



**THE DATASHEET OF
IM72D128V01XTMA1**



IM72D128V01

IP57 dust and water resistant digital PDM XENSIV™ MEMS microphone

Description

The IM72D128V01 is an ultra-high performance digital PDM MEMS microphone designed for applications which require a very high SNR (low self-noise) and low distortion (high AOP) and which is also IP57 robust to dust and water.

Best-in-class signal-to-noise ratio (SNR) of 72dB(A) enables far field and low volume audio pick-up. The flat frequency response (20Hz low-frequency roll-off) and tight manufacturing tolerance improve performance of multi-microphone (array) applications.

The digital microphone ASIC contains an extremely low-noise preamplifier and a high-performance sigma-delta ADC. Different power modes can be selected in order to suit specific clock frequency and current consumption requirements.

Each IM72D128V01 microphone is calibrated with an advanced Infineon calibration algorithm, resulting in low sensitivity tolerances (± 1 dB).

Features

- Component level IP57 water and dust resistant
- Dynamic range of 106dB
- Acoustic overload point at 128dB SPL
- Signal to noise ratio of 72dB(A) SNR
- Digital PDM output
- Flat frequency response with a low frequency roll-off at 20Hz
- Package dimensions: 4mm x 3mm x 1.2mm
- Omnidirectional pickup pattern
- Power optimized modes determined by PDM clock frequency

Typical applications

- Active Noise Cancellation (ANC) headphones and earphones
- Devices with Voice User Interface (VUI)
 - Smart speakers
 - Home automation
 - IOT devices
- High quality audio capturing
 - Laptops and tablets
 - Conference systems
 - Cameras and camcorders
- Industrial or home monitoring with audio pattern detection

Ordering information

Table 1 Ordering information

| Product name | Package | Marking | Ordering code |
|--------------|-------------|---------|---------------|
| IM72D128V01 | PG-LLGA-5-3 | I72D07 | SP005738480 |

Product validation

Product validation

Technology qualified for industrial applications.

Ready for validation in industrial applications according to the relevant tests of IEC 60747 and 60749 or alternatively JEDEC47/20/22.

Block diagram

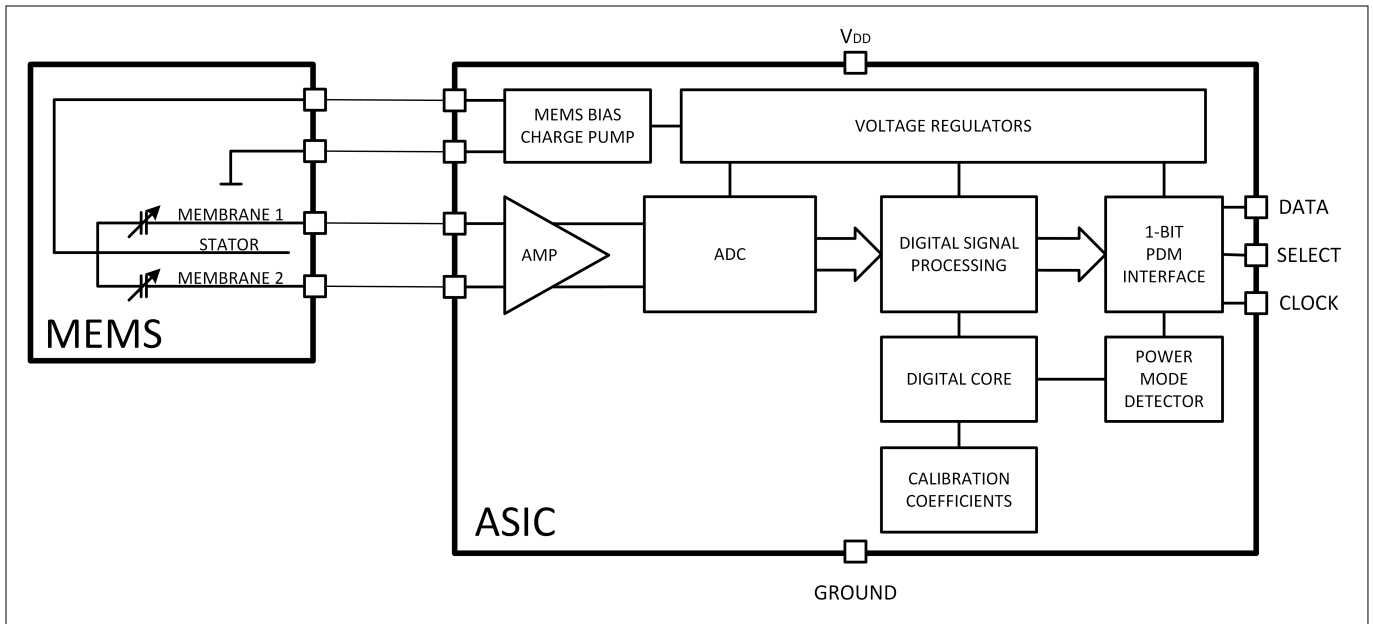


Figure 1 Block diagram

Environmental robustness

Infineon’s latest Sealed Dual Membrane MEMS technology delivers high ingress protection (IP57) at a microphone level. The sealed MEMS design prevents water or dust from entering between membrane and backplate, preventing mechanical blockage or electric leakage issues commonly observed in MEMS microphones. Microphones built with the Sealed Dual Membrane technology can be used to create IP68 devices, requiring only minimal mesh protection.

Table 2 Environmental robustness

| Test Standard | Test Condition |
|------------------------------------|--|
| IP5x dust resistance ¹⁾ | Arizona dust A4 coarse, vertical orientation , sound hole upwards, 10 cycles (15 minutes sedimentation, 6 sec blowing) |
| IPx7 water immersion ²⁾ | Temporary immersion of 1 meters for 30 minutes. Microphone tested 2 hours after removal |

¹ The number "5" stands for the dust ingress rating or the capacity to withstand the effects of fine, abrasive dust particles.

² The "7" specifies the higher water immersion rating.

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Typical performance characteristics

1 Typical performance characteristics

Test conditions: $V_{DD} = 1.8V$, $f_{CLK} = 3.072MHz$, unless otherwise specified.

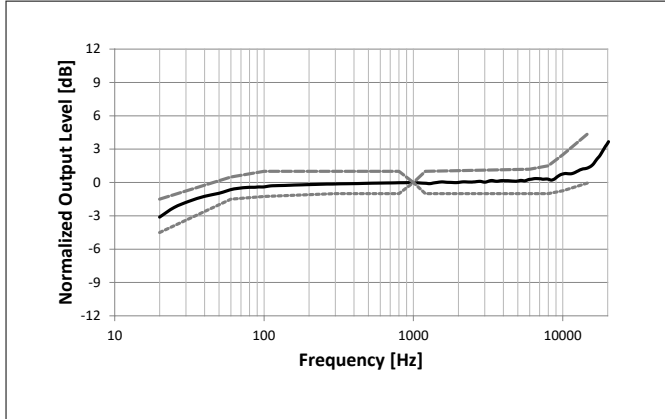


Figure 2 Typical amplitude response

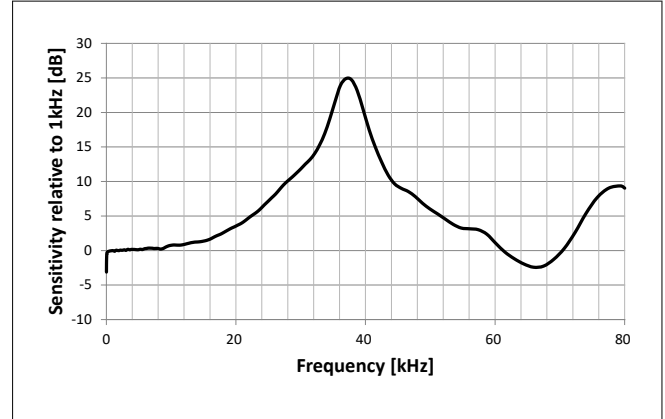


Figure 3 Typical free field ultrasonic response

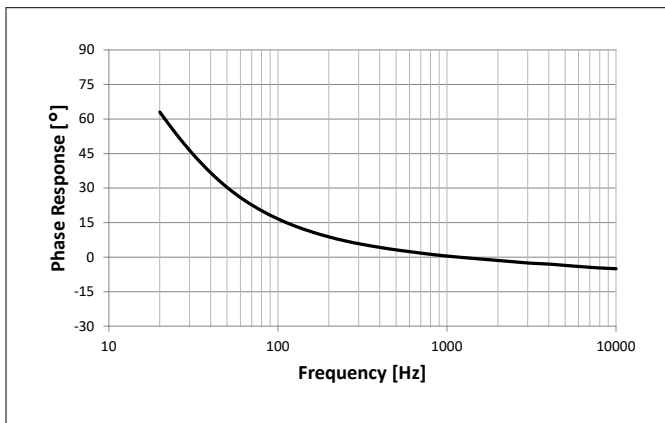


Figure 4 Typical phase response

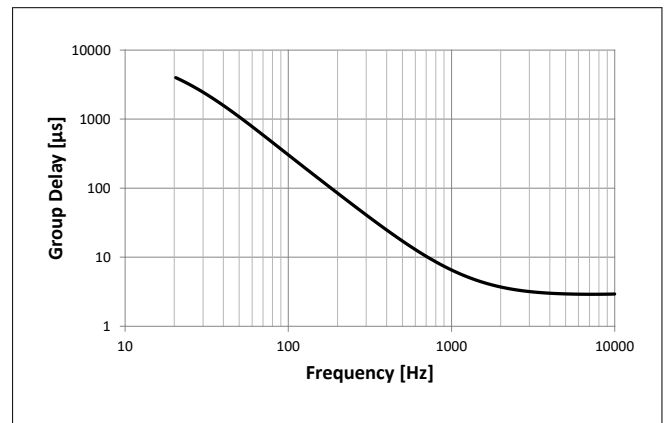


Figure 5 Typical group delay

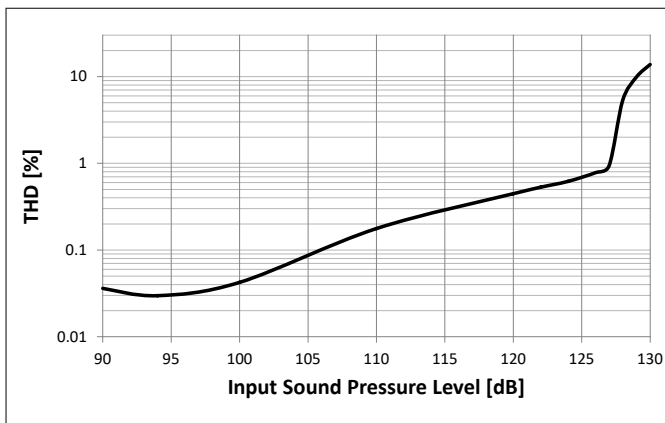


Figure 6 Typical THD vs SPL

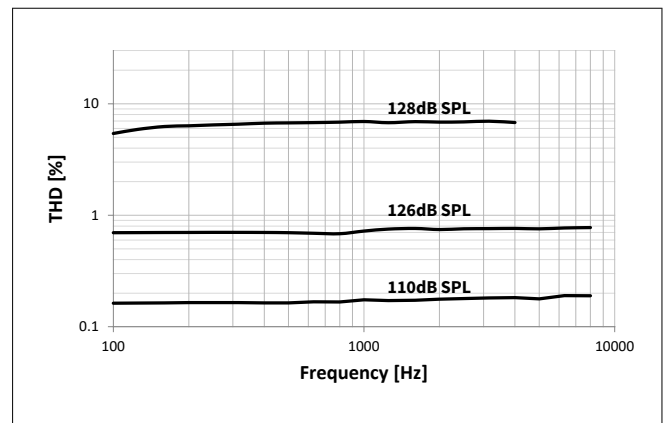


Figure 7 Typical THD vs frequency

Typical performance characteristics

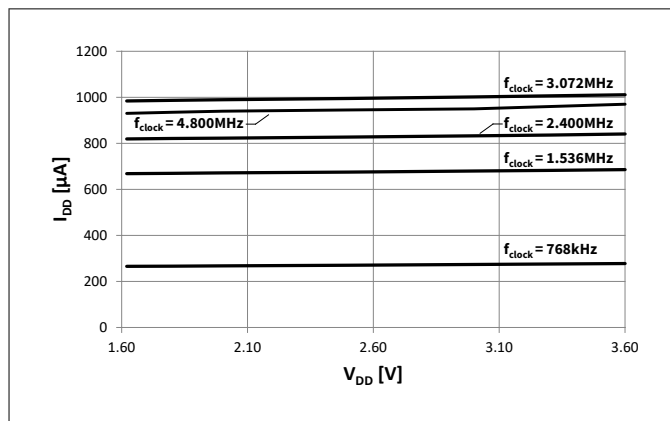


Figure 8 Typical I_{DD} vs V_{DD}

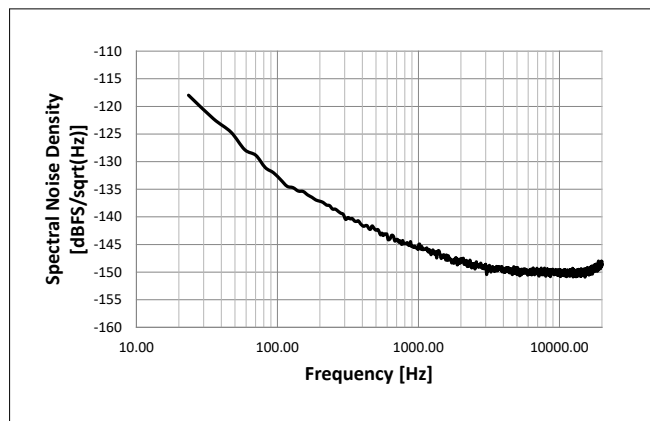


Figure 9 Typical noise floor (unweighted)

Acoustic characteristics

2 Acoustic characteristics

Test conditions (unless otherwise specified in the table): $V_{DD} = 1.8V$, $f_{CLK} = 3.072MHz$, $T_A = 25^\circ C$, 55% R.H., audio bandwidth 20Hz to 20kHz, select pin grounded, no load on DATA, $T_{edge} = 9ns$

Table 3 acoustic specifications

| Parameter | Symbol | Values | | | Unit | Note or Test Condition | |
|--|------------------------------------|---|-----------------|------|------|-------------------------------------|---|
| | | Min. | Typ. | Max. | | | |
| Sensitivity | S | -37 | -36 | -35 | dBFS | 1kHz, 94dB SPL, all operating modes | |
| Low Frequency Roll-off | LFRO | | 20 | | Hz | -3dB relative to 1kHz | |
| High Frequency Flatness ³⁾ | | | 19 | | kHz | +3dB relative to 1kHz | |
| Resonance Frequency Peak ³⁾ | | | 37 | | kHz | | |
| Signal to Noise Ratio | $f_{clock} = 768kHz$ | SNR | | 67 | | dB(A) | 20Hz to 8kHz bandwidth, A-Weighted |
| | $f_{clock} = 1.536MHz$ | | | 68 | | | |
| | $f_{clock} = 2.4MHz$ | | | 71.5 | | | 20Hz to 20kHz bandwidth, A-Weighted |
| | $f_{clock} = 3.072MHz$ | | | 72 | | | |
| | $f_{clock} = 4.8MHz$ ³⁾ | | | 71.5 | | | |
| Total Harmonic Distortion | 94dB SPL | THD | | 0.5 | | % | Measuring 2nd to 5th harmonics; 1kHz. all operating modes |
| | 126dB SPL | | | 1.0 | | | |
| Acoustic Overload Point | 10% THD | AOP | | 128 | | dB SPL | Measuring 2nd to 5th harmonics; 1kHz. all operating modes |
| Group Delay | 250Hz | | | 60 | | μs | |
| | 600Hz | | | 12 | | | |
| | 1kHz | | | 7 | | | |
| | 4kHz | | | 3.5 | | | |
| Phase Response | 75Hz | | | 20 | | ° | |
| | 1kHz | | | 0.5 | | | |
| | 4kHz | | | -2 | | | |
| Directivity | | | Omnidirectional | | | | |
| Polarity | | Positive pressure increases density of 1's, negative pressure decreases density of 1's in data output | | | | | |

³⁾ Parameter not subject to productive test. Verified by laboratory characterization / design.

Electrical characteristics and parameters

3 Electrical characteristics and parameters

3.1 Absolute maximum ratings

Stresses at or above the listed maximum ratings may affect device reliability or cause permanent device damage. Functional device operation at these conditions is not guaranteed.

Table 4 Absolute maximum ratings

| Parameter | Symbol | Values | | Unit | Note / Test Condition |
|---------------------|-----------|--------|------|------|-----------------------|
| | | Min. | Max. | | |
| Voltage on any Pin | V_{max} | | 3.6 | V | |
| Storage Temperature | T_S | -40 | 125 | °C | |
| Ambient Temperature | T_A | -40 | 85 | °C | |

3.2 Electrical parameters

Table 5 Electrical parameters and digital interface input

| Parameter | Symbol | Values | | | Unit | Note / Test Condition | |
|---------------------------------|-----------------------|----------------------|------|----------------------|------|--------------------------------------|---------------|
| | | Min. | Typ. | Max. | | | |
| Supply Voltage | V_{DD} | 1.62 | 1.8 | 3.6 | V | ⁴⁾ | |
| Clock Frequency Range | Standby Mode | f_{clock} | | | 350 | kHz | ⁵⁾ |
| | Low Power Mode | | 450 | 768 | 850 | kHz | |
| | Normal Mode | | 1.2 | 1.536 | 1.65 | MHz | |
| | High Performance Mode | | 2.0 | 2.4 | 2.6 | MHz | |
| | | | 2.9 | 3.072 | 3.3 | MHz | |
| Ultrasonic Mode | 4.56 | 4.8 | 5.04 | MHz | | | |
| V_{DD} Ramp-up Time | | | | 50 | ms | Time until $V_{DD} \geq V_{DD_min}$ | |
| Input Logic Low Level | V_{IL} | -0.3 | | $0.35 \times V_{DD}$ | V | | |
| Input Logic High Level | V_{IH} | $0.65 \times V_{DD}$ | | $V_{DD} + 0.3$ | V | | |
| Clock Rise/Fall Time | | | | 13 | ns | 10% to 90% | |
| Clock Duty Cycle | | 40 | | 60 | % | $f_{clock} \leq 3\text{MHz}$ | |
| | | 48 | | 52 | % | $f_{clock} > 3\text{MHz}$ | |
| Output Load Capacitance on DATA | C_{load} | | | 200 | pF | | |

⁴ A 1 μ F bypass capacitor shall be placed close to the microphone V_{DD} pad to ensure best SNR performance.

⁵ Data pad is high impedance in standby mode.

Electrical characteristics and parameters

3.3 Electrical characteristics

Test conditions (unless otherwise specified in the table): $V_{DD} = 1.8V$, $T_A = 25^\circ C$, 55% R.H.

Table 6 General electrical characteristics

| Parameter | | Symbol | Values | | | Unit | Note / Test Condition |
|--|---|-------------------------|---------------------|------|---------------------|---------|--|
| | | | Min. | Typ. | Max. | | |
| Current Consumption | Clock Off Mode | $I_{\text{clock_off}}$ | | | 1 | μA | CLOCK pulled low |
| | Standby Mode | I_{standby} | | 25 | 50 | | No load on DATA |
| | $f_{\text{clock}} = 768\text{kHz}$ | I_{DD} | | 280 | 310 | | <5pF load on DATA |
| | $f_{\text{clock}} = 1.536\text{MHz}$ | | | 690 | 770 | | |
| | $f_{\text{clock}} = 2.4\text{MHz}$ | | | 820 | 945 | | |
| | $f_{\text{clock}} = 3.072\text{MHz}$ | | | 980 | 1120 | | |
| | $f_{\text{clock}} = 4.8\text{MHz}$ | | | 900 | 1000 | | |
| | | | | | | | |
| Short Circuit Current | | | 1 | | 20 | mA | Grounded DATA pin |
| Power Supply Rejection | | PSR_{1k_NM} | | -80 | | dBFS | 100mV _{pp} sine wave on V_{DD} swept from 200Hz to 20kHz. |
| | | PSR_{217_NM} | | -86 | | dBFS(A) | 100mV _{rms} , 217Hz square wave on V_{DD} . A-weighted. |
| Startup Time | $\pm 0.5\text{dB}$ sensitivity accuracy | | | | 20 | ms | Time to start up in any operating modes after V_{DD_min} and CLOCK have been applied. ⁶⁾ |
| | $\pm 0.2\text{dB}$ sensitivity accuracy | | | | 50 | | |
| Mode Switch Time | $\pm 0.5\text{dB}$ sensitivity accuracy | | | | 20 | ms | Time to switch between operating modes. V_{DD} remains on during the mode switch. ⁶⁾ |
| | $\pm 0.2\text{dB}$ sensitivity accuracy | | | | 50 | | |
| Output Logic Low Level | | V_{OL} | | | $0.3 \times V_{DD}$ | V | |
| Output Logic High Level | | V_{OH} | $0.7 \times V_{DD}$ | | | | |
| Delay Time for DATA Driven | | t_{DD} | 40 | | 80 | ns | Delay time from CLOCK edge ($0.5 \times V_{DD}$) to DATA driven. |
| Delay Time for DATA High-Z ⁷⁾ | | t_{HZ} | 5 | | 30 | ns | Delay time from CLOCK edge ($0.5 \times V_{DD}$) to DATA high impedance state |

(table continues...)

⁶⁾ Verified at typical PDM clock frequencies for each power mode.

⁷⁾ t_{hold} is dependent on C_{load}

Electrical characteristics and parameters

Table 6 (continued) General electrical characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Delay Time for DATA Valid ⁸⁾ | t_{DV} | | | 100 | ns | Delay time from CLOCK edge ($0.5 \times V_{DD}$) to DATA valid ($< 0.3 \times V_{DD}$ or $> 0.7 \times V_{DD}$) |
| Power-on behaviour | Idle tone is output over PDM within 3ms of applying V_{DD} and f_{clock} , remains until a valid microphone signal is available. Idle tone consists of alternating 1s and 0s, representing a zero input signal. | | | | | |

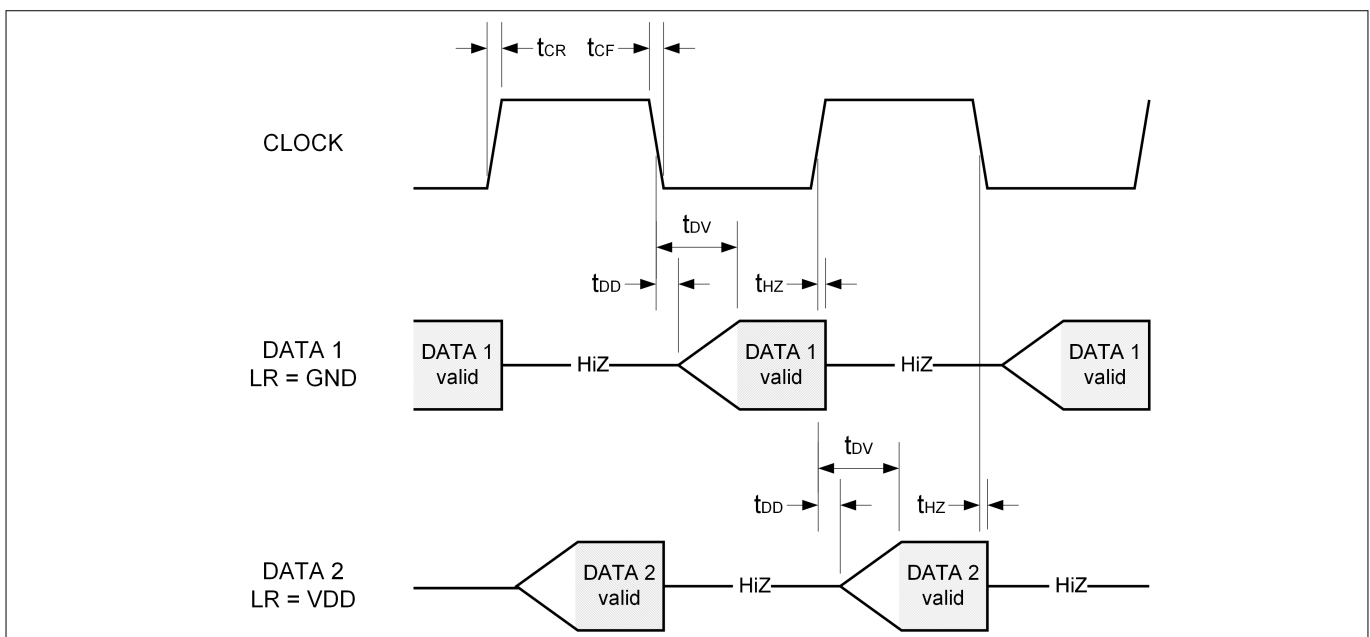


Figure 10 Timing diagram

3.4 Audio DC offset

The DC output level encoded in the DC bit stream is determined by the L/R state on startup. In each case the DC output level is stable over time and does not vary with input signal level.

Table 7 DC output level using L/R pin

| LR state | DC output level (typical) | Unit |
|----------|---------------------------|------|
| LR = GND | -80 | dBFS |
| LR = VDD | -40 | dBFS |

⁸ Load on data: $C_{load}=100pF$, $R_{load}=100k\Omega$

3.5 Stereo PDM configuration

The IM72D128V01 is designed to function in circuits with one or two microphones on the PDM bus. When two microphones are connected, data is transmitted alternately according to the L/R pin status of each microphone. When two microphones are connected to a shared PDM bus, the power modes of both microphones will be the same as both are controlled by the same PDM clock. The performance is unchanged relative to a single microphone per bus configuration.

Table 8 PDM channel configuration using L/R pin.

| Channel | Data driven | Data high-Z | L/R connection |
|---------|--------------------|--------------------|-----------------|
| DATA1 | Falling clock edge | Rising clock edge | GND |
| DATA2 | Rising clock edge | Falling clock edge | V _{DD} |

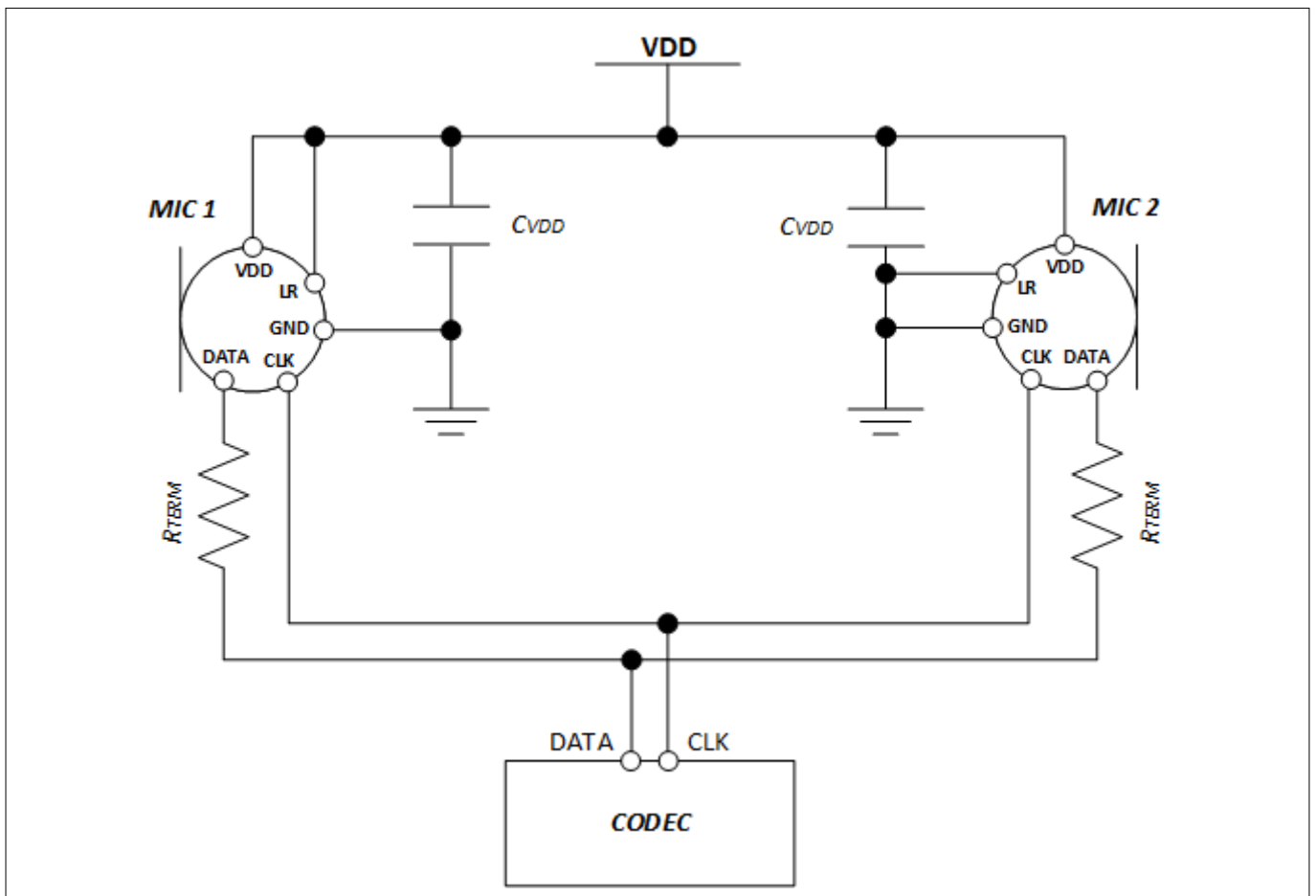


Figure 11 Typical stereo mode configuration

Note: For best performance it is strongly recommended to place a 100nF (C_{VDD_typical}) capacitor between V_{DD} and ground. The capacitor should be placed as close to V_{DD} as possible. A termination resistor (R_{TERM}) of about 100Ω may be added to reduce the ringing and overshoot on the output signal.

Package information

4 Package information

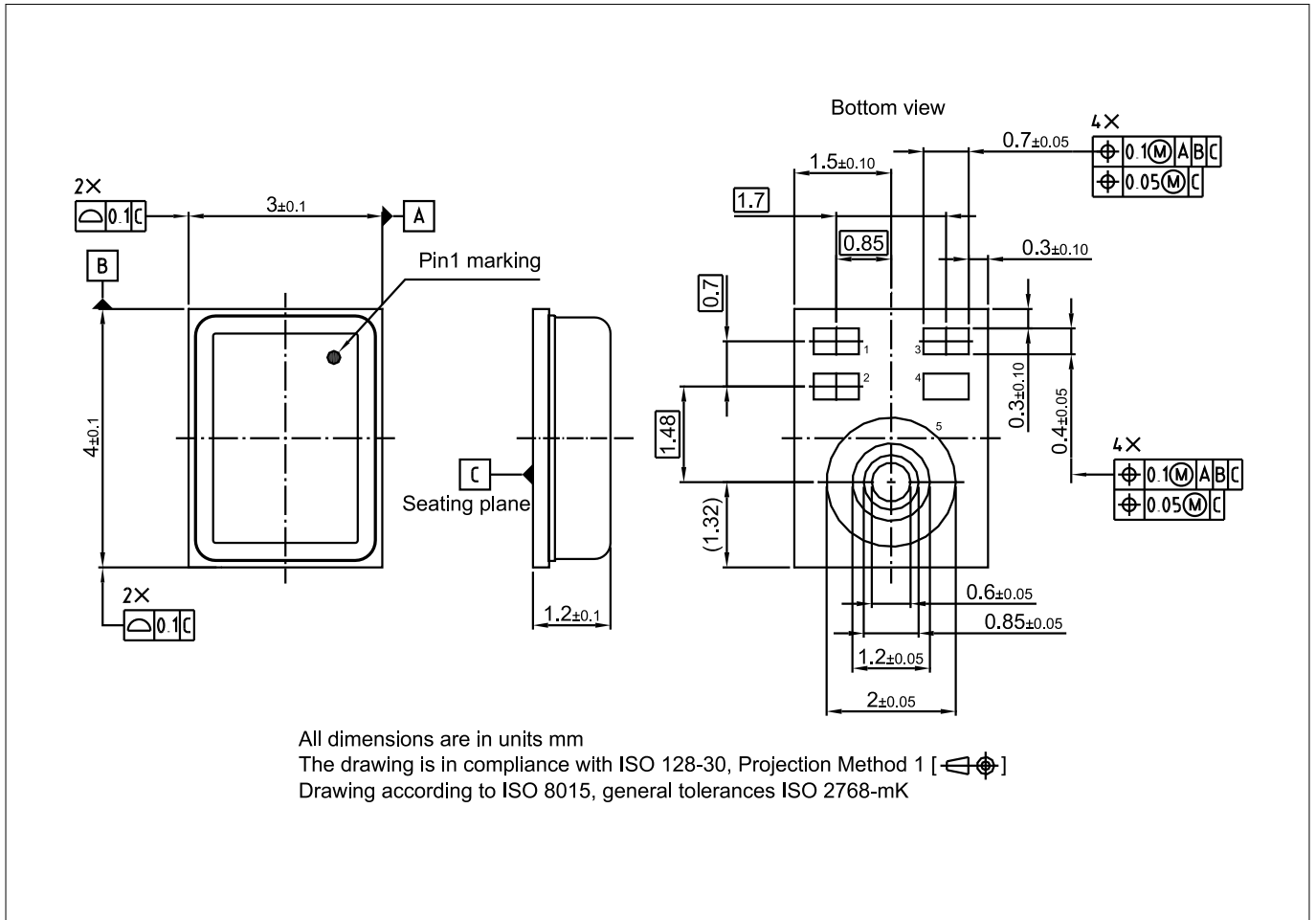


Figure 12 IM72D128V01 package drawing

Table 9 IM72D128V01 pin configuration

| Pin Number | Name | Description |
|------------|-----------------|-----------------------|
| 1 | DATA | PDM data output |
| 2 | V _{DD} | Power supply |
| 3 | CLOCK | PDM clock input |
| 4 | SELECT | PDM left/right select |
| 5 | GND | Ground |

Footprint and stencil recommendation

5 Footprint and stencil recommendation

The acoustic port hole diameter in the PCB should be larger than the acoustic port hole diameter of the MEMS Microphone to ensure optimal performance. A PCB sound port size of radius 0.4 mm (diameter 0.8mm) is recommended.

The board pad and stencil aperture recommendations shown in Figure 13 are based on Solder Mask Defined (SMD) pads. The specific design rules of the board manufacturer should be considered for individual design optimizations or adaptations.

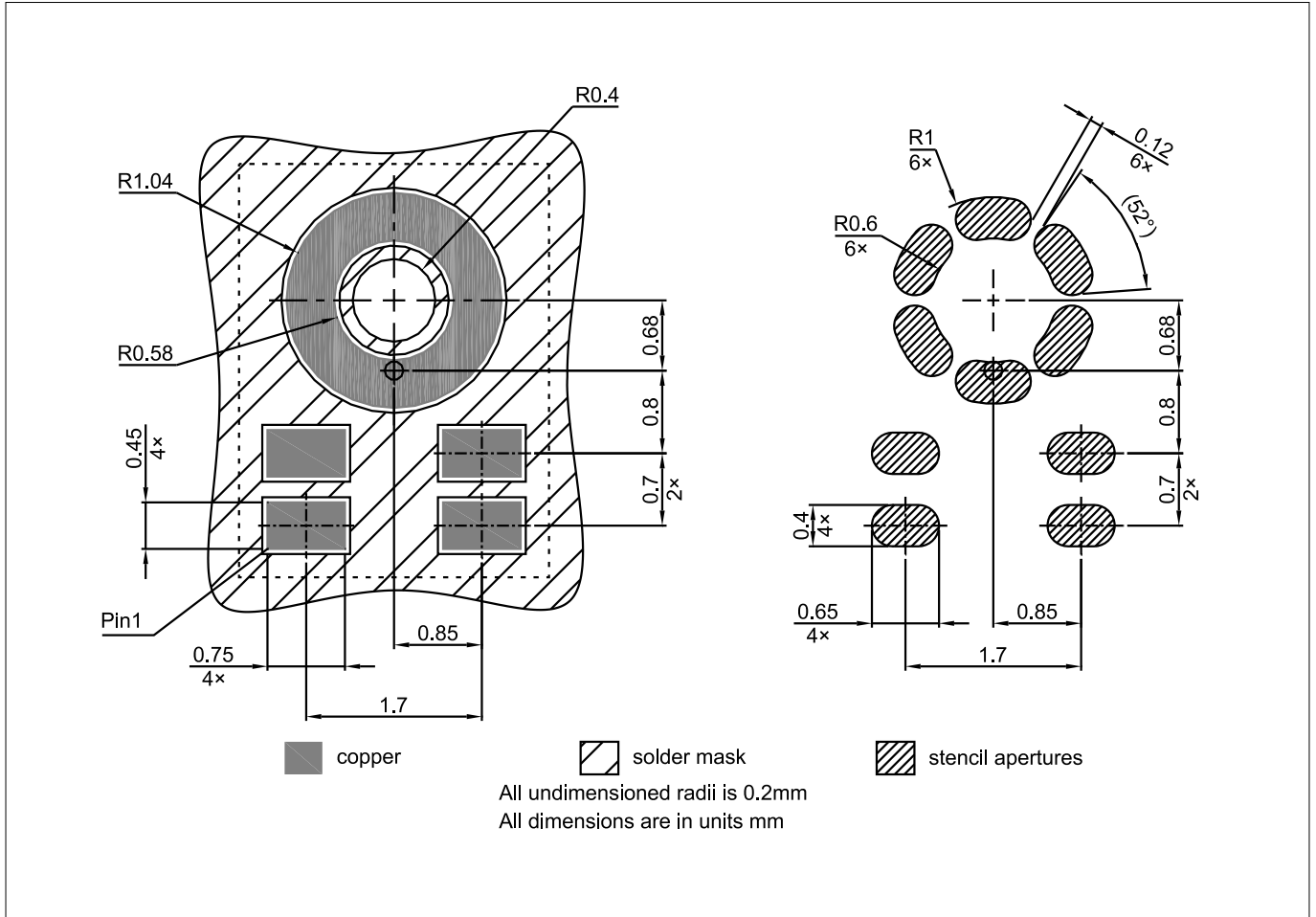


Figure 13 IM72D128V01 footprint and stencil recommendation

Note: Dimensions are in millimeters unless otherwise specified

Packing information

6 Packing information

For shipping and assembly the Infineon microphones are packed in product specific tape-and-reel carriers. A detailed drawing of the carrier can be seen in [Figure 14](#).

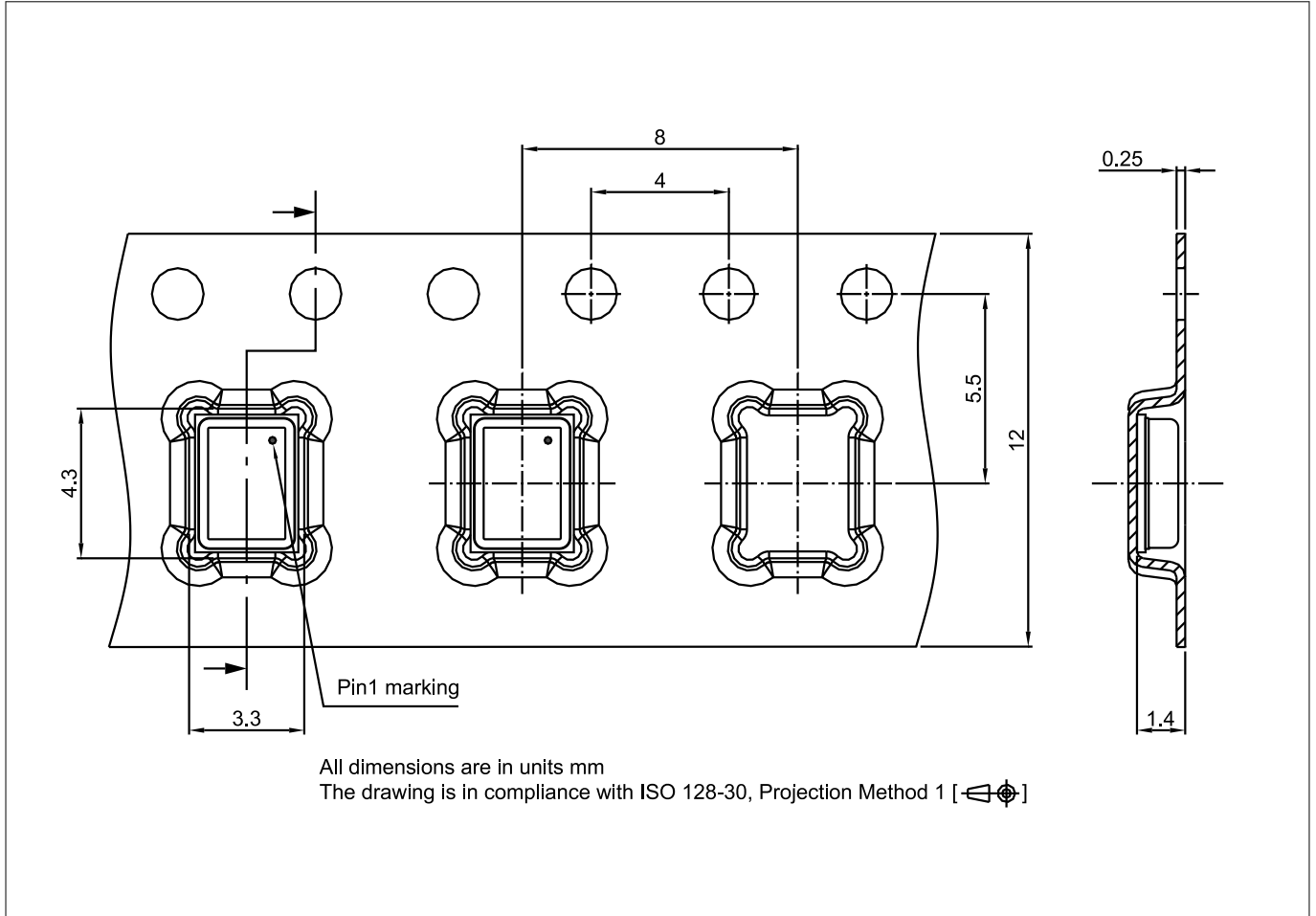


Figure 14 IM72D128V01 tape and reel packing information

7 Reflow soldering and board assembly

Infineon MEMS microphones are qualified in accordance with the IPC/JEDEC J-STD-020D-01. The moisture sensitivity level of MEMS microphones is rated as MSL1. For PCB assembly of the MEMS microphone the widely used reflow soldering using a forced convection oven is recommended.

The soldering profile should be in accordance with the recommendations of the solder paste manufacturer to reach an optimal solder joint quality. The reflow profile shown in Figure 15 is recommended for board manufacturing with Infineon MEMS microphones.

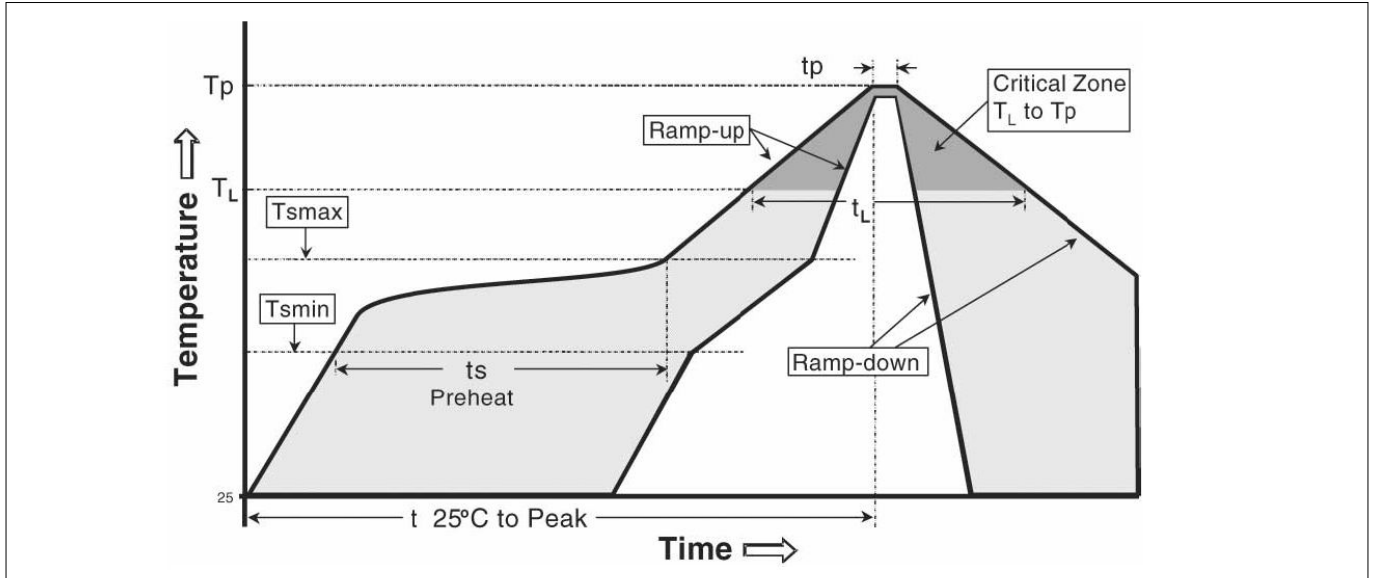


Figure 15 Recommended reflow profile

Table 10 Reflow profile limits

| Profile feature | Pb-Free assembly | Sn-Pb Eutectic assembly |
|--|------------------|-------------------------|
| Temperature Min (T_{smin}) | 150 °C | 100 °C |
| Temperature Max (T_{smax}) | 200 °C | 150 °C |
| Time (T_{smin} to T_{smax}) (t_s) | 60-120 seconds | 60-120 seconds |
| Ramp-up rate (T_L to T_p) | 3 °C/second max. | 3 °C/second max. |
| Liquidous temperature (T_L) | 217 °C | 183 °C |
| Time (t_L) maintained above T_L | 60-150 seconds | 60-150 seconds |
| Peak Temperature (T_p) | 260°C +0°C/-5°C | 235°C +0°C/-5°C |
| Time within 5°C of actual peak temperature (t_p) ⁹⁾ | 20-40 seconds | 10-30 seconds |
| Ramp-down rate | 6 °C/second max. | 6 °C/second max. |
| Time 25°C to peak temperature | 8 minutes max. | 6 minutes max. |

Note: For further information please consult the 'General recommendation for assembly of Infineon packages' document which is available on the Infineon Technologies [web page](#)

⁹⁾ Tolerance for peak profile temperature (T_p) is defined as a supplier minimum and a user maximum

Reflow soldering and board assembly

The MEMS microphones can be handled using industry standard pick and place equipment. Care should be taken to avoid damage to the microphone structure as follows:

- Do not pick the microphone with vacuum tools which make contact with the microphone acoustic port hole.
- The microphone acoustic port hole should not be exposed to vacuum, this can destroy or damage the MEMS.
- Do not blow air into the microphone acoustic port hole. If an air blow cleaning process is used, the port hole must be sealed to prevent particle contamination.
- It is recommended to perform the PCB assembly in a clean room environment in order to avoid microphone contamination.
- Air blow and ultrasonic cleaning procedures shall not be applied to MEMS Microphones. A no-clean paste is recommended for the assembly to avoid subsequent cleaning steps. The microphone MEMS can be severely damaged by cleaning substances.
- To prevent the blocking or partial blocking of the sound port during PCB assembly, it is recommended to cover the sound port with protective tape during PCB sawing or system assembly.
- Do not use excessive force to place the microphone on the PCB. The use of industry standard pick and place tools is recommended in order to limit the mechanical force exerted on the package.

Reliability specifications

8 Reliability specifications

The microphone sensitivity after stress must deviate by no more than 3dB from the initial value.

Table 11 Reliability specification

| Test | Abbreviation | Test Condition | Standard |
|--|--------------|---|-------------------------|
| Low Temperature Operating Life | LTOL | $T_a = -40^\circ\text{C}$, VDD=3.6V, 1000 hours | JESD22-A108 |
| Low Temperature Storage Life | LTSL | $T_a = -40^\circ\text{C}$, 1000 hours | JESD22-A119 |
| High Temperature Operation Life | HTOL | $T_a = +125^\circ\text{C}$, VDD=3.6V, 1000 hours | JESD22-A108 |
| High Temperature Storage Life | HTSL | $T_a = +125^\circ\text{C}$, 1000 hours | JESD22-A103 |
| Temperature Cycling | PC + TC | Pre conditioning MSL-1 | JESD22-A113 |
| | | 1000 cycles, -40°C to $+125^\circ\text{C}$, 30 minutes per cycle | JESD22-A104 |
| Temperature Humidity Bias | PC + THB | Pre conditioning MSL-1 | JESD22-A113 |
| | | $T_a = +85^\circ\text{C}$, R.H = 85%, VDD=3.6V, 1000 hours | JESD22-A101 |
| Vibration Test | VVF | 20Hz to 2000Hz with a peak acceleration of 20g in X, Y, and Z for 4 minutes each, total 4 -cycles | IEC 60068-2-6 |
| Mechanical Shock | MS | 10000g/0.1msec direction $\pm x, y, z$, 5 shocks in each direction, 5 shocks in total | IEC 60068-2-27 |
| Reflow Solder ¹⁰⁾ | RS | 3 reflow cycles, peak temperature = $+260^\circ\text{C}$ | IPC-JEDEC J-STD-020D-01 |
| Electrostatic Discharge -System Level Test | ESD - SLT | 3 discharges of $\pm 8\text{kV}$ direct contact to lid while V_{dd} is supplied according to the operational modes; (V_{dd} ground is separated from earth ground) | IEC-61000-4-2 |
| Electrostatic Discharge - Human Body Model | ESD - HBM | 1 pulse of $\pm 2\text{kV}$ between all I/O pin combinations | JEDEC-JS001 |
| Electrostatic Discharge - Charged Device Model | ESD - CDM | 3 discharges of $\pm 500\text{V}$ direct contact to I/O pins. | JEDEC JS-002 |
| Latch up | LU | Trigger current from $\pm 200\text{mA}$ | JESD78 |

¹⁰⁾ The microphone sensitivity must deviate by no more than 1dB from the initial value after 3 reflow cycles.

Revision history

Revision history

| Document version | Date of release | Description of changes |
|-------------------------|------------------------|--------------------------------|
| 1.00 | 2022-02-22 | Initial release |
| 1.01 | 2022-05-05 | Corrected ordering information |

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