANING

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

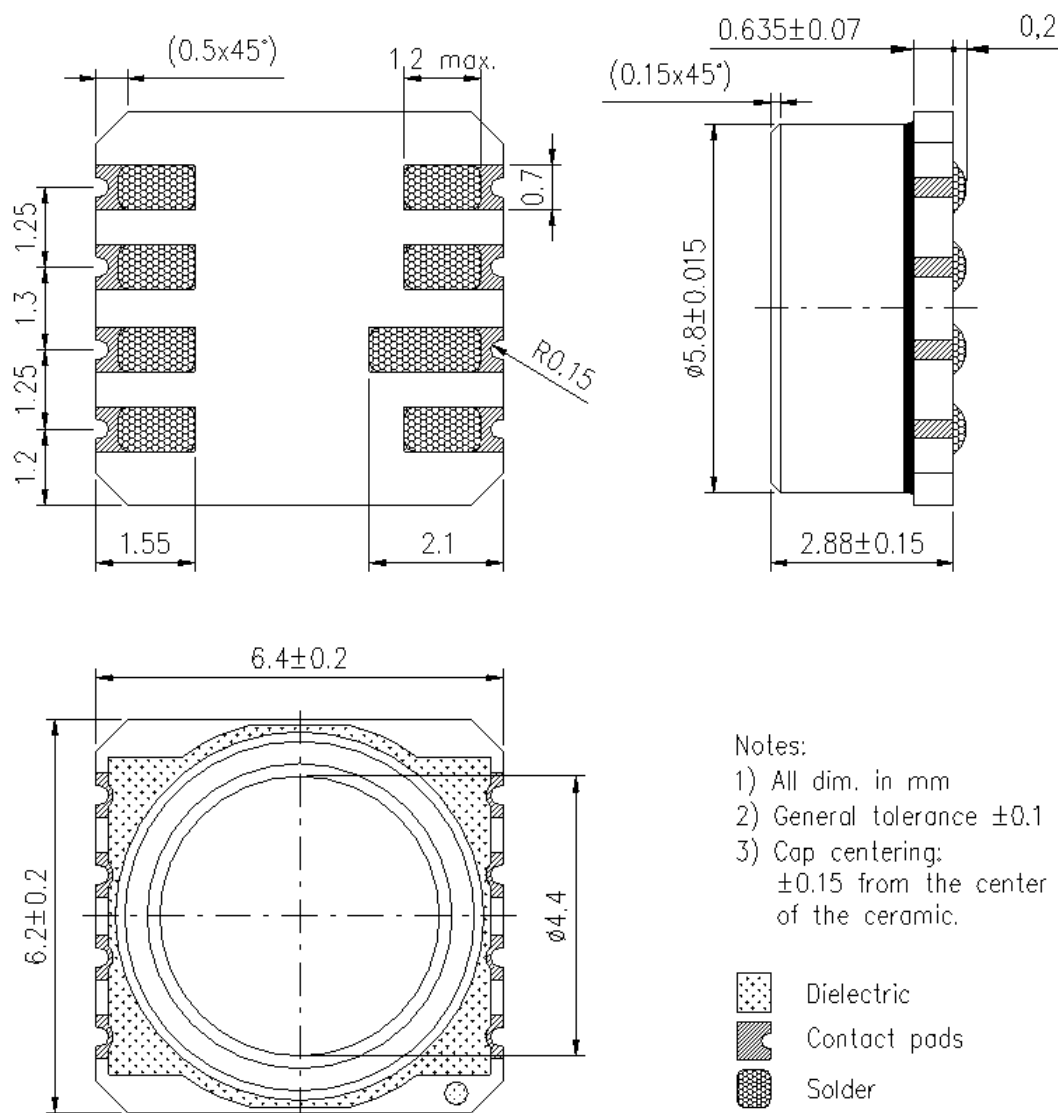
Recommended pad layout for soldering of the MS54XX on a printed circuit board



## MS54XX Miniature SMD Pressure Sensor

## PACKAGE OUTLINES

## CERAMIC CARRIER AND METAL CAP



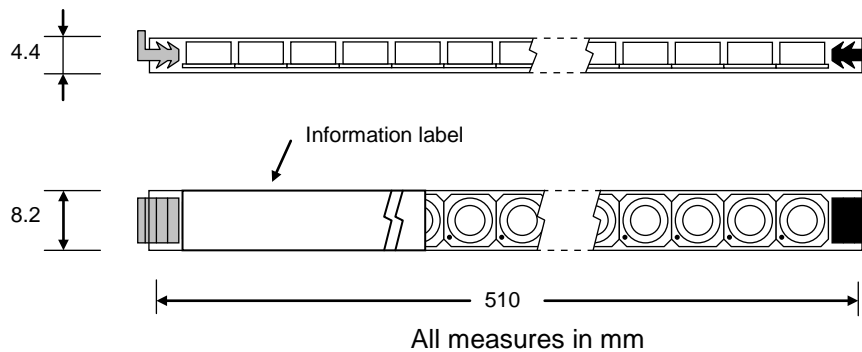
Device package outlines of **MS54XX-AM** and **MS54XX-BM**  
(M = anticorrosive and antimagnetic stainless steel cap)

## MS54XX Miniature SMD Pressure Sensor

### PACKING

The MS54XX is packed in 51 cm (20-inch) antistatic plastic tubes with rubber end-plugs of different colors: 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





# MS54XX Miniature SMD Pressure Sensor

## ORDERING INFORMATION

| Product code | Product  | Art. No      | Package                                  | Delivery Form |
|--------------|--|--------------|--|---------------|
| MS5401-AM    | Miniature pressure sensor 1 bar, High sensitivity  | 325401001-00 | Ceramic carrier                          | Tube          |
|              |  | 325401001-50 | Ceramic carrier                          | Tape and Reel |
|              |  | 325401006-00 | Ceramic carrier, without transparent gel | Tube          |
| MS5401-BM    | Pressure sensor 1 bar, High linearity              | 325401000-00 | Ceramic carrier                          | Tube          |
|              |  | 325401000-50 | Ceramic carrier                          | Tape and Reel |
|              |  | 325401002-00 | Ceramic carrier, without transparent gel | Tube          |
| MS5407-AM    | Miniature pressure sensor 7 bar, High sensitivity  | 325407000-00 | Ceramic carrier                          | Tube          |
|              |  | 325407000-50 | Ceramic carrier                          | Tape and Reel |
|              |  | 325407001-00 | Ceramic carrier, without transparent gel | Tube          |
| MS5412-BM    | Pressure sensor 12 bar, High linearity             | 325412000-00 | Ceramic carrier                          | Tube          |
|              |  | 325412000-50 | Ceramic carrier                          | Tape and Reel |
| MS5470-AM    | Miniature pressure sensor 70 bar, High sensitivity | 325470000-00 | Ceramic carrier                          | Tube          |

AX = high sensitivity

BX = high linearity

XM = anticorrosive and antimagnetic metallic cap

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