

## ***3SM221KMT1KA-P* MEMS Microphone IC**

### **Product Description**

The *3SM221KMT1KA-P* microphone IC are integrated with specialized pre-amplification & analog-to-digital converter ASIC to provide high SNR output from a capacitive audio sensor. It's packaged for surface mounting and high temperature reflow assembly. *3SM221KMT1KA-P* is ideal in many compact portable consumer electronic devices such as Notebook, TV, Smart Speaker.

### **Features**

- Top port
- High stability - no risk of membrane aging
- Suitable for automatic pick-and-place handler and SMT process
- Pulse density modulator (PDM) output interface supports two microphones on a single data line
- Miniature dimension 4.00mm x 3.00mm x 1.00mm
- RoHS/Green compliant
- Sensitivity deviation within  $\pm 1$ dB
- Package type : LGA 8-pin
- Omnidirectional

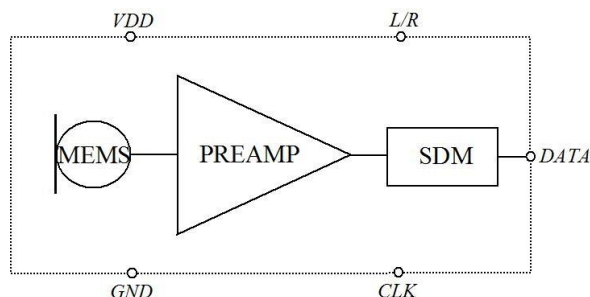
### **Applications**

- Notebooks
- TVs
- Smart Speakers
- IoT Devices

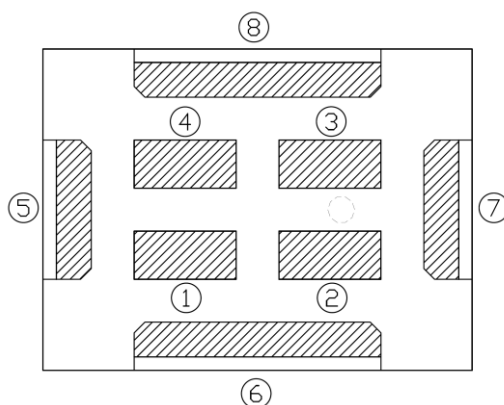
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## Functional Block Diagram



## Pin Definition and Function



Bottom View

Table 1.

Pin #	Symbol	Type	Function
1	DATA	Digital O	Digital Output Signal
2	CLK	Digital I	Clock Input to Microphone
3	L/R	Non-Digital I	Left(Low) / Right(High) Select Pin
4	VDD	Power	Power Supply
5	GND	Power	Ground
6	GND	Power	Ground
7	GND	Power	Ground
8	GND	Power	Ground

## Temperature Range

Table 2.

Storage Temperature	T <sub>STG</sub>	-40°C ~ 125°C
Operating Temperature Range	T <sub>A</sub>	-40°C ~ 105°C

## Acoustical and Electrical Characteristics

*Table 3. General Microphone Specifications*

*Typical test conditions are TA = 23 °C, VDD = 1.8V and R.H. = 50 % measured in a pressure chamber test setup. All voltages refer to GND node*

Parameters	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Low Frequency Roll-off	LFRO		50		Hz	-3dB relative to 1KHz
Supply Voltage	Vdd	1.6		3.6	V	
Output Load	C <sub>Load</sub>			100	pF	
Wake-up Time			100		ms	Fclk ≥ 1MHz
Startup Time			100		ms	
Sleep Time			1		ms	Fclk ≤ 1KHz
Data Format	1/2 Cycle PDM					
Directivity	Omnidirectional					
Polarity	Increasing density of 1's					Increasing sound pressure

*Table 4. Performance Mode Microphone Specifications*

*Typical test conditions are TA = 23 °C, VDD = 1.8V, Clock=2.4MHz and R.H. = 50 % measured in a pressure chamber test setup. All voltages refer to GND node*

Parameters	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
<b>Acoustic</b>						
Sensitivity	S	-27	-26	-25	dBFS	1KHz, 94dB SPL
Signal to Noise Ratio	S/N		64		dBA	A-weighted
Equivalent Noise Level	ENL		30		dBA	A-weighted
Total Harmonic Distortion	THD		<0.2		%	94dB SPL
			1		%	110dB SPL
Acoustic Overload Point	AOP		120		dB SPL	10% THD@1KHz, S = Typ.
<b>Electrical</b>						
Clock Frequency	Fclk	1.0		4.8	MHz	
Current Consumption	Isb		550		μA	Vdd=1.8V
			850		μA	Vdd=3.6V
Power Supply Rejection Ratio	PSRR		60		dBV/FS	1KHz, 200mV peak to peak sine wave on Vcc 2.1V
Power Supply Rejection	PSR+N		-80		dBFS (A)	217Hz, 100mV 1/8 duty cycle peak to peak square wave on Vcc 2.1V, A-weighted

**Table 5. Low-Power Mode Microphone Specifications**

Typical test conditions are  $T_A = 23\text{ }^\circ\text{C}$ ,  $V_{DD} = 1.8\text{V}$ ,  $\text{Clock} = 768\text{KHz}$  and  $R.H. = 50\%$  measured in a pressure chamber test setup. All voltages refer to GND node

Parameters	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
<b>Acoustic</b>						
Sensitivity	S	-27	-26	-25	dBFS	1KHz, 94dB SPL
Signal to Noise Ratio	S/N		64		dB	A-weighted
Equivalent Noise Level	ENL		30		dB	A-weighted
Total Harmonic Distortion	THD		<0.2		%	94dB SPL
			1		%	110dB SPL
Acoustic Overload Point	AOP		120		dB SPL	10% THD@1KHz, S = Typ.
<b>Electrical</b>						
Clock Frequency	Fclk	350		800	KHz	
Current Consumption	I <sub>sb</sub>		300		μA	V <sub>dd</sub> =1.8V
			400		μA	V <sub>dd</sub> =3.6V
Power Supply Rejection Ratio	PSRR		60		dBV/FS	1KHz, 200mV peak to peak sine wave on V <sub>cc</sub> 2.1V
Power Supply Rejection	PSR+N		-80		dBFS (A)	217Hz, 100mV 1/8 duty cycle peak to peak square wave on V <sub>cc</sub> 2.1V, A-weighted

**Table 6. Sleep Mode Microphone Specifications**

Typical test conditions are  $T_A = 23\text{ }^\circ\text{C}$ ,  $V_{DD} = 1.8\text{V}$ ,  $\text{Clock} = 0\text{Hz}$  and  $R.H. = 50\%$  measured in a pressure chamber test setup. All voltages refer to GND node

Parameters	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Clock Frequency	Fclk	0		250	KHz	
Current Consumption Sleep Mode	I <sub>sleep</sub>		10		μA	Clock = V <sub>DD</sub> or GND

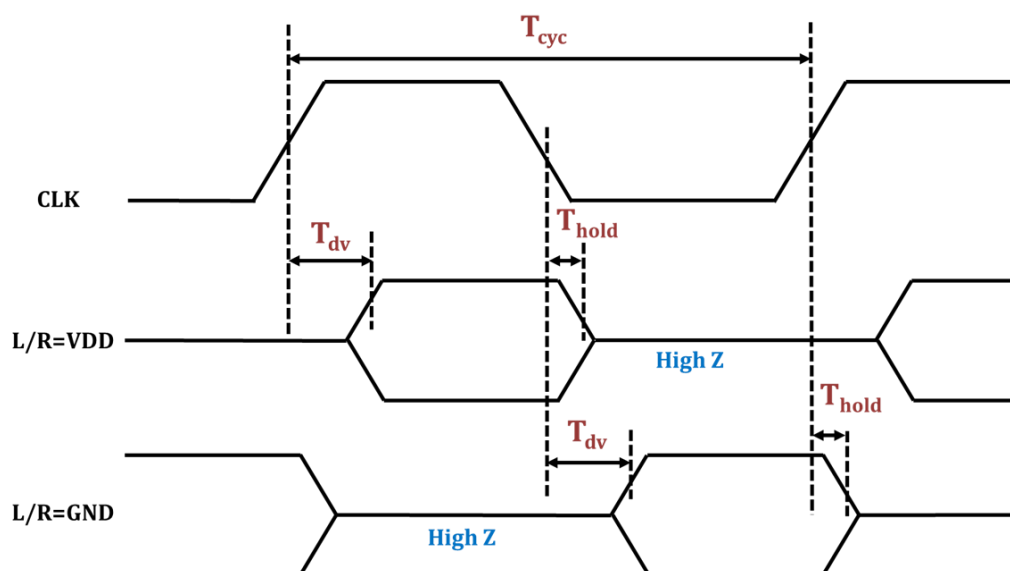
## Timing Characteristics

Table 7. Microphone Interface Specifications

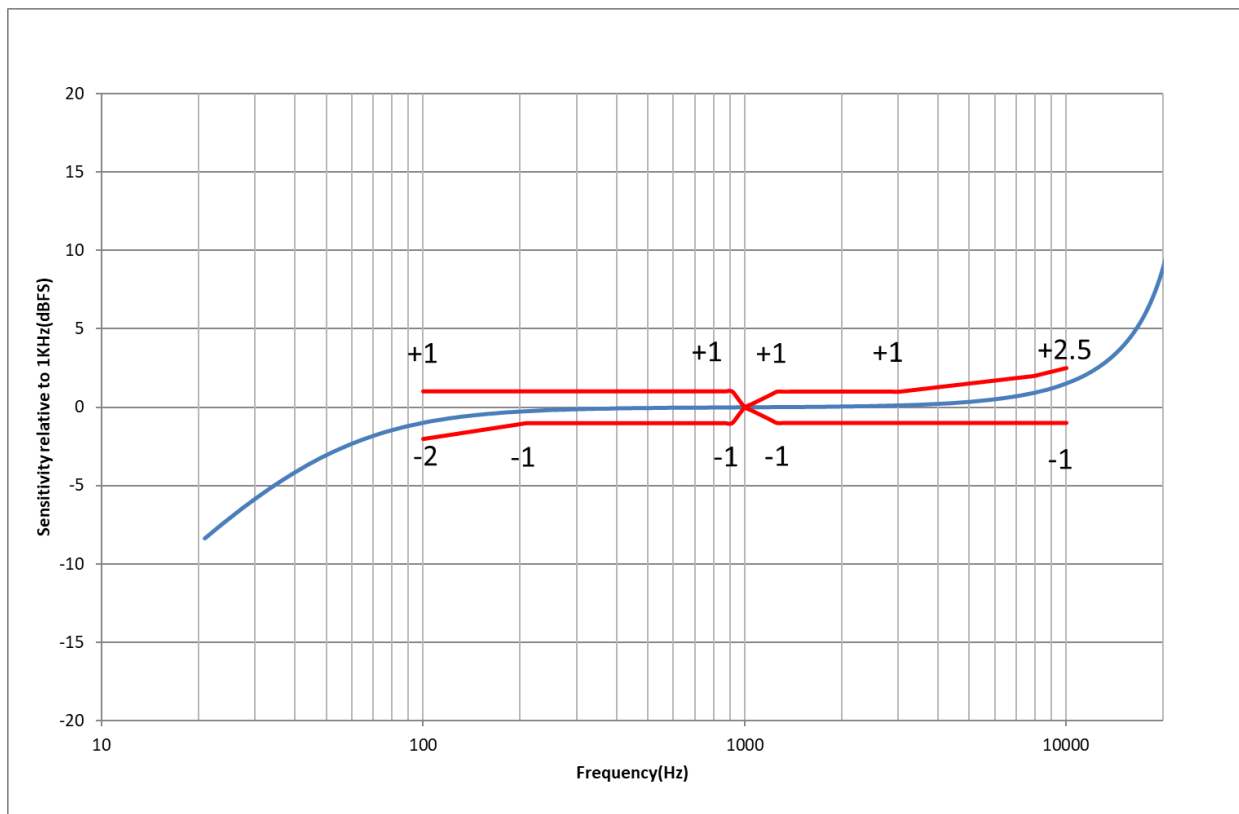
Parameters	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Logic Input High	$V_{IH}$	0.70x VDD		3.6	V	
Logic Input Low	$V_{IL}$	-0.3		0.30x VDD	V	
Logic Output High	$V_{OH}$	VDD -0.45		VDD	V	$I_{out} = 1\text{mA}$
Logic Output Low	$V_{OL}$	0		0.45	V	$I_{out} = 1\text{mA}$
Clock Frequency	$F_{clock}$			250	KHz	Sleep Mode
		350		800		Low-Power Mode
		1.0		4.8	MHz	Performance Mode
Clock Duty Cycle		40		60	%	
Clock Period for Normal Mode	$T_{cyc}$	208		1000	ns	
Data Setup Time	$T_{dv}$			100 <sup>(1)</sup>	ns	
Data Hold Time	$T_{hold}$	3 <sup>(1)</sup>			ns	

(1). Guaranteed by design

## Timing Waveforms



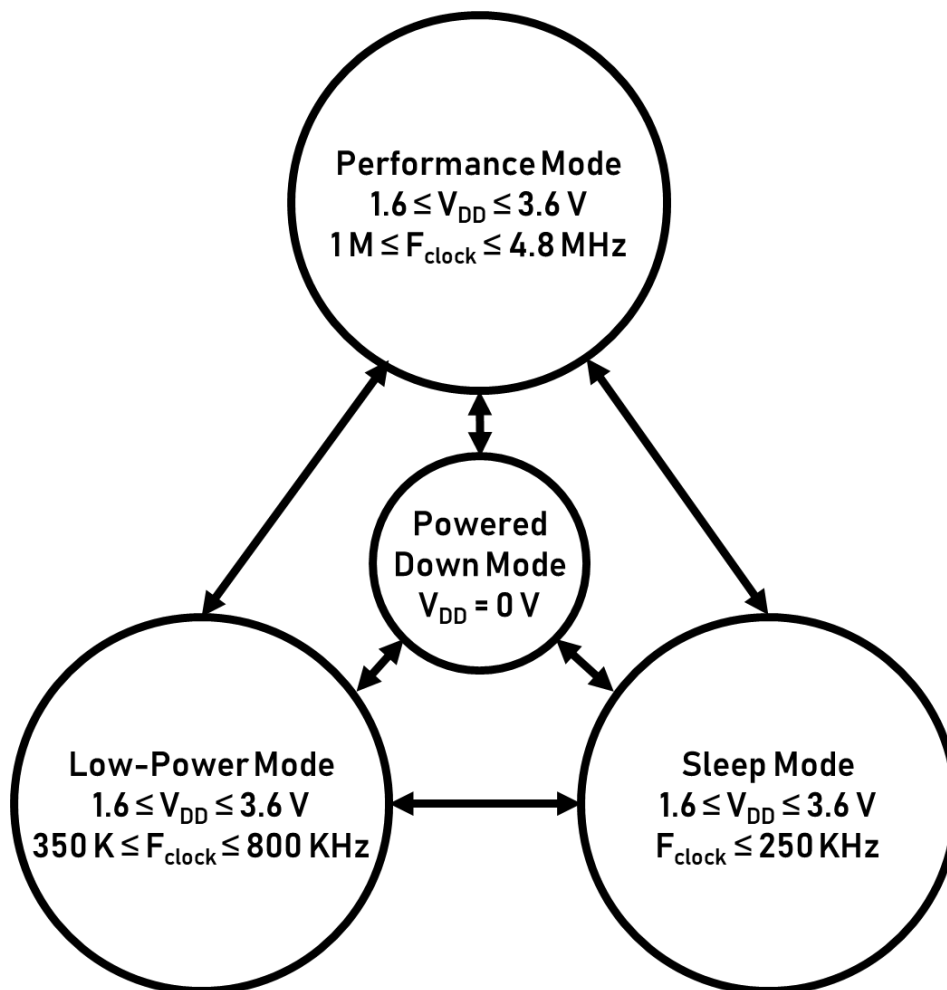
## Frequency Response



\* Measured frequency of 1 KHz

Upper Limit								
Hz	100	200	900	1000	1250	3000	8000	10000
dB ref. 1KHz	+1	+1	+1	0	+1	+1	+2	+2.5
Lower Limit								
Hz	100	200	900	1000	1250	3000	8000	10000
dB ref. 1KHz	-2	-1	-1	0	-1	-1	-1	-1

## State Diagram





## Reliability Qualifications

Table 8.

Test Item	Description
High Temperature Storage	Storage at 125°C for 1,000 hours JESD22-A103
Low Temperature Storage	Storage at -40°C for 1,000 hours JESD22-A119
High Temperature Operation Bias	Under Bias at 105°C for 1,000 hours JESD22-A108
Low Temperature Operation Bias	Under Bias at -40°C for 1,000 hours JESD22-A108
Temperature Humidity Bias	Under Bias at 85°C/85%RH for 1,000 hours JESD22-A101
Thermal Cycling Test	Thermal Cycle from -40°C~125°C, 100 cycles JESD22-A104
Reflow	5 reflow cycles with peak 260°C J-STD-020
Vibration	4 cycles lasting 12 minutes from 20 to 2KHz in X, Y and Z with peak acceleration of 20G JESD22-B103
Mechanical Shock	Total 18 pulses 10,000G in X,Y and Z JESD22-B104
ESD	HBM:3KV, MM:300V, CDM:500V Air Discharge:15KV, Contact Discharg:8KV JESD22-A114(HBM) JESD22-A115(MM) JESD22-C101(CDM) IEC 61000-4-2(Air Discharge) IEC 61000-4-2(Contact Discharge)

Notes: Microphones meet all acoustic and electrical specifications before and after reliability testing, except sensitivity which can deviate up to 3dB from its initial value.

After 5 reflow cycles, the sensitivity of the microphone shall not deviate more than 1 dB from its initial value.

## Reflow Profile

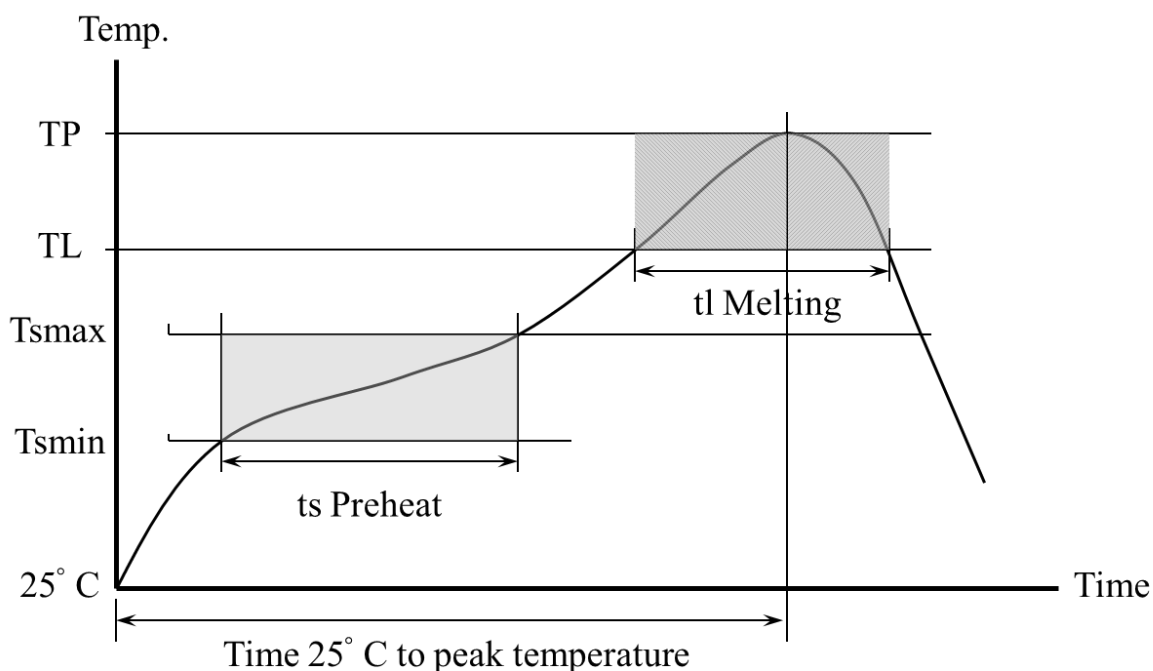


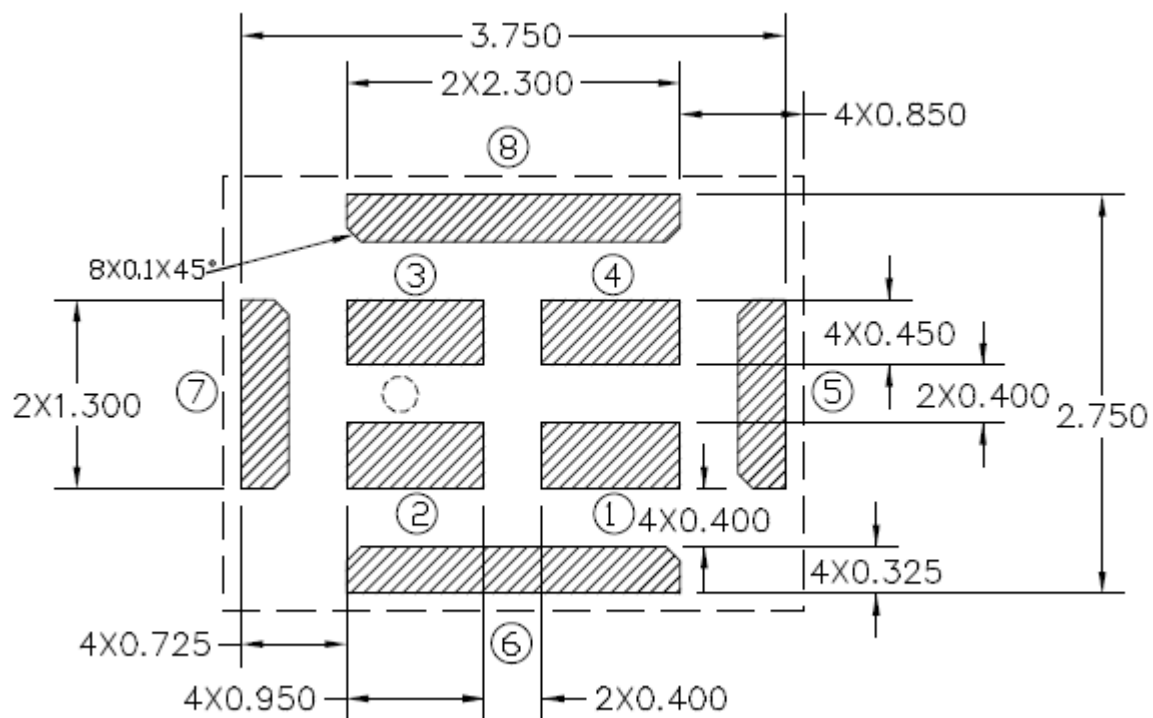
Table 9. Recommended Reflow Profile Limits

Profile Feature	Pb-free
Preheat	
Minimum temperature (Tsmmin)	150 °C
Maximum temperature (Tsmmax)	200 °C
Time (ts)	60~180 sec
Average Ramp up rate (Tsmmax to Tp)	3 °C/sec
Melting area	
Melting temperature (TL)	217 °C
Time maintained above melting (tl)	60~150 sec
Peak Temperature (TP)	260 °C
Time within 5°C of actual peak temperature	20~40 sec
Ramp down rate	6 °C/sec maximum
Time 25°C to peak temperature	8 minute maximum

Notes: Based on IPC/JDEC J-STD-020 Revision F.

All temperatures refer to topside of the package, measured on the package body surface

### PCB Land Pattern Layout



## Application Circuit

The L/R pad lets the user to select the DATA signal pattern as explained in Table 7. The L/R pin must be connected to either VDD or GND.

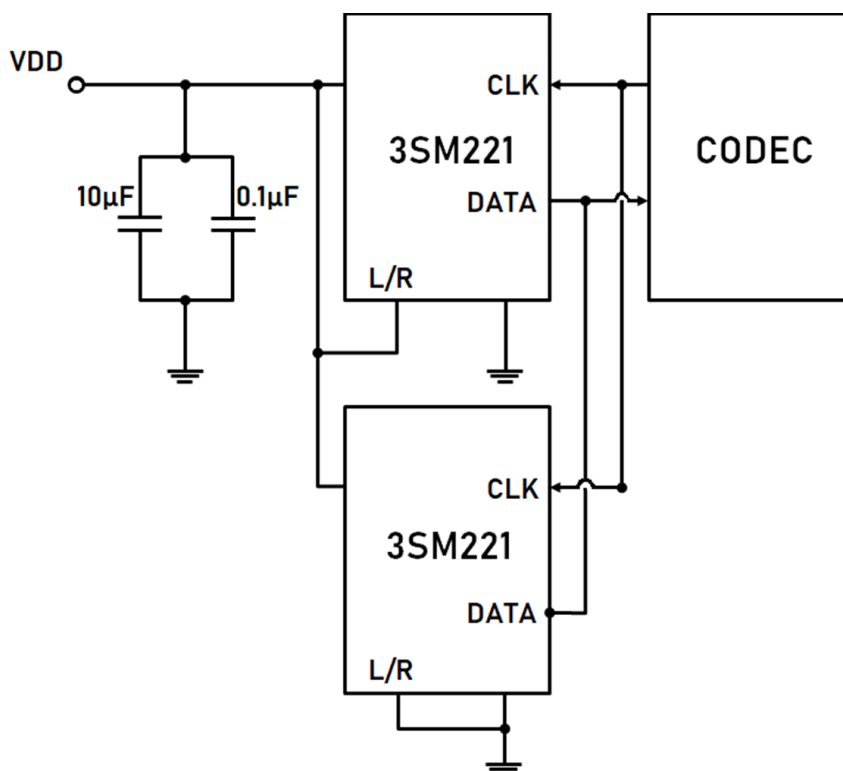
Table 10. L/R channel selection

L/R	CLK low	CLK high
GND	DATA valid	High impedance
VDD	High impedance	DATA valid

### Single microphone application:

0.1 $\mu$ F ceramic, and 10 $\mu$ F ceramic power supply decoupling capacitors should be placed as near as possible to VDD of the device. **The L/R pin must be connected to VDD or GND**

### Two microphones application:

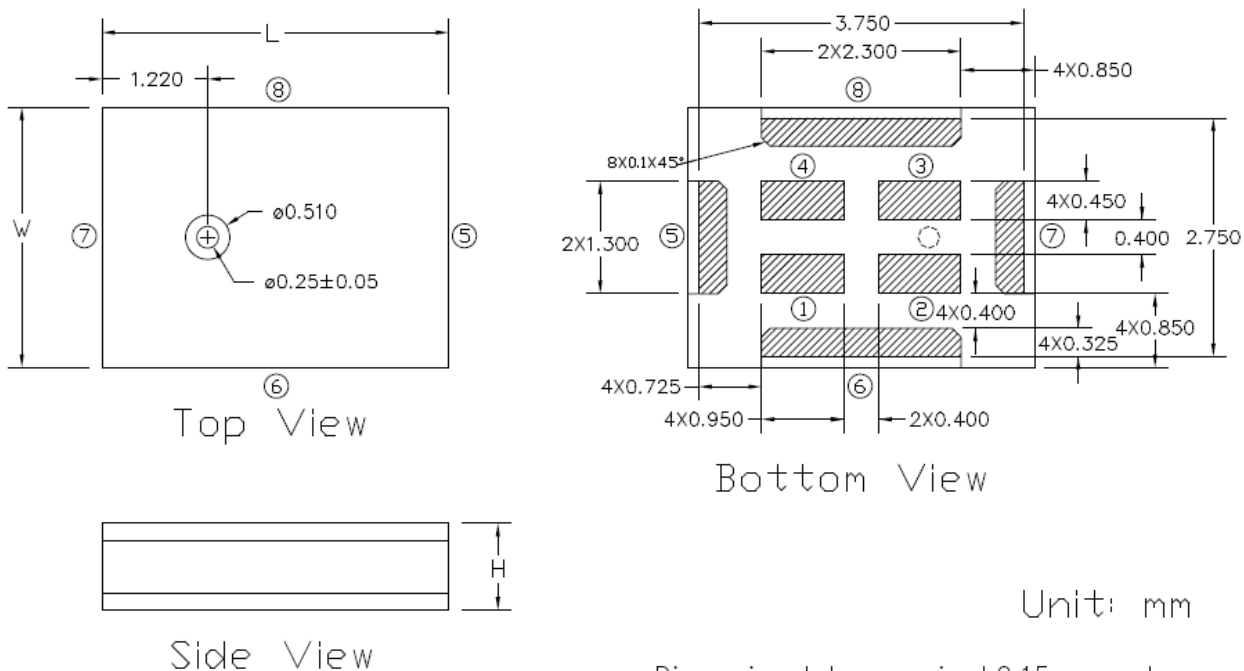


## Handling Instructions

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

- Do not apply vacuum nozzle over the acoustic port (AP) of the microphone to avoid damage to the device.
- Do not blow air directly into acoustic port.
- Brushing the board with/without solvents may damage the device.
- Do not use excessive force to place the microphone on the PCB.
- In case of manual handling, it should be handled with plastic tweezers to avoid damage the device.

## Dimensions



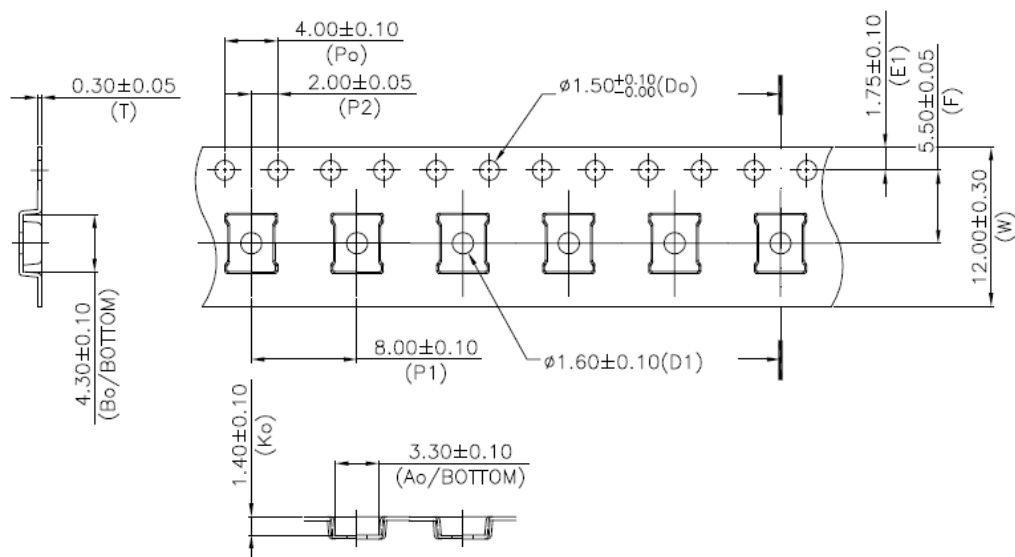
Dimension tolerance is  $\pm 0.15\text{mm}$  unless otherwise specified

Table 11. (Top View)

Item	Dimension	Tolerance
Length (L)	4.00mm	$\pm 0.10\text{mm}$
Width (W)	3.00mm	$\pm 0.10\text{mm}$
Height (H)	1.00mm	$\pm 0.10\text{mm}$
Acoustic Port	$\Phi 0.25\text{mm}$	$\pm 0.05\text{mm}$

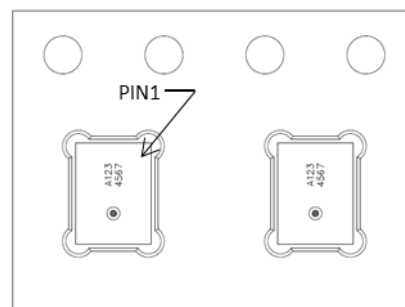
## Package Information

### Carrier Tape:

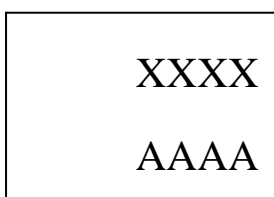


Unit: mm

1. 10 sprocket hole pitch cumulative tolerance  $\pm 0.20$ .
2. Carrier camber is within 1 mm in 250 mm.
3. Material : Black Conductive Polystyrene Alloy.
4. All dimensions meet EIA-481 requirements.
5. Thickness :  $0.30 \pm 0.05$  mm.
6. MSL(Moisture sensitivity level) Class1.

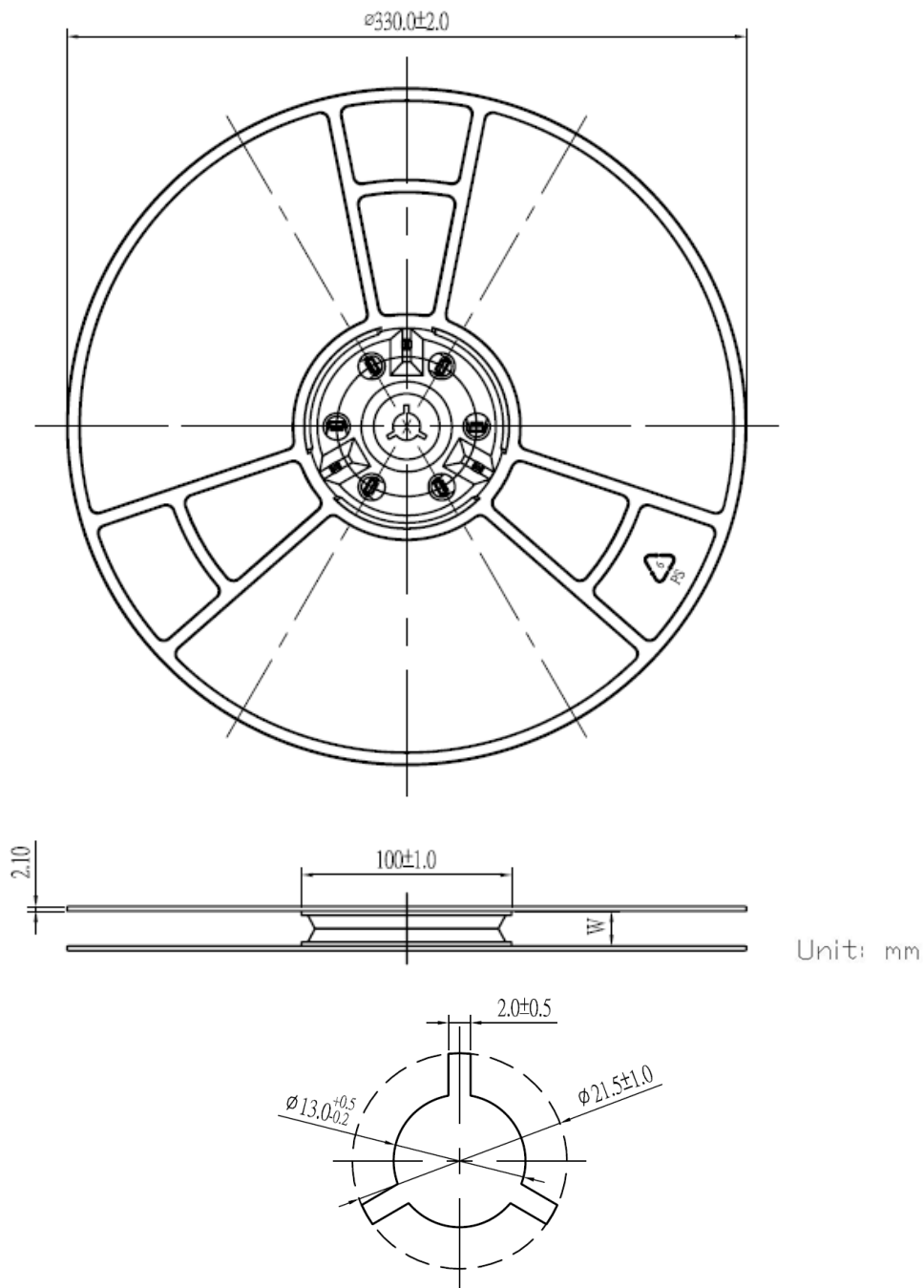


### Laser Marking:



### Laser marking on the top side

<b>XXXX</b>	<b>Internal Tracking Code</b>
<b>AAAA</b>	<b>Lot Tracking Code</b>

**13" Tape Reel :**


Model Number	Reel Diameter	Quantity Per Reel
3SM221KMT1KA-P	13"	5,000



## Revision History

<b>Revision</b>	<b>Date</b>	<b>Description</b>
1.0	2021/07/12	Formal release
1.1	2022/01/10	Modify “Acoustical and Electrical Characteristics” Modify “Timing Characteristics” Modify “State Diagram”
1.2	2022/04/12	Modify “Timing Characteristics”
1.3	2023/01/13	Modify “Timing Characteristics” Modify “Frequency Response” Modify “Reliability Qualifications”
1.4	2023/04/20	Modify “Reliability Qualifications” Modify “Package Information”