SPECIFICATION FOR APPROVAL

承 認 書

Description	:	Electret Condenser Microphone
Kingstate Part No.	:	KEXG2224PBN-A
Customer's Model No.	:	
Specification No.	:	PKO-7472
Number Of The Edition:		1.2

CUSTOMER'S APPROVED SIGNATURE		

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		Feng 02/24/10'

1 Product Overview

1.1 Introduction

The FM-M101-006 is a digital small array microphone module (DSAM Module) which works along with Fortemedia patented SAM™ (Small Array Microphone) algorithm running in a host to perform exceptional beam-forming effect, noise suppression, and echo cancellation. The conventional broadside microphone array needs wide spacing between microphones and cannot be used in space-limited applications. FM-M101-006 contains two microphones only few milimeters apart and can surpasses the performance of a conventional broadside array.

1.2 Overview

The DSAM Module consists of two omni-directional microphones which have equipped with Fortemedia SAM Coder IC. The module outputs a pulse density modulation (PDM) signal in a single-bit digital output stream which is then decimated by a digital filter in PC HD (High Definition) Audio codec. The PDM digital output is more robust than analog output from standard traditional ECM. It provides significant system design flexibility without expensive shielded cable. Additionally, its small form factor allows easy placement in an acoustically optimal position for applications such as hand-held devices and notebook computers.

1.3 Key Features

- High performances digital omni-directional microphone pair
- Microphone diameter = 6mm, Sensitivity= -24 ± 3 dBFS/Pa
- Fully compatible with Fortemedia SAM™ algorithm
- 4-pin interface: DATA, VDD, CLK, & GND
- Digital PDM output, immune from RF noise interference
- Two sound holes on front panel only, no need for back sound holes

1.4 Module Pins Assignment

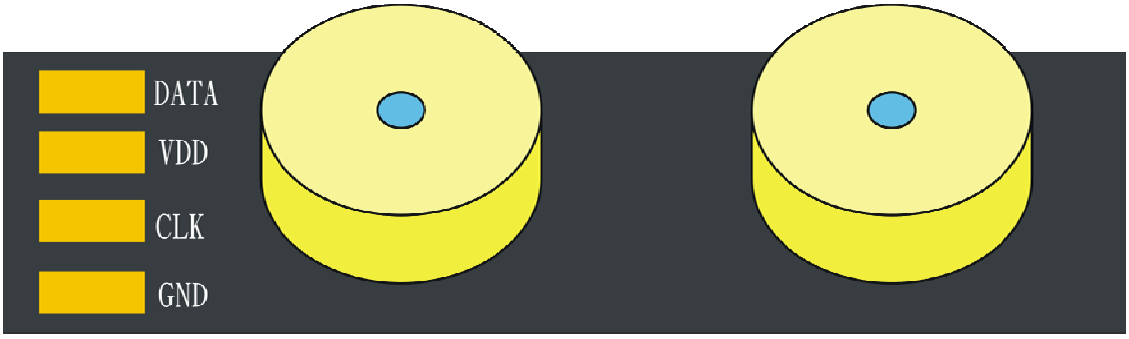


Figure **1**: Module Pin Configuration

Pin #	Pin Name	I/O Type	Pin Description	Remark
1	DATA	Out	PDM data output from small array microphone module to HD audio codec	
2	VDD	In	2.7V ~ 3.6V	
3	CLK	In	PDM clock input from HD audio codec to small array microphone module	
4	GND	In	Ground potential = 0V	

1.5 System Application Block Diagram:

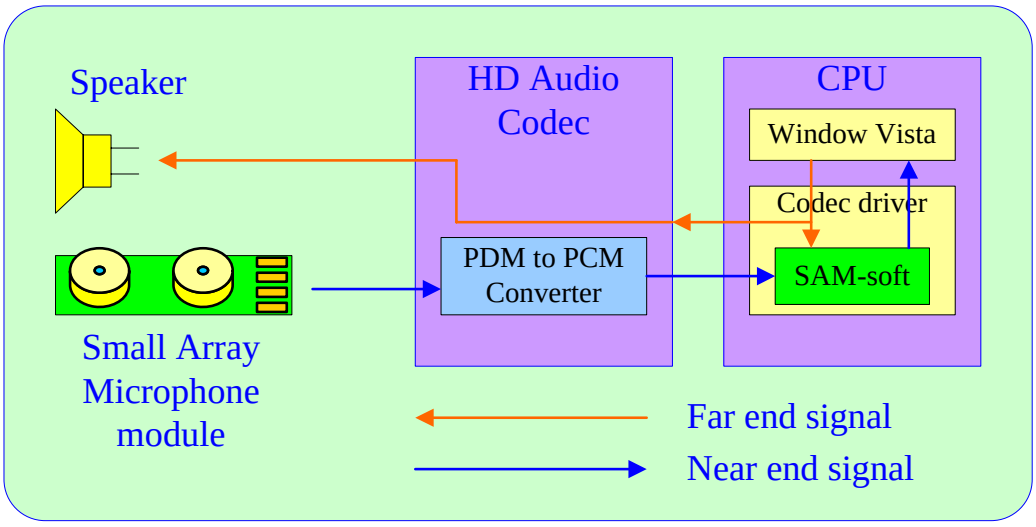


Figure **2**: System Interface Block Diagram

The DSAM Module is configured to work with Intel HD Audio codec. It takes the PDM clock from HD codec. The module has two matched omni directional microphones on it. The data from two microphone channels are multiplexed in one PDM data line; First channel data transmits on rising edge of PDM clock while second channel transmits on falling edge of PDM clock. When the PDM CLK from codec halts, module enters power down mode to conserve power.

2 Electrical and Timing Specification

Unless otherwise specified, test conditions are:

- V_{DD} = 3.3V,
- Ta = 27±2°C, Room Humidity = 65±5%,
- F_{CLK} = 1.024 MHz. Clock jitter < 0.5 nsec

2.1 Absolute Maximum Ratings

Table 1: Absolute Maximum Ratings

Parameter	Symbol	Condition	Rating	Unit
Power Supply Voltage	VDD	3.3V tolerance	0 ~ 3.6	V
Clock Input voltage	CLK		0 ~ 3.6	V
Digital Output Voltage	DATA		0 ~ 3.6	V
ESD Tolerance		HBM*	4	kV
Storage temperature		40~65% RH	-40 ~ 85	^{o}C
Operating temperature		40~65% RH	-20 ~ 70	^{o}C

HBM* = Human Body Mode (Contact mode)

2.2 Recommended Operating Conditions

Table 2: Recommended Operating Conditions

Parameters and Symbols		Specification			Unit	Conditions/Remarks
		Min	Typ	Max		
Power Supply	VDD	2.7	3.3	3.6	V	
Active Power Supply Current	I_{SU}		2.2		mA	
Power Down Current	I_{PD}		5		μA	
Input clock rate	F_{clk}	1	1.024	2.4	MHz	
Clock duty cycle	T_{Duty}	40	50	60	%	
Clock jitter	T_{jitter}		0.3	1	nsec	

To ensure best performance, the ripple on Vdd should be less than 200mVpp.

2.3 DC Characteristics

Table 3: DC Characteristics

Parameters and Symbols		Specification			Unit	Conditions/Remarks
		Min	Typ	Max		
Input Voltage High	V_{IH}		VDD - 0.3		V	
Input Voltage Low	V_{IL}			0.3	V	
Output Voltage High	V_{OH}		VDD - 0.3		V	
Output Voltage Low	V_{OL}			0.3	V	

2.4 Electro-Acoustic Characteristics

Table 4: Electro-Acoustic Characteristics

Parameters and Symbols	Specification			Unit	Conditions/Remarks
	Min	**Typ**	**Max**		
MIC0 Directivity	Omni-directional				
MIC0 SNR	-	60	-	dB	See note 1
MIC0 Sensitivity	-27	-24	-21	dBFS	See note 2
MIC0 Digital noise floor		-85		dBFS	See note 3
MIC0 Maximum Input S.P.L		114		dBSPL	See note 4
MIC1 Directivity	Omni-directional				
MIC1 SNR	-	60	-	dB	See note 1
MIC1 Sensitivity	-27	-24	-21	dBFS	See note 2
MIC1 Digital noise floor		-85		dBFS	See note 3
MIC1 Maximum Input S.P.L		114		dBSPL	See note 4
Peak Total Harmonic Distortion	-	-	-78	dB	See note 6
Acoustic Overload Point	107			dBSPL	THD<10%
Power Supply Rejection Rate	-	-55	-	dBFS	See note 7
Current Consumption	-	2.2	-	mA	Clock > 1MHz
	-	5	-	uA	Clock off
Power-up initialization	-	-	1	ms	See note 8

Note:

(1) SNR: Signal to Noise Ratio. Measured with mono tone stimulus (frequency = 1 kHz, intensity = 94dB SPL). The SNR is calculated by integrating the power spectrum density in the range of 100 Hz ~ 7.2 kHz. SNR= (Sensitivity – Digital noise floor).

(2) Sensitivity: Measured with mono tone stimulus (frequency = 1 kHz, intensity = 94 dB SPL).

(3) Digital noise floor: Measured with silent environment.

(4) Maximum input SPL: SPL = Sound pressure level. Maximum input SPL = (94- Sensitivity) dB.

(5) dBFS: decibel of Full Scale. For example, in 16 bit PCM format, sine wave with swing between -32767 ~ 32767 is 0dBFS.

(6) Measured under mono tone stimulus (Frequency = 1 kHz, intensity = 74 dB SPL)

(7) Measured under silent environment. Apply a square wave with amplitude = 100mVpp & clock rate = 217 Hz.

(8) From power down state to data valid

2.5 Timing Characteristics

Table 5: Timing Characteristics

Parameter	Symbol	Min	Typ	Max	Unit	Comments
Clock rising time	T_R			10	ns	R_L=1M , C_L=12pF
Clock falling time	T_F			10	ns	R_L=1M , C_L=12pF
DATA into hi Z time	T_Z	0		15	ns	R_L=1M , C_L=12pF
DATA valid time	T_V	18		40	ns	R_L=1M , C_L=12pF
Clock jitter				0.5	ns	
Duty cycle		40	50	60	%	
Clock rate		1		2.5	MHz	

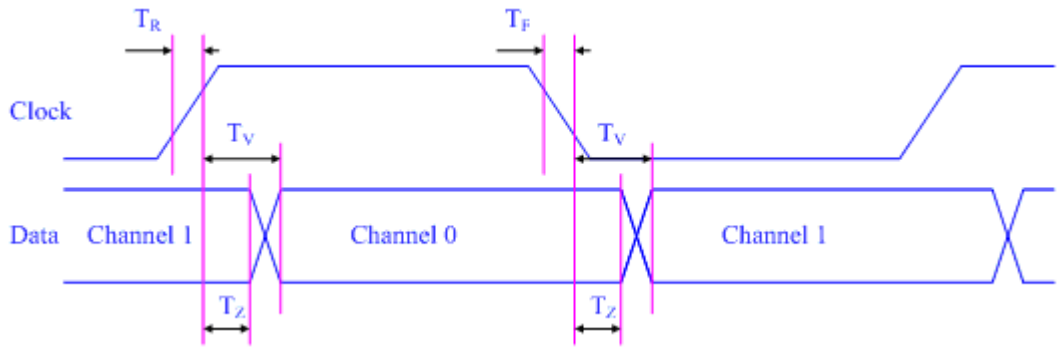


Figure 3: Timing Chart of small array microphone module

2.6 Typical Frequency Response Curve

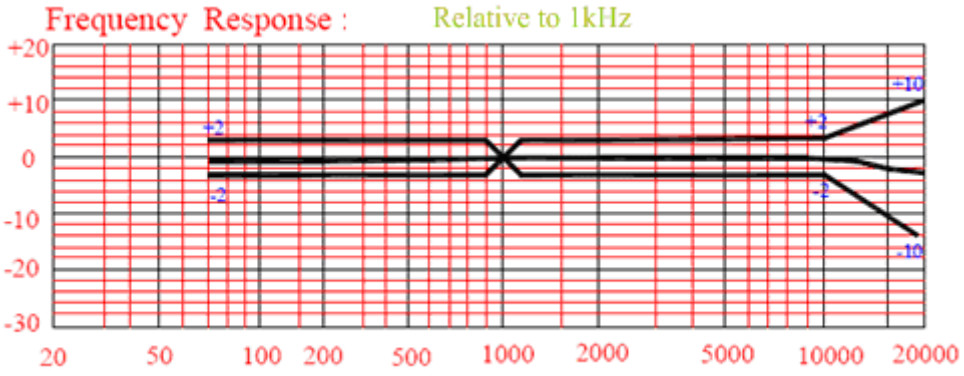


Figure 4: Omni-directional Microphone Frequency Response

(relative to 1kHz sound input)

2.7 **Electrical circuit:**

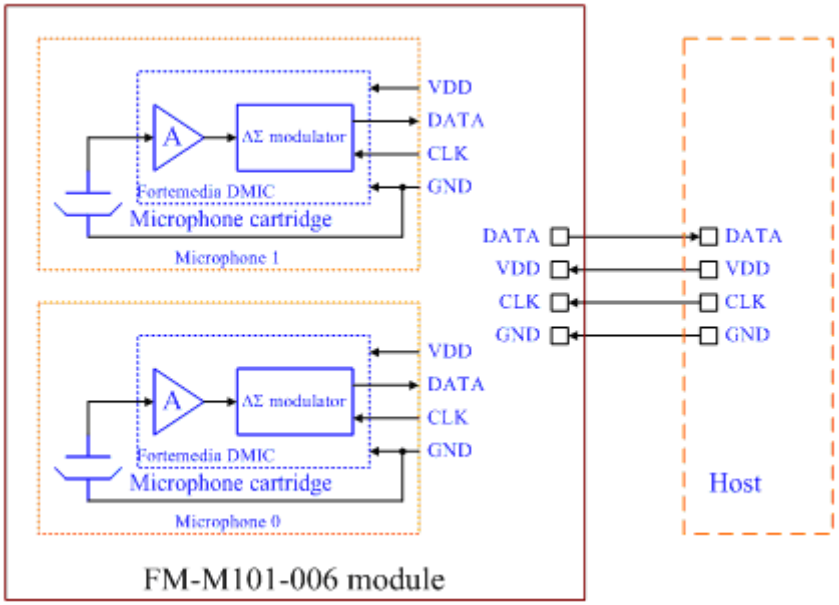


Figure 5: Electrical circuit of the FM-M101-006 module

3 Mechanical Design

3.1 Module dimension:

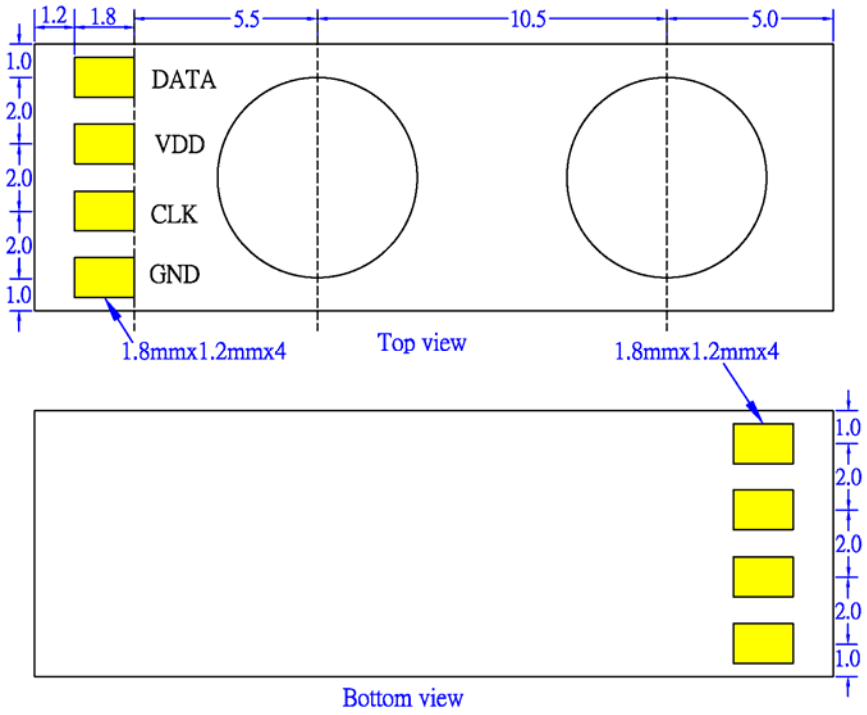


Figure 6: Top view and bottom view of module PCB

3.2 Module Dimensions:

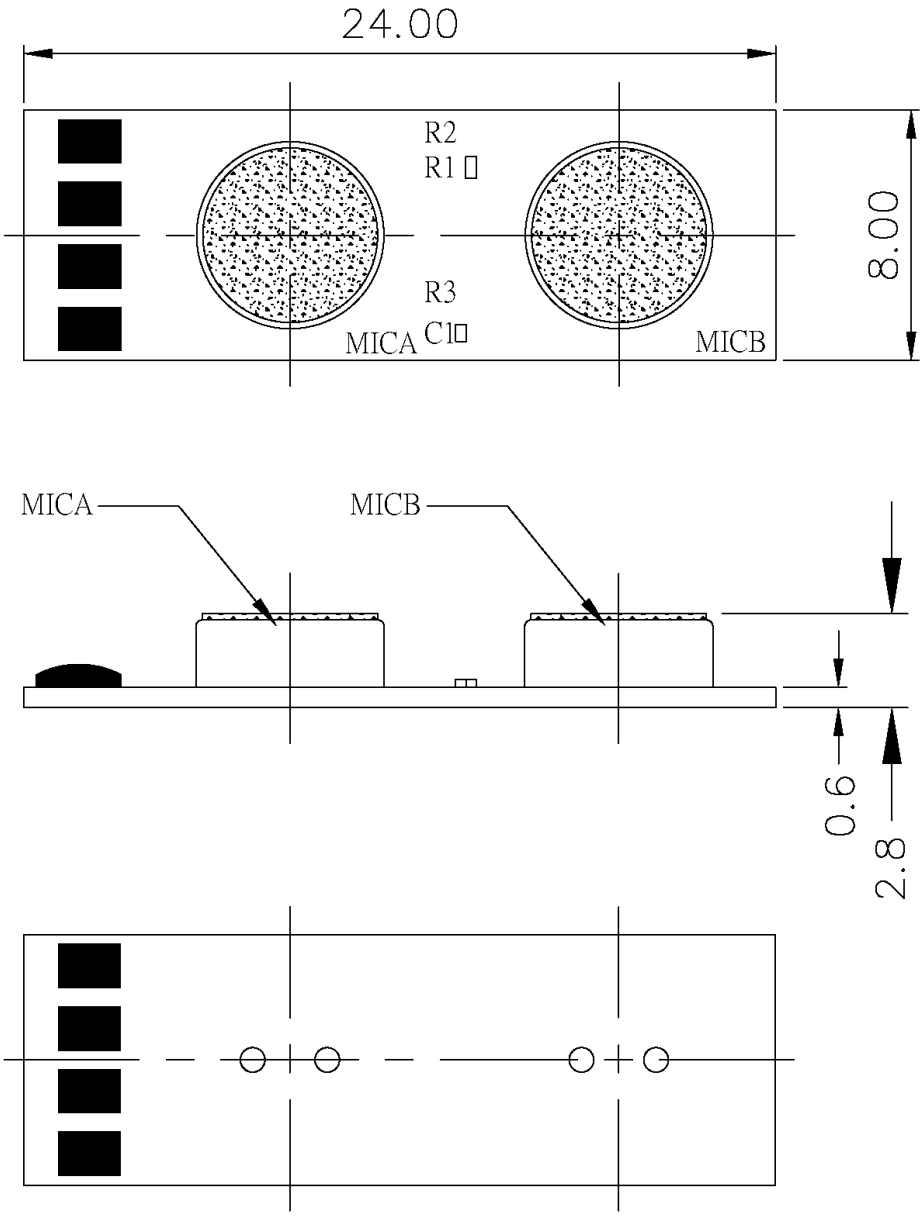
Table 6: Module dimension

Parameter	Min	Typ	Max	Unit	Comments
Module length	23.90	24.00	24.10	mm	
Module width	7.95	8.00	8.05	mm	
Module thickness	0.55	0.60	0.65	mm	
Microphone height	2.15	2.20	2.25	mm	
Microphone diameter	5.95	6.00	6.05	mm	
Microphone spacing	10.45	10.50	10.55	mm	Center to center

3.3 BOM (Bill of material):

ITEM	PART NAME	MATERIAL	QTY	SUPPLIER
1	Case	AL	2	LOCAL
2	Diaphragm	Polyester and Stainless Steel	2	LOCAL
3	Space	Polyester	2	LOCAL
4	P.C.B	FR4	2	LOCAL
5	IC	FM101B	2	TAIWAN
6	Cap	0201	5	JAPAN
7	Plate	PTFE and Metal	2	JAPAN
8	Ring	Brass	2	LOCAL
9	Cavity	PA66	2	LOCAL
10	Screen	NON-Fibercord	2	LOCAL
11	Resistor	0201	1	TAIWAN

3.4 2D drawing:



Tol: ± 0.5
Unit: mm

3.5 Packaging

Each minimum package unit of products shall be in a carton box and it shall be clearly marked with Part Number, quantity and outgoing inspection number. There shall be no mechanical damage on products during transportation and/or in storage.

外箱須標示最小包裝單位, 並註明產品型號、數量及檢驗批號.,必須是物品儲藏或運輸過程中可防止造成損傷的包裝.

4 Environmental Specifications

4.1 Reliability Test

All tests are carried out on the same test batch in the order listed.

The sensitivity needs to be within ±3 dBFs of initial sensitivity after 3 hours of operation at 20℃.

Table 7: Reliability Test

Temperature Test	After exposure to 85℃ for 200 hours, the sensitivity should be within ±3dB from the initial value.
	After exposure to –40℃ for 200 hours the sensitivity should be within ±3dB from the initial value.
Humidity Test	After exposure at 50℃ and 90~95% relative humidity for 200 hours, the sensitivity should be within ±3dB from the initial sensitivity.
Temperature Cycle Test	After exposure at –25℃ for 30 minutes, at 20℃ for 10 minutes, at +60℃ for 30 minutes, at 20℃ for 10 minutes, 5 cycles, the sensitivity to be within ±3dB from the initial sensitivity.
Vibration Test	To be no interference in operation after vibrations, 10Hz to 50Hz for 1 minute full amplitude 1.52mm, for 2 hours at 3 anises.
Drop Test	To be no interference in operation after dropped to concrete floor each one time from 1-meter height at three directions in state of packing.

5 Terminology

Table 8: Terminology

Term	Definition
Sensitivity	Sensitivity represents how efficiency a microphone can transform the sound pressure into electrical voltage. The unit is dBFS/Pa. The sensitivity is output amplitude with mono tone stimulus (frequency = 1 kHz. intensity = 94 dBSPL= 1 Pa).
Digital Noise Floor	Digital noise floor is the output amplitude when environment is silent.
dBFS (decibel relative to Full Scale)	This is unit of the digital microphone output intensity. 0dBFS means the maximum output sound. The output format is PDM (Pulse density modulation). The HD CODEC would decimate the PDM data and converts it into 16bit PCM signal (in 16kHz). 16 bit PCM signal can represent data in the range from -32768 ~ +32767. A pure tone with 0dBFS intensity would output a sine wave with peak output code =32767 and valley output code = -32768.
SNR (Signal to Noise Ratio)	Signal to noise ratio is defined as the ratio between signal power and noise power. The power is measured for 100Hz ~ 7.2 kHz. SNR= Sensitivity (dBFS) – Digital noise floor (dBFS).
Sound Pressure Level (SPL)	The sound (speech, music) is conducted through air. Human heard the sound by sensing the air pressure variation. The MKS unit of air pressure is Pa (Pascal). For convenience, scientists define another unit to represent the sound pressure. It is called SPL. SPL is also another kind of unit for pressure. 1 Pa = 94 dB SPL.
THD (Total Harmonic Distortion)	To measure the THD, the FFT of the DATA output is recorded. Input signal is single tone (1 kHz) and amplitude is specified. The measured power (P_1) for 1kHz is called base band power. The measured power (P_N) for N kHz is called harmonic power. THD can be calculated by dividing the sum of harmonic power by base band power. $THD = 100 \times [\frac{\sum_{N=2\sim7} P_N}{P_1}]^{0.5}$