

### GENERAL INFORMATION

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.

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  $\mu$ A of supply current (or 18  $\mu$ 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  $\mu$ 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 solder reflow compatible with no sensitivity degradation. It operates in environmentally harsh surroundings because it is dust- and moisture-resistant.

### FEATURES

- ZeroPower Listening™
- Full audio output upon waking
- Capable of voice detection with just 18  $\mu$ W operation
- Extends standby battery life up to 10x and typical operating battery life up to 7x
- Dust and water resistant to IP57

### ORDERING INFORMATION

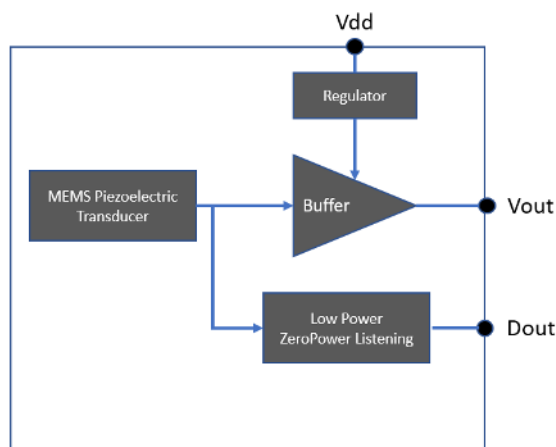
Product	Package Description	Quantity
VM1010AA	13" Tape and Reel	5,000



### APPLICATIONS

- Smart Voice Remotes
- IP Security Cameras
- TV Remotes
- Headsets / Hearables / Wearables
- Smart Home Devices
- Battery Operated Applications with wake word / event detection

### BLOCK DIAGRAM



Functional Block Diagram

**TABLE OF CONTENTS**

MICRPHONE MODES .....	3
ACOUSTIC SPECIFICATIONS .....	3
ELECTRICAL SPECIFICATIONS.....	4
DIGITAL INTERFACE SPECIFICATIONS .....	4
ABSOLUTE MAXIMUM RATINGS.....	4
ENVIRONMENTAL ROBUSTNESS .....	5
MICROPHONE OPERATION.....	5
SYSTEM ARCHITECTURE.....	6
TYPICAL PERFORMANCE CHARACTERISTICS.....	7
SOLDER REFLOW PROFILE.....	8
HANDLING INSTRUCTIONS .....	8
DIMENSIONS AND PIN LAYOUT.....	8
PCB DESIGN AND LAND PATTERN LAYOUT .....	9
TAPE AND REEL SPECIFICATIONS .....	10
LID MARKING .....	11
COMPLIANCE INFORMATION.....	11
CONTACT DETAILS .....	11
LEGAL INFORMATION .....	11
REVISION HISTORY.....	12

### MICROPHONE MODES

Mode Logic Level	Mic Mode	I <sub>dd</sub> (μA)	V <sub>out</sub>	D <sub>out</sub> pin
High	Wake on Sound	10	GND	Low, then latches high after first wake-up event
Low or floating	Normal	85	Analog Audio Output	Tied to GND through low impedance

### ACOUSTIC SPECIFICATIONS

All specifications are at 25°C, VDD = 1.8 V unless otherwise noted

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
<b>Normal Mode Specifications</b>						
Sensitivity		1 kHz, 94 dB SPL	-41	-38	-35	dBV
Signal-to-Noise Ratio	SNR	94 dB SPL at 1 kHz signal, 20Hz to 20kHz, A-weighted Noise		60.5		dB(A)
Signal-to-Noise Ratio Voice Band	SNR	94 dB SPL at 1 kHz signal, 20Hz to 8kHz, A-weighted Noise		62.5		dB(A)
Total Harmonic Distortion	THD	94 dB SPL		0.1		%
Acoustic Overload Point	AOP	10.0% THD		126		dB SPL
Sensitivity Recovery Time After High SPL Event <sup>1</sup>		135 dB SPL for 50msec followed by 94 dB SPL		10		mS
Roll Off Frequency		-3dB at 1KHz		100		Hz
Directivity			Omni			
Polarity		Increase in sound pressure	Increase in output voltage			
<b>Wake on Sound Specifications</b>						
Max Acoustic Threshold (default)	PaTH	Rg= Open (default), 1kHz signal		89		dB SPL
Mid Threshold	PaTH	Rg= 90kOhm, 1kHz signal		77		dB SPL
Min Acoustic Threshold	PaTH	Rg= 18kOhm, 1kHz signal		65		dB SPL

Note: Rg is the resistance configured by user between GA1 and GA2 pins. A 1% tolerance resistor is recommended. Engineering material date code 1810 and lower have a different range and resistor values and are now obsolete.

<sup>1</sup> Microphone is subjected to 135 dB SPL input at 1kHz for 50msec and then 94 dB SPL at 1kHz for measuring sensitivity recovery time. Recovery time is defined as the time taken for sensitivity to be within +1dB or -0.5dB of actual sensitivity.

**ELECTRICAL SPECIFICATIONS**

All specifications are at 25°C, VDD = 1.8 V unless otherwise noted

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
<b>Normal Mode Specifications</b>						
Supply Voltage	VDD		1.6	1.8	3.6	V
Supply Current	IDD	VDD ≤ 1.8 V, Mode = Low		85	100	µA
Power Supply Rejection Ratio	PSRR	VDD = 1.8, 1kHz, 200mV <sub>PP</sub> Sine wave		53		dB
Power Supply Rejection	PSR	VDD = 1.8, 217Hz, 100mV <sub>PP</sub> square wave, 20 Hz – 20kHz, A-weighted		-85		dB(A)
Output Impedance	ZOUT			1		kΩ
Output DC Offset				0.8		V
<b>Wake on Sound Specifications</b>						
Supply Voltage	VDD		1.6	1.8	3.6	V
Supply Current	IDD	Mode = High	7	10	14	µA

**DIGITAL INTERFACE SPECIFICATIONS**

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Logic Input High			0.65*VDD		3.6	V
Logic Input Low			-0.3		0.35*VDD	V
Logic Output High		I <sub>Load</sub> = 0.5mA	0.7*VDD	VDD		V
Logic Output Low		I <sub>Load</sub> = 0.5mA		0	0.3*VDD	V
Driving Capability					100	pF

**ABSOLUTE MAXIMUM RATINGS**

Parameter	Rating	Units
Supply Voltage	-0.3 to +3.6	V
Sound Pressure Level	160	dB re 20 µPa
Operating Temperature Range	-40 to +85	°C
Storage Temperature Range	-55 to +150	°C

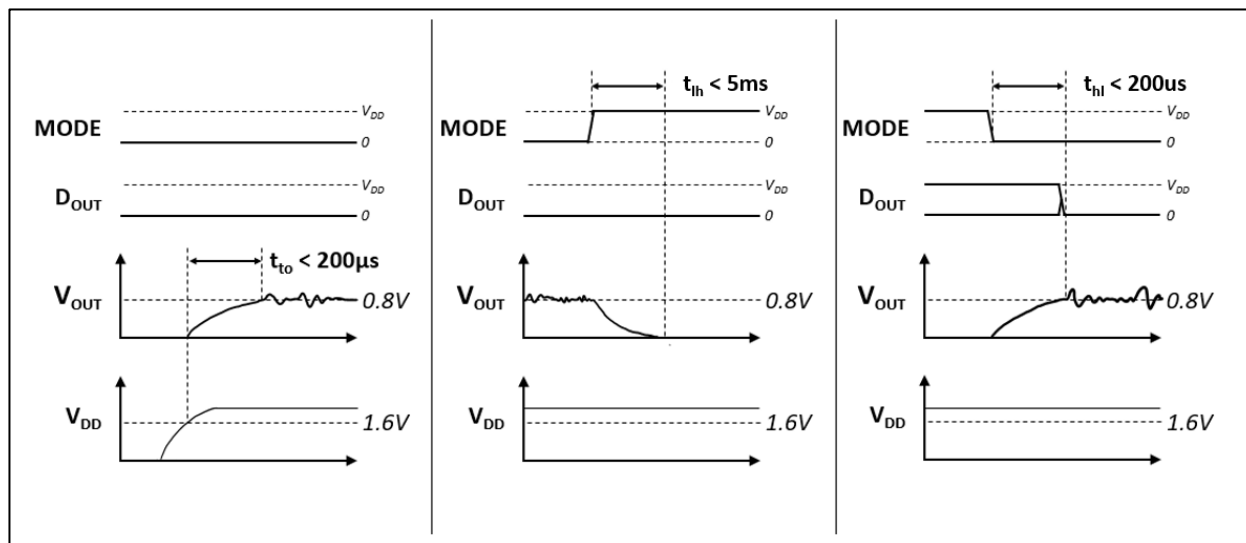
## ENVIRONMENTAL ROBUSTNESS

IP adherence is evaluated by 1kHz Sensitivity spec post stress

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

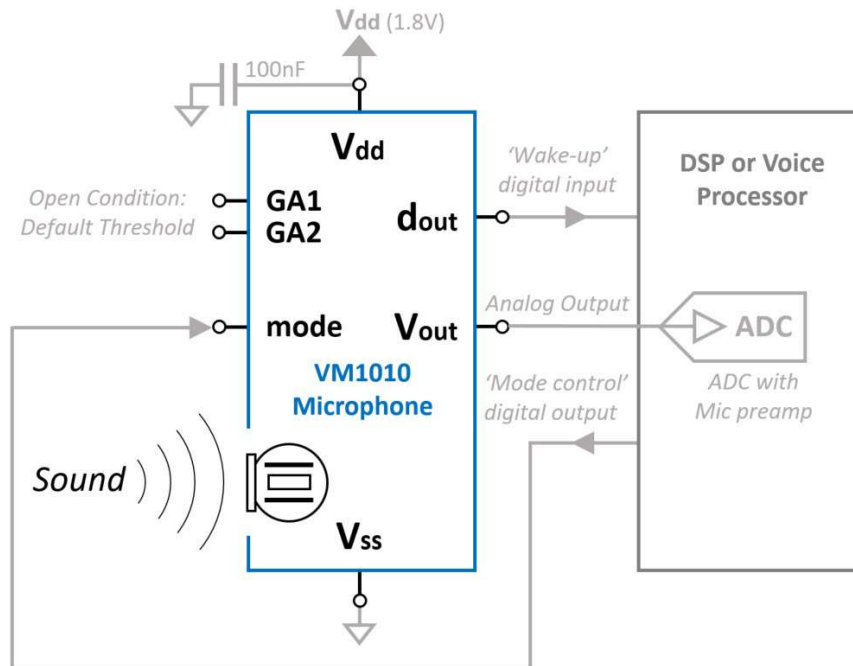
## MICROPHONE OPERATION

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 7 shows the states of various pins that are either user-provided (*MODE*, *V<sub>DD</sub>*) or VM1010-provided (*DOUT*, *V<sub>OUT</sub>*) at three points of operation. We recommend powering up the microphone in Normal mode (mode pin low), and then entering Wake on Sound mode as needed.



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

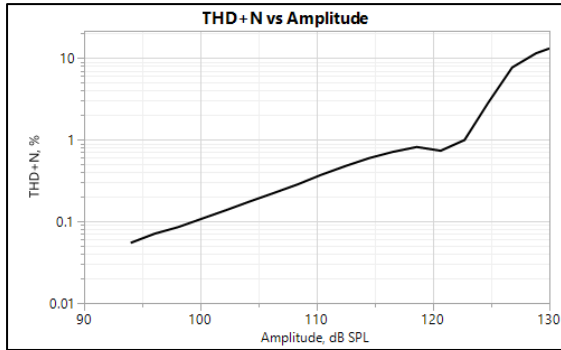
**SYSTEM ARCHITECTURE**



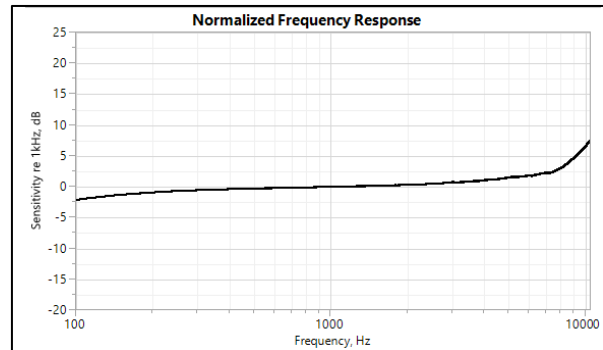
*Block Diagram of example system build around VM1010 Microphone*

Figure 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.

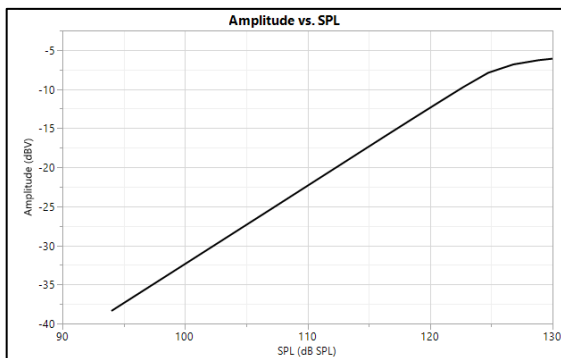
**TYPICAL PERFORMANCE CHARACTERISTICS**



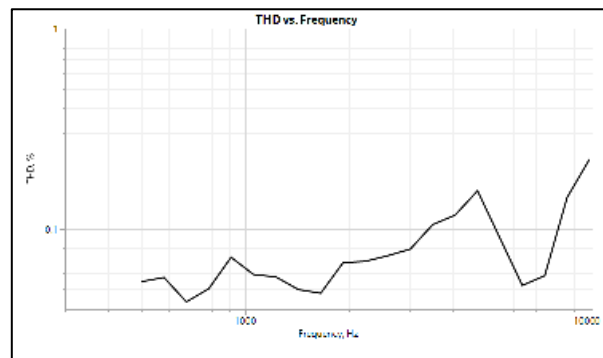
*THD+N vs Amplitude at 1kHz*



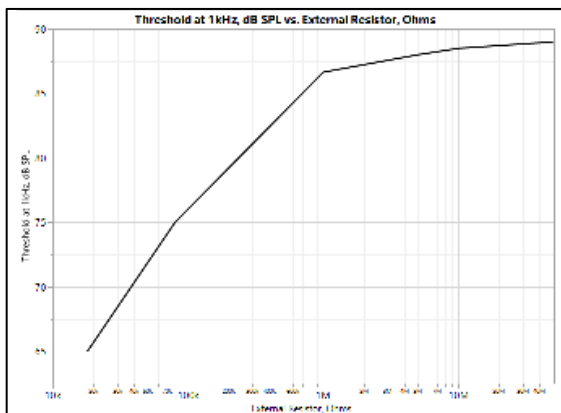
*Normalized Frequency Response*



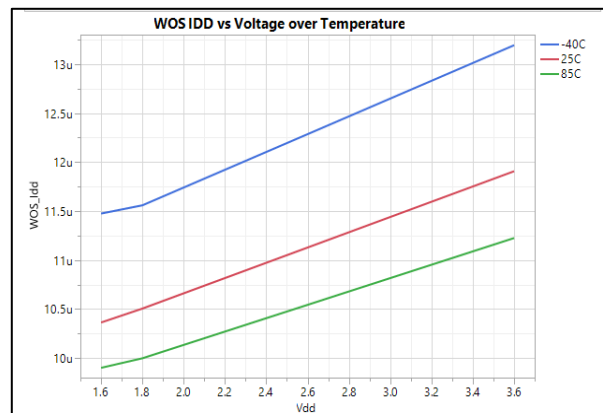
*Linearity at 1kHz*



*THD vs Frequency, 94dB SPL*

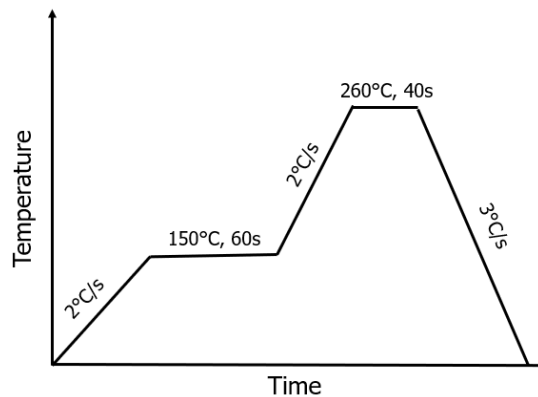


*WOS Threshold vs Gain Resistor*



*WOS vs Vdd over Temperature*

## SOLDER REFLOW PROFILE



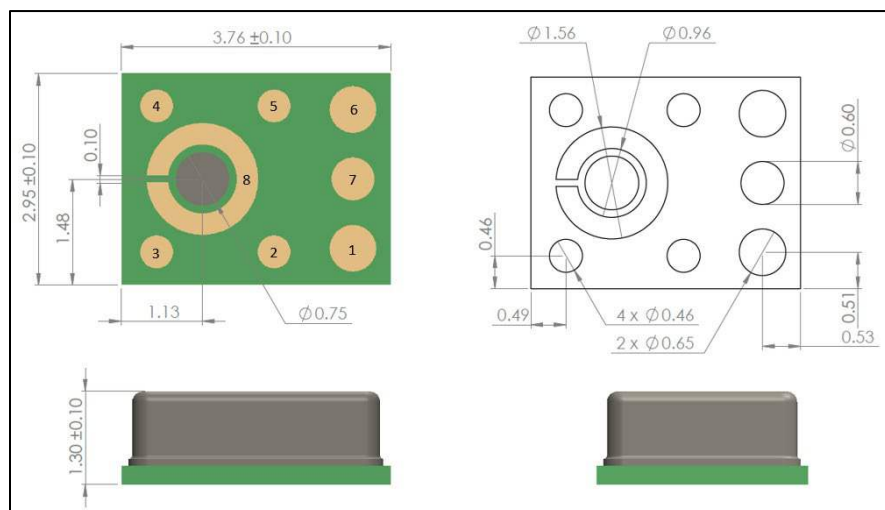
*Solder Reflow Profile*

## 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.
- Do not handle without a standard ESD control procedure such as grounding of equipment, wrist straps worn by operators etc.

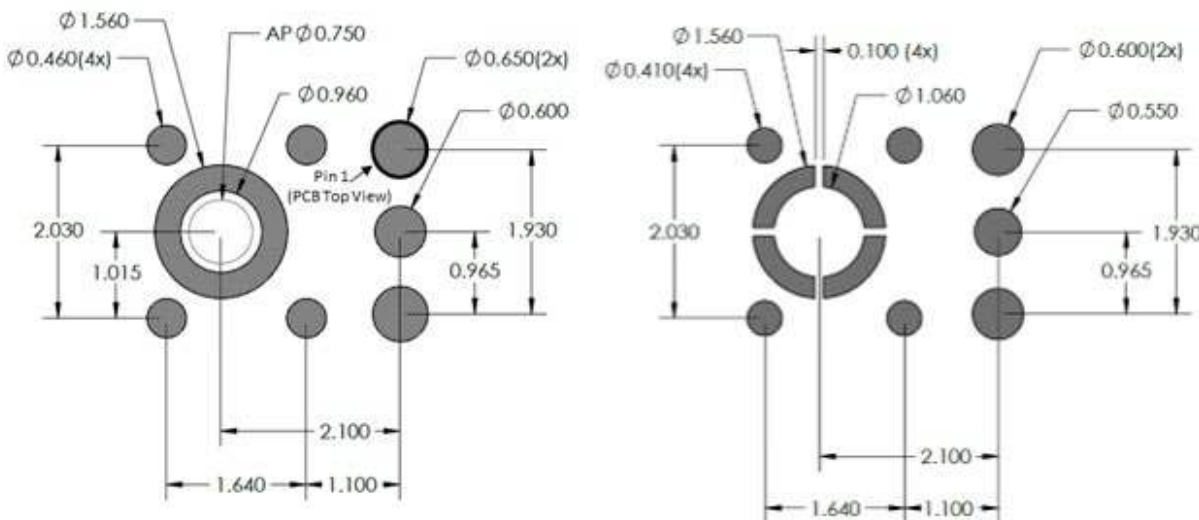
## DIMENSIONS AND PIN LAYOUT





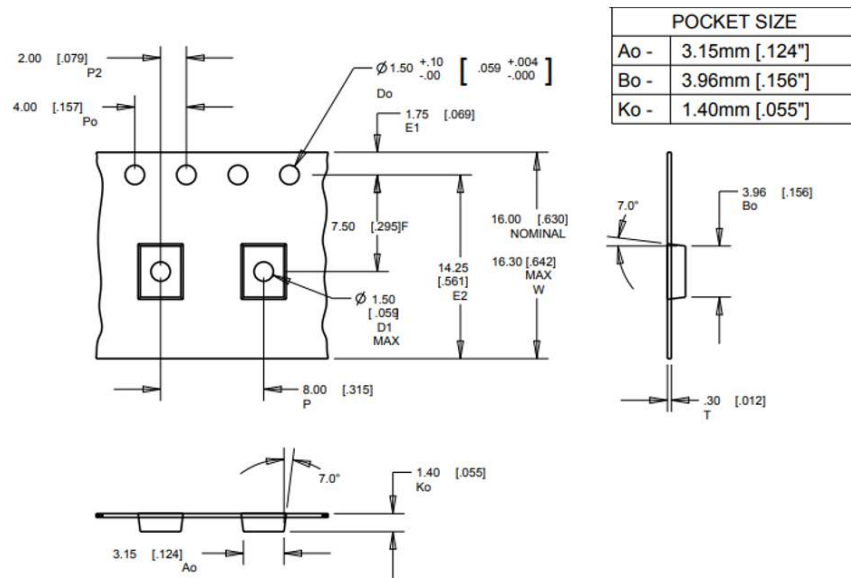
Pin Number	Pin Name	Description
1	VOUT	Analog Output Voltage
2	GA2	Wake-on-Sound Acoustic Threshold Adjust pin 2
3	GA1	Wake-on-Sound Acoustic Threshold Adjust pin 1
4	GND	Ground
5	MODE	Mode control (High=Wake on Sound, Low=Normal)
6	VDD	Power Supply (1.6V to 3.6V)
7	DOUT	Digital output for Wake on Sound trigger
8	GND	Ground

**PCB DESIGN AND LAND PATTERN LAYOUT**

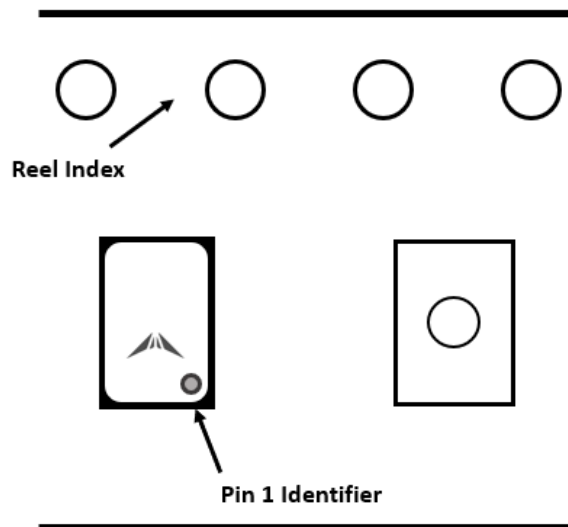


*PCB and Solder Stencil Pattern. All dimensions are in mm*

**TAPE AND REEL SPECIFICATIONS**

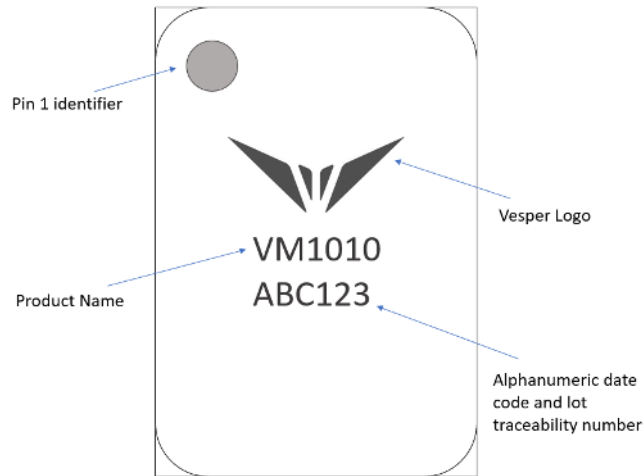


*Tape and Reel specification - All dimensions are in millimeters (inches)*



*Part Orientation in Reel (Note: dimensions not to scale)*

## LID MARKING



*Lid Marking Descriptions*

## COMPLIANCE INFORMATION

Electrostatic discharge (ESD) sensitive device:

Although this product features industry standard protection circuitry, damage may occur if subjected to excessive ESD. Proper ESD precautions should be taken to avoid damage to the device.



## CONTACT DETAILS

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## LEGAL INFORMATION

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**REVISION HISTORY**

Revision	Date	Description
0.0.0	02/22/2019	Initial revision for new document control system. VM1010_Datasheet_RevA renamed and reformatted to R0.0.0. Product Name changed to VM1010AA.