Open Acoustic Devices

µMoth 1.0.0 Datasheet

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This datasheet describes the µMoth (micro-moth) hardware, a micro sized development version of the acoustic monitoring device AudioMoth®. This document is intended for skilled users with suitable levels of design knowledge to integrate the development board into other boards or products.

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1 µMoth overview

µMoth is the micro-sized development version of the standard AudioMoth®. It uses a JST-PH connector for easy attachment to off-the-shelf 3.7V Li-Po batteries and standard pitch 2.54mm pads to expose useful peripherals for modular expansion.

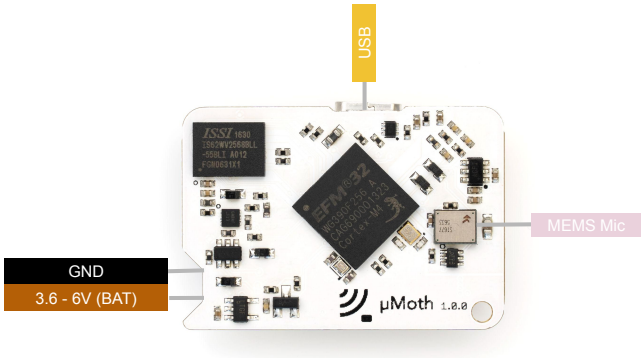

Figure 1: *Top layer of µMoth*

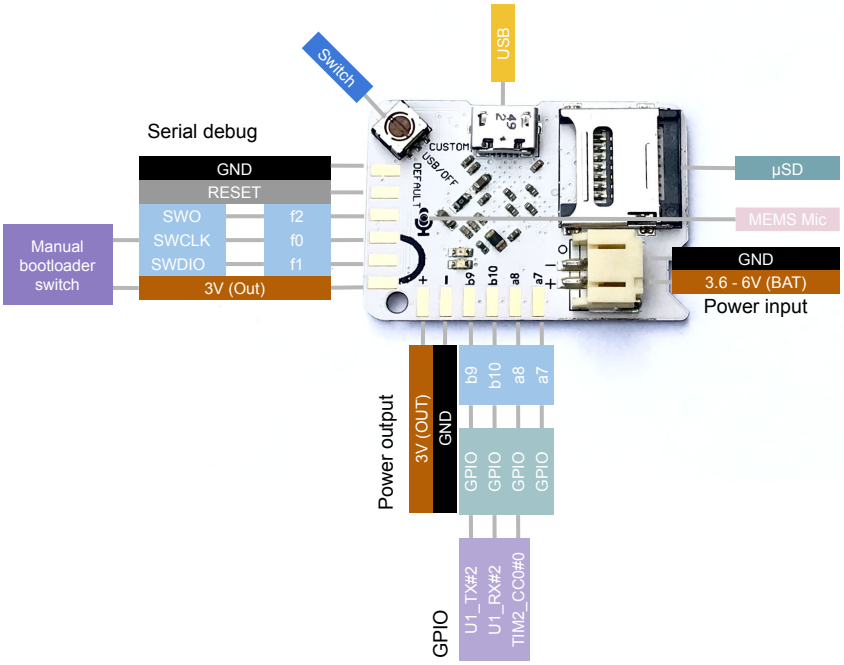

Figure 2: *Bottom layer of µMoth*

μMoth has the following features:

- Silicon Labs Wonder Gecko microcontroller
  - 48MHz 32-bit processor
  - DSP instruction support and floating-point unit
  - 256kB Flash
  - 32kB RAM plus an extra 256kB of external SRAM
  - For full details of the Wonder Gecko microcontroller please see the Wonder Gecko reference manual.
- On-board analog MEMS microphone, Sensitivity -18 dBV/Pa, 63 dBA SNR, 10Hz to 192kHz
- Sample rates up to 384kHz
- Micro-USB B port for power, configuration and for reprogramming the Flash
- 2-pin JST-PH header for connecting external power supplies (3.6V to 6V)
- 6-pin 2.54mm pitch header for multi-function 3V General Purpose I/O (GPIO)
- 6-pin 2.54mm pitch serial wire debug port
- MicroSD card connector compatible with up to 1TB capacity

μMoth is powered by an ultra low power (ULP) Silicon Labs EFM32WG390F256 ARM Cortex-M4F 32-bit micro-controller, chosen for its large number of in-built features and ULP consumption (211 μA/MHz in run mode and 20 nA/MHz in shutoff mode). The overall hardware utilises features such as cascaded operational amplifiers for microphone pre-amplification, 12-bit ADC with 16-bit oversampling, DMA for data routing in low energy modes, SPI for high-speed MicroSD card communications and USB for device configuration. DMA routing uses the additional feature of the external bus interface (EBI) to synchronise with an external IS62WV2568BLL-55BLI 4-Mbit static random access memory (SRAM) IC to improve on the internal 32-kB RAM for audio buffering.

μMoth can be configured to record at many sample rates, making it suitable for monitoring sounds from different source types. These include: anthropogenic noise, such as gunshots, chainsaws or engine noise (8 kHz sample rate); audible wildlife, such as bird, insect or frog vocalisation (48 kHz sample rate); and ultrasonic wildlife, such as bat or amphibian calls (384 kHz sample rate). The device can be used in multiple deployment scenarios, such as scheduled or triggered acoustic monitoring in remote areas, animal-borne acoustic monitoring, large-scale acoustic monitoring projects, long-term acoustic monitoring projects, environmental monitoring for education, and large scale citizen science projects.

All usable IO pins are exposed on the bottom layer of the μMoth board (See Figure 2). The main usable GPIO pins of the microcontroller are exposed on the bottom 6-pin edge connector pads. 3V is supplied on the right two pads. These can be used to communicate with other boards. μMoth uses a 3V regulator, which can run from a wide range of input voltages (3.6V to 6V). A 2-pin JST-PH header is exposed on the right for power input. This allows flexibility in powering the unit from various sources such as a single Lithium-Ion cell, 3 AA cells in series or a 6V lantern battery. Configuring and reprogramming μMoth can be done using USB and the AudioMoth Configuration App and AudioMoth Flash App desktop apps, respectively. For debug and trace, six pads are exposed on the left side of the PCB and configured to standard J-Link serial wire output (SWO). Serial debug and trace use the standard Silicon Labs tool, Simplicity Studio.

The top layer of the board is used to attach the device to a case, either by adhesion or with the 2mm drill hole, which is located on the bottom right corner of the PCB (See Figure 1).

2 Mechanical Specification

µMoth consists of a single SD card sized (36 x 25 x 5 mm) PCB, which includes a flat headed screwdriver rotary 3-way switch, USB port, red & green light emitting diode (LED) and MicroSD card port. The acoustic sensor is located inside the silkscreened microphone symbol on the bottom PCB layer. Behind the drill hole sits a bottom ported Knowles MEMS microphone. Figure 3 shows the mechanical drawing of µMoth, which is designed to be used for device expansion and integration into other boards or products, such as external modules or enclosures to support alternate battery supplies. The board has a 2-pin JST-PH connector for power attachment and hence it is compatible with off-the-shelf JST-PH battery assemblies from well known distributors.

Figure 3: *Mechanical drawing of µMoth showing dimensions in milimeters*

3 Maximum Ratings

Maximum operating conditions for the µMoth are:

- Operating Temp Max 85°C
- Operating Temp Min -40°C
- 3.6V minimum input voltage
- 6V maximum input voltage
- 3V maximum output voltage
- Maximum 100mA output current

4 Electrical Specification

TEST CONDITIONS: temperature 23±2°C, running AudioMoth Firmware Basic version 1.5.0.

Parameter	Conditions	Min	Typ	Max	Units
Supply voltage		3.3	4.1	6	V
Supply current	Energy Mode 0, no SD card operation	19	21	23	mA
	Energy Mode 1, no SD card operation	8	10	12	mA
	Average current during SD card write	21	33	44	mA
	Sleep current, no external mic	-	65	-	μA
MEMS mic specifications					
Sensitivity	94 dB SPL @ 1 kHz	-21	-18	-15	dBV/Pa
Signal to Noise Ratio	94 dB SPL @ 1 kHz, A-weighted	-	63	-	dB(A)
External mic socket	for electret condenser mics				
Supply voltage	-	-	3	-	V
Pre-amplification					
Variable gain	AudioMoth Configuration App low, mid and high gain. 20×log (Audio output voltage / Audio input voltage).	27.2	30.6	32.0	dB
Storage					
MicroSD card	Formatted to exFAT	-	32	1000	GB
Power to external boards					
Supply voltage		-	3	-	V
Supply Current	Current available to external boards when μMoth is writing to SD card, in Energy Mode 0 and when asleep	40	50	99	mA

5 Applications Information

5.1 Connecting a power supply

As there are no recognised standards for the polarity of JST-PH wire assemblies used for battery connections, care must be taken to check correct orientation before connecting batteries to µMoth. Red should line up with the '+' silkscreen and black the '-' silkscreen (Figure 4).

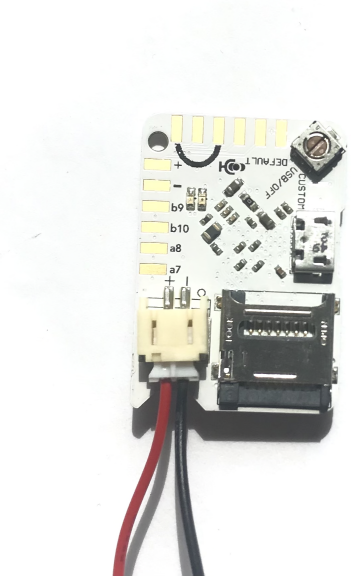

Figure 4: *Wiring of power input*

5.1.1 Advanced power capabilities

µMoth can also be powered directly by batteries up to 20V; however, the 3V regulator on µMoth will experience high temperatures, possibly causing irreversible damage to the device. The temperatures need to be accounted for when using larger batteries (Table 1). Power sources over 6V should only be used by advanced users. The power dissipated by the device is equal to:

$$P = I_{OUT(MAX)}(V_{IN} - V_{OUT}) + I_{GND}(V_{IN})$$

The regulator temperature rise is approximately equal to:

$$T = P(150°C/W)$$

The maximum regulator temperature will be equal to the regulator temperature rise above ambient plus the maximum ambient temperature.

Battery voltage (V)	Temperature above ambient (°C)
6	17.1
8	29.4
10	41.7
12	54.0
14	66.3
16	78.6
18	90.9
20	103.2

Table 1: *Temperatures above ambient that can be reached when recording to SD card with >6V batteries*

5.2 Connecting an external board

External boards can be powered by the two bottom left pads on the 6-pin edge header (Figure 2). μMoth supplies a regulated 3V supply with a maximum of 100mA current. Approximately 40mA of this current should be reserved for use by μMoth, leaving 60mA available to the external board.

As well as power, the 6-pin edge header can be used to communicate with other boards. It exposes four GPIO pins that directly connect to the microcontroller. These pins can be controlled in any number of ways using custom AudioMoth firmware. The pins available include b9 (GPIO and UART TX), b10 (GPIO and UART RX), a8 (GPIO and Timer compare capture pin) and a7 (GPIO).