Open Acoustic Devices

AudioMoth Dev 1.0.1 Datasheet

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30th October 2023

This datasheet describes the AudioMoth Dev hardware, a 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.

Contents

1 AudioMoth Dev overview

AudioMoth Dev is the development version of the standard AudioMoth, which uses JST-PH headers to expose useful peripherals for modular expansion.

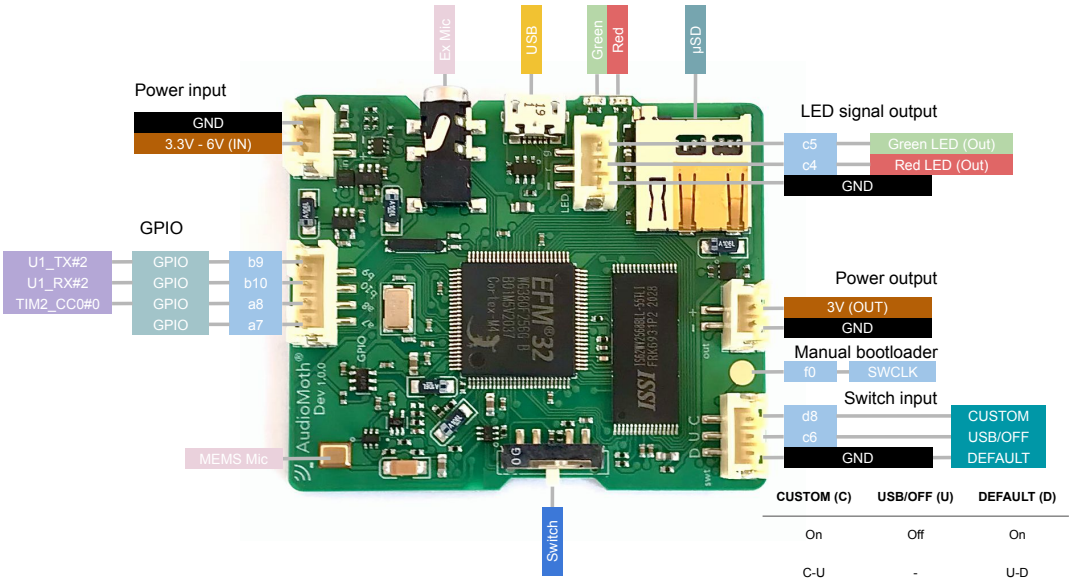

Figure 1: *Top layer of AudioMoth Dev*

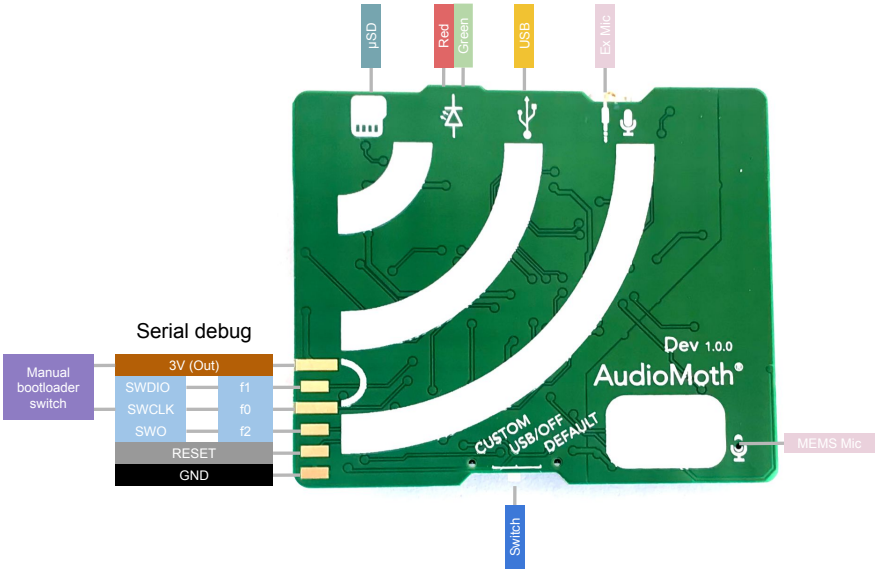

Figure 2: *Bottom layer of AudioMoth Dev*

AudioMoth Dev is an acoustic monitoring development platform, with 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 (SPU0410LR5H-QB), Sensitivity -38 dBV/Pa, 63 dBA SNR, 10Hz to 192kHz
- Sample rates up to 384kHz
- 3.5 mm jack socket for external electret condenser microphones
- Micro-USB B port for power, configuration and for reprogramming the Flash
- 5 separate JST-PH style headers for board-board/board-case integration
  - 2pin JST-PH header for connecting external power supplies (3.3V to 6V)
  - 2pin JST-PH header for powering external 3V boards or products from AudioMoth Dev
  - 3pin JST-PH header for external red and green LED's
  - 3pin JST-PH header for an external switch
  - 4pin JST-PH header for multi-function 3V General Purpose I/O (GPIO)
- 6-pin serial wire debug port
- MicroSD card connector compatible with up to 1TB capacity
- Daily clock drfit of ±0.89 seconds

AudioMoth Dev is powered by an ultra low power (ULP) Silicon Labs EFM32WG380F256 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 IS61LV25616AL4 4-Mbit static random access memory (SRAM) IC to improve on the internal 32-kB RAM for audio buffering.

AudioMoth Dev 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, handheld 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 top layer of the AudioMoth Dev board (See Figure 1). The main usable GPIO pins of the microcontroller are exposed on the left 4-pin JST-PH header. These can be used to communicate with other boards. External red and green LEDs can be driven by the 3-pin JST-PH header in the middle of the board. AudioMoth Dev uses two 3V regulators. One used for digital circuitry and one for analog circuitry. These regulators can run from a wide range of input voltages (3.3V to 6V). A 2-pin JST-PH header is exposed on the left for this 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. Sourced from the digital regulator, 3V can also be supplied using the other 2-pin JST-PH header, which is exposed on the right side of the board.

Configuring and reprogramming AudioMoth Dev can be done using USB and the AudioMoth Configuration App and AudioMoth Flash App desktop apps, respectively. Once configured settings are persistent. However, time is lost whenever the device loses power. To redeploy the device after power loss, the time can be set using the smartphone AudioMoth Chime App and the desktop AudioMoth Time App.

The bottom layer of the board displays the user interface, showing peripheral locations with white silkscreen labels (See Figure 2). For debug and trace, six pads are exposed and configured to standard J-Link serial wire output (SWO). Serial debug and trace use the standard Silicon Labs tool, Simplicity Studio.

2 Mechanical Specification

Figure 3: *Mechanical drawing of AudioMoth Dev showing dimensions in milimeters*

AudioMoth Dev consists of a single credit-card sized (58 x 48 x 8 mm) PCB, which includes a side-mounted switch, USB port, red & green light emitting diode (LED), 3.5 mm jack socket and MicroSD card port. The acoustic sensor is located inside the silk-screened 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 AudioMoth Dev, 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 various JST-PH connectors to access individual peripherals and hence it is compatible with off-the-shelf JST-PH wire assemblies from well known distributors.

3 Maximum Ratings

Maximum operating conditions for the AudioMoth Dev 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 1.8.2.

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	20	33	60	mA
	Sleep current, no external mic	-	65	-	μA
Internal microphone	Knowles SPU0410LR5H-QB				
Sensitivity	94 dB SPL @ 1 kHz	-41	-38	-35	dBV/Pa
Signal to Noise Ratio	94 dB SPL @ 1 kHz, A-weighted	-	63	-	dB(A)
External mic socket	Electret condenser mics only				
Supply voltage	2.7kΩ bias resistance	-	3	-	V
Pre-amplification					
Standard gain range	AudioMoth Configuration App low, mid and high gain	4.33	15.00	30.00	A_V
Low gain range	AudioMoth Configuration App low, mid and high gain with low gain range selected	0.33	1.00	2.00	A_V
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 AudioMoth Dev is writing to SD card, in Energy Mode 0 and when asleep	-	50	-	mA
Clock					
Daily time drift	±20ppm	-	±0.89	-	s

5 Applications Information

5.1 Connecting a power supply

Care must be taken to check the wires are correctly orientated when connecting batteries to AudioMoth Dev. Most RC standard JST-PH wire assemblies can be used. Red should line up with the '+' silkscreen and black the '-' silkscreen (Figure 4).

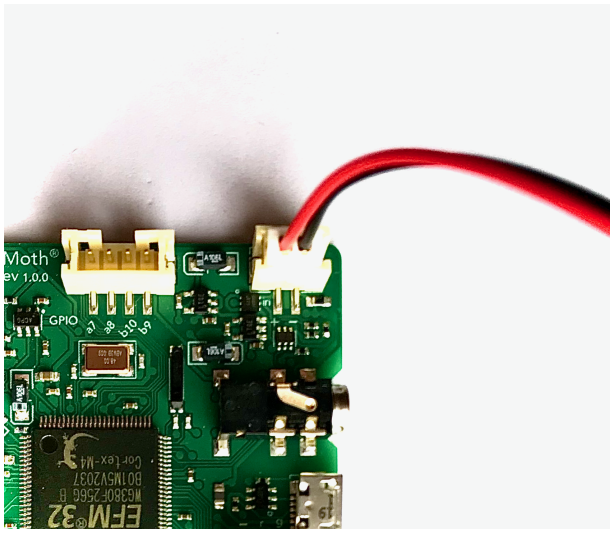

Figure 4: *Wiring of power input*

5.1.1 Advanced power capabilities

AudioMoth Dev can also be powered directly by batteries up to 20V; however, the 3V regulator on AudioMoth Dev 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
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 External microphone Compatibility

AudioMoth Dev is compatible with plug-in power electret condenser mics. For a detailed guide see the 'Using AudioMoth with External Electret Condenser Microphones' application note.

5.3 Connecting an external switch

The bottom right edge JST-PH header can be used to connect an external 3-way switch to AudioMoth Dev (Figure 1). When using an external switch the on-board switch must be in the USB/OFF position. The switch is configured as ON-OFF-ON, where OFF is the middle position (U) (Table 2).

CUSTOM (C)	USB/OFF (U)	DEFAULT (D)
On	Off	On
C-U	-	U-D

Table 2: *External 3-way switch configuration. NOTE: The on-board switch must be in the USB/OFF position*

5.4 Adding External LEDs

The middle 3-pin JST-PH header exposes the driving pins that allow external LEDs to be used. These are useful to show LED events on enclosures. The pins expose the red LED signal, the green LED signal and ground '-'. The LED signals are driven at 3V and will need external circuitry with tuned resistor values to account for varying LED brightness.

5.5 Connecting an external board

External boards can be powered by the 2-pin JST-PH header on the middle right edge of the AudioMoth Dev board (Figure 1). AudioMoth Dev supplies a regulated 3V supply with a maximum of 100mA current. Approximately 40mA of this current should be reserved for use by AudioMoth Dev, leaving 60mA available to the external board.

As well as power, the 4-pin JST-PH header on the left edge of AudioMoth Dev can be used to communicate with other boards. The 4-pin JST-PH header 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).

6 Hardware version changes

Version 1.0.1 (Current)

- Replaced 3.5mm socket component

Version 1.0.0

- Initial version