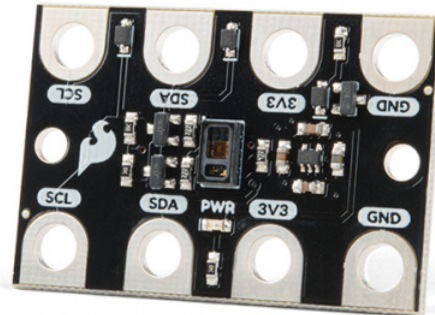


# SparkFun gator:particle Hookup Guide

## Introduction

Do you have an experiment involving biometrics or particle detection?



## SparkFun gator:particle - micro:bit Accessory Board © SEN-15271

The gator:particle is an amazing tool that uses a high-sensitivity pulse oximeter and heart-rate sensor, the MAX30102. Similar to the SparkFun Particle Sensor, with the MAX30105 high-sensitivity optical sensor, the gator:particle can also be used for particle detection. The primary difference between these boards is that the SparkFun Particle Sensor also uses a green LED that requires more power than the micro:bit can provide. This tutorial will show you how to get started using the gator:particle sensor with the gator:bit (v2) in the micro:bit development environment.

**Product Showcase: gator:boards - micro:bit Accessory Boards**



## Required Materials

To get started, you'll need a micro:bit to control everything.



SparkFun Inventor's Kit for micro:bit

🕒 KIT-14542



micro:bit Go Bundle

🕒 DEV-14336



micro:bit Board

🕒 DEV-14208

To easily use the gator board ecosystem, one of the gator:bit boards will help breakout the necessary pins. You will also need alligator cables to connect the gator:bit to the gator:particle.



SparkFun gator:bit v2.0 - micro:bit Carrier Board  
● DEV-15162



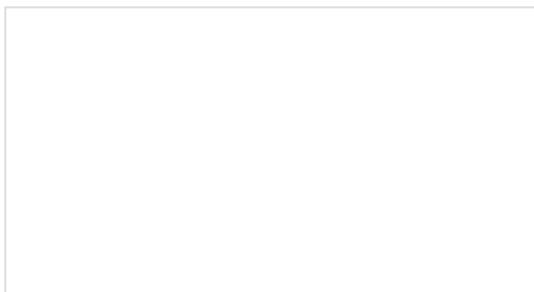
Alligator Test Leads - Multicolored (10 Pack)  
● PRT-12978



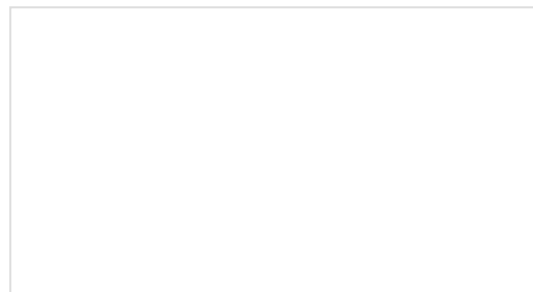
SparkFun gator:bit  
● DEV-14484

## Suggested Reading

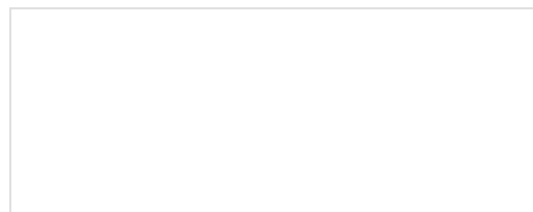
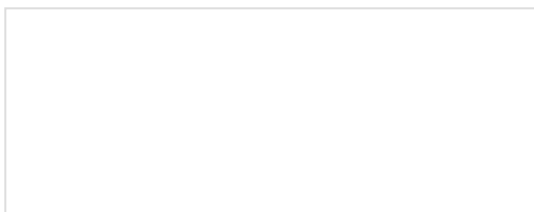
There isn't much to learning how to use the gator:particle sensor. However, you may find the following concepts useful along the way.



**Light**  
Light is a useful tool for the electrical engineer. Understanding how light relates to electronics is a fundamental skill for many projects.




**Logic Levels**  
Learn the difference between 3.3V and 5V devices and logic levels.





## I2C

An introduction to I2C, one of the main embedded communications protocols in use today.



## MAX30105 Particle and Pulse Ox Sensor Hookup Guide

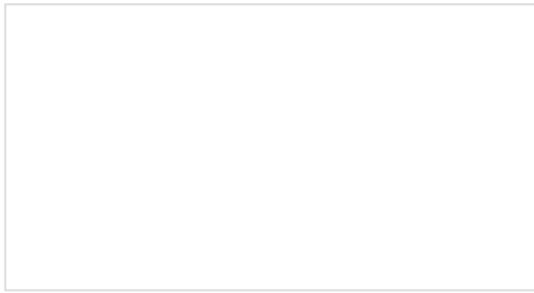
The SparkFun MAX30105 Particle Sensor is a flexible and powerful sensor enabling sensing of distance, heart rate, particle detection, even the blinking of an eye. Get ready. Set. Shine!

If you aren't familiar with the micro:bit, we recommend reading here for an overview.

### Product Showcase: micro:bit and SparkFun bits

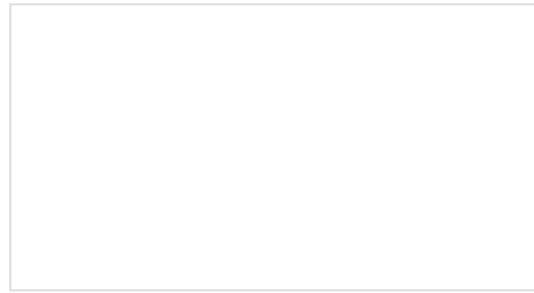


We would also recommend taking a look at the following tutorials if you aren't familiar with them.



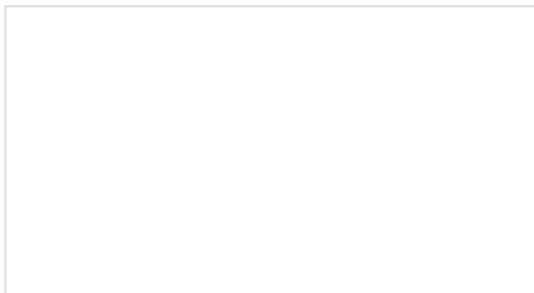
### Getting Started with the micro:bit

The BBC micro:bit is a compact, powerful programming tool that requires no software installation. Read on to learn how to use it YOUR way!



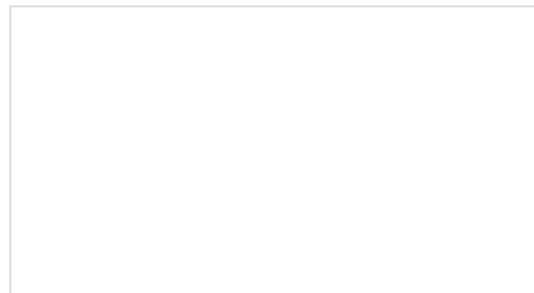
### Getting Started with MicroPython and the SparkFun Inventor's Kit for micro:bit

Learn MicroPython with the micro:bit.



### How to Load MicroPython on a Microcontroller Board

This tutorial will show you how to load the MicroPython interpreter onto a variety of development boards.



### SparkFun gator:bit v2 Hookup Guide

The gator:bit v2 is a breakout board for the BBC micro:bit. The gator:bit exposes almost every pin on the micro:bit to clippable pad with circuit protection. It also has as built-in addressable LEDs and a built-in buzzer.

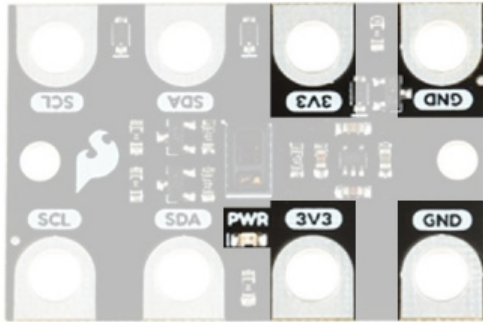
## Hardware Overview

The gator:particle consists of 4 pads for power and data.

Contacts	Direction	Description
GND	N/A	Ground: Reference voltage and ground loop.
3.3V	In	Power: Provides <b>3.3V</b> to board.
SDA	Bi-directional	Data: Data and commands are transmitted between the sensor and microcontroller.
SCL	In	Clock: The microcontroller provides the timing needed to communicate on the data line.

### Power

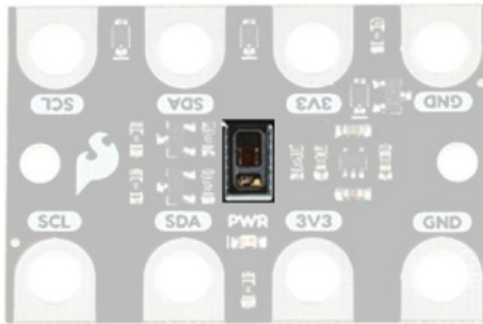
The specified operating voltage for the MAX30102 is between **1.7V - 2V**. For use with the gator:bit (v2) and micro:bit, you should provide **3.3V** through the **3V3** and **GND** pads to keep the logic levels consistent; the 3.3V input is then regulated to **1.8V** for the MAX30102.



*Power connection pads and power indication LED.*

## MAX30102

The MAX30102 is a high-sensitivity pulse oximeter and heart-rate sensor that communicates over an I<sup>2</sup>C bus. The MAX30102 uses both red and IR LEDs along with a very sensitive photodetector for pulse oximetry (SpO<sub>2</sub>), heart-rate (HR) monitoring, and particle (PM) detection. For the most part, users will only need to know I<sup>2</sup>C addresses to prevent address conflicts with other devices or sensors.



*MAX30102: HR and SpO<sub>2</sub> sensor.*

Here are some of the characteristics of the MAX30102 sensor from the datasheet:

Characteristic	Range
Operating Voltage	<b>1.8V to 2V</b>
Supply Current	Heart Rate and SpO <sub>2</sub> Mode: 600 to 1200 $\mu$ A IR Only Mode: 600 to 1200 $\mu$ A
Operating Temperature	-40°C to 85°C
( $\Sigma\Delta$ ) ADC	Resolution: 15 to 18-bits (programmable) Sampling Rate: 50 - 3200 sps (programmable)

IR LED	LED Wavelength: 870 to 900 nm (avg. 880 nm) Forward Voltage: 1.4V Radiant Power: 6.5 mW LED Driver Current: 0 to 50 mA (programmable)
Red LED	LED Wavelength: 650 to 670 nm (avg. 660 nm) Forward Voltage: 2.1V Radiant Power: 9.8 mW LED Driver Current: 0 to 50 mA (programmable)
Photodetector	Spectral Range of Sensitivity: 600 to 900 nm Radiant Sensitive Area: 1.36 mm <sup>2</sup>
I <sup>2</sup> C Address	0xAE - Write Address 0xAF - Read Address

## What are Heart-Rate and Oxygen Saturation?

Heart-rate is the speed at which your heart pumps blood through your body. Pulse oximetry is a noninvasive method of determining saturation of oxygen in your blood. However, this is a peripheral measurement is not always a direct reflection of the arterial oxygen saturation (SaO<sub>2</sub>), but two are correlated enough for clinical purposes. There are a multitude of applications for these measurements; especially, in the medical field.

Here are some examples of studies using HR monitoring and pulse oximetry:

- Accuracy of pulse oximeters in estimating heart rate at rest and during exercise
- Pulse oximetry: Understanding its basic principles facilitates appreciation of its limitations **PDF Download**
- Experiment: Exercise, Blood Pressure, and Oxygen Saturation Levels

Here are additional resources on how the MAX30102 functions for HR detection and pulse oximetry:

- AN6410: Signal to Noise Ratio (PDF)
- AN6433: Depth Penetration for Biosensors (PDF)
- Maxim: Open Source Heart Rate Algorithm (Arduino)

### Heart Rate Monitor Demo



**Note:** The MAX30102 can be used as a biosensor that for SpO<sub>2</sub> and HR measurements on finger tips or earlobes. The sensor does need **good contact with constant pressure** against the epidermis for accurate results.

## What are Particulates?

Particulate matter is the accumulation of matter (solid or liquid) in Earth's atmosphere. These particles vary in size, composition, and distribution. Their effects range from individual health on a microscopic scale to regional climate on a macroscopic scale. Particulate matter is also used in the food industry. Apiarist traditionally use bee smokers when harvesting honey. Smoking is also a method of flavoring and preserving meats and other products.

Here is a link to some experiments involving PM:

- Hands-on Activity: Particulate Matter: For Your Eyes Only

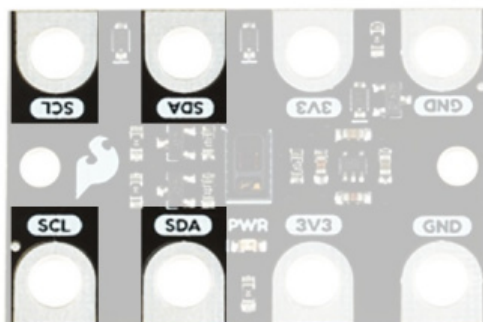
For more information on particulate matter and their detection, check out some of these resources:

- Particulate Matter (PM) Basics
- Optical Monitoring of Particulate Matter
- Maxim: Using Optical Sensors to Detect Particles
- Optical Particle Counters
- Smoke Detectors

**Note:** Particle detection is another application of the MAX30102. The sensor relies on the reflection and scattering of the red and IR light from particles to detect their presence.

## I<sup>2</sup>C Connection

I<sup>2</sup>C is a communication protocol used to transfer data between *master* and *slave* devices. It is a 2-wire connection consisting of SDA (data) and SCL (clock). The protocol is pretty well defined so it can be shared with multiple devices. This is beneficial for daisy chaining multiple devices together on a single bus. The primary thing users will need to watch out for is address conflicts (you can't have devices with the same address).

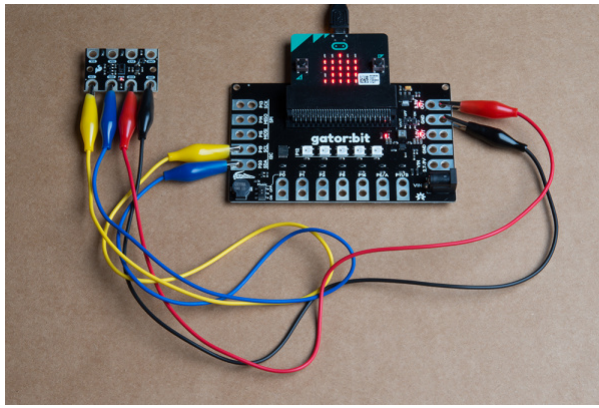


*I<sup>2</sup>C connection pads.*

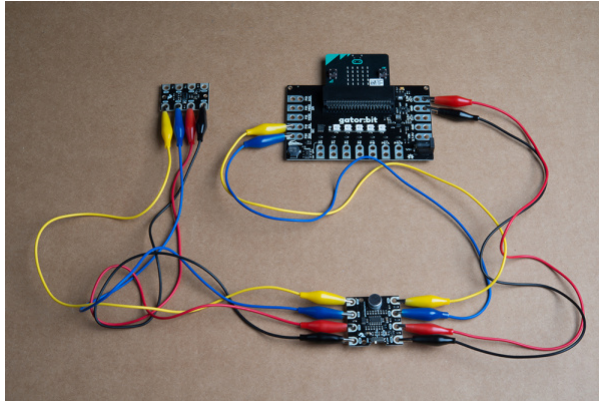
## Hardware Assembly

Connecting your gator:particle to the gator:bit (v2) is simple. The board can also be daisy-chained with other I<sup>2</sup>C boards. This can easily be done with alligator cables.





Hardware assembly of connections used in example. [Click to enlarge.](#)



Example of daisy chaining multiple I<sup>2</sup>C gator boards. [Click to enlarge.](#)

<b>Gator:UV</b>	GND	3V3	SDA	SCL
<b>Gator:Bit</b>	GND	3.3V OUT	P20 (SDA)	P19 (SCL)

## Adding the MakeCode Extension

**Note:** This tutorial assumes you are familiar with MakeCode, the gator:bit (v2), and the micro:bit board.

- If you have not previously used **MakeCode**, please check out the Quick Start Guide from micro:bit.
- If this is your first time using a **micro:bit**, please review our Getting Started with the micro:bit guide.
- If this is your first time using the **gator:bit (v2)**, please review our SparkFun gator:bit v2 Hookup Guide.

The easiest way to get started using the gator:particle is to use Microsoft MakeCode, a web-based block editor. This tutorial assumes you are familiar with the with MakeCode, the gator:bit (v2), and the micro:bit development board. If this is your first time check out this guides linked in the suggested reading section (above).

## Installing Extensions

To get started with using MakeCode with the micro:bit, head over to the MakeCode for micro:bit website by Microsoft. Then, click the **New Project** button to start a new project and open the *Editor*. (*\*Yes, all you only need to get start coding is a computer with internet access, an up-to-date web browser, and an available USB port!*)

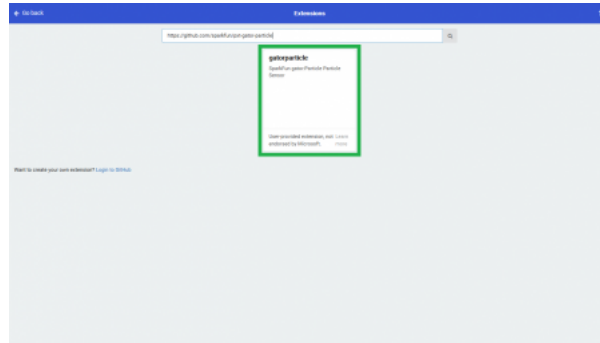


**Note:** Unfortunately, it does take time to get an extension approved by the micro:bit Educational Foundation before it can be searchable by name. Part of the requirements for the approval process involves a [live](#) product page. Therefore, at the time of the launch of this product, the extension has not been approved yet and the only method of adding the extension is to use the link to the GitHub repository of the pxt-package. We will update this tutorial as soon as the extension has been approved.↩

## Search for the PXT-Package

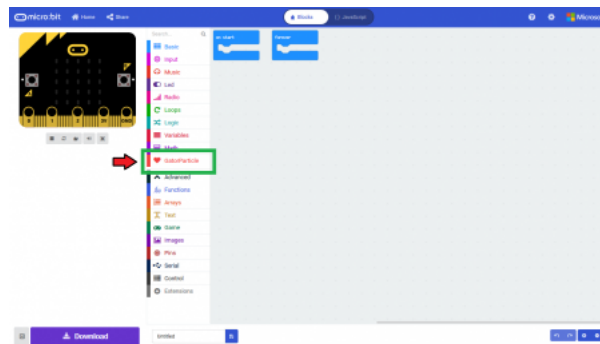
Search for the gator:particle extension using the GitHub repository link to the pxt-package:

```
https://github.com/sparkfun/pxt-gator-particle
```



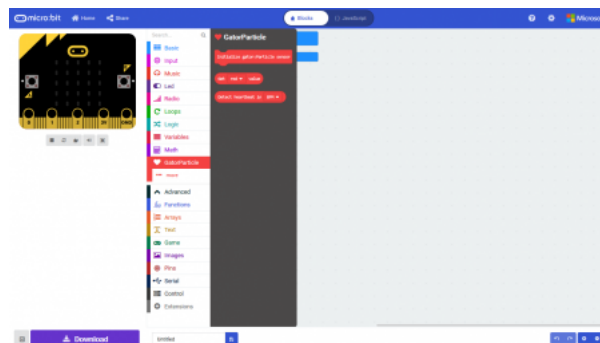
*Search for Extension. Then, click on the box to add it to the block library. Click on image to enlarge.*

Then, click on the box for the extension to add it to the block library. The gator:particle extension should now appear in the block library.



*Extension in the block library; click on the block to open menu options. Click on image to enlarge.*

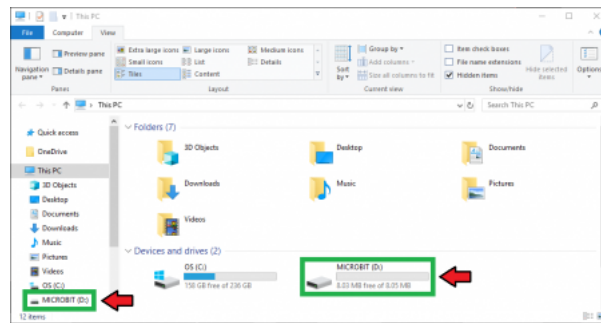
To verify that you have added the extension, click on the `gator:particle` block to make sure that your drop down menu options match the image below.



*Available blocks for the gator:particle extension. Click on image to enlarge.*

## MakeCode Example

Now that you have added the gator:particle extension to the *Editor*, lets start with some example code. Plug the micro:bit into your computer using an USB micro-B cable after you have assembled your hardware with the instructions from the previous section. The micro:bit should appear on your computer as a removable storage device.



The micro:bit showing up as a USB drive on a Windows computer. Click to enlarge.

To upload new code, this is where you will be copying the downloaded .hex file to later.

## Block Functions

### **initialize gator:particle sensor**

This block should be pretty self explanatory, it sets the sensor up to be used. You should use this within the on start block.

#### **get \_\_\_\_ value**

This is a value block as indicated by the block's shape. The output is an integer value from 0 to 262,143 for the sensor's detection of the specified wavelength. There is a drop down menu with selectable options for the sensor reading for the block. Below is a description of the available menu options:

- red - An 18-bit integer value for sensor detection in the IR wavelength ( 0 and 262,143 ).
- infrared - An 18-bit integer value for sensor detection in the IR wavelength ( 0 and 262,143 ).
- *With the default LED intensity, I was only able to see a maximum of approximately 120,000. To get higher values, the LED intensity needs to be turned up.*

#### **detect heartbeat in \_\_\_\_**

This is a value block as indicated by the block's shape. There is a drop down menu with selectable options for the output value of the block. Below is a description of the available menu options:

- BPM - Outputs a single heart-rate measurement in beats per minute (BPM).
- AVG - Outputs the average of the last four heart-rate readings in BPM.

### **Set LED mode to read \_\_\_\_**

This block should allows users to designate the LED modes. There are only two options:

- red - Only the red LED is used or on.
- red & infrared - Both the red and IR LEDs are on.
- *There is no option to use only the IR LED.*

### **Change strength of \_\_\_\_ to \_\_\_\_**

This block should allows users to control the brightness or intensity of the LEDs.


1. LED- Users designate which LED to control.
  - red
  - infrared
2. Strength- Users specify the intensity of the LED. Enter an integer.

## Basic Read

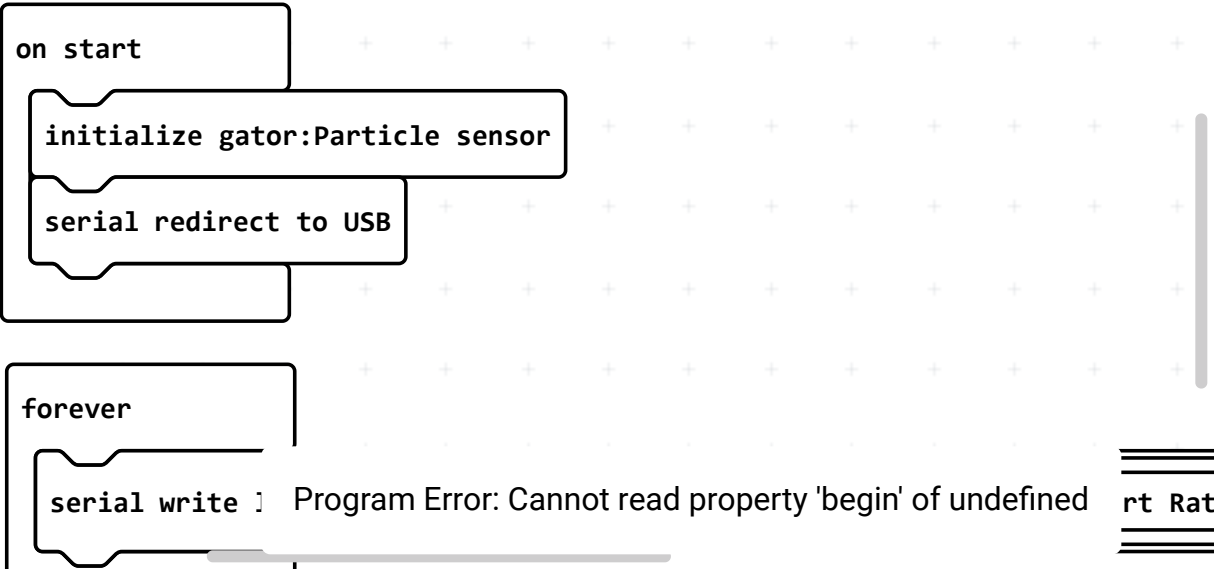
Below, is a simple example of how to take simple measurements from the sensor. To use this example, there are multiple options for accessing the .hex file:

- Replicate the block functions from the display below to copy the example project. Then download the .hex file.
- Expand the display widow to pull up the example project. Then download the .hex file.
- Use this link to pull up the example project. Then download the .hex file.
- Download the .hex file from the button below or the link on the bottom of the display.

**DOWNLOAD .HEX FILE FOR EXAMPLE**

 This site uses cookies for analytics, personalized content and ads. By continuing to browse this site, you agree to this use. [Learn more](#)

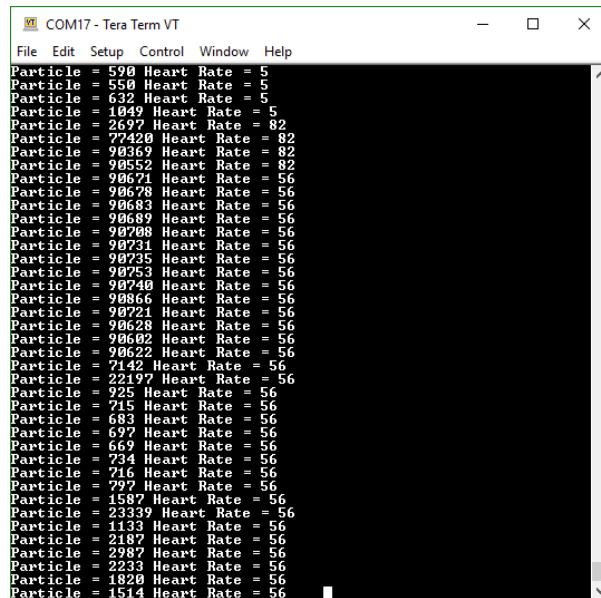
 Simulator    Blocks    JavaScript    Edit



```
on start
  initialize gator:Particle sensor
  serial redirect to USB

forever
  serial write [Program Error: Cannot read property 'begin' of undefined]
  rt Rat
```

The output is redirected over the serial port to avoid conflicts on pins P0 and P1, which are also used for serial communication. To read the sensor values, pull up your favorite serial terminal emulator. Then, connect to the serial port that the micro:bit is on; the default baud rate is 115200 bps. Below, is an example of the sensor output for the example code.



```
COM17 - Tera Term VT
File Edit Setup Control Window Help
Particle = 590 Heart Rate = 5
Particle = 550 Heart Rate = 5
Particle = 632 Heart Rate = 5
Particle = 1049 Heart Rate = 5
Particle = 2697 Heart Rate = 82
Particle = 77420 Heart Rate = 82
Particle = 90369 Heart Rate = 82
Particle = 90552 Heart Rate = 82
Particle = 90671 Heart Rate = 56
Particle = 90678 Heart Rate = 56
Particle = 90683 Heart Rate = 56
Particle = 90689 Heart Rate = 56
Particle = 90700 Heart Rate = 56
Particle = 90731 Heart Rate = 56
Particle = 90735 Heart Rate = 56
Particle = 90753 Heart Rate = 56
Particle = 90740 Heart Rate = 56
Particle = 90866 Heart Rate = 56
Particle = 90721 Heart Rate = 56
Particle = 90628 Heart Rate = 56
Particle = 90602 Heart Rate = 56
Particle = 90622 Heart Rate = 56
Particle = 7142 Heart Rate = 56
Particle = 22197 Heart Rate = 56
Particle = 925 Heart Rate = 56
Particle = 715 Heart Rate = 56
Particle = 683 Heart Rate = 56
Particle = 697 Heart Rate = 56
Particle = 669 Heart Rate = 56
Particle = 734 Heart Rate = 56
Particle = 716 Heart Rate = 56
Particle = 797 Heart Rate = 56
Particle = 1587 Heart Rate = 56
Particle = 23339 Heart Rate = 56
Particle = 1133 Heart Rate = 56
Particle = 2187 Heart Rate = 56
Particle = 2987 Heart Rate = 56
Particle = 2233 Heart Rate = 56
Particle = 1820 Heart Rate = 56
Particle = 1514 Heart Rate = 56
```

*Example of readings from the sensor.*

## Troubleshooting Tips

Here are a few tips for troubleshooting this device.

### Heart-Rate and SpO<sub>2</sub>

Make sure that you are making good contact and have constant pressure on the sensor. For the best results, use your finger tip. A special open-source algorithm is used to determine the Heart-Rate and SpO<sub>2</sub> measurements. The algorithm is relatively accurate, but is primarily meant for demonstration purposes and should not be used in critical applications for monitoring a person's health.

If you still have questions or issues with this product, please create a post on our forum under the Gator Products topic.

Additionally, if you are an **educator** and you have class or application based questions, please create a post on our forum under the Educational Products topic.

## Resources and Going Further

For more product information, check out the resources below:

- Schematic (PDF)
- Eagle Files (ZIP)
- MAX30102 Datasheet (PDF)
  - AN6410: Signal to Noise Ratio (PDF)
  - AN6433: Depth Penetration for Biosensors (PDF)
- gator:particle PXT Package
- GitHub Product Repo
- micro:bit Landing Page
- SFE Product Showcase

Interested in the micro:bit? Check out some of these other micro:bit products:



SparkFun Inventor's Kit for micro:bit Lab Pack  
🕒 LAB-15229



SparkFun gator:bit v2.0 - micro:bit Carrier Board  
🕒 DEV-15162

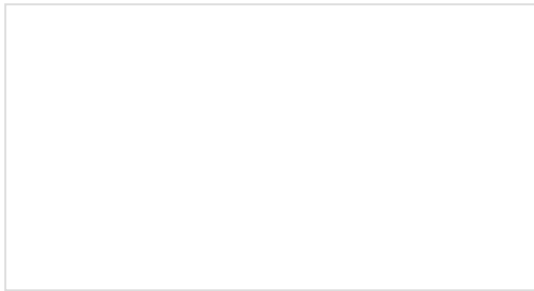


micro:bit Educator Lab Pack  
🕒 LAB-15230

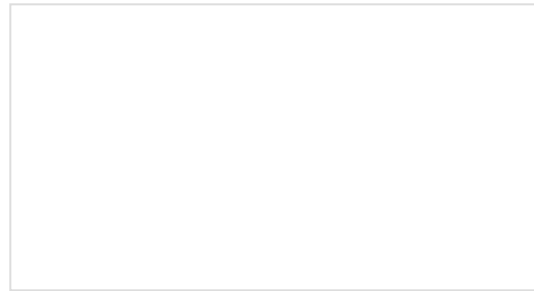


SparkFun Inventor's Kit for micro:bit  
🕒 KIT-14542

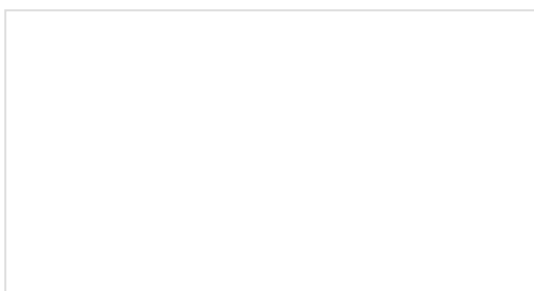
Need some inspiration for your next project? Check out some of these other micro:bit product tutorials:



**micro:arcade Kit Experiment Guide**  
We love games! We love writing games, building games and yes, even building game consoles. So we want to introduce to you the micro:arcade kit for the micro:bit!



**micro:bit Breakout Board Hookup Guide**  
How to get started with the micro:bit breakout board.



## Gator:control ProtoSnap Hookup Guide

Buttons and switches and inputs oh my! Start adding more control to your gator:bit with the SparkFun gator:control.

## SparkFun gator:soil Hookup Guide

The gator:soil is analog soil moisture sensor. This tutorial will get you started using the gator:soil with the micro:bit platform.