

# AudioMoth

A low-cost, open-source acoustic logger for biodiversity and environmental monitoring  
From Open Acoustic Devices

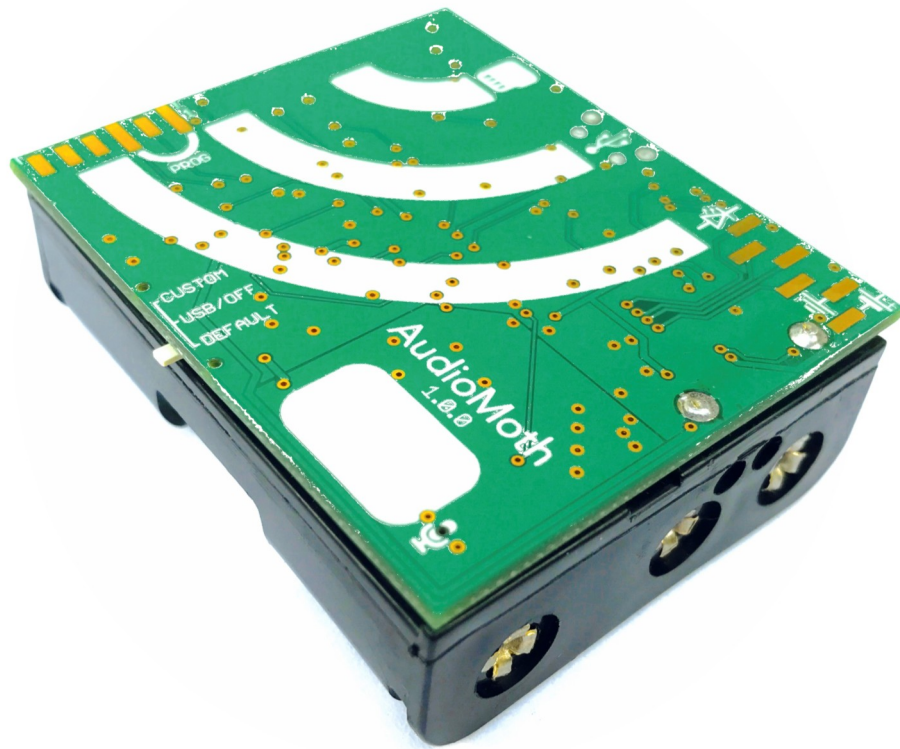


[www.openacousticdevices.info](http://www.openacousticdevices.info)

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# About

AudioMoth is a low-cost, full-spectrum acoustic logger, based on the Silicon Labs Gecko processor range. Just like its namesake, AudioMoth can listen for sound from audible frequencies, well into ultrasonic frequencies. It is capable of recording uncompressed audio to micro SD card from 8,000 samples per seconds to 384,000 samples per second.



- EFM32 Gecko processor
- Capable of recording at sample rates up to 192kHz
- Experimental mode at 384kHz
- Records uncompressed WAV files to SD card
- Powered by 3 x AA batteries
- Analog MEMS microphone
- Analog pre-amplifier with adjustable gain
- Measures just 58 x 48 x 15 mm
- Configurable USB interface
- Onboard real-time clock keeps track of time in UTC

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# Initial Setup

To use your AudioMoth you must first purchase appropriate batteries and microSD card for your deployment. SD cards must be re-formatted to MS-DOS (FAT32) before use.

## SD cards



For recording at sample rates between 16kHz and 48kHz, a microSD card with a speed class of 10 or greater is required to make sure the cards keep up with the device.

For recording at sample rates greater than 192kHz, a microSD card with a speed class of U3 or greater is required to make sure the cards keep up with the device.

The speed class should be marked on the card itself as well as mentioned in its product description.

SD cards must be re-formatted before use to MS-DOS (FAT32) and must have a memory capacity of 32GB or less.

Card	Speed specification	Max tested sample rate
Toshiba Exceria	UHS-I U3	96 kHz
Transcend microSDHC	UHS-I U1	96 kHz
Hama microSDHC	UHS-I U3	192 kHz
SanDisk Extreme PLUS	UHS-I U3	192 kHz
SanDisk Extreme	UHS-I U3	384 kHz

For high sample rate recording, we recommend the Sandisk Extreme UHS speed class 3 cards, available from Amazon and many other hardware suppliers.

We've tested these cards and are confident they produce satisfactory recordings up to 192kHz.

# Initial Setup

To use your AudioMoth you must first purchase appropriate batteries and microSD card for your deployment. SD cards must be re-formatted to MS-DOS (FAT32) before use.

## Batteries



The AudioMoth configuration app uses the given recording settings and periods to calculate the approximate energy consumption of the device each day in mAh.

On average, good quality alkaline AA batteries have a capacity of approximately 2600mAh, whereas equivalent lithium batteries have approximately 3600mAh.

Sample rate (kHz):	<input type="radio"/> 8	<input type="radio"/> 16	<input type="radio"/> 48	<input checked="" type="radio"/> 96	<input type="radio"/> 192	<input type="radio"/> 222
Gain:		<input type="radio"/> Low	<input type="radio"/>	<input checked="" type="radio"/> Mid	<input type="radio"/>	<input type="radio"/> High
Sleep duration (s):					<input type="text" value="5"/>	
Recording duration (s):					<input type="text" value="10"/>	

Each day this will produce 480 files, each of size 1875 kB, totalling 879 MB.  
Daily energy consumption will be approximately 16 mAh.

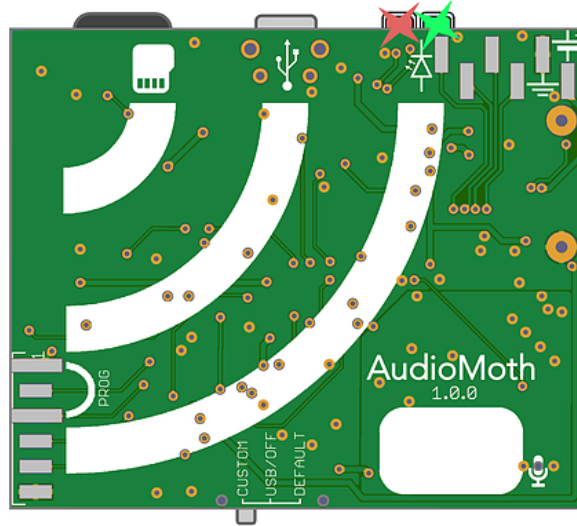
[Configure AudioMoth](#)

Due to the low power consumption of the AudioMoth in general, any AA battery is suitable for standard deployments.

For more intensive deployments involving long recordings or high sample rates, we advise using lithium batteries to maximise lifetime.

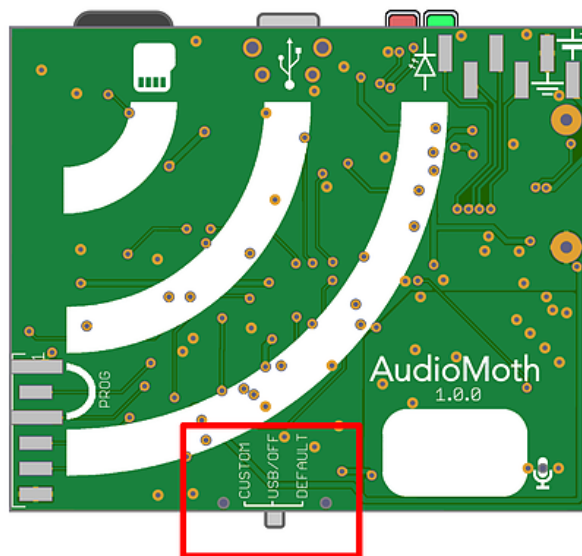
# Initial Setup

## Step 1



After purchasing the appropriate batteries and SD card, insert them into your device.

## Step 2



Set the switch on the side of the device to USB/OFF.

# Initial Setup

## Step 3

Download and install your platform's app.

[AudioMoth Configuration App on Open Acoustic Devices](#)

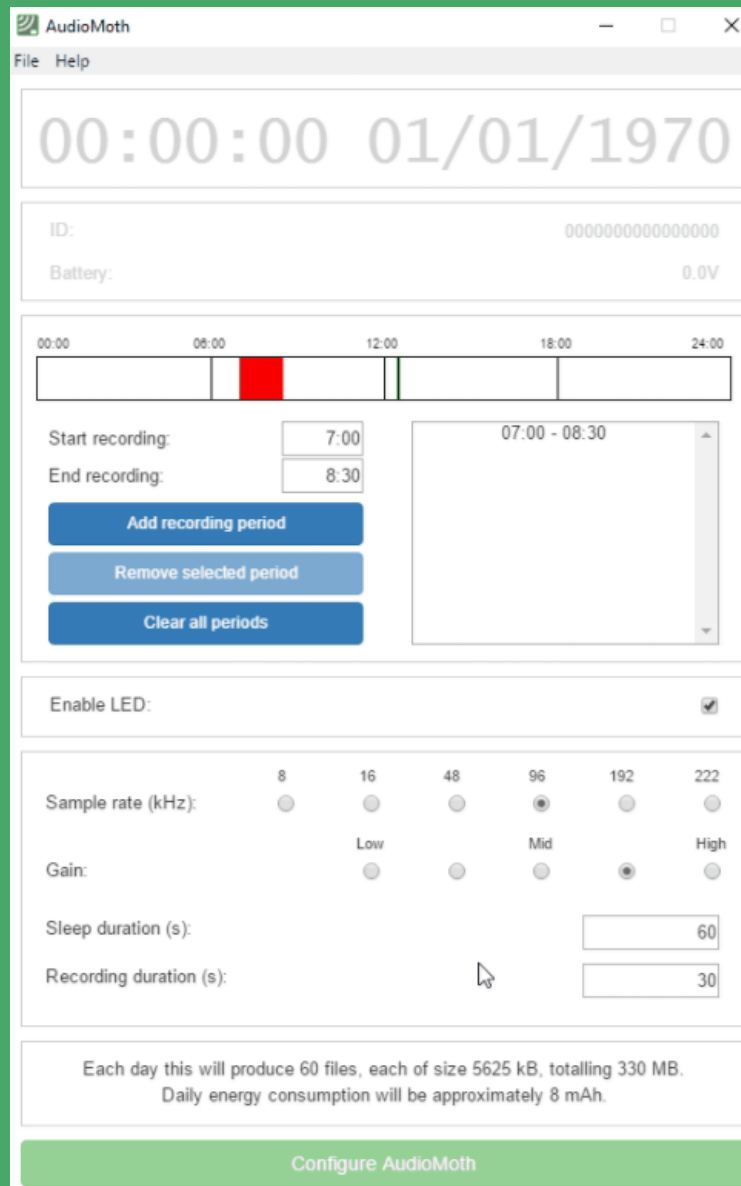
## Step 4

The screenshot shows the AudioMoth configuration application window. At the top, it displays a timer at 00:00:00 and a date of 01/01/1970. Below this, the ID is 0000000000000000 and the battery level is 0.0V. A timeline from 00:00 to 24:00 shows a red bar indicating a recording period from 07:00 to 08:30. The 'Start recording' field is set to 7:00 and the 'End recording' field is set to 8:30. There are three buttons: 'Add recording period' (highlighted with a mouse cursor), 'Remove selected period', and 'Clear all periods'. Below the buttons, there is a section for 'Enable LED' which is checked. The 'Sample rate (kHz)' is set to 48, and the 'Gain' is set to Mid. The 'Sleep duration (s)' is set to 5 and the 'Recording duration (s)' is set to 10. At the bottom, a green bar contains the text 'Configure AudioMoth'.

Enter up to 5 periods in which the device will record and then sleep repeatedly until the period is over.

# Initial Setup

## Step 5



The screenshot shows the AudioMoth configuration window. At the top, it displays the time 00:00:00 and the date 01/01/1970. Below this, the ID is 0000000000000000 and the battery level is 0.0V. A timeline from 00:00 to 24:00 shows a red bar indicating a recording period from 07:00 to 08:30. The 'Start recording' field is set to 7:00 and the 'End recording' field is set to 8:30. There are three buttons: 'Add recording period', 'Remove selected period', and 'Clear all periods'. The 'Enable LED' checkbox is checked. The 'Sample rate (kHz)' is set to 96, and the 'Gain' is set to High. The 'Sleep duration (s)' is 60 and the 'Recording duration (s)' is 30. At the bottom, a green button says 'Configure AudioMoth'. A text box at the bottom of the window states: 'Each day this will produce 60 files, each of size 5625 kB, totalling 330 MB. Daily energy consumption will be approximately 8 mAh.'

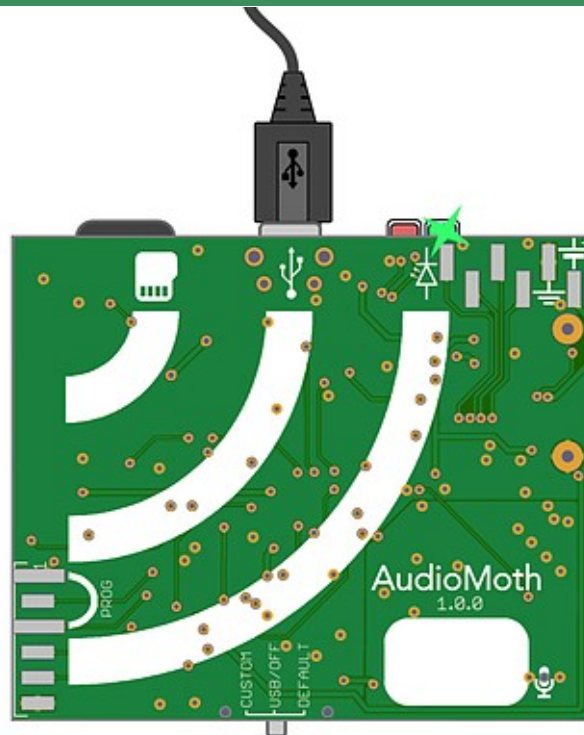
Set the sample rate, gain and length of the recordings you wish to collect.

The app will then calculate the energy and storage consumption of your configuration.



# Initial Setup

## Step 6

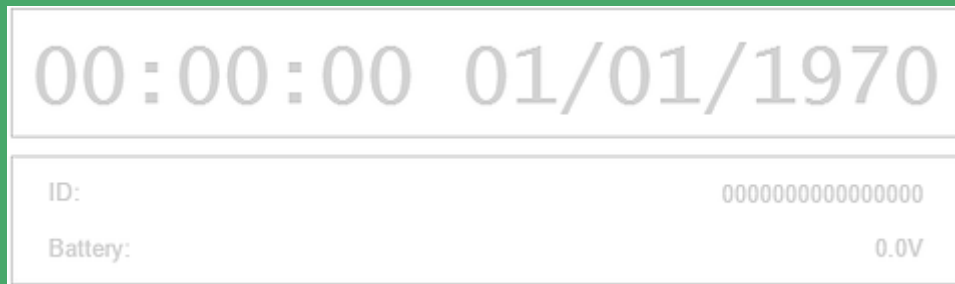


Set the switch on the side of your AudioMoth device to USB/OFF and attach it to your computer via USB.

Ensure the device has batteries inserted or the configuration will be lost when the device is disconnected and it loses power.

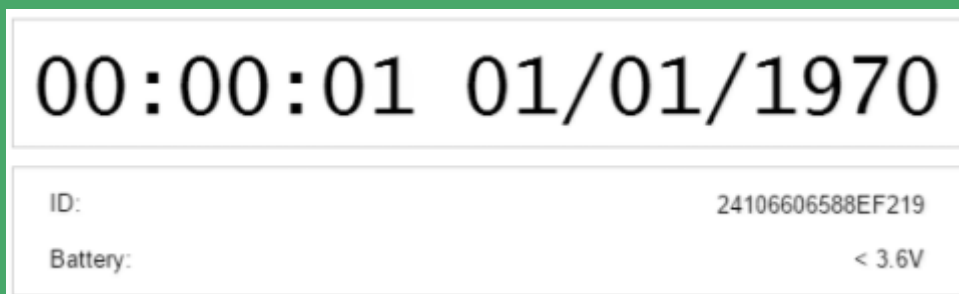
# Initial Setup

## Step 7



Without a successful connection to an AudioMoth device, the configuration app will display a greyed out time, ID and battery level.

When you have successfully connected to your AudioMoth, the device information will no longer be greyed out and the clock should tick upwards from 01/01/1970.



Each AudioMoth possesses an inbuilt clock, used to record at scheduled times and to name recording files.

As the clock cannot advance when the device is without battery power, a start time must be given.

Configuring your device will set the start time to your machine's current time in UTC.

Clock times are presented in UTC to remain consistent across timezones.

**Make sure this is done before each deployment.**

# Initial Setup

## Step 8



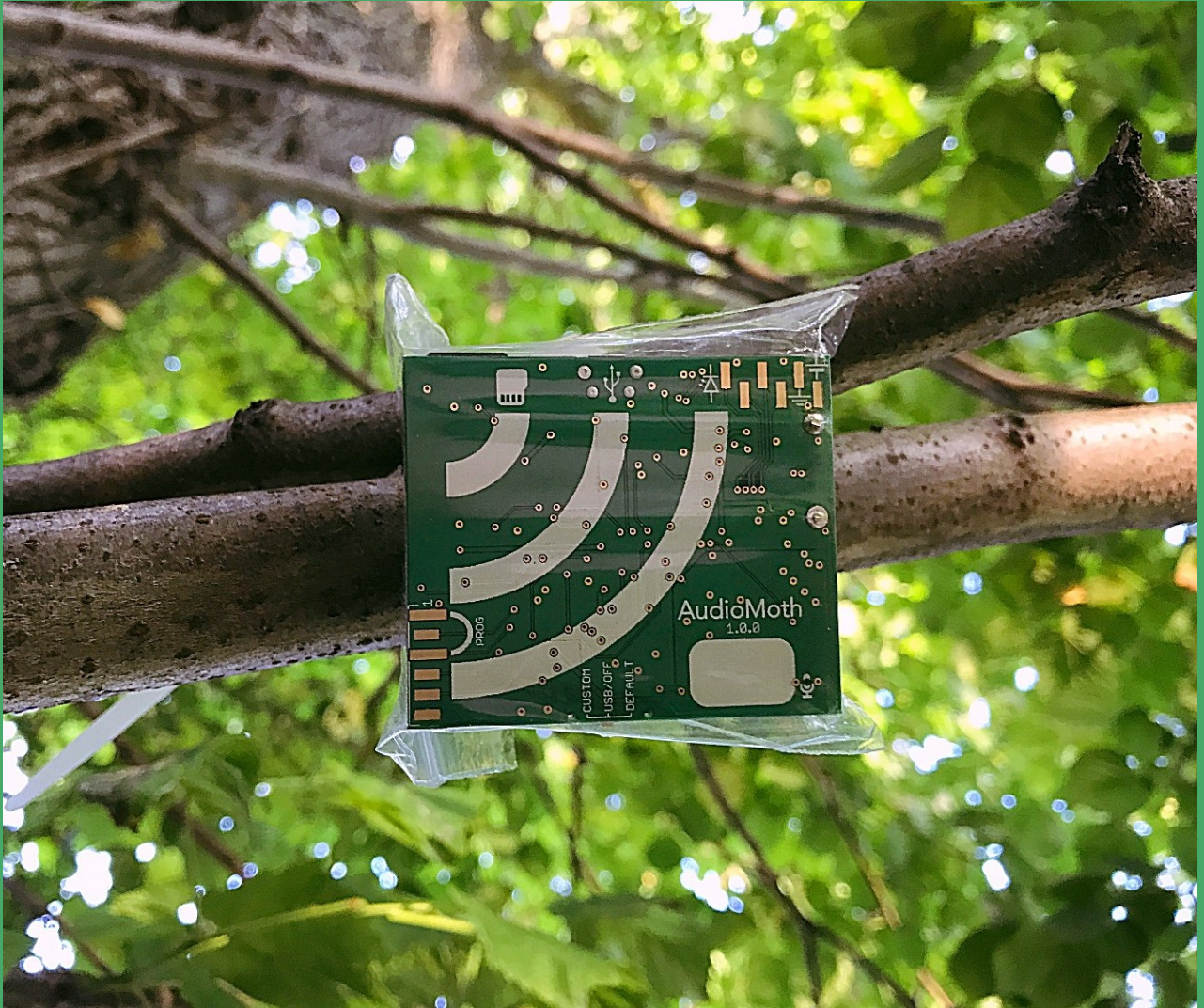
Once device is connected, the clock display should begin to update.

Click "Configure AudioMoth" to apply configuration.

Configurations can also be saved to distribute or for later use. Save or load a configuration from the File menu.

# Initial Setup

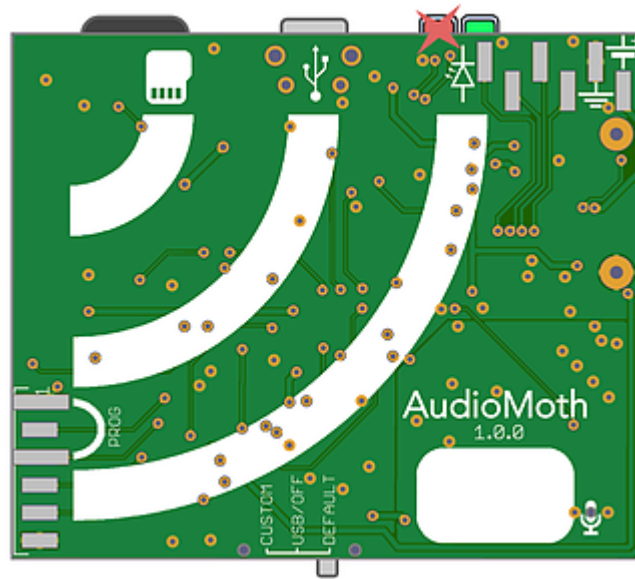
## Step 9



With the AudioMoth configured and the switch in the CUSTOM position the device can now be deployed in the field.

# Additional Functionality

## Recording on the fly



With switch set to DEFAULT AudioMoth will start recording immediately outside of the configured timing schedule, at either the \*default settings (if the device wasn't configured) or at the set sample rate, sleep length and record length configured.

Default settings:

*Sample rate: 48kHz*

*Sleep Duration: 0 seconds*

*Record Duration: 60 seconds*

# Flashing the firmware

## Step 1

Download the relevant Flash application and place executable in a new folder.

[AudioMoth Flash application](#)

If the file you download possesses an extension such as ".dms", rename the file and remove the extension before continuing.

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On Mac and Linux you must now set the permissions of the file.

To do this, open a terminal, navigate to the location of the flash file and run the following command:

```
chmod a+x flash
```

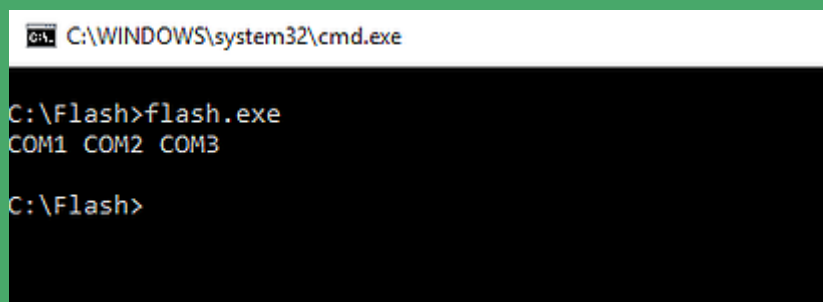
## Step 2

Download the latest firmware `.bin` or your own custom firmware and place in the same folder as the Flash executable.

[AudioMoth firmware releases](#)

# Flashing the firmware

## Step 3



```
C:\WINDOWS\system32\cmd.exe
C:\Flash>flash.exe
COM1 COM2 COM3
C:\Flash>
```

Open a command window in the created folder location.

Run the Flash executable by typing in the command window "flash.exe" for Windows OS or "./flash" for Linux and Mac OS.

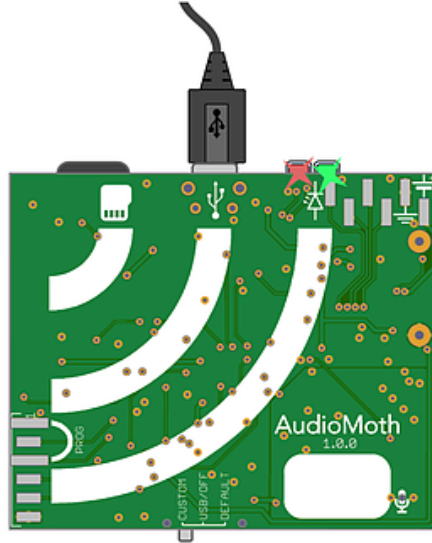
Running the flash executable displays a list of currently connected communicable devices.

The names of the ports will display as '/dev/tty.usbmodem14xx' on macOS and '/dev/ttyACMx' on Linux.

Do this first without your AudioMoth attached.

# Flashing the firmware

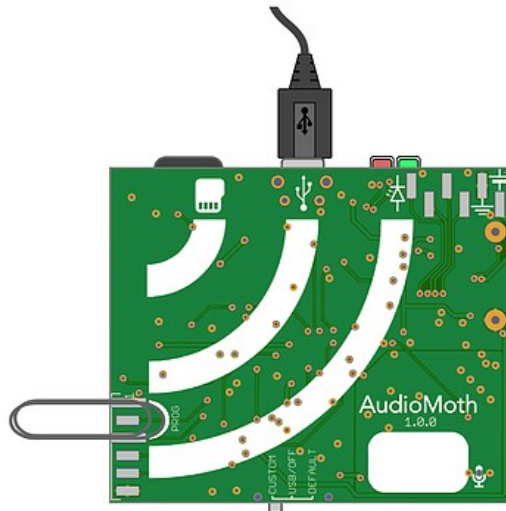
## Step 4



Set the switch on the side of your AudioMoth device to CUSTOM, remove the device's batteries and attach it to your computer via USB.

Both LEDs should start to flash.

## Step 5



To enable Programming mode on your device, use a standard paperclip to connect the two metal contacts marked "PROG".

If done correctly, the LEDs should stop flashing, which means the paperclip can now be removed.



# Flashing the firmware

## Step 6

```
C:\WINDOWS\system32\cmd.exe

C:\Flash>flash.exe
COM1 COM2 COM3

C:\Flash>
```

Open the command line and run the Flash executable once again.

Compare the list of ports to the previous list to find the name of the port which has opened since the AudioMoth was plugged in.

```
C:\WINDOWS\system32\cmd.exe

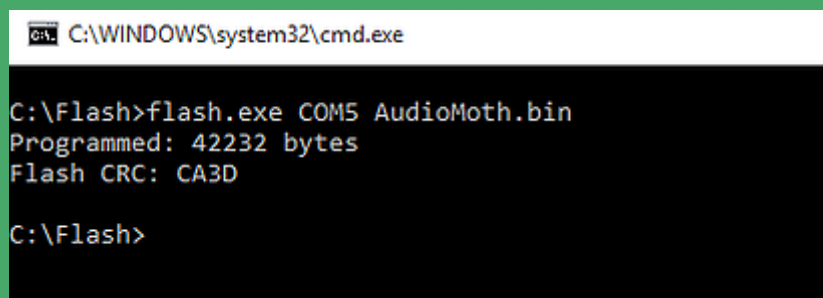
C:\Flash>flash.exe
COM5 COM1 COM2 COM3

C:\Flash>
```

In this case, the AudioMoth is using port COM5.

# Flashing the firmware

## Step 7



```
cmd C:\WINDOWS\system32\cmd.exe

C:\Flash>flash.exe COM5 AudioMoth.bin
Programmed: 42232 bytes
Flash CRC: CA3D

C:\Flash>
```

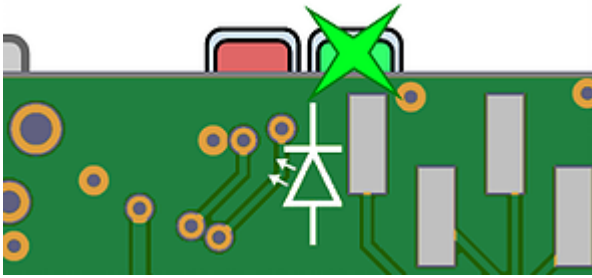
Run the Flash executable, providing the port name and the .bin file as arguments.

This should take a few seconds. Once the application has finished, verify the "Programmed" size and "Flash CRC" value match those given by the GitHub release.

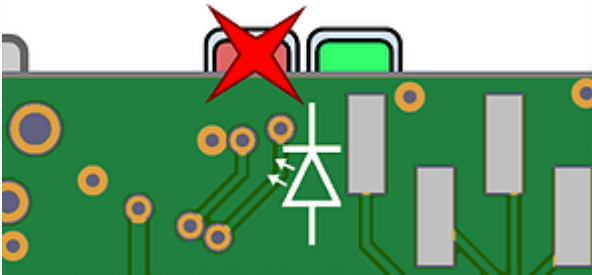
After 5 seconds the LED should start flashing again, and everything is ready to go.

# LED meanings

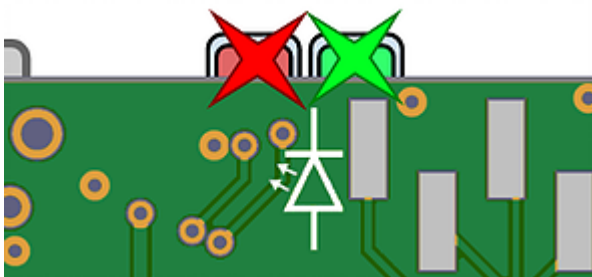
## With switch set to CUSTOM



Sleeping between recordings.



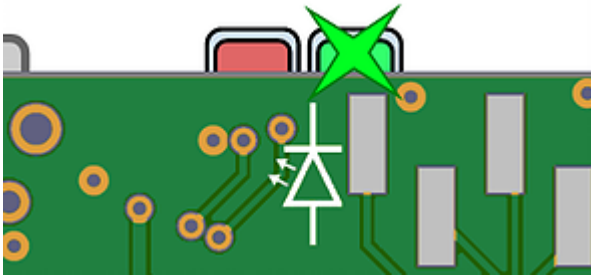
Recording.



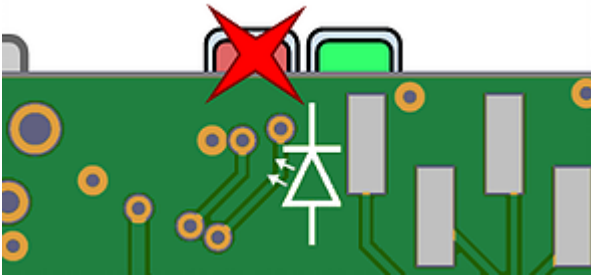
**Error**  
Either the time is not set or no recording periods set.

# LED meanings

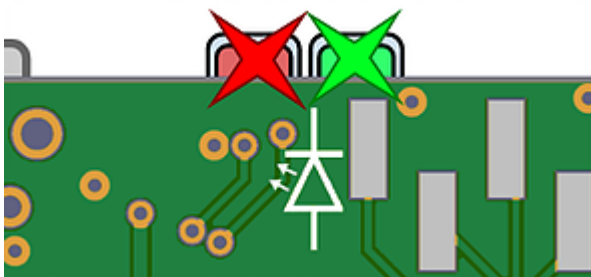
With switch set to DEFAULT



Sleeping between recordings.



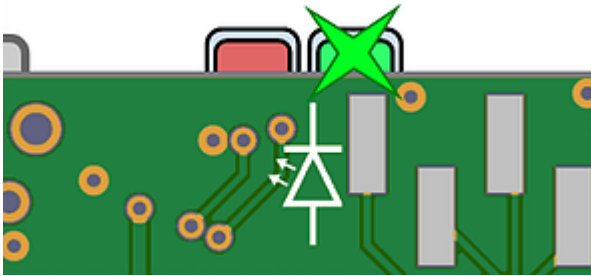
Recording.



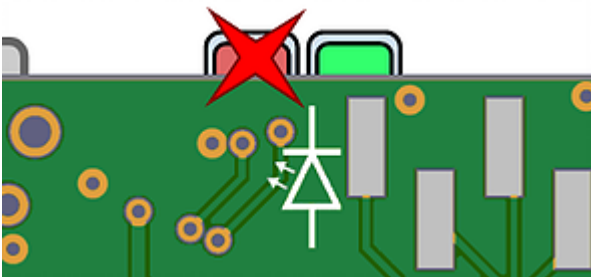
**Error**  
Cannot make recording. Check SD  
card is inserted correctly.

# LED meanings

With switch set to USB/OFF



Connected to USB.



## Battery level

4 flashes:	> 4.6 V
3 flashes:	> 4.4 V
2 flashes:	> 4.0 V
1 flash:	> 3.6 V
10+ flashes:	< 3.6 V

# Frequently asked questions

## How are AudioMoth recording files named?

In order to make opening files on the device as quick as possible, filenames are limited to 8 characters (longer file names are handled by maintaining a lookup table of filenames). These 8 characters are used to express the time of the recording as a UNIX timestamp (the number of seconds since the UNIX epoch at 0:00 01/01/1970) in hexadecimal.

For example, the file name "592D42A3.wav" can be converted from hexadecimal to decimal to produce the timestamp 1496138403. This timestamp in turn, can be converted to 30/05/2017 at 10:00.

You can either use this conversion process or simply use the "Date Modified" property for each file.

## Why does the configuration/timesetter app claim it's 01/01/1970?

AudioMoth possesses an inbuilt clock which ticks up every second from a start time. When an AudioMoth is configured using the app, the start time is matched with the computer clock. As it isn't possible to increment the clock when the device has no battery power, it defaults to the number of seconds since the UNIX epoch until it is set.

## How do I calculate the battery lifespan?

First check the capacity of the batteries being used (provided on the packaging in mAh). To calculate how many hours the batteries will last for, divide this battery capacity by the daily energy consumption given in the configuration app.

For example, Energiser Ultimate Lithium batteries possess a capacity of 3600mAh. With a daily energy consumption of 102mAh, three Energiser Lithium batteries should operate for  $3600 / 102 = 35$  days.

Each day this will produce 332 files, each of size 22 MB, totalling 7302 MB.  
Daily energy consumption will be approximately 102 mAh.

Configure AudioMoth

# AudioMoth team

[theteam@openacousticdevices.info](mailto:theteam@openacousticdevices.info)



**Alex Rogers**

Team Leader  
Professor  
Oxford University

[alex.rogers@cs.ox.ac.uk](mailto:alex.rogers@cs.ox.ac.uk)



**Andrew Hill**

Electronic Design  
PhD Researcher  
University of Southampton

[ah1u14@soton.ac.uk](mailto:ah1u14@soton.ac.uk)



**Peter Prince**

Algorithm and Software Design  
PhD Researcher  
University of Southampton

[pcp1g11@soton.ac.uk](mailto:pcp1g11@soton.ac.uk)

**Jake Snaddon**  
University of Southampton  
[j.l.snaddon@soton.ac.uk](mailto:j.l.snaddon@soton.ac.uk)

**Patrick Doncaster**  
University of Southampton  
[cpd@soton.ac.uk](mailto:cpd@soton.ac.uk)