

# IM69D120

## High performance digital XENSIV™ MEMS microphone

### Description

The IM69D120 is designed for applications where low self-noise (high SNR), wide dynamic range, low distortions and a high acoustic overload point is required.

Infineon's Dual Backplate MEMS technology is based on a miniaturized symmetrical microphone design, similar as utilized in studio condenser microphones, and results in high linearity of the output signal within a dynamic range of 95dB. The microphone distortion does not exceed 1% even at sound pressure levels of 118dB SPL. The flat frequency response (28Hz low-frequency roll-off) and tight manufacturing tolerance result in close phase matching of the microphones, which is important for multi-microphone (array) applications.

With its low equivalent noise floor of 25dB SPL (SNR 69dB(A)) the microphone is no longer the limiting factor in the audio signal chain and enables higher performance of voice recognition algorithms.

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 current consumption requirements.

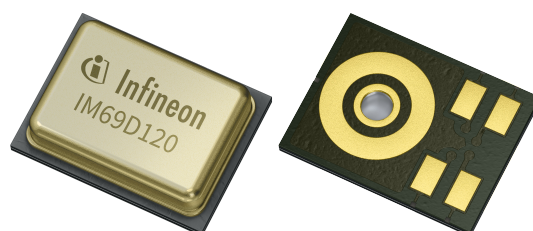
Each IM69D120 microphone is calibrated with an advanced Infineon calibration algorithm, resulting in small sensitivity tolerances ( $\pm 1$ dB). The phase response is tightly matched ( $\pm 2^\circ$ ) between microphones, in order to support beamforming applications.

### Features

- Dynamic range of 95dB
  - Signal to noise ratio of 69dB(A) SNR
  - <1% total harmonic distortions up to 118dB SPL
  - Acoustic overload point at 120dB SPL
- Sensitivity ( $\pm 1$ dB) and phase ( $\pm 2^\circ$  @1kHz) matched
- Flat frequency response with low frequency roll off at 28Hz
- Very fast analog to digital conversion speed (6 $\mu$ s latency @1kHz)
- Power optimized modes determined by PDM clock frequency
- Package dimensions: 4mm x 3mm x 1.2mm
- PDM output
- Omnidirectional pickup pattern

### Typical applications

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

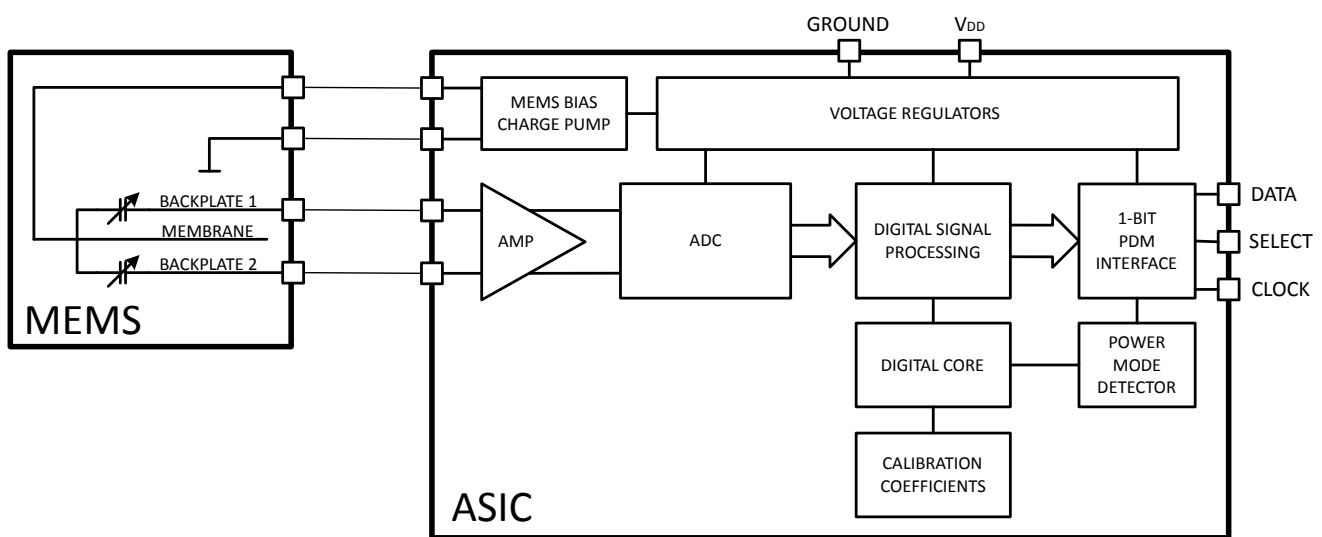


## Use cases

### Use cases

- Below 1% total harmonic distortion
  - Voice command during music from the loud speaker
  - Effective active noise cancellation even close to loud noise source
  - Recordings in a discotheque or at a rock concert
- High Signal to noise ratio
  - Far field audio signal pick-up
  - Low volume audio and whispered voice capturing
  - Microphone noise is no longer limiting the audio chain
- Sensitivity and phase matching
  - Full utilization of voice algorithms capability
  - Audio beam forming
  - High and precise attenuation of background noise
- Power optimized modes
  - Low current consumption for always on applications
  - Long operating time of battery powered devices

## Block diagram



**Figure 1** IM69D120 block diagram

## 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.

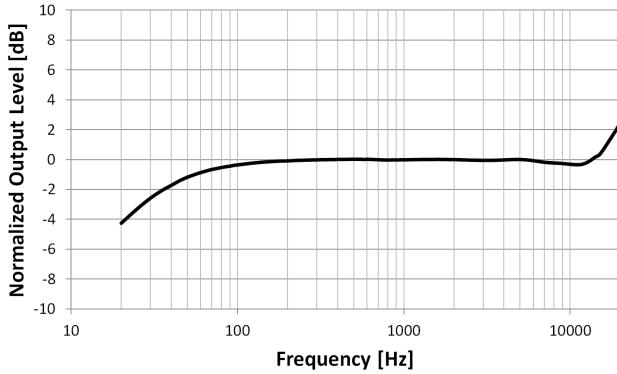
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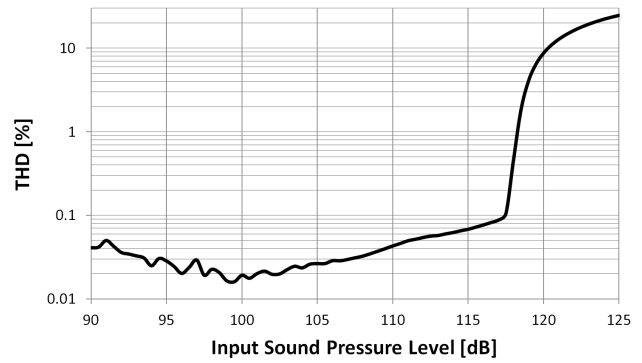
## Typical performance characteristics

### 1 Typical performance characteristics

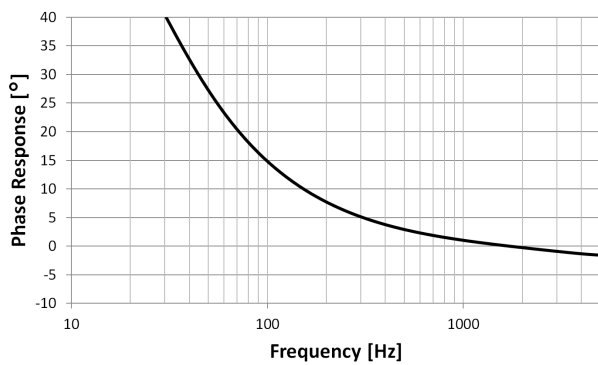
Test conditions:  $V_{DD} = 1.8V$ ,  $f_{CLK} = 3.072MHz$ , no load on DATA



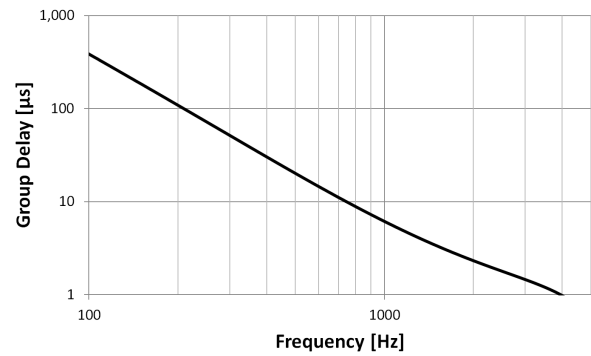
**Figure 2** Typical freefield frequency response



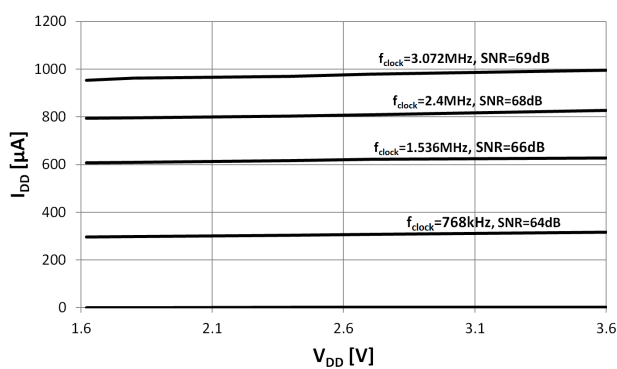
**Figure 3** Typical THD vs SPL



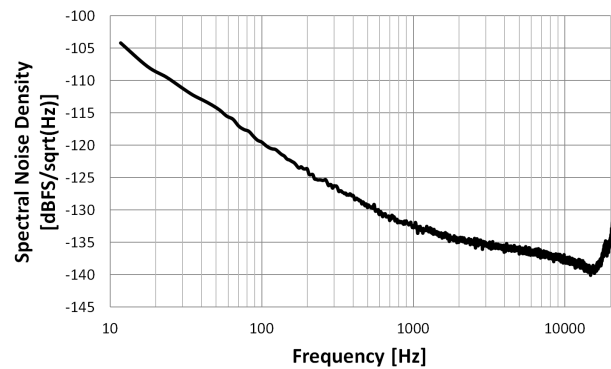
**Figure 4** Typical phase response vs frequency



**Figure 5** Typical group delay vs frequency



**Figure 6** Typical  $I_{DD}$  vs  $V_{DD}$



**Figure 7** Typical noise floor (unweighted)

## Acoustic characteristics

### 2 Acoustic characteristics

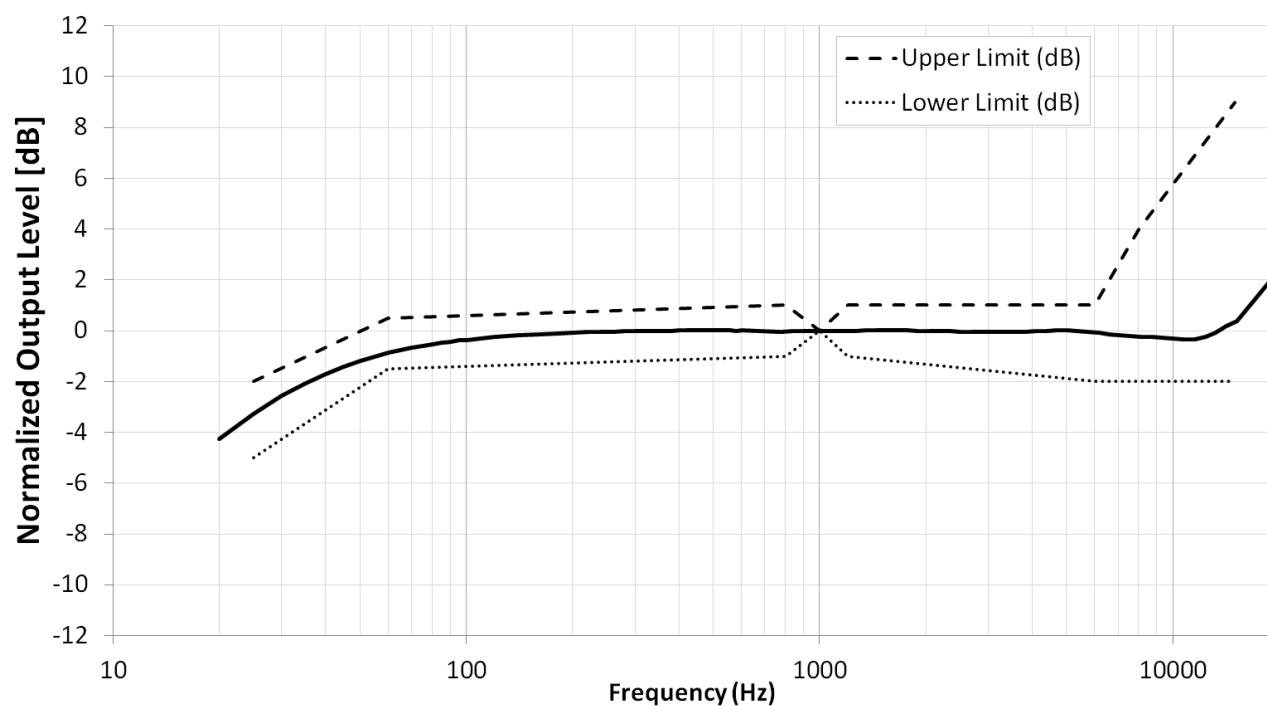
Test conditions ( unless otherwise specified in the table):  $V_{DD} = 1.8V$ ,  $f_{CLK} = 3.072MHz$ ,  $T_A = 25^{\circ}C$ , 55% R.H., audio bandwidth 20Hz to 20kHz, select pin grounded, no load on DATA,  $T_{edge} = 9ns$

**Table 1 IM69D130 acoustic specifications**

Parameter		Symbol	Values			Unit	Note or Test condition
			Min.	Typ.	Max.		
Sensitivity			-27	-26	-25	dBFS	1kHz, 94 dBSPL, all operating modes
Acoustic Overload Point		AOP		120		dBSPL	THD = 10%, all operating modes
Signal to Noise Ratio	$f_{clock}=3.072MHz$	SNR		69		dB(A)	A-Weighted  20Hz to 8kHz bandwidth, A-Weighted
	$f_{clock}=2.4MHz$			68			
	$f_{clock}=1.536MHz$			66			
	$f_{clock}=768kHz$			64			
Noise Floor	$f_{clock}=3.072MHz$			-95		dBFS(A)	A-Weighted  20Hz to 8kHz bandwidth, A-Weighted
	$f_{clock}=2.4MHz$			-94			
	$f_{clock}=1.536MHz$			-92			
	$f_{clock}=768kHz$			-90			
Total Harmonic Distortion	94dBSPL	THD		0.5		%	Measuring 2nd to 5th harmonics; 1kHz, all operating modes
	118dBSPL			1.0			
	119dBSPL			2.0			
	120dBSPL			10.0			
Low Frequency Cutoff Point		$f_{CLP}$		28		Hz	-3dB point relative to 1kHz
Group Delay	250Hz			70		$\mu s$	
	600Hz			15			
	1kHz			6			
	4kHz			1			
Phase Response	75Hz			19		$^{\circ}$	
	1kHz			2			
	3kHz			-1			
Directivity			Omnidirectional				Pickup pattern
Polarity			Positive pressure increases density of 1's, negative pressure decreases density of 1's in data output				

## Acoustic characteristics

### 2.1 Free field frequency response



**Figure 8** IM69D120 free field frequency response

**Table 2** IM69D120 free field frequency response, normalized to 1kHz sensitivity value

Frequency (Hz)	Upper Limit (dB)	Lower Limit (dB)
25	-2	-5
60	+0.5	-1.5
800	+1	-1
1000	0	0
1200	+1	-1
6000	+1	-2
8000	+4	-2
15000	+9	-2

## Electrical parameters and characteristics

### 3 Electrical parameters and characteristics

#### 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 3 Absolute maximum ratings**

Parameter	Symbol	Values		Unit	Note / Test Condition
		Min.	Max.		
Voltage on any Pin	$V_{\max}$		4	V	
Storage Temperature	$T_S$	-40	125	°C	
Ambient Temperature	$T_A$	-40	70	°C	$V_{DD} > 3.0V$
		-40	100	°C	

#### 3.2 Electrical parameters

**Table 4 Electrical parameters and digital interface input**

Parameter		Symbol	Values			Unit	Note / Test Condition
			Min.	Typ.	Max.		
Supply Voltage		$V_{DD}$	1.62		3.6	V	A 100nF bypass capacitor should be placed close to the microphone's VDD pin to ensure best SNR performance
Clock Frequency Range	Operating Modes	$f_{\text{clock}}$	2.9	3.072	3.3	MHz	
			2.1	2.4	2.65		
			1.05	1.536	1.9		
			400	768	950		
	Standby Mode				250	kHz	DATA = high-Z
$V_{DD}$ Ramp-up Time					50	ms	Time until $V_{DD} \geq V_{DD\_min}$
PDM Clock Frequency		$f_{\text{clock}}$	0.4		3.3	MHz	
Clock Duty Cycle			40		60	%	$f_{\text{clock}} < 2.65\text{MHz}$
			48		52	%	$f_{\text{clock}} \geq 2.9\text{MHz}$
Clock Rise/Fall Time					13	ns	
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	
Output Load Capacitance on DATA		$C_{\text{load}}$			200	pF	

## Electrical parameters and characteristics

### 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 5 General electrical characteristics**

Parameter		Symbol	Values			Unit	Note / Test Condition
			Min.	Typ.	Max.		
Current Consumption	$f_{clock} = 3.072MHz$	$I_{DD}$		980	1300	$\mu A$	No load on DATA
	$f_{clock} = 2.4MHz$			800	1050		
	$f_{clock} = 1.536MHz$			620	800		
	$f_{clock} = 768kHz$			300	380		
	Standby Mode	$I_{standby}$		25	50		
	Clock Off Mode	$I_{clock\_off}$			1		CLOCK pulled low
Short Circuit Current			1		20	mA	Grounded DATA pin
Power Supply Rejection		$PSR_{1k\_NM}$		-80		dBFS	100mV <sub>pp</sub> sine wave on $V_{DD}$ swept from 200Hz to 20kHz
		$PSR_{217\_NM}$		-86		dBFS(A)	100mV <sub>rms</sub> , 217Hz square wave on $V_{DD}$ . A-weighted
Startup Time	$\pm 0.5dB$ sensitivity accuracy				20	ms	Time to start up in all operating modes after $V_{DD\_min}$ and CLOCK have been applied
	$\pm 0.2dB$ sensitivity accuracy				50		
Mode Switch Time	$\pm 0.5dB$ sensitivity accuracy				20	ms	Time to switch between operating modes. $V_{DD}$ remains on during the mode switch
	$\pm 0.2dB$ sensitivity accuracy				50		
Hysteresis Width		$V_{hys}$	$0.1 \times V_{DD}$		$0.29 \times V_{DD}$	V	
Output Logic Low Level		$V_{OL}$			$0.3 \times V_{DD}$	V	$I_{out} = 2mA$
Output Logic High Level		$V_{OH}$	$0.7 \times V_{DD}$				$I_{out} = 2mA$
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 <sup>1)</sup>		$t_{HZ}$	5		30	ns	Delay time from CLOCK edge ( $0.5 \times V_{DD}$ ) to DATA high impedance state

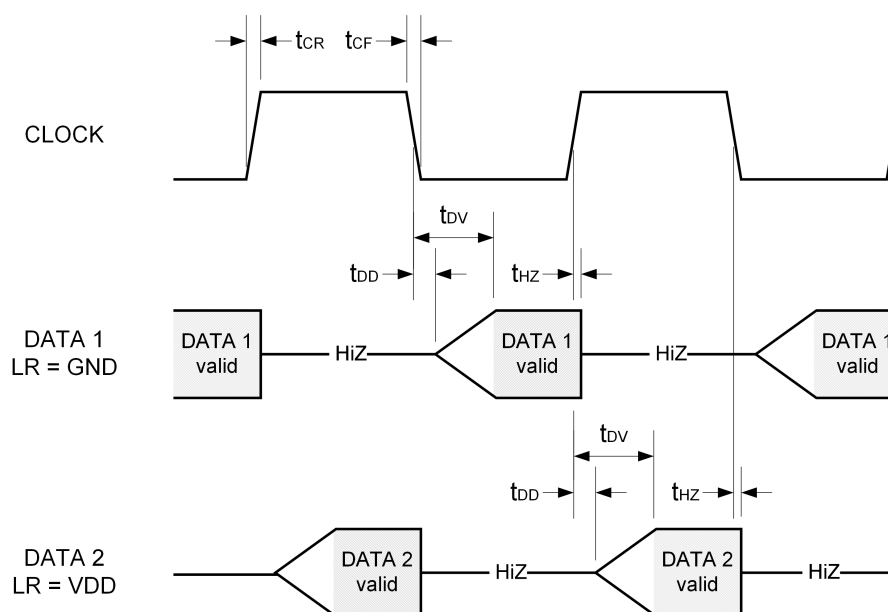
<sup>1</sup>  $t_{hold}$  is depended on  $C_{load}$



## Electrical parameters and characteristics

**Table 5** General electrical characteristics (continued)

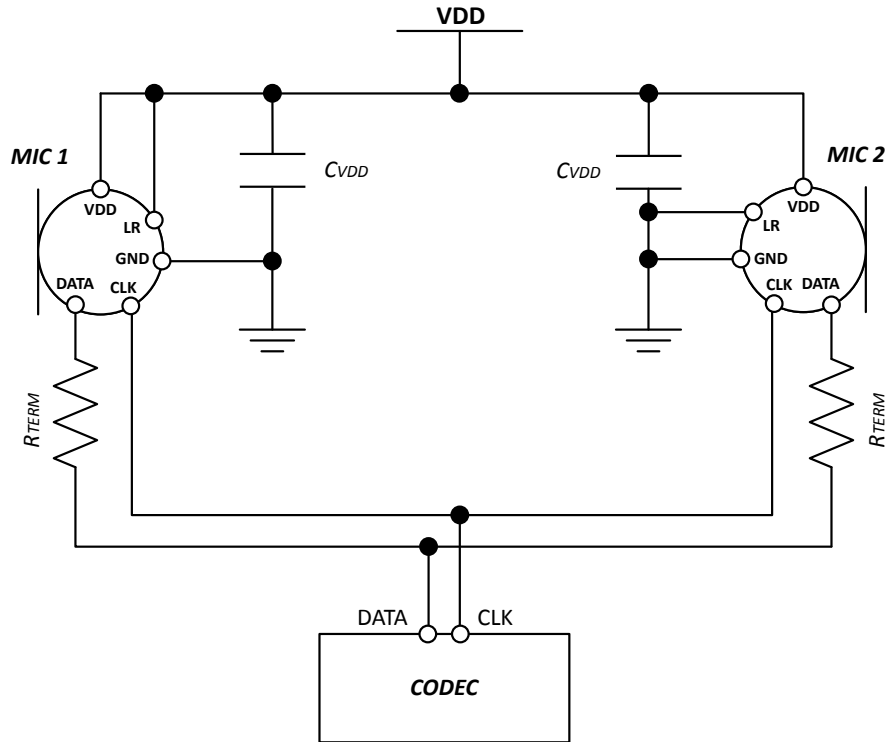
Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Delay Time for DATA Valid <sup>2)</sup>	$t_{DV}$			100	ns	Delay time from CLOCK edge ( $0.5 \times V_{DD}$ ) to DATA valid ( $< 0.3 \times V_{DD}$ or $> 0.7 \times V_{DD}$ )



**Figure 9** Timing diagram

<sup>2</sup> Load on data:  $C_{load}=100pF$ ,  $R_{load}=100k\Omega$

## 4 Typical stereo application circuit



**Figure 10** IM69D120 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.

## Reliability specifications

### 5 Reliability specifications

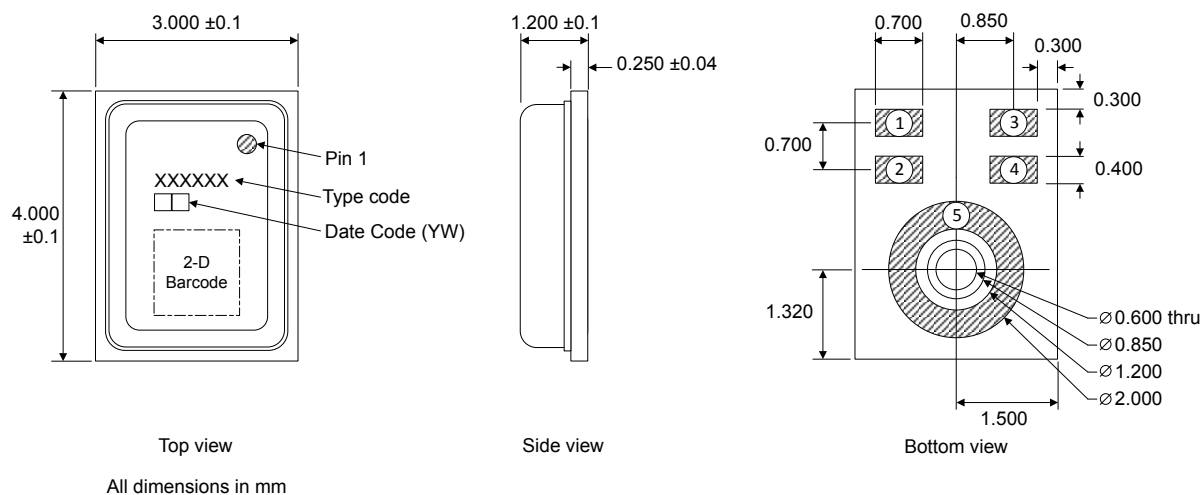
The microphone sensitivity after stress must deviate by no more than 3dB from the initial value.

**Table 6 Reliability tests**

Test	Test Condition	Standard
Vibration	20Hz to 2000Hz with a peak acceleration of 20g in X, Y, and Z for 4 minutes each, total 4 cycles	MIL-STD-883J
High Temperature Storage	$T_a = +125^{\circ}\text{C}$ , 1000 hours	JESD22 A-103E
Low Temperature Storage	$T_a = -40^{\circ}\text{C}$ , 1000 hours	JESD22-A119A
High Temperature Operation	$T_a = +125^{\circ}\text{C}$ , VDD=2.5V, 1000 hours	JESD22 A-108D
Cold Temperature Operation	$T_a = -40^{\circ}\text{C}$ , VDD=3.2V, 1000 hours	JESD22 A-108D
Temperature/Humidity Bias	$T_a = +85^{\circ}\text{C}$ , R.H = 85%, VDD=3.2V, 1000 hours	JESD22-A101D
Mechanical Shock	10000g/0.1msec direction $\pm x, y, z$ , 5 shocks in each direction, 30 shocks in total	IEC 60068-2-27
Thermal cycle	1000 cycles, $-40^{\circ}\text{C}$ to $+125^{\circ}\text{C}$ , 30 minutes per cycle	JESD22.A104E
Reflow Solder	3 reflow cycles, peak temperature = $+260^{\circ}\text{C}$	IPC-JEDEC J-STD-020D-01
ESD-SLT	3 contact discharges of $\pm 8\text{kV}$ to lid while $V_{dd}$ and $f_{clock}$ are supplied according to the operational modes; ( $V_{dd}$ and $f_{clock}$ ground is separated from earth ground)	IEC-61000-4-2
ESD-HBM	1 pulse of $\pm 2\text{kV}$ between all I/O pin combinations	JS001
Latch up	Trigger current from $\pm 150\text{mA}$	JESD 78E

## Package information

### 6 Package information



**Figure 11 IM69D120 package drawing**

**Table 7 IM69D120 pin configuration**

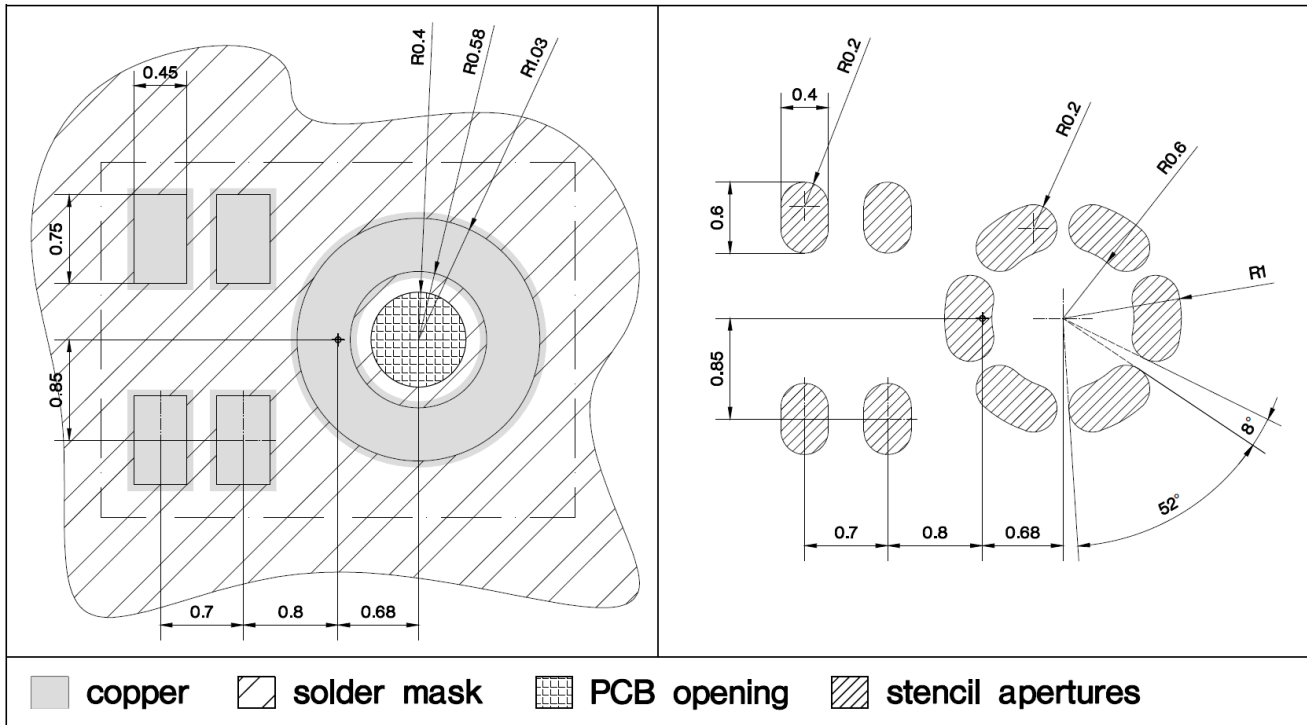
Pin Number	Name	Description
1	DATA	PDM data output
2	V <sub>DD</sub>	Power supply
3	CLOCK	PDM clock input
4	SELECT	PDM left/right select
5	GND	Ground

## Footprint and stencil recommendation

### 7 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 12](#) 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 12 IM69D120 footprint and stencil recommendation**

*Note: Dimensions are in millimeters unless otherwise specified*



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**Revision history**

**Revision history**

<b>Document version</b>	<b>Date of release</b>	<b>Description of changes</b>
1.0	20.12.2017	Initial datasheet

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