



Introduction

The device (or “sensor package”) made available for this project is intended to facilitate data capture of five environmental variables (temperature, humidity, pressure, light, and motion) while abstracting away unimportant details about the underlying hardware. The device (54 x 54 x 12.5 mm, less the sensor modules) features a 2 inch LCD display, 1 power / reset button (found on the left-hand side), 3 contextual buttons (used to navigate the user interface), a micro SD card slot, three proprietary ports (used to connect to the sensor modules), and a USB-C port (which we will use to provide power).



Figure 1. User interface (home) - measurement preview

Upon start-up (or reset), the device will beep, flash a white light, and step-into the “home” screen. Press the red power button once to power on or to reset the device and twice to turn the device off (when unplugged). Note that the device will power cycle (*and interrupt data collection*) if a power source is lost and the device must switch to a battery-powered mode. The home screen presents the value of each metric alongside a standard unit:

- + Temperature, C
- + Humidity, %
- + Pressure, Pa
- + Light, dimensionless on a 12-bit (0-4095) scale
- + Motion, binary with a transient pulse response (~ 2 seconds)

A red cursor (>) on the left hand-side of the display denotes the row ready for selection. A description for the function of each contextual button can be found at the bottom of the screen. Red text just above the contextual button mapping will prompt the user to proceed or provide updates throughout the interface. An estimate of battery level (25, 50, 75, 100%) can be found in the top right-hand corner.



Figure 2. User interface (value / unit selection) - setting parameter values

To proceed with data collection, you'll need to first set each of 10 sampling parameters. For each metric, there are two values and two units you'll need to set:

1. Sample rate — values (1-99), units (seconds, minutes, hours)
2. Duration — values (1-99), units (seconds, minutes, hours)

Together, these settings for a single metric might prompt sampling to proceed once every 15 seconds for 3 hours (for example). To adjust each setting, you'll want to use the UP and DOWN buttons to select the metric of interest and toggle through the desired values / units. A press and hold option is available for selecting values. Neither setting will wrap at an extreme. Once a value and unit has been CONFIRMED, the device will return to the home screen. With all parameters set, the user can choose to start a new data collection session by selecting START.

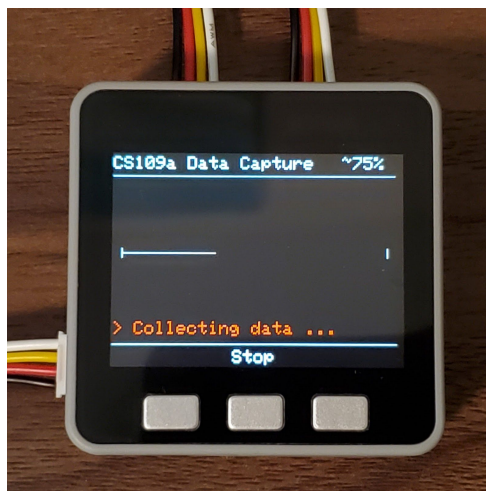


Figure 3. User interface (data collection) - progress bar

A progress bar is presented throughout data collection. The user can opt to STOP the session. In the event that a session is stopped, the data recorded will be preserved up until the minute within which the user opted to end data collection. An estimate of battery level (25, 50, 75, 100%) can be found in the top right-hand corner. Remember that the device will power cycle (*and interrupt data collection*) if a power source is lost and the device must switch to a battery-powered mode. For this reason, we recommend that the device be powered via the included 6' power cable.

Specifications

For context on the measurements the device returns, here are details for the sensor modules:

- + Temperature (port A) - DHT12, $-20 \sim 60\text{ }^{\circ}\text{C} \pm 0.2\text{ }^{\circ}\text{C}$
- + Humidity (A) - DHT12, $20 \sim 95\text{ \%RH} \pm 1\text{ \%RH}$
- + Pressure (A) - BMP280, $300 \sim 1100\text{ hPa} \pm 1\text{ hPa}$
- + Light (B) - cadmium sulfide photoresistor, dimensionless on a 12-bit (0-4095) scale
 - Photoconductive, non-linear, with non-uniform spectral response
- + Motion (C) - passive infrared detector, 150 cm over $< 100^{\circ}$, $\sim 2\text{ s}$ pulse

Parameter selection & time

It is important to note that parameter selection will **not** be saved once data collection has been started (including instances where a session is stopped). For each session, you will want to set and verify these parameters.

It will be important to take note of the **date** and **time** upon starting a session, since you will be expected to extrapolate timestamps for each observation from the sample rate you selected.

Data retrieval

Your data can be retrieved from the device using the provided micro SD card and card reader. While the card reader features a USB-A connector that may be incompatible with newer laptops, the Active Learning Labs can provide USB-C adaptors on request.

IMPORTANT — data will **not** be saved if the microSD card is **not** inserted into the device

Throughout data collection (every minute, more precisely), the device offloads data collected over the last sampling window (with length 1 minute) from its internal memory to the SD card. This is achieved by writing to / appending a series of comma delimited text files named:

CS109a_temperature.txt
CS109a_humidity.txt
CS109a_pressure.txt
CS109a_light.txt
CS109a_motion.txt

Frequently asked questions

1. Does the direction or orientation of the sensor modules matter?
 - + It is important to consider what you are trying to measure and how the mode of transduction for each sensor is (or is not) affected by orientation / placement.
2. There are five metrics, but only three sensors modules. What's missing?
 - + The sensors for temperature, humidity, and pressure are all contained within a single module with label "ENV" for environmental.
3. I am pressing the power button once (or twice), but the device isn't powering off.
 - + To power off the device, unplug the USB-C power cable (as applicable), wait for the device to restart (if previously plugged in), and press the red power button (found on the left-hand side) twice.
4. The device appears to be "dead." How can I charge it?
 - + Use the provided USB-C power cable and AC-DC wall adapter
5. Why does the battery power level jump from 25% (for example) to 100% immediately when I plug it in?
 - + The device may report a 100% level when plugged in, despite the actual battery level being lower. Unplug the device to see an approximation.
6. I've completed a data collection session, see files on the SD card, but one or more of the files is empty.
 - + If you select a sample rate that is longer than the duration (e.g., sample every 3 minutes for 1 minute), the length of data recorded will be nil.
7. I've attempted to insert the microSD card into the device, but it has become stuck.
 - + It is possible to insert the microSD card at an angle so that it enters the internals of the casing, rather than the intended socket. Refer to *troubleshooting*.

Troubleshooting

In the event that the device does not behave as you expect, please take a picture or video recording of the irregularity and send a brief description to the contact listed below. In many cases, restarting the device can help.

If the microSD card is inserted at an angle so that it enters the internals of the casing, rather than the intended socket, use an allen key to unfasten the back panel, a flathead screwdriver to pry the device open using the indentation just about the text “M5” on the right-hand side, and retrieve the card. In closing the device, you’ll want to take care to align the header pins / sockets that connect the two halves of the device.



Figure 4. SD card stuck within casing

Contact information

If you have technical questions about the device (rather than clerical questions about the project mechanics), feel free to reach out to J. Evan Smith, with contact information:

email - jesmith@seas.harvard.edu

subject line - CS109a Technical Support