

AS-MLV-P2

Air Quality Sensor

General Description

The **ams** AS-MLV-P2 is a MOS (metal oxide semiconductor) based gas sensor component. It was specifically designed for a broad detection of reducing gases such as VOCs (volatile organic compounds) and CO (carbon monoxide) associated with bad air quality. The AS-MLV-P2 sensor component is a MEMS (micro electromechanical system) device using silicon wafer technology.

[Ordering Information](#) and [Content Guide](#) appear at end of datasheet.

Key Benefits & Features

The benefits and features of AS-MLV-P2, Air Quality Sensor are listed below:

Figure 1:
Added Value of Using AS-MLV-P2 Sensor

| Benefits | Features |
|---|---|
| <ul style="list-style-type: none">• High sensitivity to volatile organic compounds (VOCs) | <ul style="list-style-type: none">• Limit of detection in a low ppm range |
| <ul style="list-style-type: none">• Very low power consumption | <ul style="list-style-type: none">• 34 mW at 300°C |
| <ul style="list-style-type: none">• Maintenance free | <ul style="list-style-type: none">• 10 year lifetime |
| <ul style="list-style-type: none">• Reflow capable | <ul style="list-style-type: none">• Surface Mount Package |

Applications

- Indoor air monitor
- Kitchen hood
- Weather stations
- Smart home
- Internet of Things (IoT)

Pin Assignment

Figure 2:
Pin Diagram

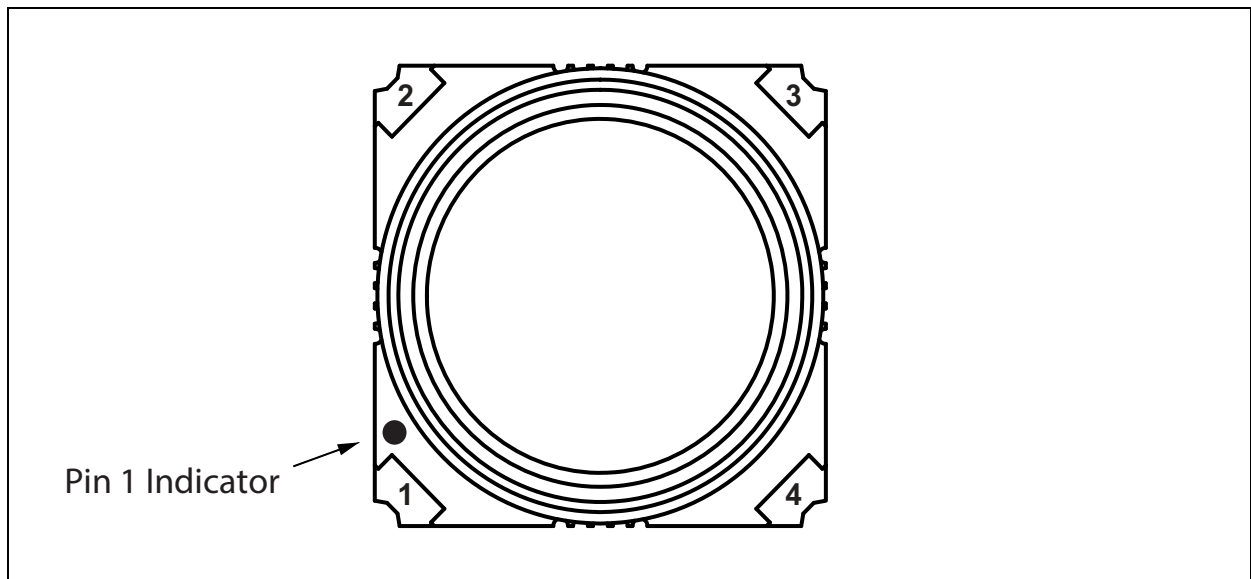


Figure 3:
Pin Description

| Pin Number | Pin Name | Description |
|------------|----------|--------------------|
| 1 | RS1 | Sensor electrode 1 |
| 2 | RH1 | Heater 1 |
| 3 | RS2 | Sensor electrode 2 |
| 4 | RH2 | Heater 2 |

Environmental Specifications

The sensor element characteristics are valid under the following environmental conditions:

Figure 4:
Environmental Operating Conditions

| Description | Value |
|--|---------------|
| Ambient Operating Range | |
| Temperature range | 0°C to 50°C |
| Humidity range (relative humidity, non-condensing) | 5% to 95% |
| Ambient Storage Range | |
| Storage temperature range | -40°C to 85°C |
| Storage humidity range (relative humidity, non-condensing) | 5% to 95% |
| Air Flow | |
| Experienced air velocity | 0m/s to 4m/s |

Note(s):

1. The sensor must be kept separate from all sources of silicone contamination to fulfill the functional and lifetime requirements.

Electrical Characteristics

The sensor elements operate at an elevated temperature. The elevated temperature is realized by means of the Pt heater which is implemented within the silicon nitride membrane. The recommended operating temperature for the AS-MLV-P2 is 300°C, which is equivalent to an applied power of approx. 34mW at room temperature.

Figure 5:
Electrical Characteristics

| Description | Value |
|--|------------------------------|
| Resistance Values | |
| Sensor resistance range | 3kΩ to 3MΩ |
| Typical baseline in ambient air | 50kΩ to 500kΩ |
| Heater resistance ⁽²⁾ | 150Ω ± 30Ω at 300°C |
| Absolute Maximum Supply Ratings | |
| Power supply | 50mW (very short time range) |
| Heater current | 25mA |
| Heater Voltage | 3.0 V |
| Lifetime Requirements | |
| Expected lifetime ⁽¹⁾ | 10 years |
| With a minimum of | 85.000 hours |
| On/off cycles | 20.000 times |
| Sensor Element Response | |
| Response from | 10% |
| To its final value | 90% |
| For 0 - 20 ppm CO within | < 10sec |
| Sensor Element Recovery | |
| Response from | 10% |
| To its final value | 90% |
| Back from 20 – 0 ppm CO | < 1min |

Note(s):

1. This lifetime can only be reached with respect to the recommended operation of the sensor. Especially the maximum ratings during operation have to be followed carefully. With this background, the AS-MLV-P2 is maintenance free and shall require no replacement during specified lifetime.
2. Pt heater element operates at 300°C

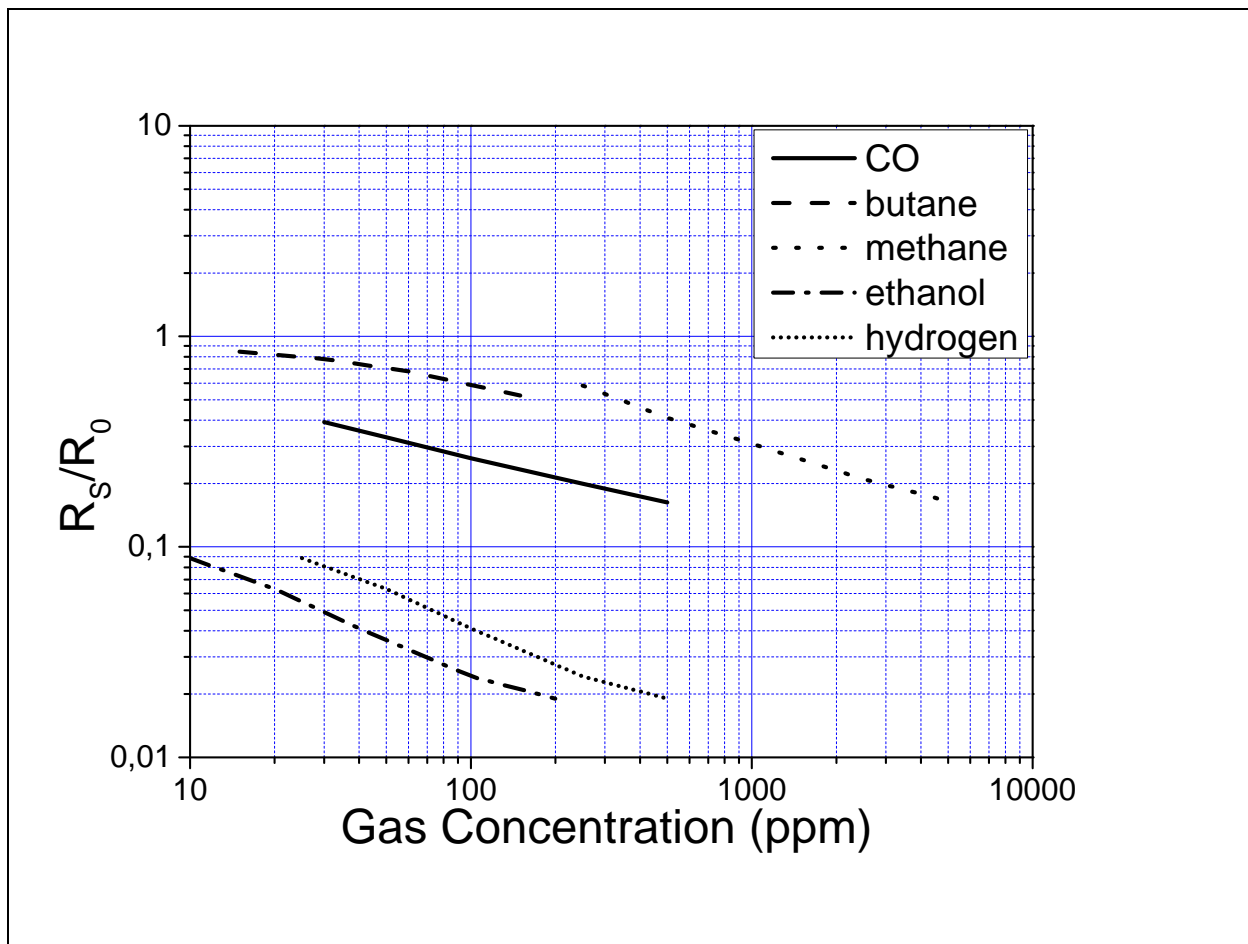
Detailed Description

AS-MLV-P2 heater and inter-digital electrode structures use Platinum and are implemented in an approximately one micrometer-thin silicon nitride membrane to achieve ultimate stability and lowest possible power consumption. A highly sensitive and long-term stable polycrystalline tin dioxide-based sensitive material is deposited on the inter-digital electrodes. At an elevated operation temperature of approx. 300°C, this catalytically active material shows a gas concentration dependent resistance change.

Sensing Properties

The AS-MLV-P2 sensor component shows a strong sensitivity to a wide range of reducing gases as can be seen in [Figure 6](#). Please note that those results may vary due to different environmental conditions.

Figure 6:
Sensor Sensitivity

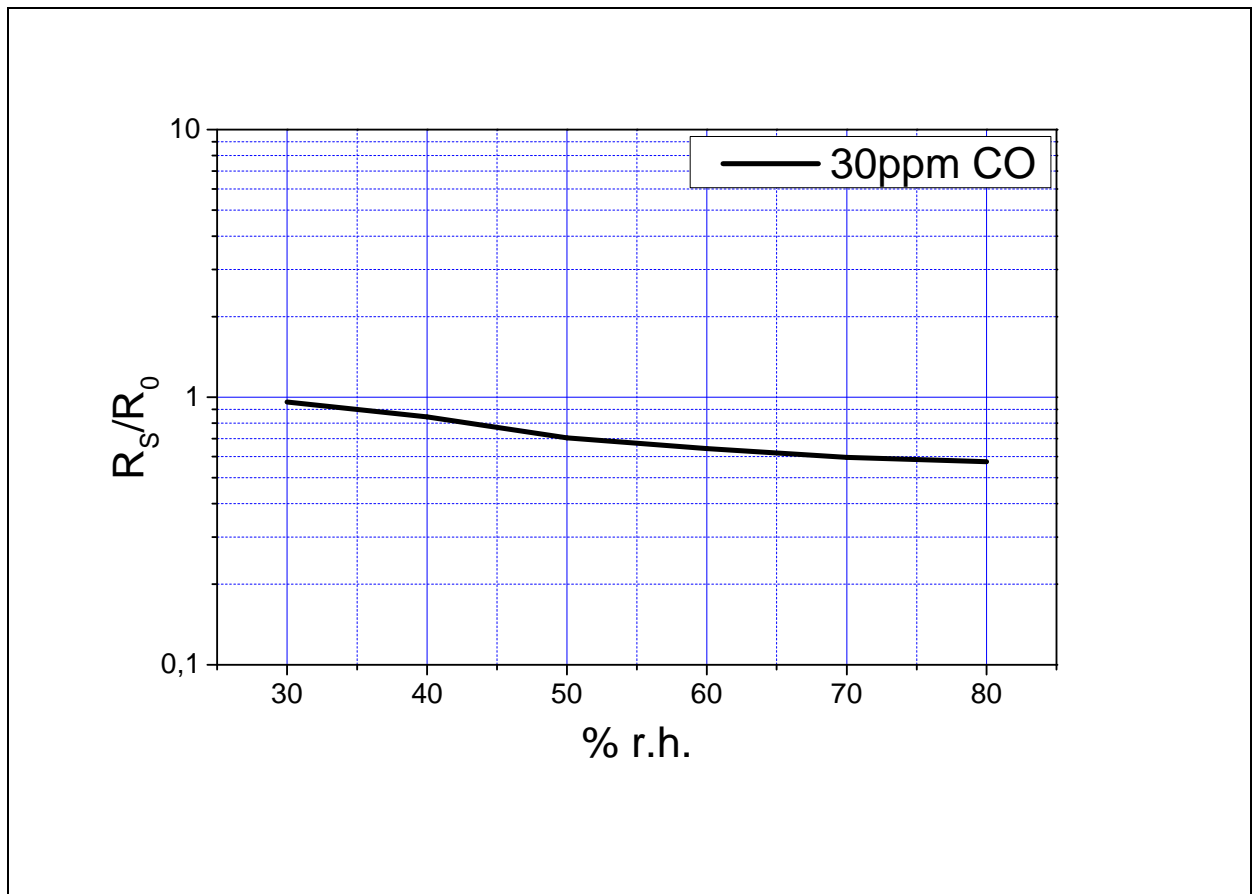


Sensor Sensitivity: Sensitivities for various gas concentrations, this graph shall just give an indication and can vary slightly from sensor to sensor.

Cross Sensitivities

Due to the basic operation principle of MOS gas sensors, the AS-MLV-P2 sensor component does have a cross sensitivity to humidity changes. This effect provides additional information and widens the application range for the sensor. This feature especially supports applications in environments where the detection of significant humidity changes is supporting the functionality, such as bathroom and kitchen environments. Figure 7 shows the dependency of humidity using the example of CO signals to get a visualized feeling for the effect. Please note that this dataset is just meant to be an example and the values may vary from sensor to sensor.

Figure 7:
Cross Sensitivity of Humidity for CO



Cross Sensitivity of Humidity for CO: Cross sensitivity of humidity for the example of CO. This data is just meant to be a visualization of the influence of humidity and will vary slightly from sensor to sensor.

Application Information

Due to the characteristics of the sensor, there are some issues to be taken care of while implementing. The operation temperature of the sensor has to be kept constant; therefore the circuit on heater site shall have the possibility to be regulated. The critical issue of the sensor resistance is the wide range of values which has to be covered during operation.

All following circuits are meant to be examples which have to be adapted carefully to the different applications.

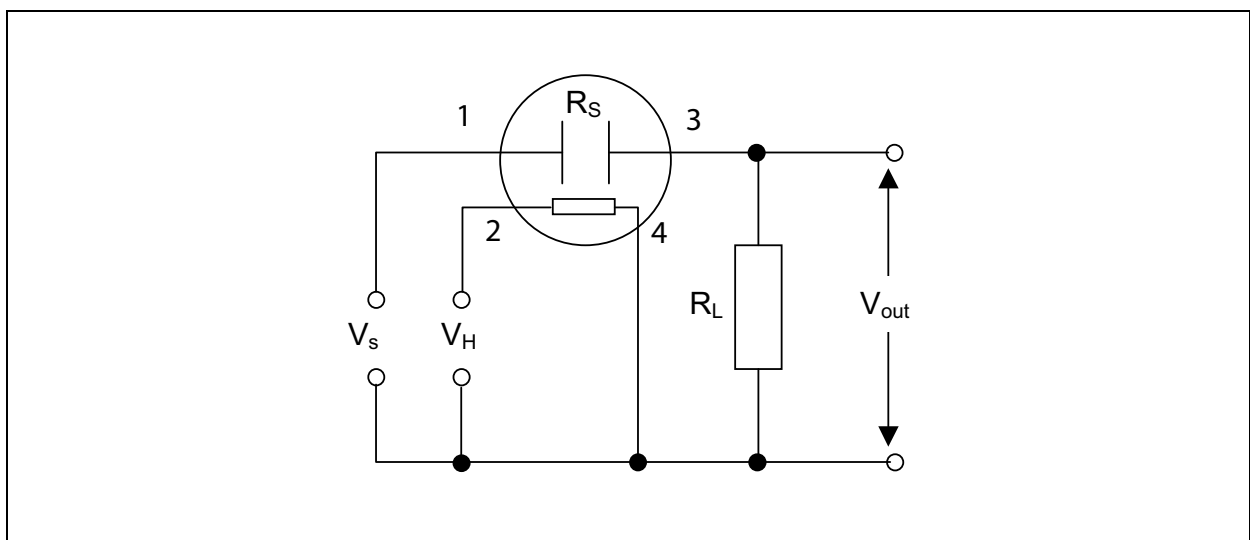
Sensor Resistance

The sensitive layer can change its resistance over several orders of magnitude, depending on the production and gas exposition. The electrical power dissipated in the sensitive layer must be limited and must not exceed 2mA. This power shall also avoid performing high changes over short time. Because of this issue a measuring range shifting realized with series resistors will have an effect to the sensor signal and should be avoided.

As a suggestion we measure the sensor resistance with a simple voltage divider as shown in Figure 8. V_H determines the heater voltage and therefore the operation temperature of the sensor. This regulation is described in a later chapter. Here we focus on the sensor resistance measuring. To meet the described specification a value of 10kOhm or 100kOhm for the load resistor (R_L) and a Voltage of 5V for V_S is a good starting point for a broad range of the sensor applications. A high precision noise free voltage source is recommended for generating V_S . R_S and R_L form a voltage divider, which can be used to calculate R_S (see EQ 1).

$$(EQ1) \quad R_S = R_L \left(\frac{V_S}{V_{out}} - 1 \right)$$

Figure 8:
A Basic Measurement Circuit for the Sensor Resistance



The resolution of the measurement of R_S is recommended to be better or equal to 1% of the actual reading. This allows making use of the full performance of the sensor. The requirements for the A/D conversion of the output voltage V_{out} is described in the following section.

The input impedance of the A/D converter should be high enough not to influence the level of the voltage divider, a ration of at least 10 between input impedance and values of R_S and/or R_L is recommended.

Averaging A/D conversion procedures are recommended in order to suppress fast resistance changes from the sensitive layer (resistive noise and change of the resistance due to chemical influences).

In order to achieve 1% of precision of the read-out of R_S , the A/D conversion of V_{out} needs lower resolution, if sensor- and load resistor match. A larger difference between R_S and R_L requires a higher resolution of the A/D conversion. The following figure gives a few examples for $V_S = 5V$.

Figure 9:
Examples for Readout of R_S with 1% Resolution ($V_S=5V$)

| R_S [Ohm] | R_L [Ohm] | V_{out} [V] | A/D Voltage Step for 1% Resolution |
|-------------|-------------|---------------|------------------------------------|
| 100 | 10k | 4.95 | 0.5mV |
| 1k | 10k | 4.5454 | 4.1mV |
| 10k | 10k | 2.5 | 12.4mV |
| 100k | 10k | 0.4545 | 4.1mV |
| 1M | 10k | 0.0495 | 0.5mV |
| 1k | 100k | 4.95 | 0.5mV |
| 10k | 100k | 4.5454 | 4.1mV |
| 100k | 100k | 2.5 | 12.4mV |
| 1M | 100k | 0.4545 | 4.1mV |

Examples for Readout of R_S with 1% Resolution: The series resistor R_L has also the functionality to limit the power dissipated to the sensitive layer.

If the A/D conversion is single ended (common ground) it might be useful to change the sequence of load resistor and sensor resistor in the voltage divider. This enables to increase the resolution by using a lower reference voltage for the A/D conversion.

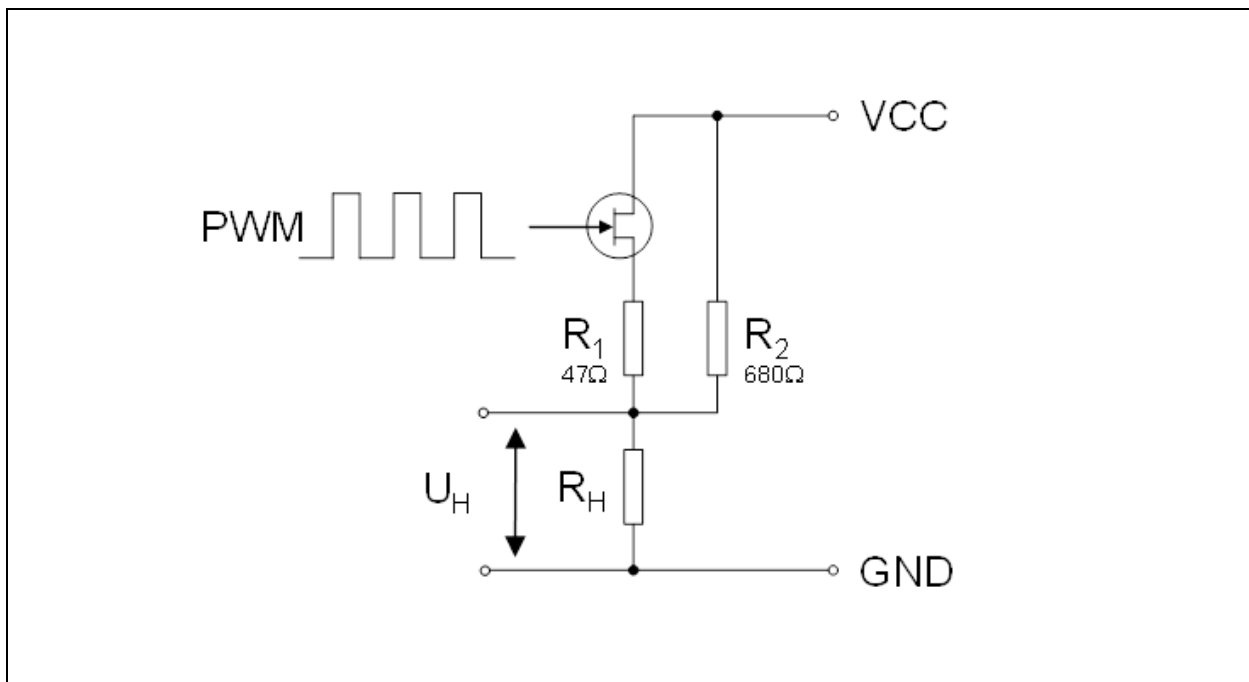
A constant current source can also be used to read-out the sensitive layer. In this case the electrical power dissipated in the sensitive layer must be limited and must not exceed 1mW for all values of R_S .

Heater Control

To solve the application the sensor needs a certain temperature, the operation point. This temperature correlates with the heater resistance of the sensor module. The heater resistance and its TCR varies with production and the sensor temperature should be adjusted by applying a calibration step up front. In this calibration step the characteristic of the correlation of temperature and heater power is used. For iAQ applications the dependency for the operation temperature of $\sim 300^\circ\text{C}$ is 34mW @ $23^\circ\text{C} \pm 2^\circ\text{C}$. The measured heater resistance value with this applied conditions is the set-point which will be important for the further operation.

Variation of ambient temperature may have an influence in the sensor temperature and its heater resistance. The chosen circuit shall be adjustable and should keep the heater resistance constant at the desired set-point. This can be solved by a basic PWM circuit shown in [Figure 10](#).

Figure 10:
Basic PWM Circuit for Heater Control



Basic PWM Circuit for Heater Control: A typically heater driver circuit, R1 is the current limit resistor, R2 is needed as a bypass resistor

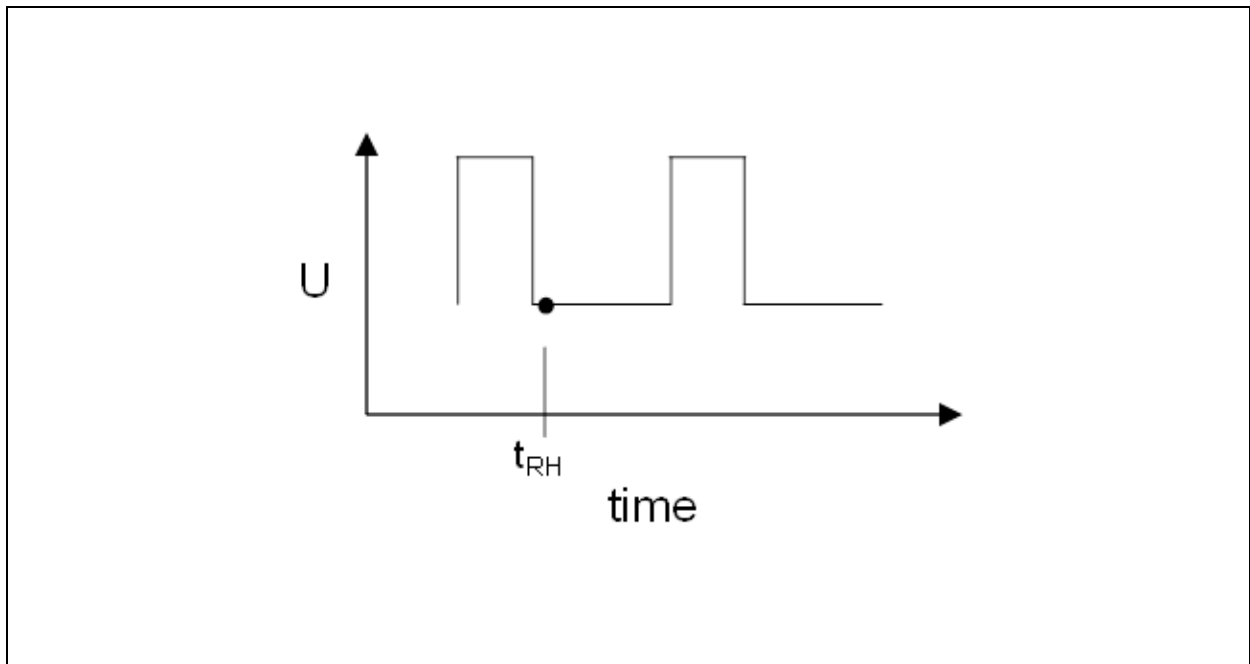
To use the example a p-channel MOSFET is mandatory; using an n-channel will need a change of the overall circuit design. In this case the Voltage VCC is 5V with a max ripple of 20mV, but the circuit is also valid for 3.3V. The circuit should be designed to achieve a PWM of 30-60% depending on heater set-point. This range gives the security that all specified environmental temperature ranges can be compensated.

The heater resistance should be measured at the beginning of the low phase indicated as t_{RH} in the drawing [Figure 11](#). The Voltage drop U_H is measured and R_h can be calculated as shown in [EQ 2](#).

$$(EQ2) \quad R_H = \frac{U_H \cdot R_2}{VCC - U_H}$$

Please note that this circuit are just mend to be an example and each circuit which can fulfill the conditions and respects the absolute maximum ratings of the sensor can be used.

Figure 11:
Example of PWM Cycle with Measurement Point



The heater can also be controlled by a DAC controlled circuit with a voltage divider.

Heater Calibration

As mentioned in the previous chapter the each sensor has its own set-point at the operation temperature. This set-point can be determined by a previous calibration step. This means that the AS-MLV-P2 is started at room temperature ($23^{\circ}\text{C} \pm 3^{\circ}\text{C}$) and powered with 34mW. With these conditions the heater resistance is measured and stored into the EEPROM. This heater resistance is the certain set-point which is kept constant with the regulating PWM during operation.

General Characteristics

The sensor has some native characteristics which should be considered in the application development.

Burn-In Behavior

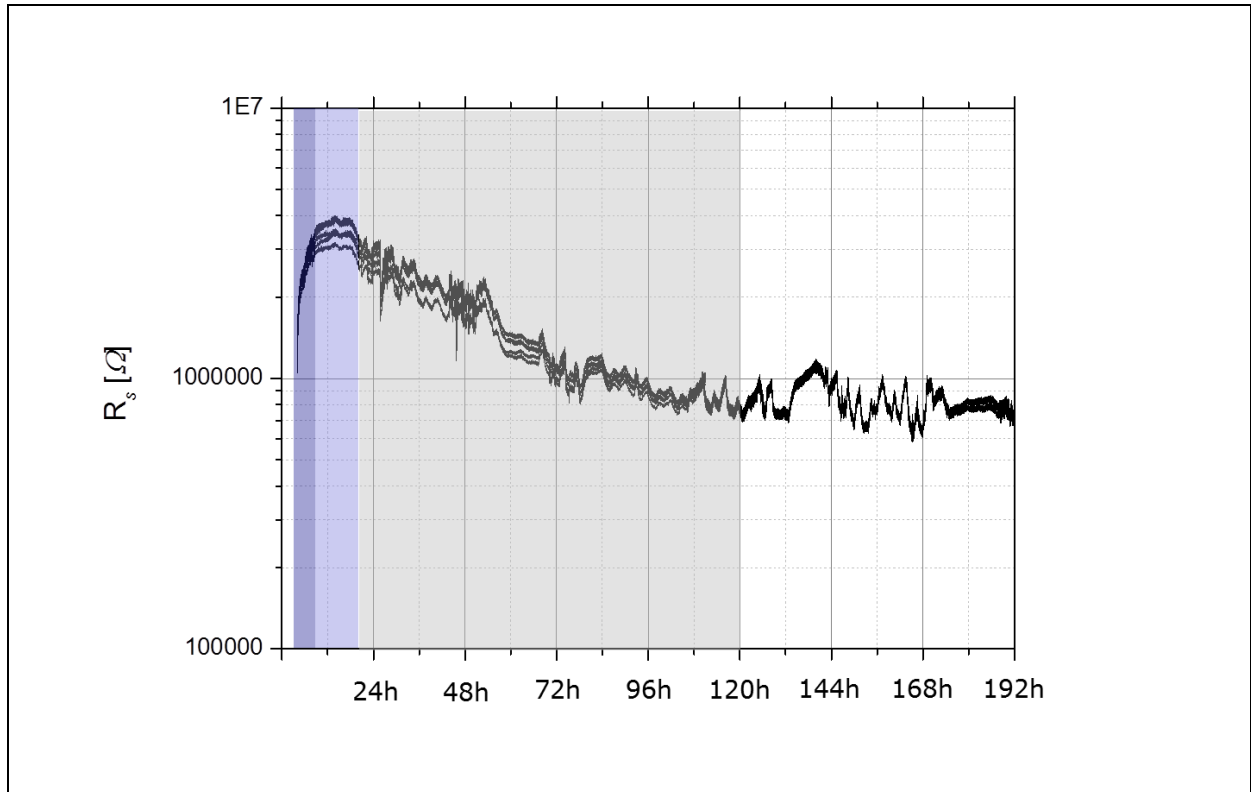
Once in lifetime the sensor performs a special burn in behavior, this curve is characterized in three phases which are described with the following figure.

Figure 12:
Burn-In of Sensor

| Description | | Duration |
|-------------|---|------------|
| Phase 1 | Fast increase of the sensor resistance | ~ 10 hours |
| Phase 2 | Plateau with nearly stable baseline | ~ 12 hours |
| Phase 3 | Long drift like decrease of the sensor resistance | > 4 days |

A characteristic example is shown in Figure 13. This behavior is caused due to manufacturing issues and is mandatory. After once following this issue it will never appear again. During the burn in phase the resistance range can be exceeded considerably.

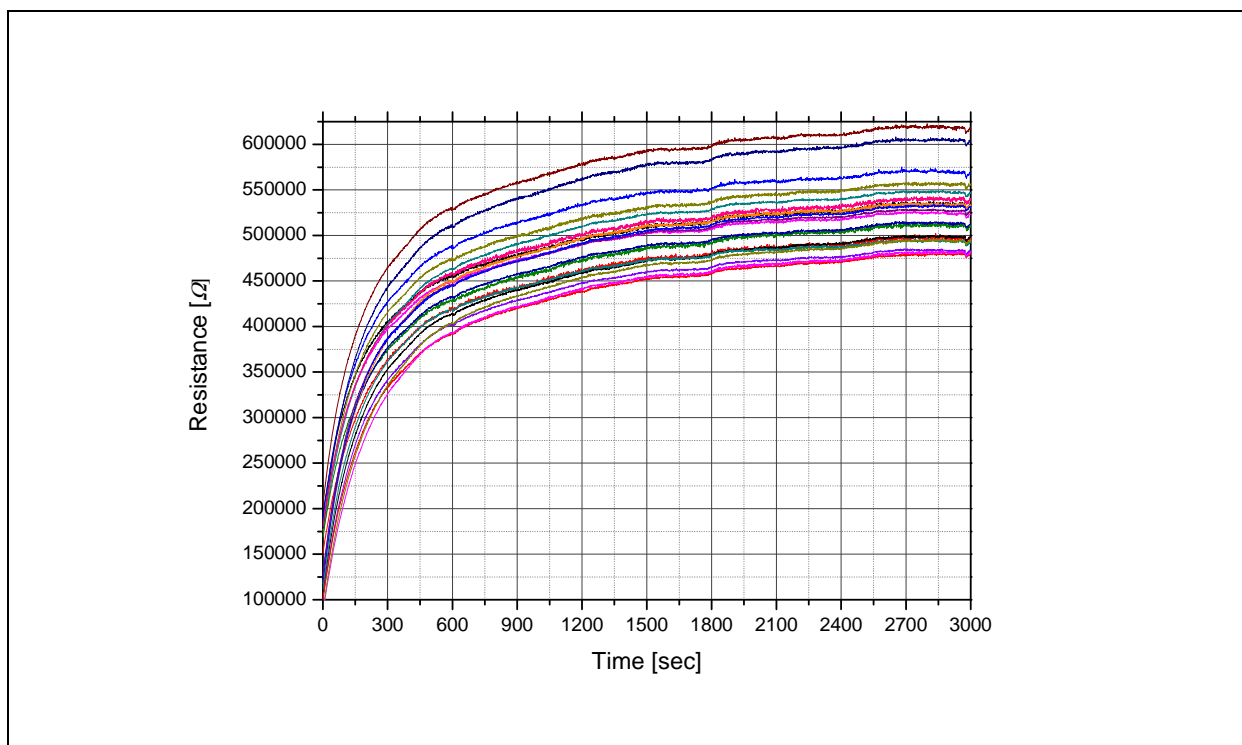
Figure 13:
Characteristic Resistance Curve during Burn-In



Run-In

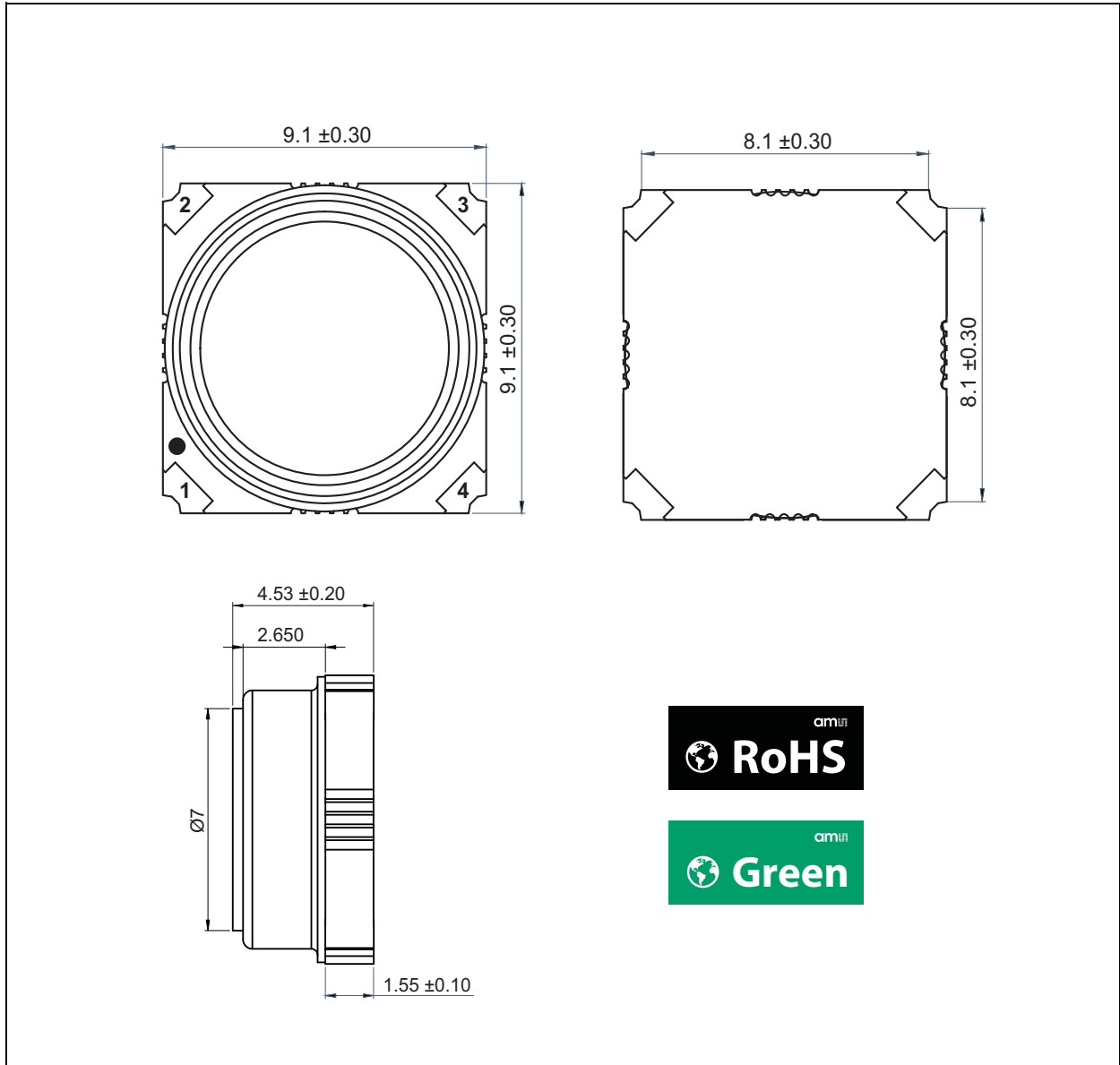
Each time after powering the sensor, the baseline of the sensitive layer performs a small run in phase. The curve is characterized with a steady increasing resistance. The length of this phase is depending on the sensors history. The longer the sensor was unpowered the longer the run in phase will take. The standard duration is approx. 3-5 minutes.

Figure 14:
Run-In Phase of Sensor



Mechanical Information

Figure 15:
Module Dimensions



Note(s):

1. All Dimensions are in millimeters.

Figure 16:
Module Markings

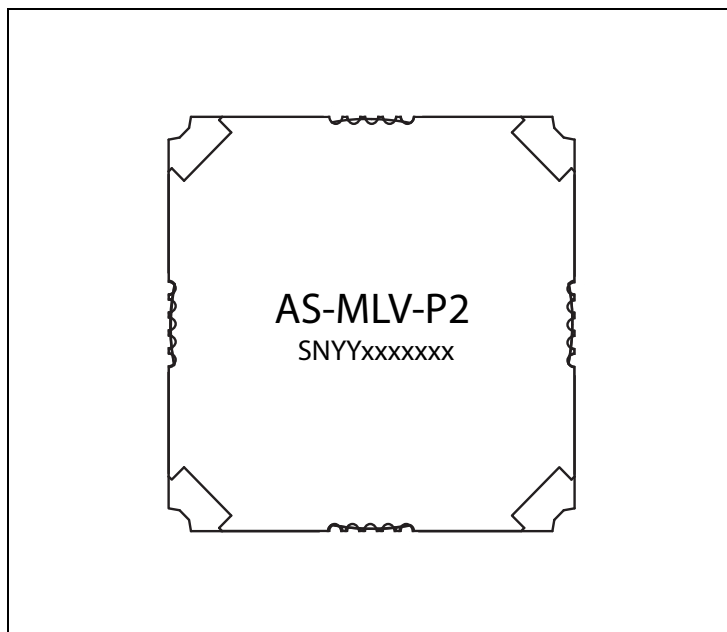
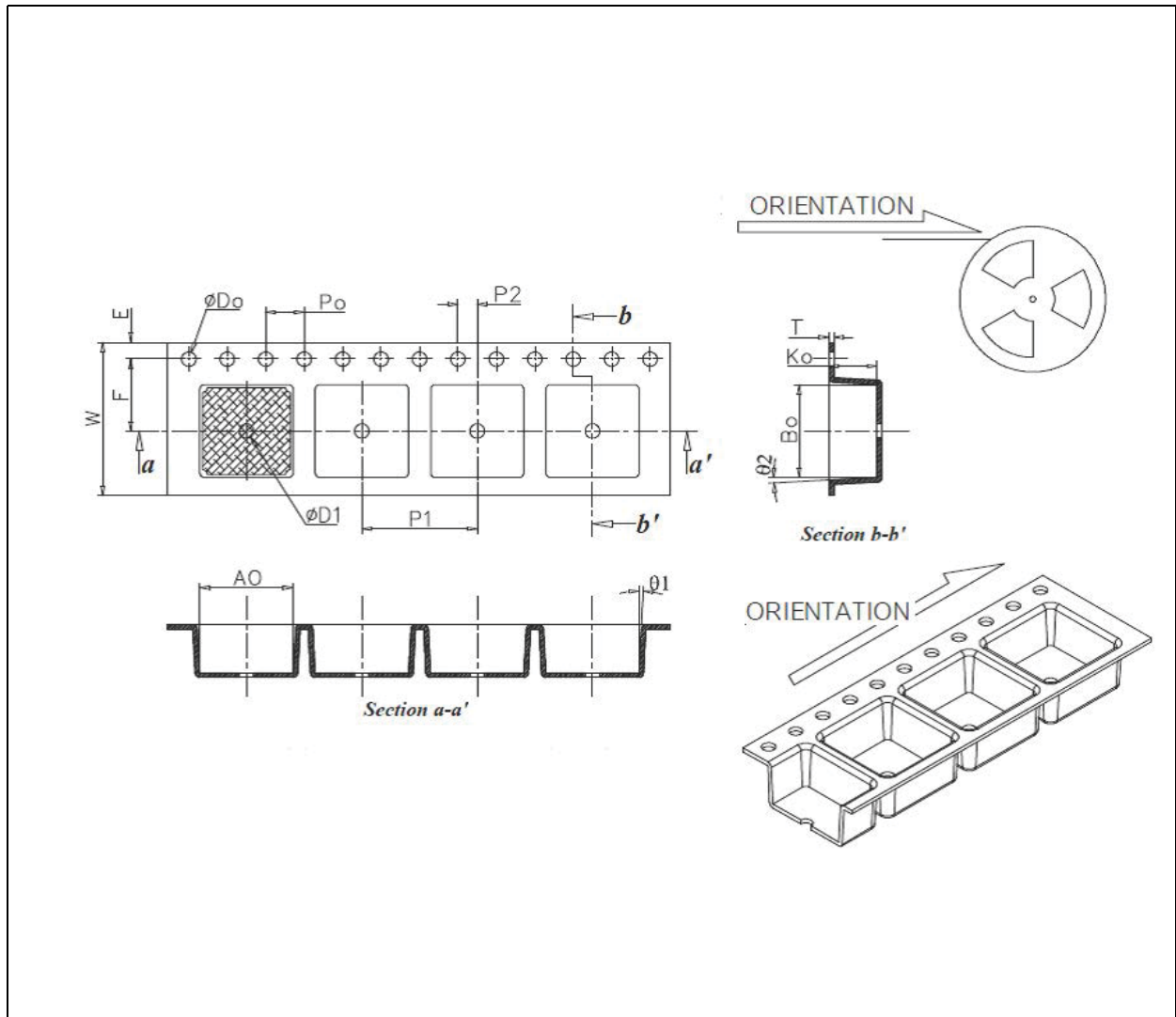


Figure 17:
Module and Marking Elements

| Item | Description |
|----------------------------|---|
| PCB Material | FR4 with gold surface (7µm Ni / 3µm Au) |
| Connector | Edge connector |
| Marking PIN1 | White mark |
| Label | Laser mark AS-MLV-P2 |
| Product name (first row) | AS-MLV-P2 |
| Serial number (second row) | SNYYxxxxxxx |
| | YY → two digits production year |
| | xxxxxxx → 7 digits running number |

Figure 18:
Tape and Reel Information



| Description | Items | Symbol | Value | Unit | Tolerance |
|-------------|--------|--------|-------|--------|-----------|
| Pocket | Length | Ao | 9.70 | mm | ±0.10 |
| | Width | Bo | 9.70 | | |
| | Depth | Ko | 5.00 | | |
| | Pitch | P1 | 12.00 | | |
| | Angle | θ1 | 3 | Degree | Max. |
| | Angle | θ2 | 3 | | |

| Description | Items | Symbol | Value | Unit | Tolerance |
|------------------------------|---|--------|-------|------|-----------|
| Perforation | Diameter | ØD0 | 1.50 | mm | +0.10 |
| | Diameter | ØD1 | 1.50 | | -0.00 |
| | Pitch | P0 | 4.00 | | ±0.10 |
| | Pitch | P2 | 2.00 | | |
| | Position | E | 1.75 | | |
| Distance between center line | Width | F | 7.50 | | |
| Carrier tape material | Type | Echips | | | |
| | Width | W | 16.00 | mm | ±0.30 |
| | Thickness | T | 0.50 | | ±0.05 |
| Requirement/ Notice | 1. Camber 250mm. Should be less than 1.00mm by Camber gauge. 2. Must conform to E.I.A. Standard. | | | | |

Note(s):

1. All dimensions are in millimeters unless otherwise stated.
2. Unspecified dimension tolerance should be ±0.10mm.
3. Cumulative tolerance of 10 sprocket holes is ±0.20mm.

Soldering Information

Handling

The AS-MLV-P2 should be handled carefully, shear stress should be avoided. The sensor is protected against particles and liquids by a membrane. This membrane shall not be removed or touched.

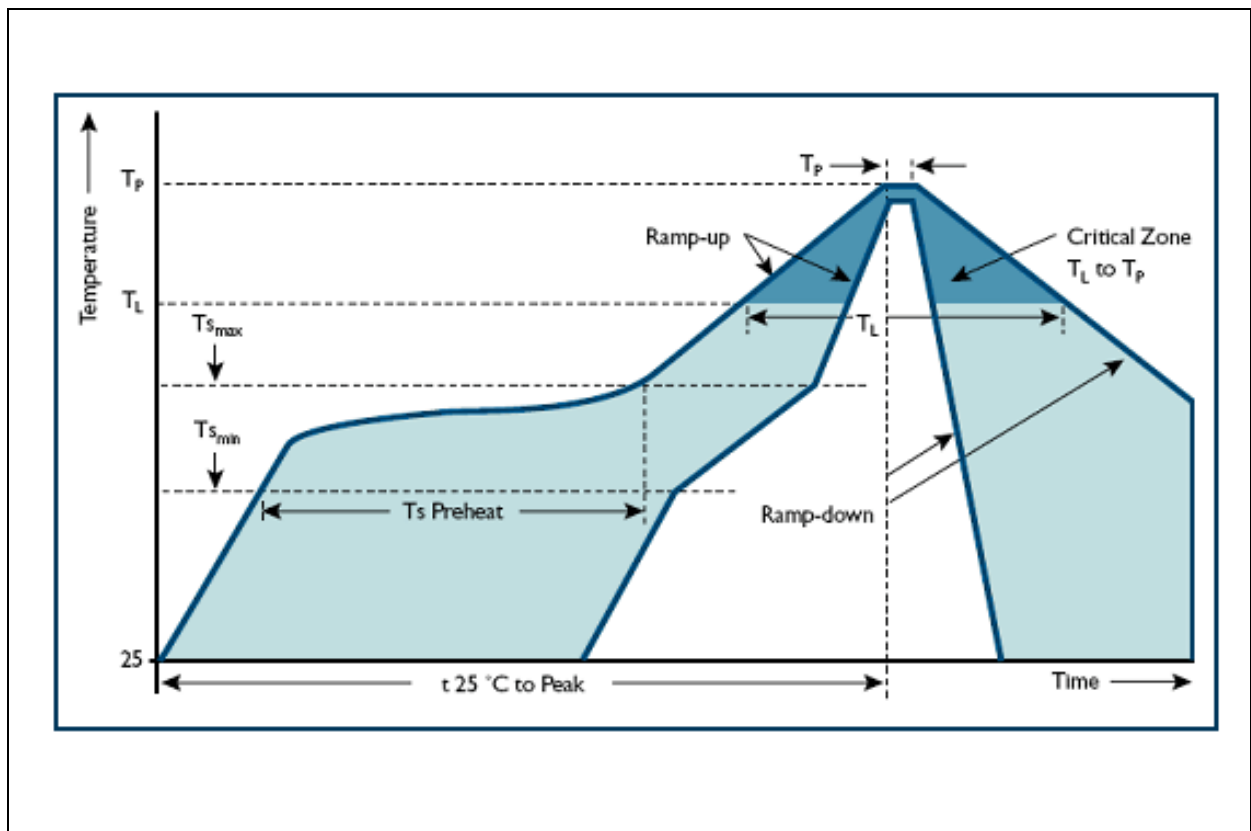
Soldering Instructions

The AS-MLV-P2 can be soldered in standard reflow soldering ovens. The reflow oven shall be purged with clean air. Other gases must be avoided. For the lead free reflow process a standard process IPC/JEDEC J-STD-020 with peak temperature up to maximum 230°C on surface is suggested. See [Figure 19](#) for more detailed description.

Note(s): The device shall be kept clear of liquids; therefore a PCB washing process must be avoided in any case.

For manual soldering: contact must be limited to 5 seconds at a maximum temperature of 350°C.

Figure 19:
Solder Reflow Graph



Ordering & Contact Information

Figure 20:
Ordering Information

| Ordering Code | Marking | Delivery Form | Delivery Quantity |
|---------------|-----------|---------------|-------------------|
| AS-MLV-P2 | AS-MLV-P2 | Tape & Reel | 900 |

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Document Status

| Document Status | Product Status | Definition |
|--------------------------|-----------------|--|
| Product Preview | Pre-Development | Information in this datasheet is based on product ideas in the planning phase of development. All specifications are design goals without any warranty and are subject to change without notice |
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Revision Information

| Changes from 1-00 (2015-Jul-10) to current revision 1-01 (2015-Oct-12) | Page |
|--|------|
| Updated Figure 3 | 2 |
| Updated EQ1 | 7 |
| Updated Figure 8 | 7 |

Note(s):

1. Page and figure numbers for the previous version may differ from page and figure numbers in the current revision.
2. Correction of typographical errors is not explicitly mentioned.

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