| Data Sheet	PMM-3738-VM1010-R

PUI Audio, with Vesper's exclusive technology, presents the **PMM-3738-VM1010-R**: The world's first ZeroPower Listening™ piezoelectric MEMS microphone designed for ultra-low power always listening solution; delivering voice activation to battery-powered devices.

Features:
- ZeroPower Listening™ technology
- Full audio output on wake-up
- Capable of voice detection with just 18 µW operating power
- Extends Battery life up to 10x
- Dust and moisture resistant to IP57
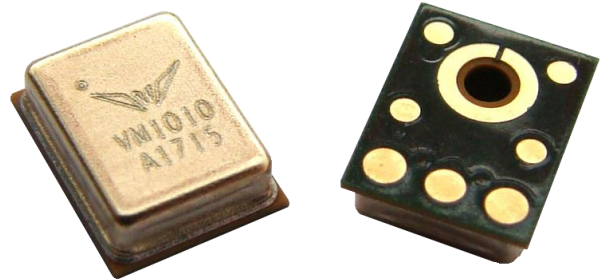
The **PMM-3738-VM1010-R** is a single-ended analog MEMS microphone with *Wake on Sound*. The *Wake on Sound* mode allows for detection of voice activity while consuming only 10 µA of supply current (18 µW of power). In *Wake on Sound* mode, a sound in the vocal band above the level threshold instantly alerts a processor of an acoustic event. The processor (DSP or Voice Processor) then switches the **PMM-3738-VM1010-R** into *Normal* mode, with full audio output within 200 microseconds! Fast enough for the microphone to capture the triggering sound and pass it along for processing. This is the system architecture for *ZeroPower Listening™*.

Wake on Sound delivers voice activation to battery-powered voice-interface consumer devices—while drawing nearly zero power—such as smart speakers, smart TV remote controls, smart headphones, and IoT smart home products.

Specifications

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

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units

Normal Mode Acoustic Specifications

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Sensitivity		1 kHz, 94 dB SPL	-41	-38	-35	dBV
Signal-to-Noise Ratio	SNR	94 dB SPL at 1 kHz signal, 20 Hz – 20 kHz, A-weighted Noise		60.5		dB(A)
Signal-to Noise Ratio Voice Band	SNR	94 dB SPL at 1 kHz signal, 20 Hz – 8 kHz, A-weighted		62.5		dB(A)
Total Harmonic Distortion	THD	94 dB SPL		0.1		%
Acoustic Overload Point	AOP	10.0% THD		126		dB SPL
Roll Off Frequency		-3db at 1 kHz		100		Hz
Directivity				Omni		

Wake on Sound Acoustic Specifications
(on material Date Code 1811 and higher)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Max Acoustic Threshold (default)	PaTH	Rg = Open, 1 kHz signal		89 dB		SPL
Mid Acoustic Threshold	PaTH	Rg = 90kOhm, 1 kHz signal		77 dB		SPL
Min Acoustic Threshold	PaTH	Rg = 18kOhm, 1 kHz 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.

Normal Mode Electrical Specifications

Supply Voltage	VDD		1.6	1.8	3.6	V
Supply Current		$V_{DD} \leq 1.8$ V, Mode Normal		85	100	µA
Power Supply Rejection Ratio	PSRR	VDD = 1.8, 1kHz, 200mV$_{PP}$ Sine wave		53		dB
Power Supply Rejection	PSR	VDD = 1.8, 217Hz, 100mV$_{PP}$ square wave, 20 Hz – 20kHz, A-weighted		-85		dB(A)
Output Impedance	Z_{OUT}			1000		Ω
Output DC Offset				0.8		V

Wake on Sound Mode Electrical Specifications

Supply Voltage	VDD		1.6	1.8	3.6	V
Supply Current	IDD	Mode = High	7	10	14	µA

Digital Electrical Interface Specifications

Logic Input High			0.65*VDD		3.6	V
Logic Input Low			-0.3		0.35*VDD	V
Logic Output High		I_{Load} = 0.5 mA	0.7*VDD	VDD		V
Logic Output Low		I_{Load} = 0.5 mA		0	0.3*VDD	V
Driving Capability					100	pF

Absolute Maximum Ratings

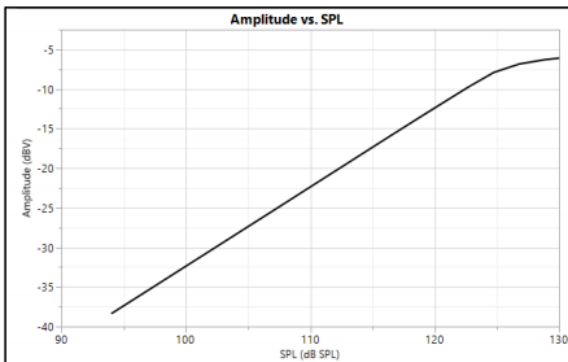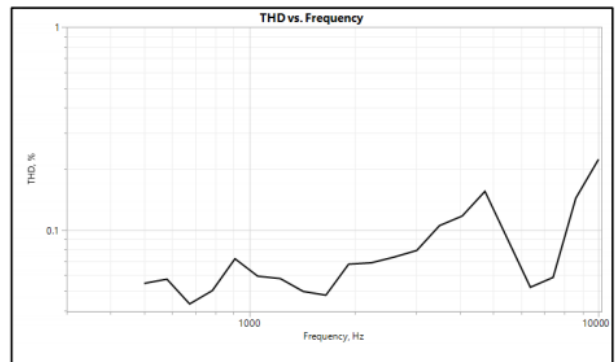| Parameter	Maximum	Units
Supply Voltage	-0.3 to3.6	V
Sound Pressure Level	160	dB, re 20 µPa
Temperature Range	-40 to +85	°C
Storage Temperature Range	-55 to +150	°C

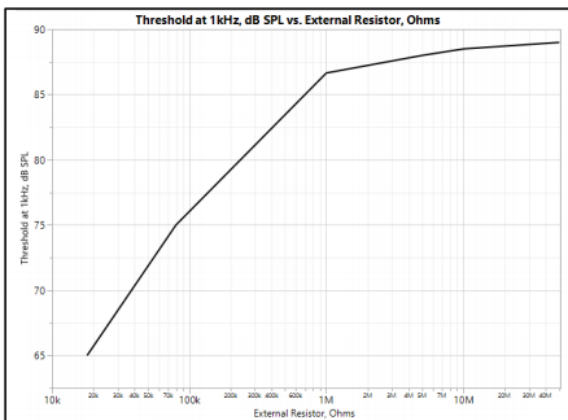## Typical Performance Characteristics
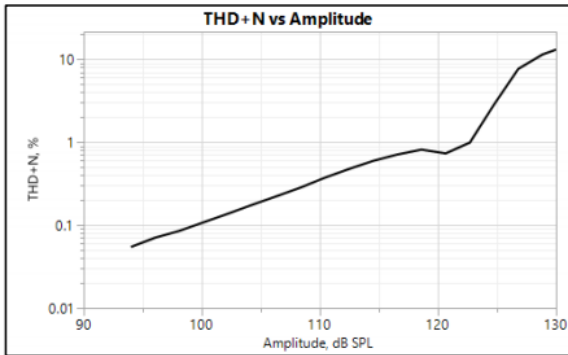
THD+N vs Amplitude at 1kHz
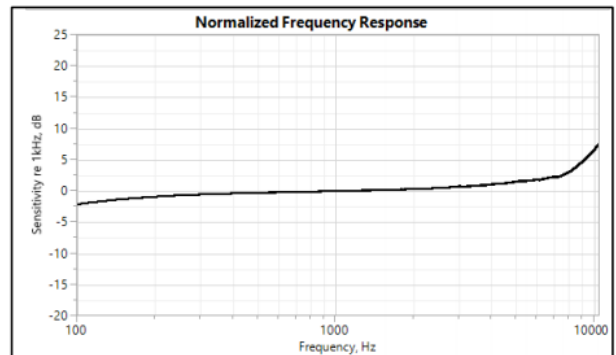
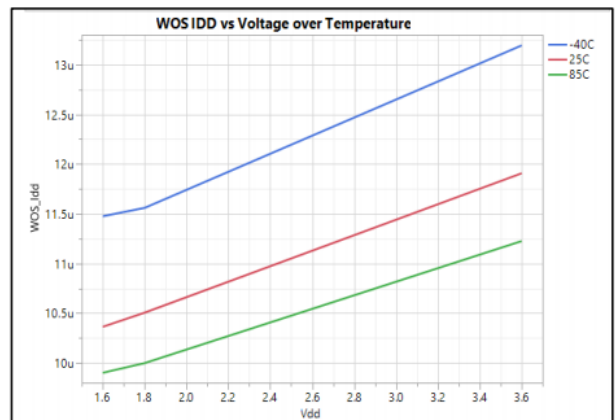Normalized Frequency Response

Linearity at 1kHz

THD vs Frequency, 94dB SPL

WOS Threshold vs Gain Resistor

WOS vs Vdd over Temperature

Environmental Robustness

IP adherence is evaluated by 1 kHz Sensitivity spec post stress

Ingress Protection Type	Description
Dust Resistance, Water Immersion	IP5X, IPX7 2 hours drying time in 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
low or floating	Normal-Power	85	audio output	Tied to GND through low impedance

Microphone Operation

The **PMM-3738-VM1010-R** 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 into *Wake on Sound* or *Normal* modes 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 would at some later point, provide a digital high to the *mode* pin to return the microphone to *Wake on Sound* mode. Figure 2 shows the states of various pins that are either user provided (*mode*, *Vdd*) or PMM-3738-VM1010-R provided (*dout*, *Vout*) at three points of operation.
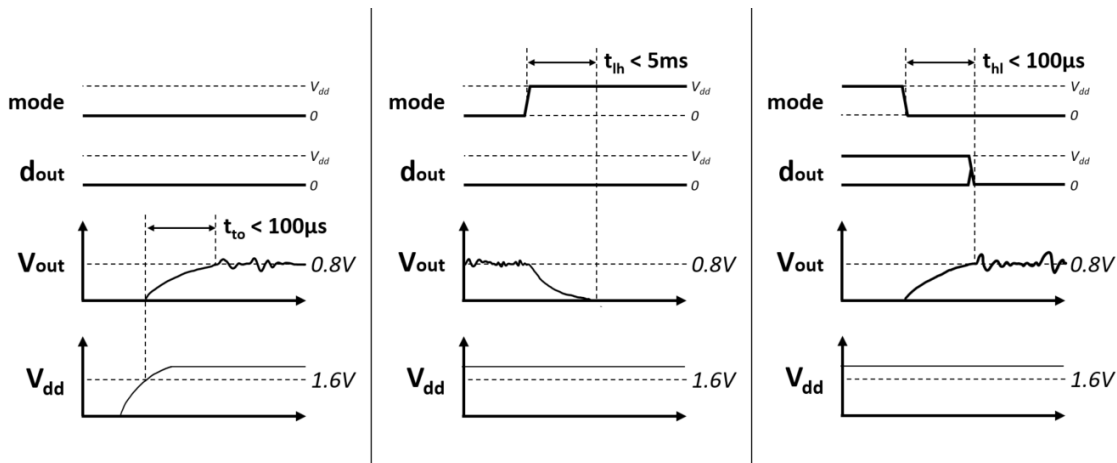

Figure 2: Timing diagrams showing turn-on time (left), transition time into *Wake on Sound* mode (center) & *Normal* mode (right)

It is recommend to power up the microphone in *Normal* mode (*mode* pin low), and then enter into *WoS* mode as needed.

Product Revision Technical Update

The PMM-3738-VM1010-R has been updated with a wider Wake on Sound range, on parts date code 1811 and higher, giving designers more configurability in the acoustic threshold and allowing for ZeroPower Listening to be used in more applications. Previously, this range was from 65 to 78 dB SPL. On parts date code 1811 and higher, this range has been extended from 65 dB to 89 dB SPL. To accommodate this change, users simply need to change the Rg (GA1 to GA21 external resistor) value. See the table below for the value of Rg to use to configure the turn-on threshold.

Threshold (dB SPL)	Old (Obsolete) Rg: Date Code 1810 or Lower	Current Rg: Date Code 1811 or Higher
65	100kΩ	18kΩ
68	150kΩ	32kΩ
72	300kΩ	50kΩ
78	Open	100kΩ
84		300kΩ
89		Open

System Architecture
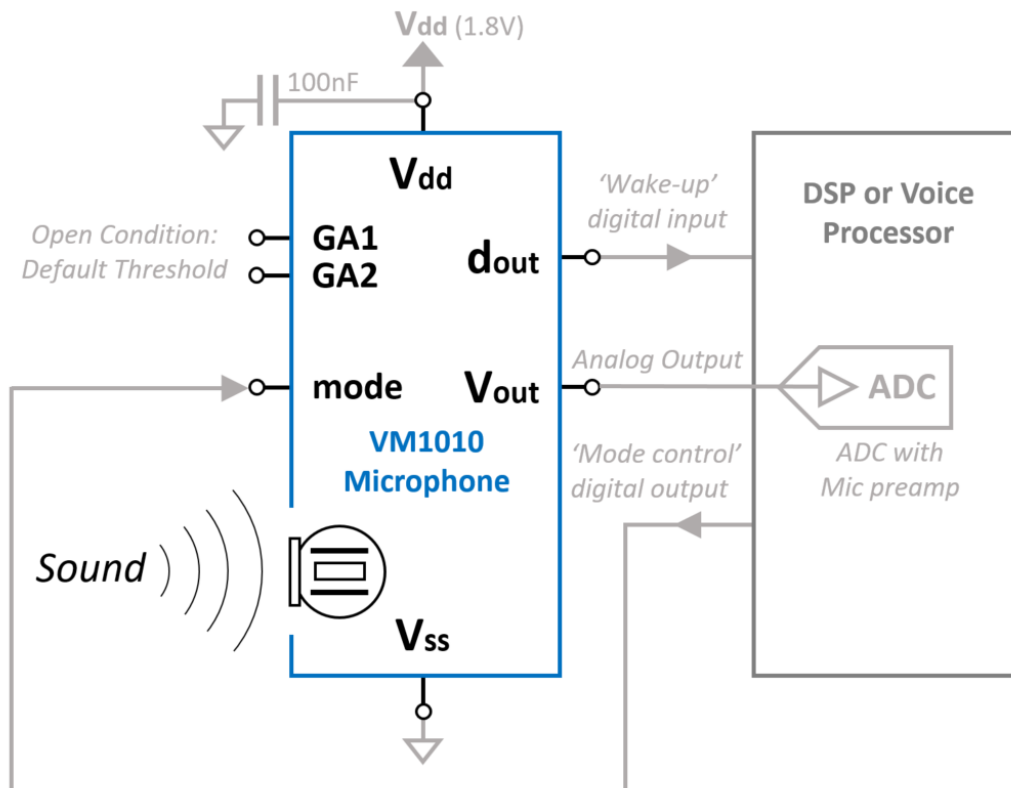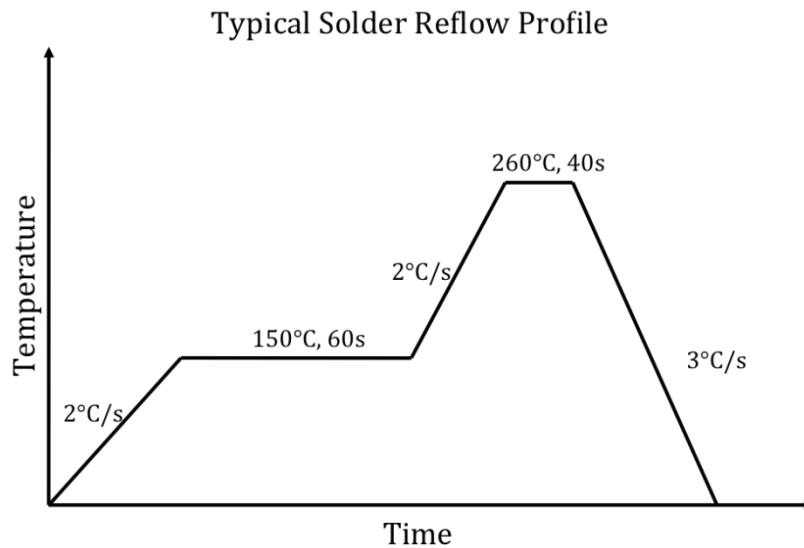
    A. Control loop for *Wake-on-Sound*:

Figure 3: Block diagram of example system built around the PMM-3738-VM1010- R microphone

In the figure above, the PMM-3738-VM1010-R wakes the system when triggered by sound. The DSP or Voice Processor can be kept in low-power state when there is no sound to process.

Solder Reflow Profile

Typical Solder Reflow Profile

Temperature (y-axis) vs Time (x-axis)

- 2°C/s (initial ramp up)
- 150°C, 60s
- 2°C/s
- 260°C, 40s
- 3°C/s

Handling Instructions

PUI Audio's piezoelectric MEMS microphones are very robust 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 help to 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 robust 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
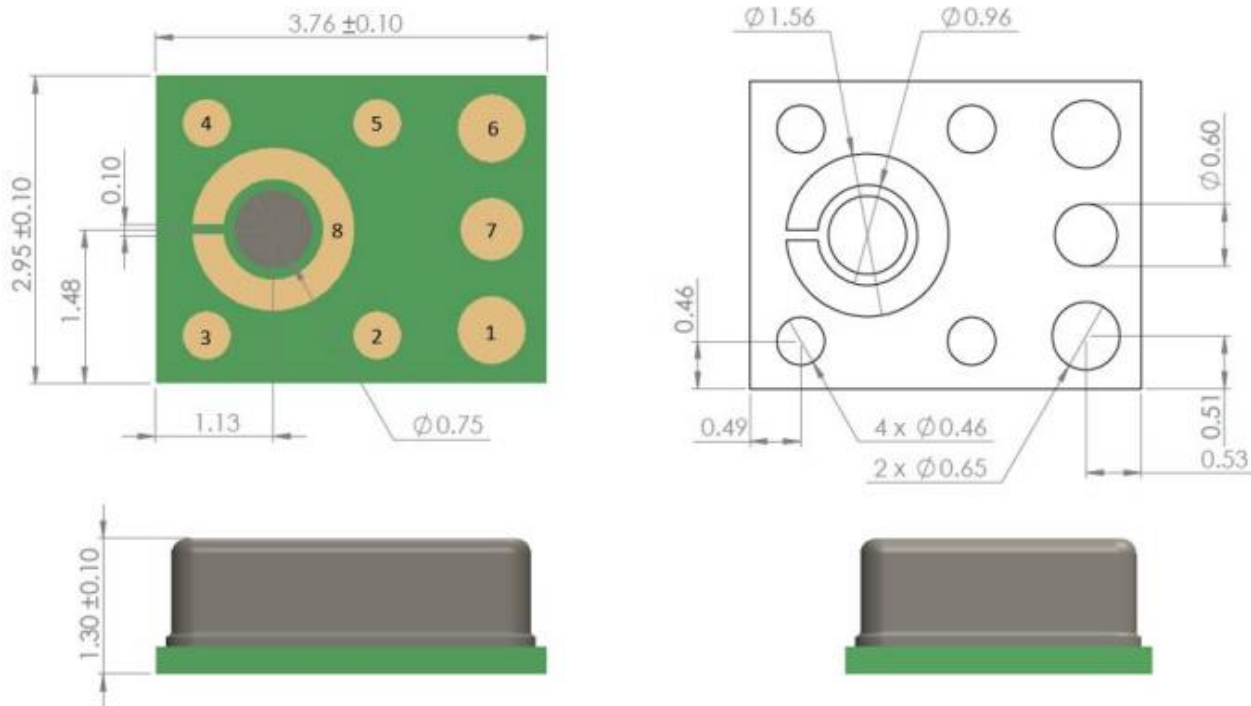
Pin Number	Pin Name	Description
1	V$_{out}$	Analog Output Voltage
2	GA2	Wake-on-Sound Acoustic Threshold Adjust pin 2
3	GA1	Wake-on-Sound Acoustic Threshold Adjust pin 1
4	GND	Ground
5	mode	Mode control *(hi=Wake-on-Sound, lo=Normal-Power)*
6	V$_{dd}$	Power Supply *(1.6V to 3.6V)*
7	d$_{out}$	Digital output for Wake-on-Sound trigger
8	GND	Ground

PCB Land Pattern Layout (All dimensions are in millimeters)
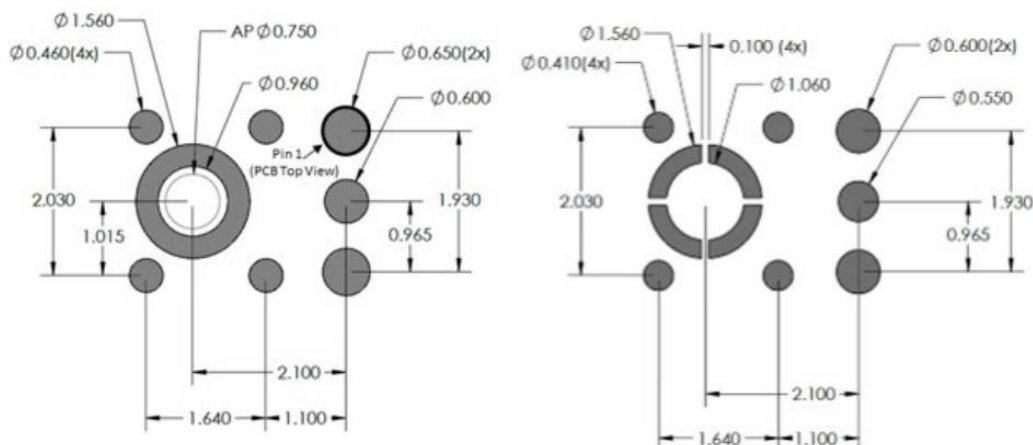
Specifications Revisions

Revision	Description	Date
Preliminary	Released from Engineering	6/1/2017
A	Revised Pin Numbers on Drawing	6/26/2017
B	Revised Dimensions on Pins 1, 2, 3, 4, 5, and 6	8/14/2017
C	Revised current draw, added storage temperature ratings, and added Product Revision Technical Update on page 5 regarding Wake on Sound range	5/23/2018
D	Revised dimensions	2/14/2020

Note:
1. All dimensions are in millimeters.
2. Specifications subject to change or withdrawal without notice.
3. This part is RoHS 2011/65/EU Compliant.