# MLX90822

Absolute Pressure Sensor with analog output
Datasheet

## 1. Features and Benefits

- +/-0.5% full scale lifetime accuracy
- Ratiometric analog output
- Fast response time (min 0.4ms)
- All-in-one solution: MEMS, interface and passive components in one easy to integrate package validated according to leading OEM EMC standards
- -40°C to 160°C temperature range, up to 170°C for short durations
- Excellent harsh media resistance against halogens, acids, …
- Qualified according to AEC-Q100 and AEC-Q103-002
- Configurable diagnostic features like internal broken connection, over voltage, under voltage, …
- Factory calibrated and fully programmable through the connector with the PTC04 programming tool for customized calibration curves
- Extended over (+40V) and reverse (-40V) voltage capabilities (supply & output)
- Easy to use due to its PCB-less package with ridges to enable glued pressure seals
- ASIL compliant developed as an ASIL A SEooC as per ISO 26262

## 2. Application Examples

- Automotive applications with absolute pressure from 1bar to 4bar
- Manifold and Turbo Manifold Air Pressure for automotive, truck and motorcycle applications
- Air management for any combustion powered applications (boat, mower tractor, chainsaw, …)
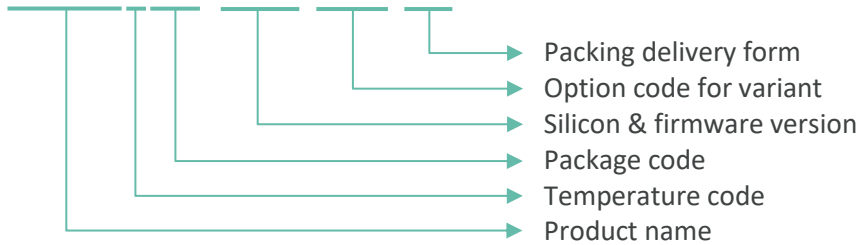- CNG/LPG injectors



*Figure 1: MLX90822*

## 3. Ordering Information

| Ordering Code | Temperature | Package | Option code | Packing |
|---|---|---|---|---|
| MLX90822GXP-BAA-300-RE | -40°C to 160°C | SMP7 | 0.1 to 1.15bar absolute pressure<br>0.5V to 4.5V analog output | Reel |
| MLX90822GXP-BAA-304-RE | -40°C to 160°C | SMP7 | 0.1 to 1.15bar absolute pressure<br>0.4V to 4.65V analog output | Reel |
| MLX90822GXP-BAB-301-RE | -40°C to 160°C | SMP7 | 0.1 to 3bar absolute pressure<br>0.5V to 4.5V analog output | Reel |
| MLX90822GXP-BAB-302-RE | -40°C to 160°C | SMP7 | 0.1 to 4bar absolute pressure<br>0.5V to 4.5V analog output | Reel |

## MLX90822GXP-BAA-300-RE

- Packing delivery form
- Option code for variant
- Silicon & firmware version
- Package code
- Temperature code
- Product name

## 4. Package Diagram



*Figure 2: Internal wiring of MLX90822*
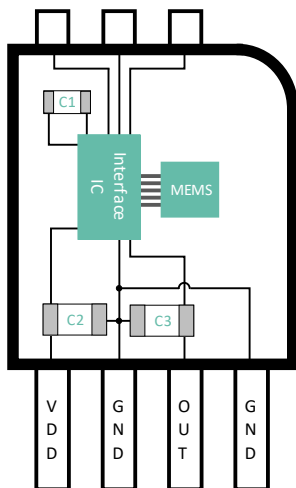
| Component | Value |
|---|---|
| C1 | 47nF |
| C2 | 100nF |
| C3 | 100nF |

*Table 1: MLX90822 capacitors configuration*

## 5. General Description

The MLX90822 is a packaged PCB-less, factory calibrated, absolute pressure sensor measuring spans from 1 to 4 bar. It delivers an analog output signal.

The MLX90822 consists of a MEMS pressure sensor element, an interface chip (CMOS technology) and passive components. This optimized solution exhibits excellent EMC performance. The DSP based signal interface provides outstanding initial accuracy. A smart package and die assembly concept enable high output stability over life, even in stringent automotive temperature and stress conditions.

# Contents

# 6. Glossary of Terms

Absolute pressure: Pressure measured relative to a vacuum reference
ADC: Analog to Digital Converter
Bar: Pressure unit (1bar = 100kPa)
DSP: Digital Signal Processor
EMC: Electro Magnetic Compatibility
FS: Full scale, span
HTOL: High-temperature operating life
Lower Fault Band: Output voltage below normal output range to indicate a diagnostic
OV: Over Voltage
PCB: Printed Circuit Board
POR: Power-on Reset
PTC04: Melexis Programming Tool
RV: Reverse Voltage
SEooC: Safety Element out of Context
TA: Ambient temperature
Upper Fault Band: Output voltage above normal output range to indicate a diagnostic

# 7. Absolute Maximum Ratings

| Parameter | Symbol | Value | Units | Comment |
|---|---|---|---|---|
| Supply Voltage (overvoltage) | OV | 40 | V | Max 2 hours |
| Reverse Voltage Protection | RV | -40 | V | |
| Positive output voltage | | 40 | V | |
| Reverse output voltage [1] | | -40 | V | |
| Operating Ambient Temperature Range[2] | $T_A$ | -40 to 160 | °C | |
| Extended Operating Ambient Temperature Range | | -40 to 170 | °C | 10 minutes continuous period, max 20 hours total duration over life |
| Storage Temperature Range | | -40 to 160 | °C | |
| Programming Ambient Temperature Range | | -40 to 125 | °C | |
| Proof pressure (1 bar versions) | | 5 | Bar | BAA-300 and BAA-304 |
| Proof pressure (>3 bar versions) | | 10 | Bar | BAB-301 and BAB-302 |
| Burst pressure (1 bar versions) | | 6 | Bar | BAA-300 and BAA-304 |
| Burst pressure (>3 bar versions) | | 16 | Bar | BAB-301 and BAB-302 |
| ESD, human body model [3] | | 2000 | V | Class 1C acc. ANSI/ESDA/JEDEC JS-001 |
| ESD, charged device model [3] | | 1000 | V | Class C3 acc. ANSI/ESDA/JEDEC JS-002 |

*Table 2: Absolute maximum ratings*

1  *Absolute maximum DC negative output at floating supply or supply shorted to output. Maximum DC negative output at operating supply: -5.5V.*

2  *HTOL accelerated aging test equivalent to 3680 hours at 150°C.*

3  *Device level performance including test pins. VDD, GND and SENT output are much more robust to account for module level ESD requirements.*

Exceeding the absolute maximum ratings may cause permanent damage. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability. Maximum duration of over voltage and reverse voltage conditions is 2 hours.

# 8. Pin Definitions and Descriptions
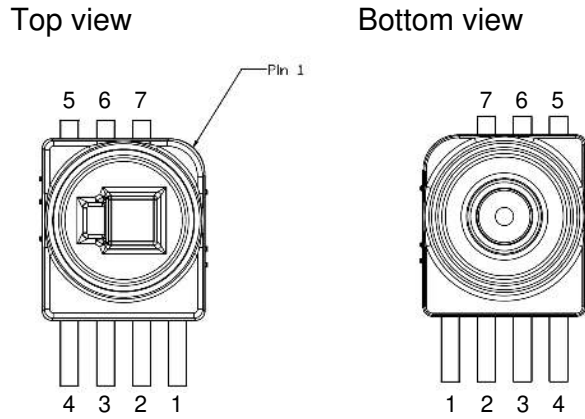


*Figure 3: Package pinout*

| Pin number | Description |
|---|---|
| 1 | Ground (GND) [4] |
| 2 | Analog output |
| 3 | Ground (GND) [4] |
| 4 | Supply input (VDD) |
| 5 | Test pin |
| 6 | Test pin |
| 7 | Test pin |

*Table 3: Pinout definitions and descriptions*
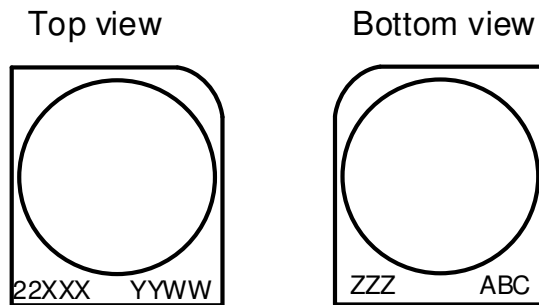


*Figure 4: Package marking*

| Symbol | Function / Description |
|---|---|
| XXX | MEMS and ASIC traceability letter [5] |
| ZZZ | Last three characters of lot number |
| ABC | Sub lot indication |
| YYWW | Date code |

*Table 4: Package marking definition*

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4 *Either pin 1 or pin 3 can be used as Ground (GND) connection, it is not required to connect both pins. The unused pin may be left floating.*

5 *Linked to first three letters of option code.*

# 9. General Electrical Specifications

DC Operating Parameters $T_A$ = -40°C to 160°C

| Parameter | Symbol | Remarks | Min | Typ[6] | Max | Units |
|---|---|---|---|---|---|---|
| Nominal supply voltage | Vdd | | 4.5 | 5 | 5.5 | V |
| Nominal supply current | Idd | No output load | | 9.5 | 12 | mA |
| Current consumption at supply overvoltage | IDD_OV | | | | 20 | mA |
| Current consumption at supply reverse voltage | IDD_RV | | | | 20 | mA |
| Output short-circuit current | IOUT_SH | | | | 20 | mA |
| Resistive load on output | Rload | Pull up | 3 | | 425 | kOhm |
| | | Pull down | 3 | | 470 | kOhm |
| Capacitive load on output | Cload | MLX90822 has an integrated 100nF output capacitor in its package. No additional capacitor needed. | 0 | | 110 | nF |
| Output current | IOUT | | | | 2 | mA |
| Under voltage detection range | | Programmable. In default configuration set to 4.3V. | 4.15 | | 4.8 | V |
| Over voltage detection range | | Programmable. In default configuration set to 5.7V. | 5.2 | | 5.75 | V |
| Under voltage detection tolerance | | | -50 | | 50 | mV |
| Over voltage detection tolerance | | | -50 | | 50 | mV |
| Power up time | | Time from reaching minimum allowed supply voltage of 4.5V till having the output within specification | | | 4 | ms |
| Default response time [7] | | For versions BAA-300, BAA-304, BAB-301, BAB-302 | | | 1 | ms |
| Fastest response time [6] | | | | | 0.4 | ms |
| Refresh rate | | Time between two consecutive updates on the output | | | 75 | μs |
| Operating Output voltage range | | Output range where the linearity is in spec with any resistive load inside the specified range | 4 | | 96 | %Vdd |
| Upper Fault Band | | | 97 | | 100 | %Vdd |
| Lower Fault Band | | | 0 | | 3 | %Vdd |
| Pressure output noise | | Default configuration BAA-300, BAA-304, BAB-301, BAB-302 | | | 2 | mV rms |

*Table 5: Electrical specifications*

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[6] *Typical values are defined at $T_A$ = +25 °C and $V_{DD}$ = 5V.*

[7] *From input pressure step to output reaching 90% of settled output.*

# 10. Detailed General Description

The MLX90822 consists of a pressure sensor element, a DSP-based interface chip and passive components.

The pressure sensor element consists of a diaphragm realized in the silicon chip by wafer bonding on an etched cavity with built in reference vacuum. The diaphragm reacts to a change in absolute pressure. The internal strain increases, in particular at the border of the diaphragm. Here, the piezo-resistive elements have been implanted into the silicon diaphragm forming a Wheatstone bridge, which act as a transducer.

The analog front-end of the interface chip applies filtering and converts the analog signal to a digital value. The DSP performs the compensations over temperature. Furthermore, the digital circuit provides some filtering, the possibility to linearize the pressure signal and also implements the clamping function. This chip has an analog output proportional to the pressure and supply voltage. A broken wire detection block ensures the analog output goes to one of the rails in case of a broken supply or ground connection.

Extensive protection of the supply lines and output allows the MLX90822 to handle extreme overvoltage conditions and makes it resistant to severe external disturbances. Several diagnostic functions (over-voltage, under-voltage, overpressure, under pressure detections) have been implemented on the MLX90822 and can be enabled by programming EEPROM settings. Figure 5 shows the MLX90822 block diagram. Passive components are integrated in the package to bring excellent EMC performance without the need for additional components at module level.
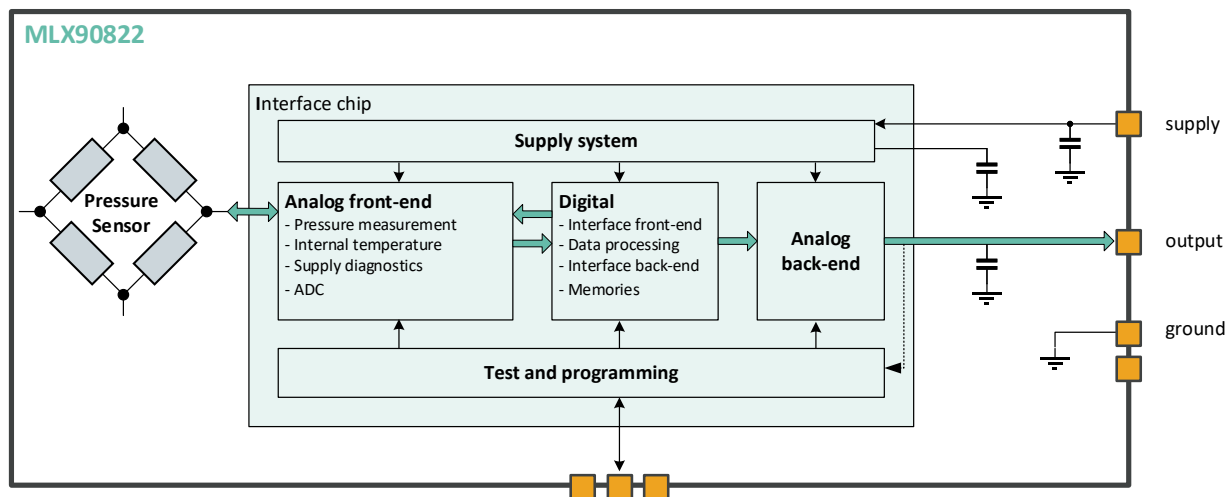


*Figure 5: MLX90822 block diagram*

# 11. Default Programmed Settings

The MLX90822 is calibrated at the final manufacturing test steps. During the calibration, settings are stored in the on chip EEPROM to define the pressure transfer curve.
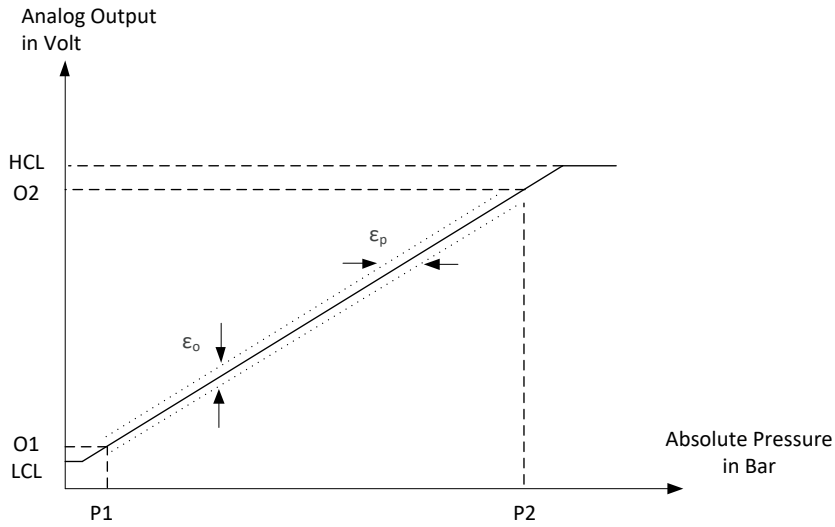


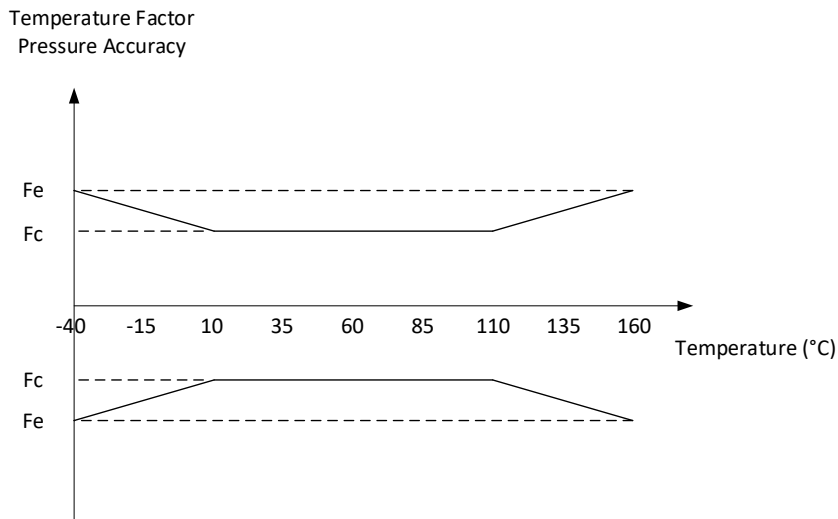*Figure 6: Pressure transfer function description at room temperature*



*Figure 7: Pressure accuracy temperature factor*

## 11.1. MLX90822GXP-BAA-300

| Transfer Curve Parameter | Symbol | Remarks | Value | | | Unit |
|---|---|---|---|---|---|---|
| Pressure 1 | P1 | See Figure 6: Pressure transfer function description at room temperature | 0.1 | | | Bar |
| Pressure 2 | P2 | | 1.15 | | | Bar |
| Output 1 | O1 | | 0.5 | | | V |
| Output 2 | O2 | | 4.5 | | | V |
| Low clamping level | LCL | | 0.3 | | | V |
| High clamping level | HCL | | 4.7 | | | V |
| **Pressure Accuracy Parameter** | **Symbol** | **Remarks** | **Min** | **Typ** | **Max** | **Unit** |
| Output accuracy | $\varepsilon_o$ | Overall accuracy expressed as output value (FS range from 0.5V to 4.5V) | -20 -0.5 | | 20 -0.5 | mV %FS |
| Pressure accuracy | $\varepsilon_p$ | Overall accuracy expressed as pressure value | -5.25 | | 5.25 | mBar |
| Center temperature accuracy factor | Fc | See Figure 7: Pressure accuracy temperature factor | | | 1 | |
| Extended temperature accuracy factor | Fe | | | | 1.5 | |

*Table 6: BAA-300 Default configuration*

## 11.2. MLX90822GXP-BAA-304

| Transfer Curve Parameter | Symbol | Remarks | Value | | | Unit |
|---|---|---|---|---|---|---|
| Pressure 1 | P1 | See Figure 6: Pressure transfer function description at room temperature | 0.1 | | | Bar |
| Pressure 2 | P2 | | 1.15 | | | Bar |
| Output 1 | O1 | | 0.4 | | | V |
| Output 2 | O2 | | 4.65 | | | V |
| Low clamping level | LCL | | 0.3 | | | V |
| High clamping level | HCL | | 4.7 | | | V |
| **Pressure Accuracy Parameter** | **Symbol** | **Remarks** | **Min** | **Typ** | **Max** | **Unit** |
| Output accuracy | $\varepsilon_o$ | Overall accuracy expressed as output value (FS range from 0.5V to 4.5V) | -21 -0.5 | | 21 -0.5 | mV %FS |
| Pressure accuracy | $\varepsilon_p$ | Overall accuracy expressed as pressure value | -5.25 | | 5.25 | mBar |
| Center temperature accuracy factor | Fc | See Figure 7: Pressure accuracy temperature factor | | | 1 | |
| Extended temperature accuracy factor | Fe | | | | 1.5 | |

*Table 7: BAA-304 Default configuration*

## 11.3. MLX90822GXP-BAB-301

| Transfer Curve Parameter | Symbol | Remarks | Value | | | Unit |
|---|---|---|---|---|---|---|
| Pressure 1 | P1 | See Figure 6: Pressure transfer function description at room temperature | 0.1 | | | Bar |
| Pressure 2 | P2 | | 3 | | | Bar |
| Output 1 | O1 | | 0.5 | | | V |
| Output 2 | O2 | | 4.5 | | | V |
| Low clamping level | LCL | | 0.3 | | | V |
| High clamping level | HCL | | 4.7 | | | V |
| Pressure Accuracy Parameter | Symbol | Remarks | Min | Typ | Max | Unit |
| Output accuracy | $\varepsilon_o$ | Overall accuracy expressed as output value (FS range from 0.5V to 4.5V) | -20 -0.5 | | 20 -0.5 | mV %FS |
| Pressure accuracy | $\varepsilon_p$ | Overall accuracy expressed as pressure value | -14.5 | | 14.5 | mBar |
| Center temperature accuracy factor | Fc | See Figure 7: Pressure accuracy temperature factor | | | 1 | |
| Extended temperature accuracy factor | Fe | | | | 1.25 | |

*Table 8: BAB-301 Default configuration*

## 11.4. MLX90822GXP-BAB-302

| Transfer Curve Parameter | Symbol | Remarks | Value | | | Unit |
|---|---|---|---|---|---|---|
| Pressure 1 | P1 | See Figure 6: Pressure transfer function description at room temperature | 0.1 | | | Bar |
| Pressure 2 | P2 | | 4 | | | Bar |
| Output 1 | O1 | | 0.5 | | | V |
| Output 2 | O2 | | 4.5 | | | V |
| Low clamping level | LCL | | 0.3 | | | V |
| High clamping level | HCL | | 4.7 | | | V |
| Pressure Accuracy Parameter | Symbol | Remarks | Min | Typ | Max | Unit |
| Output accuracy | $\varepsilon_o$ | Overall accuracy expressed as output value (FS range from 0.5V to 4.5V) | -20 -0.5 | | 20 -0.5 | mV %FS |
| Pressure accuracy | $\varepsilon_p$ | Overall accuracy expressed as pressure value | -19.5 | | 19.5 | mBar |
| Center temperature accuracy factor | Fc | See Figure 7: Pressure accuracy temperature factor | | | 1 | |
| Extended temperature accuracy factor | Fe | | | | 1.25 | |

*Table 9: BAB-302 Default Configuration*

## 12. Diagnostics

The MLX90822 has built in diagnostics which can flag fault conditions. This is done by having an output set to 0V or 5V, this is beyond the upper and lower clamp levels of a valid output signal. There are two groups. The first is the broken connection diagnostic which triggers when the device is connected incorrectly. The second group consists of the internal diagnostics, these are used to flag abnormal states during operation.

### 12.1. Broken Connection Diagnostics

Table 10 shows the output behavior of the MLX90822 if a connection is broken or incorrect.

| GND | VDD | Analog out | Effect on output | Action after wrong connection |
|---|---|---|---|---|
| 0V | 5V | Pull-down or Pull-up | Normal operation | Normal operation |
| Disconnected | 5V | Pull-down or Pull-up | Lower Fault Band for Pull-down Upper Fault Band for Pull-up | Normal operation |
| 0V | Disconnected | Pull-down or Pull-up | Low Fault Band for Pull-down Upper Fault Band for Pull-up | Normal operation |
| 0V | 5V | Disconnected | Low Fault Band for Pull-down Upper Fault Band for Pull-up | Normal operation |
| 0V | 5V | 0V | Low Fault Band | Normal operation |
| 0V | 5V | 5V | Upper Fault Band | Normal operation |

*Table 10: Broken connections*

### 12.2. Internal Diagnostics

The MLX90822 has several internal checks which monitor the status of the device. These checks or diagnostic sources can be enabled or disabled based on the sensor module requirements. It's possible to separately define some sources to appear as a Low Fault Band error and others as a High Fault Band. Table 11 shows the available diagnostic sources which can be programmed to result in either a high fault band output or low fault band output.

| Bit | Error condition | Default settings |
|---|---|---|
| 0 | Supply voltage too high | Disabled |
| 1 | Supply voltage too low | Disabled |
| 2 | Internal error | Lower Fault Band |
| 3 | Broken pressure membrane | Lower Fault Band |
| 4 | Pressure parameter error | Lower Fault Band |
| 5 | Pressure output error | Lower Fault Band |
| 6 | Internal regulator out of range | Disabled |

*Table 11: Diagnostic sources*

# 13. Digital

The digital is built around a 16-bit microcontroller. It contains besides the processor also ROM, RAM and EEPROM and a set of user and system IO registers. Temperature compensation of the pressure signal and pressure linearization is handled by the microcontroller. For the pressure compensation there are EEPROM parameters allocated to be able to cover a large variety of calibration approaches.

Both for gain and offset of the pressure signal, there is a separate temperature dependency which is programmable up to a third order compensation. This is reflected in EEPROM parameters for the offset (O0, O1, O2 and O3) and for the gain (G0, G1, G2 and G3).

If required, the linearity of the pressure signal can also be compensated with a first order temperature dependency through EEPROM parameters L0 and L1.

# 14. Application Information

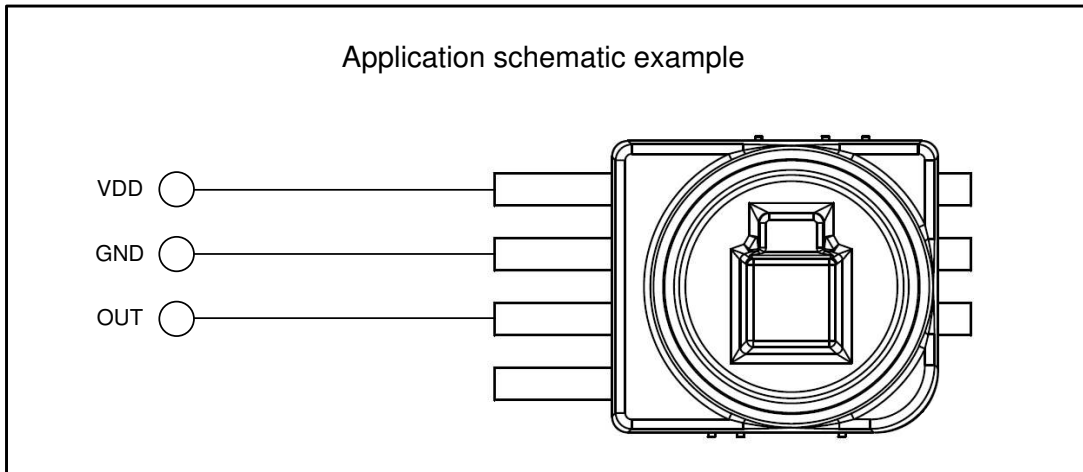The MLX90822 has two GND pins, only one needs to be connected in the application.



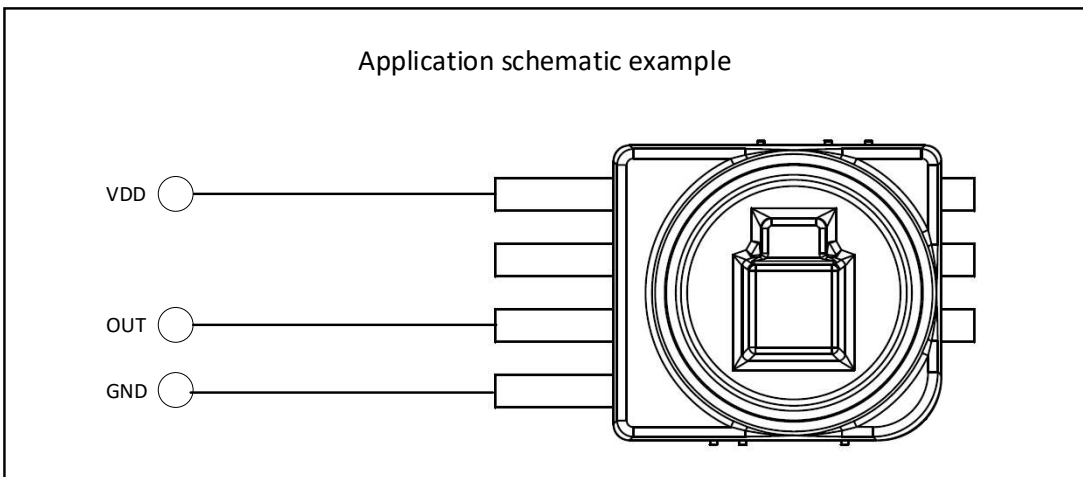*Figure 8: Basic application example with pin 3 as GND*



*Figure 9: Basic application example with pin 1 as GND*

## 15. Storage and Handling of Plastic Encapsulated ICs

Plastic encapsulated ICs shall be stored and handled according to their MSL categorization level (specified in the packing label) as per J-STD-033.

Electronic semiconductor products are sensitive to Electro Static Discharge (ESD). The component assembly shall be handled in EPA (Electrostatic Protected Area) as per ANSI S20.20

For more information refer to Melexis *Guidelines for storage and handling of plastic encapsulated ICs* [8]

## 16. Assembly of Encapsulated ICs

For Surface Mounted Devices (SMD, as defined according to JEDEC norms), the only applicable soldering method is reflow.

For Through Hole Devices (THD), the applicable soldering methods are reflow, wave, selective wave and robot point-to-point. THD lead pre-forming (cutting and/or bending) is applicable under strict compliance with Melexis *Guidelines for lead forming of SIP Hall Sensors* [8].

Melexis products soldering on PCB should be conducted according to the requirements of IPC/JEDEC and J-STD-001.  Solder quality acceptance should follow the requirements of IPC-A-610.

For PCB-less assembly refer to the relevant application notes [8] or contact Melexis.

Electrical resistance welding or laser welding can be applied to Melexis products in THD and specific PCB-less packages following the *Guidelines for welding of PCB-less devices*[8].

Environmental protection of customer assembly with Melexis products for harsh media application, is applicable by means of coating, potting or overmolding considering restrictions listed in the relevant application notes [8]

For other specific process, contact Melexis via www.melexis.com/technical-inquiry
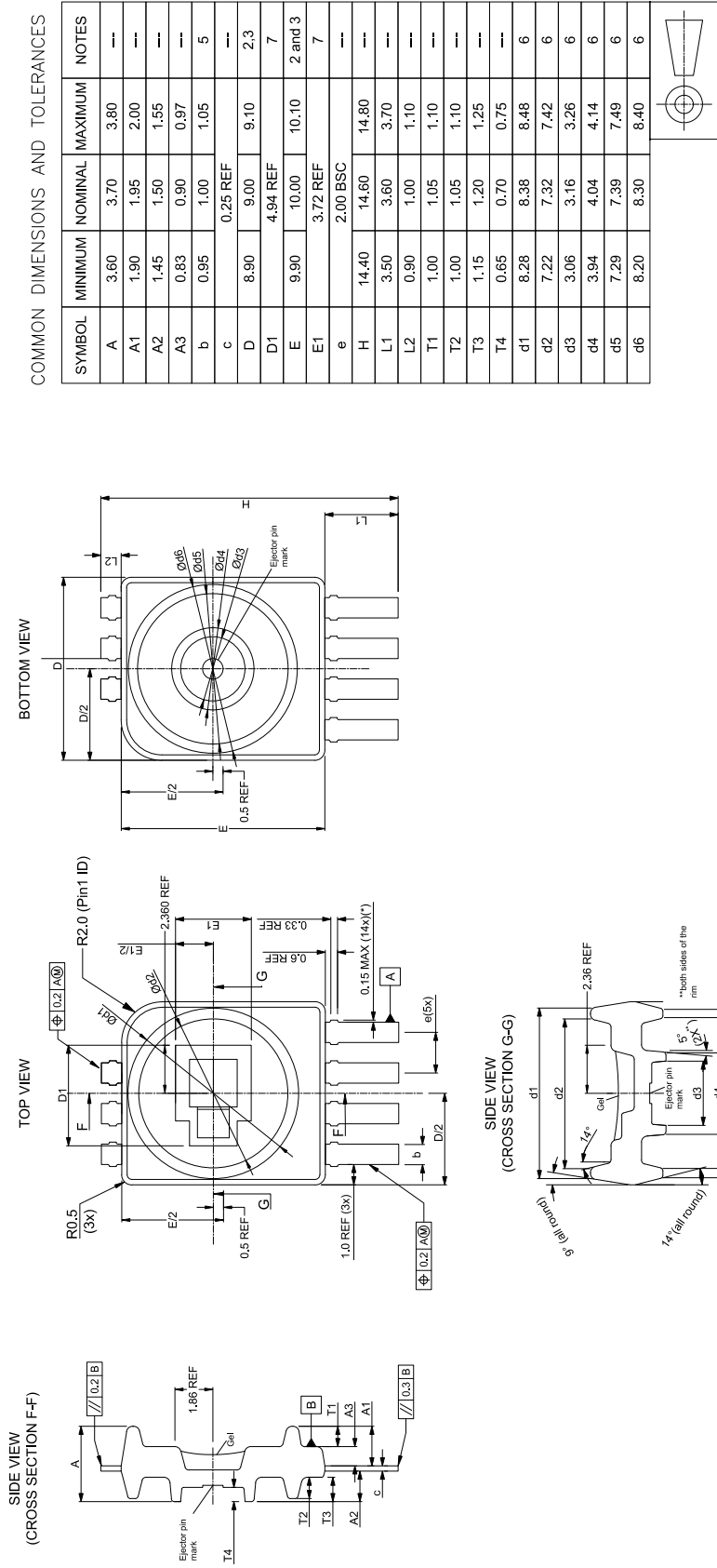
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Melexis is contributing to global environmental conservation by promoting non-hazardous solutions. For more information on our environmental policy and declarations (RoHS, REACH…) visit www.melexis.com/environmental-forms-and-declarations

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[8] www.melexis.com/ic-handling-and-assembly

# 18. Package Information

| SYMBOL | MINIMUM | NOMINAL | MAXIMUM | NOTES |
|---|---|---|---|---|
| A | 3.60 | 3.70 | 3.80 | --- |
| A1 | 1.90 | 1.95 | 2.00 | --- |
| A2 | 1.45 | 1.50 | 1.55 | --- |
| A3 | 0.83 | 0.90 | 0.97 | --- |
| b | 0.95 | 1.00 | 1.05 | 5 |
| c | | 0.25 REF | | --- |
| D | 8.90 | 9.00 | 9.10 | 2,3 |
| D1 | | 4.94 REF | | 7 |
| E | 9.90 | 10.00 | 10.10 | 2 and 3 |
| E1 | | 3.72 REF | | 7 |
| e | | 2.00 BSC | | --- |
| H | 14.40 | 14.60 | 14.80 | --- |
| L1 | 3.50 | 3.60 | 3.70 | --- |
| L2 | 0.90 | 1.00 | 1.10 | --- |
| T1 | 1.00 | 1.05 | 1.10 | --- |
| T2 | 1.00 | 1.05 | 1.10 | --- |
| T3 | 1.15 | 1.20 | 1.25 | --- |
| T4 | 0.65 | 0.70 | 0.75 | --- |
| d1 | 8.28 | 8.38 | 8.48 | 6 |
| d2 | 7.22 | 7.32 | 7.42 | 6 |
| d3 | 3.06 | 3.16 | 3.26 | 6 |
| d4 | 3.94 | 4.04 | 4.14 | 6 |
| d5 | 7.29 | 7.39 | 7.49 | 6 |
| d6 | 8.20 | 8.30 | 8.40 | 6 |

COMMON DIMENSIONS AND TOLERANCES



Note:
1. ALL DIMENSIONS IN MILLIMETERS (mm) UNLESS NOTED OTHERWISE.
2. PACKAGE DIMENSIONS "D", "E" AND "R2.0" DO NOT INCLUDE MOLD FLASHES, PROTRUSIONS OR GATE BURRS. CONTACT MELEXIS FOR SPECIFIC DESIGN RECOMMENDATIONS.
3. PACKAGE TOP SURFACE MAY BE SMALLER THAN PACKAGE BOTTOM.
4. SHINY SURFACE OUTLOOK DUE TO USE OF FILM.
5. DIMENSION b DOES NOT INCLUDE DAMBAR(*) PROTRUSION.
6. MIN AND MAX VALUES DEPEND ON THE RADIUS OF THE RIM WHICH CAN VARY FROM POSITION TO POSITION.
7. DIMENSIONS "D1" AND "E1" CORRESPOND TO THE GEL FILLED CAVITY. ANY MECHANICAL CONTACT WITHIN MINIMUM DIAMETER OF "d2" SHOULD BE AVOIDED AT ALL TIME. CONTACT MELEXIS FOR SPECIFIC DESIGN RECOMMENDATIONS.

*Figure 10: MLX90822 package drawing*

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