



Low-Noise Bottom Port Piezoelectric
MEMS Microphone
With Wake on Sound Feature

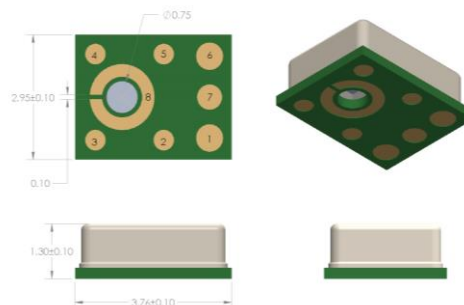
Data Sheet

VM1010

The VM1010 is the world's first ZeroPower Listening™ piezoelectric MEMS microphone. It provides an ultra-low power always listening solution, bringing voice activation to battery powered consumer devices.

Features:

- ZeroPower Listening Technology
- Full audio output upon waking
- Capable of voice detection with just 18 μ W operation
- Extends battery life up to 10x
- Dust resistant to IP5x



The VM1010 is a low-noise single-ended analog MEMS microphone with a *Wake on Sound* mode that allows detection of voice activity while consuming only 10 μ A of supply current (or 18 μ W of power). In this *Wake on Sound* mode, the microphone detects sounds in the voice band above a configurable acoustic threshold level. When the microphone detects a sound above the threshold, it instantly alerts the system of the acoustic event. The system can then switch the VM1010 to *Normal* mode with full audio output within 200 μ Sec. This is fast enough for the VM1010 to capture the sound that exceeds the threshold and send it to the system for processing. This creates the system architecture for *ZeroPower Listening*.

The VM1010's *Wake on Sound* mode brings voice activation to battery-powered consumer devices — while drawing nearly zero power, making it ideal for voice-interface devices such as smart speakers, TV remotes, smart earbuds, and smart home products.

The VM1010 has a small 3.76 mm X 2.95 mm X 1.3 mm package and is reflow solder-compatible with no sensitivity degradation. It operates in environmentally harsh surroundings because it is dust- and moisture-resistant.

Specifications

All specifications are at 25°C, $V_{DD} = 1.8\text{ V}$ unless otherwise noted. Valid for Date Code 1811 and higher.

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
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Normal Mode Acoustic Specifications

Sensitivity		1 kHz, 94 dB SPL	-41	-38	-35	dBV
Signal-to-Noise Ratio	SNR	94 dB SPL at 1 kHz signal		60		dB(A)
		20 Hz – 20 kHz, A-weighted Noise				
Signal-to Noise Ratio Voice Band	SNR	94 dB SPL at 1 kHz signal		62		dB(A)
		20 Hz – 8 kHz, A-weighted				
Total Harmonic Distortion	THD	94 dB SPL		0.1		%
Acoustic Overload Point	AOP	10.0% THD		125		dB SPL

Roll Off Frequency		-3db at 1KHz		100		Hz
Directivity			Omni			

Wake on Sound Acoustic Specifications

Specifications valid on material Date Code 1811 (lid marking A811..) and higher.

Max Acoustic Threshold (default)	PaTH	Rg= Open		89		SPL
Mid Threshold	PaTH	Rg= 90kOhm		77		SPL
Min Acoustic Threshold	PaTH	Rg= 18kOhm		65		SPL

Note: Rg is the resistance configured by user between GA1 and GA2 pins. A 1% tolerance resistor is recommended.

Previous material 1810 and lower have a different range and resistor values and are now obsolete.

Normal Mode Electrical Specifications

Supply Voltage	VDD		1.6	1.8	3.6	V
Supply Current		$V_{DD} \leq 1.8$ V, Mode Normal		83	100	μ A
Power Supply Rejection Ratio	PSRR	VDD = 1.8, 1kHz, 200mV _{pp} Sine wave		56		dB
Power Supply Rejection	PSR	VDD = 1.8, 217Hz, 100mV _{pp} square wave, 20 Hz – 20kHz, A-weighted		-87		dB(A)

Output Impedance	Z_{OUT}			1		k Ω
Output DC Offset				0.75		V

Wake on Sound Mode Electrical Specifications

Supply Voltage	VDD		1.6	1.8	3.6	V
Supply Current		$V_{DD} \leq 1.8$ V, Mode WoS	7	10	14	μ A

Digital Electrical Interface Specifications

Logic Input High			$0.65 \cdot V_{DD}$		3.6	V
Logic Input Low			-0.3		$0.35 \cdot V_{DD}$	V
Logic Output High		$I_{Load} = 2$ mA	$0.7 \cdot V_{DD}$	VDD		V
Logic Output Low		$I_{Load} = 2$ mA		0	$0.3 \cdot V_{DD}$	V
Driving Capability					100	pF

Absolute Maximum Ratings

Parameter	Maximum	Units
Supply Voltage	3.6	V
Sound Pressure Level	160	dB re 20 μ Pa
Operating Temperature Range	-40 to +85	$^{\circ}$ C
Storage Temperature Range	-50 to +150	$^{\circ}$ C

Typical Performance Characteristics

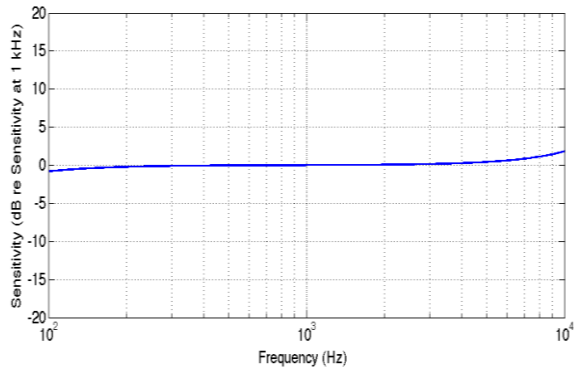


Figure 1. Frequency Response (Normal Mode)

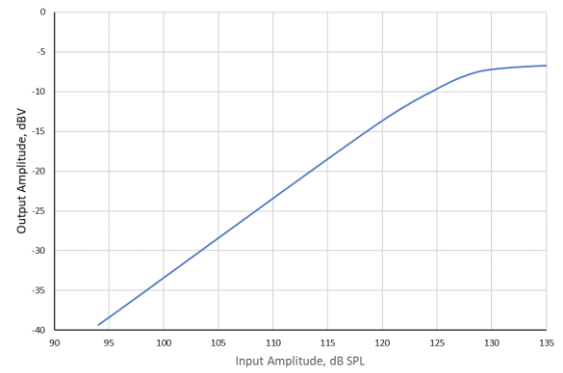


Figure 2. Linearity (Normal Mode)

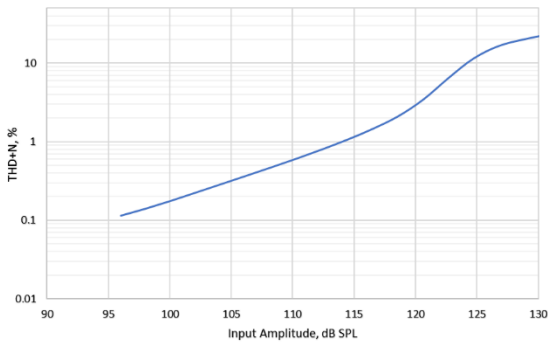


Figure 3. THD+N vs Amplitude (Normal Mode)
(Normal Mode)

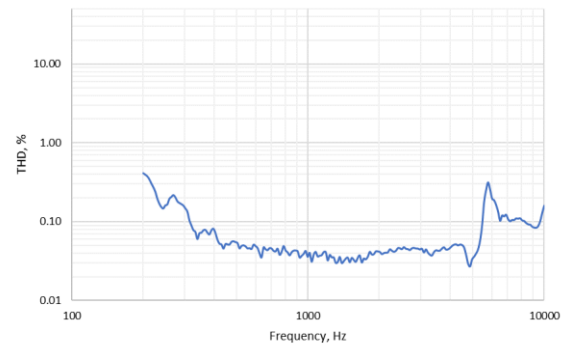


Figure 4. THD vs Frequency, 94dB SPL

Environmental Robustness

IP adherence is evaluated by 1kHz Sensitivity spec post stress

Ingress Protection Type	Description
Dust Resistance	IP5X
Water Immersion	IPX7; 2hrs drying time, dry environment

Microphone Modes

mode pin	Mic mode	I _{dd} , typ. (μA)	V _{out} pin	d _{out} pin
high	Wake on Sound	10	GND	low, then latches high after first wake-up event
low or floating	Normal	83	audio output	Tied to GND through low impedance

Table 2: Effect of mode pin on microphone mode, supply current & output pins

Microphone Operation

The VM1010 is a user-controlled multi-mode microphone. Through the single-bit digital input pin *mode*, the user provides a signal that will put the microphone in the *Wake on Sound* or *Normal* mode of operation. When in the *Wake on Sound* mode, should a sound be detected, the microphone will output a digital high through the *dout* pin. The user can then switch the microphone to *Normal* mode by providing a digital low to the *mode* pin. The user can at some later point provide a digital high to the *mode* pin to return the microphone to *Wake on Sound* mode. Figure 5 shows the states of various pins that are either user-provided (*mode*, *V_{dd}*) or VM1010-provided (*dout*, *V_{out}*) at three points of operation.

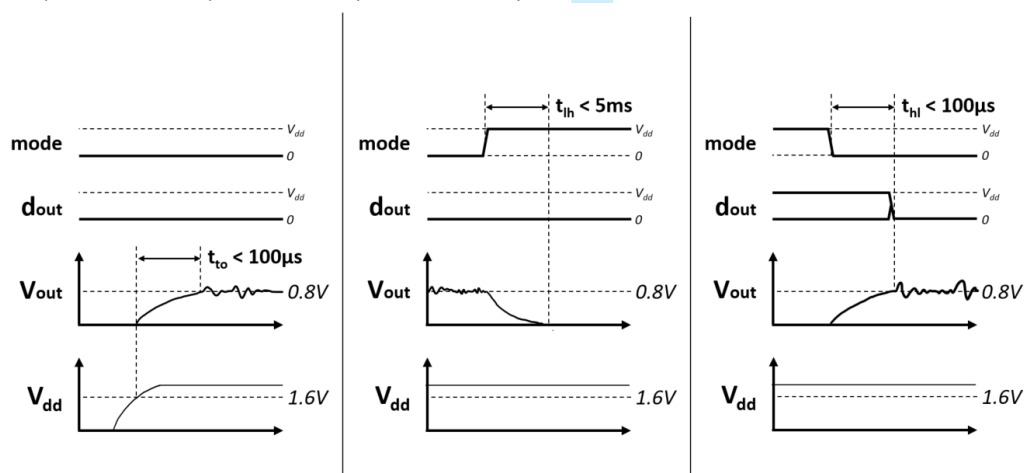


Figure 5: Timing diagrams showing turn-on time (left), transition time into *Wake on Sound* mode (center) & *Normal* mode (right)

We recommend powering up the microphone in *Normal* mode (*mode* pin low), and then entering *Wake on Sound* mode as needed.

System Architecture

Control loop for *Wake on Sound*:

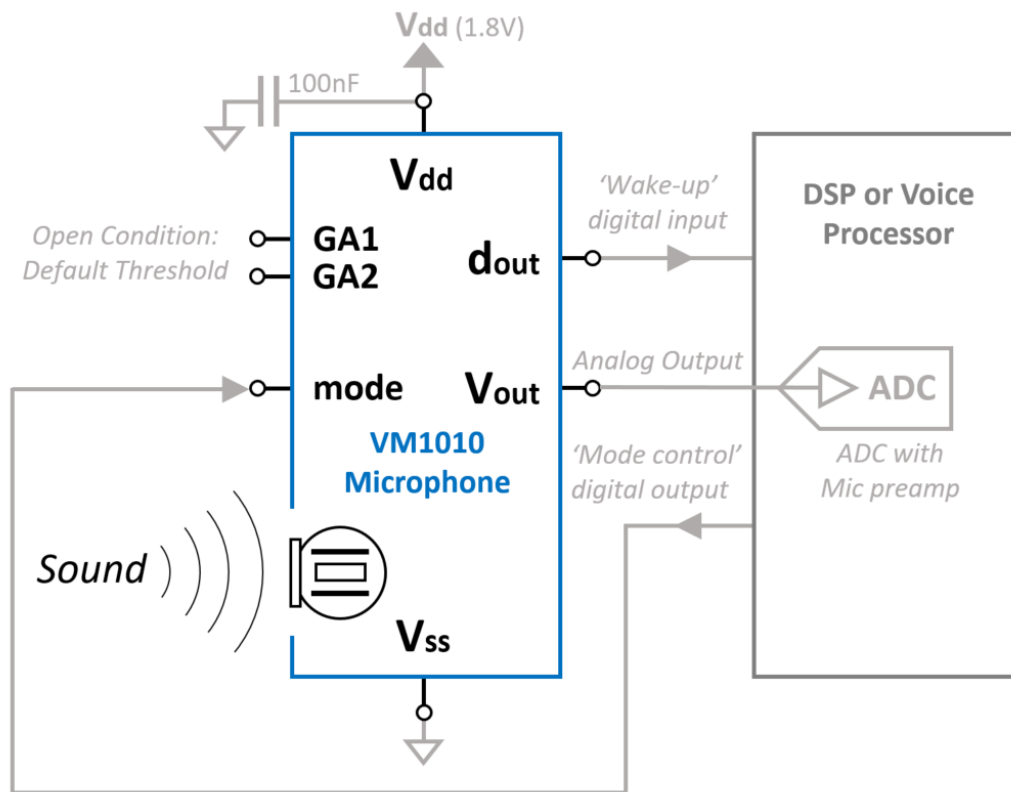


Figure 6: Block diagram of an example system built around VM1010 microphone

Figure 6 above shows a full-featured system built around the VM1010. The VM1010 wakes up the system when triggered by sound. The DSP or voice processor can be kept in a low-power state when there is no sound to process.

Solder Reflow Profile

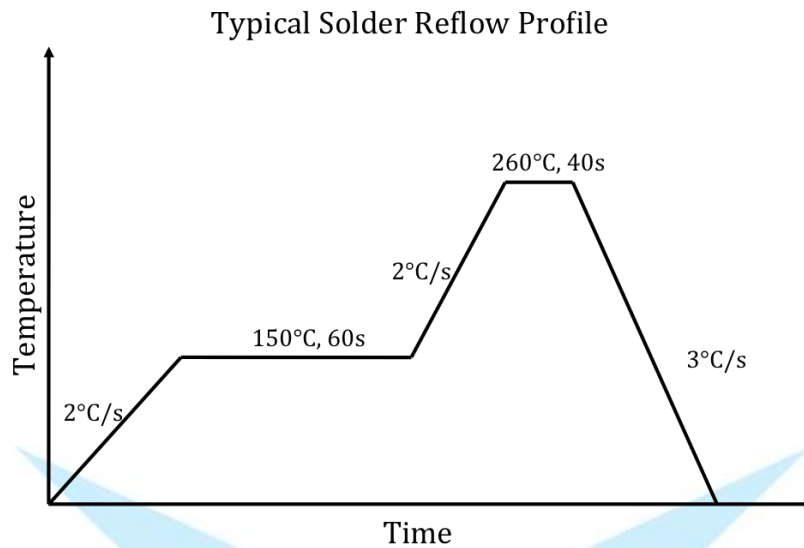


Figure 7: Solder reflow profile

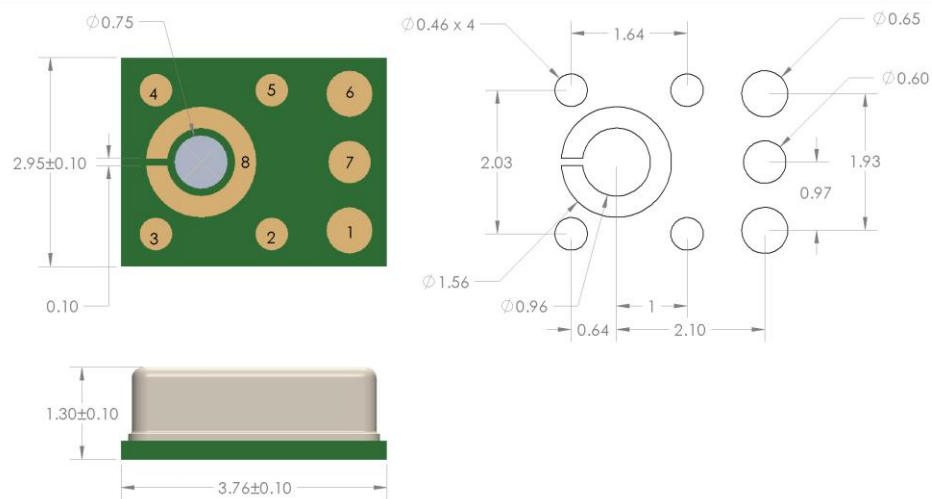
Handling Instructions

Vesper's piezoelectric MEMS microphones are very resistant to harsh environments such as dust and moisture. However, to avoid mechanical damage to the microphone, we recommend using appropriate handling procedures when manually handling the parts or when using pick and place equipment. The following guidelines will avoid damage:

- Do not apply a vacuum to the bottom side of the microphone. A vacuum pen may be used with care on the top side only.
- Do not apply very high air pressure over the port hole.
- Do not insert any large particles or objects in the port hole. The microphone is resistant to small particles per IP5x specification.
- Do not board wash or clean after the reflow process or expose the acoustic port to harsh chemicals.

Dimensions and Pin Layout

All dimensions are in mm



Pin Number	Pin Name	Description
1	V _{out}	Analog Output Voltage
2	GA2	Wake-on-Sound Acoustic Threshold Adjust pin 2
3	GA1	Wake-on-Sound Acoustic Threshold Adjust pin 1
4	GND	Ground
5	Mode	Mode control (<i>hi</i> =Wake-on-Sound, <i>lo</i> =Normal-Power)
6	V _{dd}	Power Supply (1.6V to 3.6V)
7	d _{out}	Digital output for Wake-on-Sound trigger
8	GND	Ground

All dimensions are in mm

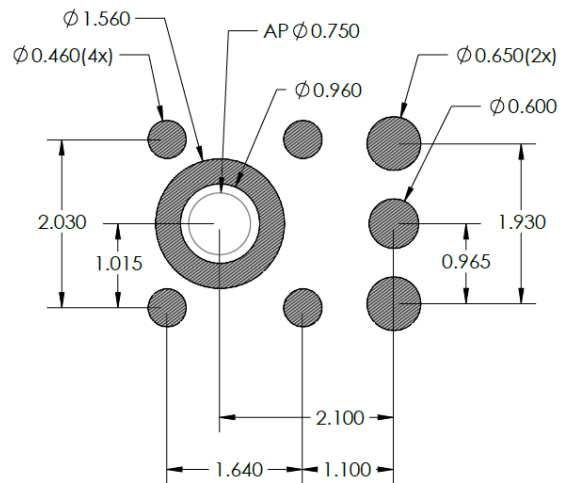


Figure 9: PCB Land Pattern

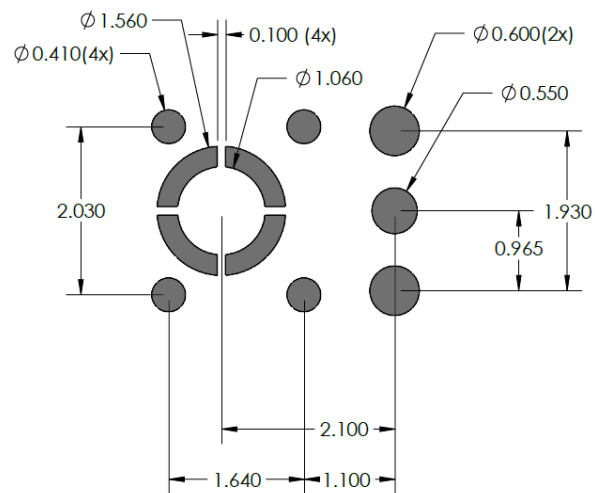


Figure 10: Solder Stencil Pattern

Tape and Reel Specifications

Dimensions are in mm (and inches)

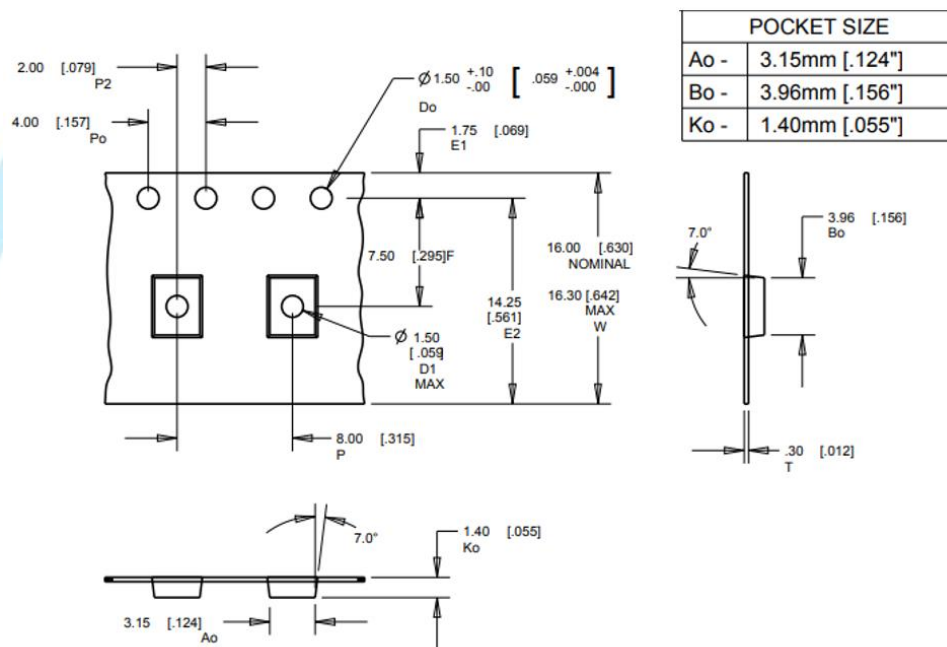


Figure 11: Tape and Reel Specification

Ordering Guide

Product	Package Description	Ordering Quantity
VM1010-U7-R13	13" Tape and Reel	5,000

Lid Marking

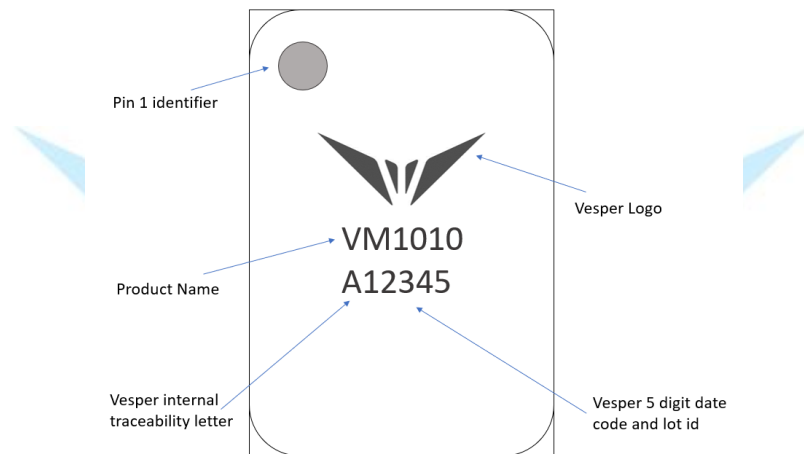


Figure 11. Lid Marking Description

Engineering Samples

Engineering samples may vary from the technical specifications contained in this data sheet. They are not intended for use in end products and are intended for client evaluation and testing of the product. The test of an engineering sample will not reflect the testing of a final product. Material identified as engineering samples are provided without any guarantees or warranty. In association with engineering samples, Vesper makes no warranties of any kind, either express or implied, including but not limited to warranties of merchantability, fitness for a particular purpose, of title, or of noninfringement of third-party rights implied.

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