FLIR Lepton Hookup Guide

Introduction

Note: This tutorial was originally written for the FLiR Lepton [KIT-13233]. However, the FLiR Lepton 2.5 with Radiometry should function the same.

When our team found out that we'd be testing a Long Wave Infrared (LWIR) camera, there were two words that we couldn't stop saying: Predator Vision. That's right, we were finally going to be able to see the invisible world of heat, which would aid us greatly if we ever found ourselves hunting a team of special operatives in a remote jungle… or, you know, trying not to scald ourselves on a hot cup of tea.

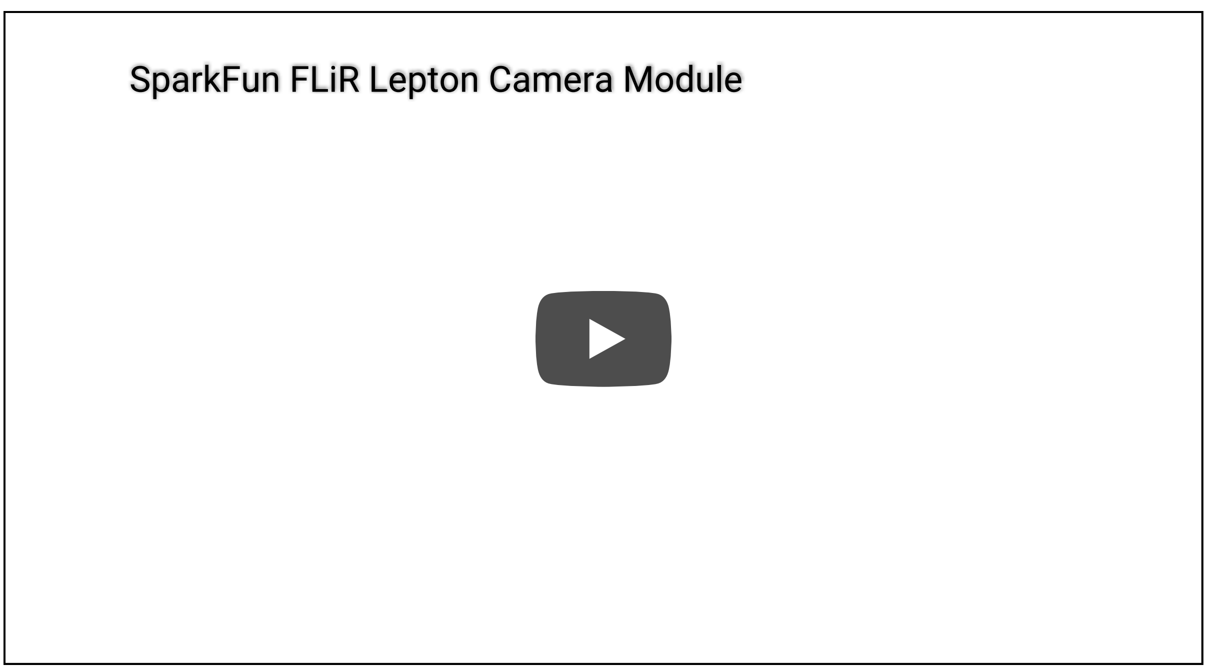
As it happens, the FLIR Lepton is an excellent little module for the price and Pure Engineering has done a bang up job spinning the breakout board and documentation.

FLiR Dev Kit
KIT-13233

FLIR Radiometric Lepton Dev Kit
KIT-14654

There are, however, a few minor “gotchas” in the setup process and so we figured it was best if we shared what we learned in playing with this thing. But first… A bit of theory…

Suggested Videos



Having a hard time seeing the videos? Try viewing the videos in full screen mode.

Required Materials

To follow along with this tutorial, you will need the following hardware and software. You may not need everything though depending on what you have and your setup. Add the hardware to your cart, read through the guide, and adjust the cart as necessary.

Hardware

Today we'll be setting up the Raspberry Pi example code as provided by Pure Engineering and featured in our product videos. At a minimum, we'll be needing a Raspberry Pi… and not much else, actually. Just a handful of jumper wires as well as a monitor, keyboard, accompanying cables for your Raspberry Pi, and the FLIR Lepton camera of your choice.

Below is a wishlist of the suggested parts:

FLIR Lepton Hookup Guide Wishlist SparkFun Wish List

Raspberry Pi 3 B+ Starter Kit
KIT-14644
There's a lot of Raspberry Pi information going around lately. Whether it's Pi A, A+, B, B+, or Pi 2 B, a…

FLIR Radiometric Lepton Dev Kit
KIT-14654
The FLiR Dev Kit includes a breakout as well as a Lepton® longwave infrared (LWIR) imager. With thi…

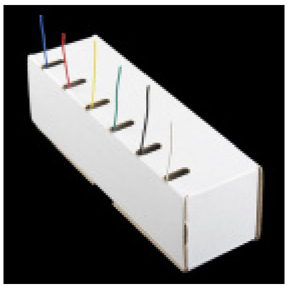
SmartiPi Touch
PRT-14059
The SmartiPi Touch is a case and stand for the official [Raspberry Pi 7" Touchscreen LCD](https://ww…

Raspberry Pi LCD - 7" Touchscreen

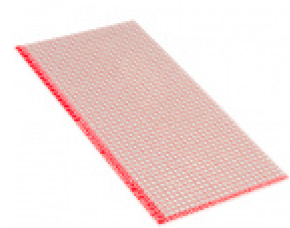
LCD-13733
This 7" Raspberry Pi Touchscreen LCD provides you with the ability to create a standalone device…

Multimedia Wireless Keyboard

Note: To reduce the number of components used, you could wire the thermal camera straight to the Pi using F/F jumper wires. For a secure connection, you could also use solder a custom Raspberry Pi hat using a prototyping board.



Hook-Up Wire - Assortment (Solid Core, 22 AWG)
PRT-11367



SparkFun Snappable Protoboard
PRT-13268

Jumper Wires Premium 6" F/F - 20 AWG (10 Pack)
PRT-11710

Raspberry Pi GPIO Tall Header - 2x20
PRT-14017

Heads up! If you are getting the PureThermal 2: FLIR Lepton Smart I/O Board, the board does **not** include the FLIR Lepton camera module. However, this handles control of the camera and raw video data via USB. This is useful if you are attaching it to your computer and using it as a USB web camera.

PureThermal 2 - FLIR Lepton Smart I/O Board
DEV-14670

USB micro-B Cable - 6 Foot
CAB-10215

For more information on setting up the smart I/O board with your computer, check out the following videos related to your setup to install the official Lepton app.

- Windows
- Mac OS
- Raspberry Pi

Software

The example code has been tested on a Raspberry Pi model B, but it should work fine on any model so long as you have Raspbian installed.

RASPBERRY PI: RASPBIAN IMAGE

You will also need to install the QT dev tools and example. Check out the **Software** later in the tutorial for more information.

Suggested Reading

If you aren't familiar with the following concepts, we recommend checking out these tutorials before continuing. This tutorial will assume you have a little bit of Raspberry Pi knowledge. If the Pi is new to you, have no fear. You can visit our Installing Raspbian and DOOM tutorial, if you need a primer. Also helpful is our Raspberry Pi GPIO tutorial. The Lepton uses SPI communication to send its video stream and it uses an I^2C-like Communication protocol as the control interface. If you are unfamiliar with either of those communication methods, please visit the corresponding tutorials.

Serial Peripheral Interface (SPI)

SPI is commonly used to connect microcontrollers to peripherals such as sensors, shift registers, and SD cards.

I2C

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

Setting up Raspbian (and DOOM!)

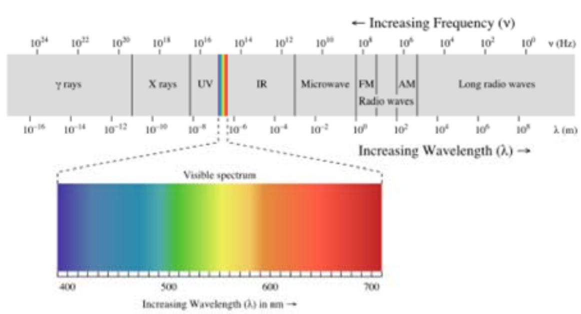
How to load a Raspberry Pi up with Raspbian -- the most popular Pi Linux distribution. Then download, compile, install and run the classic: Doom.

Raspberry gPIo

How to use either Python or C++ to drive the I/O lines on a Raspberry Pi.

Theory

Electromagnetic radiation is all around (and within, and throughout) us and is comprised of everything from gamma radiation on the high frequency end to radio waves on the low frequency end. While most imaging sensors detect radiation in the visible spectrum (wavelengths from 380 to 700 nanometers), long wave infrared sensors detect radiation from 900 to 14,000 nanometers. This is known as the infrared spectrum, and it accounts for most of the thermal radiation emitted by objects near room temperature.



Electromagnetic spectrum with visible light highlighted. Image courtesy of Wikimedia Commons.

The sensor inside the FLiR Lepton is a **microbolometer** array. Microbolometers are made up of materials which change resistance as they're heated up by infrared radiation. By measuring this resistance, you can determine the temperature of the object that emitted the radiation and create a false-color image that encodes that data.

Thermal imaging of this type is often used in building inspection (to detect insulation leaks), automotive inspection (to monitor cooling performance), and medical diagnosis. Also, because of its ability to produce an image without visible light, thermal imaging is ideal for night vision cameras.

When it comes to robotics, thermal cameras are especially useful heat detectors because the image that they produce (by virtue of being, well, an image) can be processed using the same techniques and software as visible light images. Imagine using something like OpenCV to track, not just color centroids, but heat centroids! That's right, you could be building heat-seeking robots right in your own home!

In fact, what are we waiting for? Let me give you the tour…

Hardware Overview

Listed below are some of the characteristics of the FLIR Lepton's specs. The cells highlighted in blue indicate the slight differences between the two versions of the FLIR Lepton camera module.

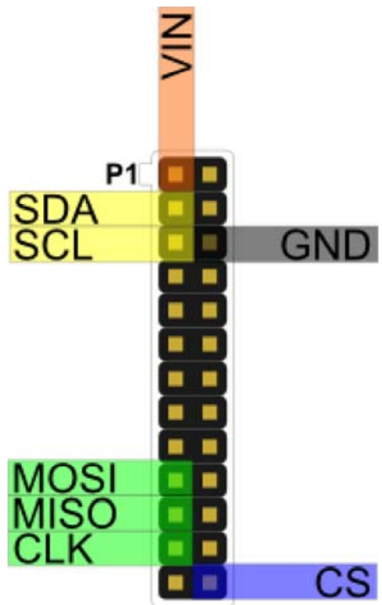
	FLIR Lepton	**FLIR Lepton v2.5 w/ Radiometry**
Resolution (h x v)	80 pixels x 60 pixels	80 pixels x 60 pixels
Spectral Range	8μm to 14μm	8μm to 14μm
Horizontal Field of View	51°	50°
Thermal Sensitivity	< 50mK	< 50mK
Frame Rate	< 9Hz	< 9Hz
Control Interface	I2C	I2C
Video Interface	SPI	SPI
Promised Time to Image	< 0.5 sec	< 1.2 sec (*~0.5 sec in real world testing*)
Integral Shutter		✓
Radiometry	14-bit pixel value	14-bit pixel value, Kelvin
Operating Power	~150 mW	~150 mW

Hardware Hookup

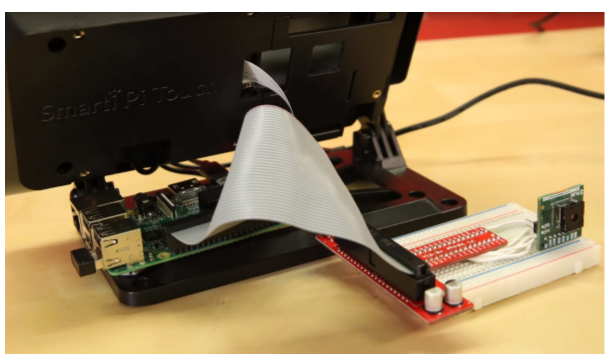
⚡ **Warning:** It is worth mentioning that while the Lepton module isn't particularly sensitive to electrostatic discharge, it is a complex and relatively pricey component. You might want to take a few precautions while working with it so you don't accidentally zap it.

Circuit Diagram

Connect the FLIR breakout to the Raspberry Pi GPIO according to the diagram below. If you need a refresher on how the GPIO pins are oriented, visit our Raspberry Pi GPIO tutorial. Make sure that your Lepton module is securely snapped into the socket on the breakout board.



There are several methods of connecting and mounting your system together. If you used a breadboard and LCD touchscreen with the Pi, your setup should look similar to the image below.



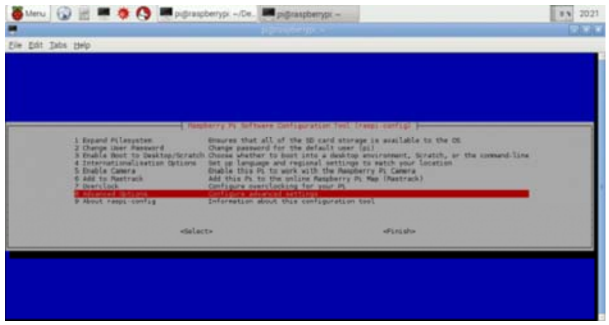
Congratulations, that's the hardware part done. Now onto the software configuration!

Software

As I mentioned earlier, you'll want to have the Raspbian OS installed on your Raspberry Pi. Boot it up, and open the Terminal program. Our first matter of business will be enabling the Pi's SPI and I2C interfaces. Luckily, Raspbian makes this easy to do by including a utility called **raspi-config**. To run the utility just type:

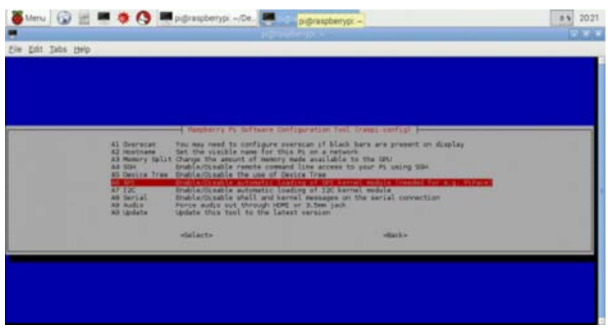
```
sudo raspi-config
```

You should be presented with the following screen as shown below. Click on the "**Advanced Options**" menu.



Having a hard time seeing the circuit? Click on the image for a closer look.

Select SPI and follow the instructions on the following screens. After you've completed the SPI steps, do the same thing for I2C. When you exit **raspi-config**, it will ask if you want to reboot. Go ahead and do it so that the changes we just made will stick.

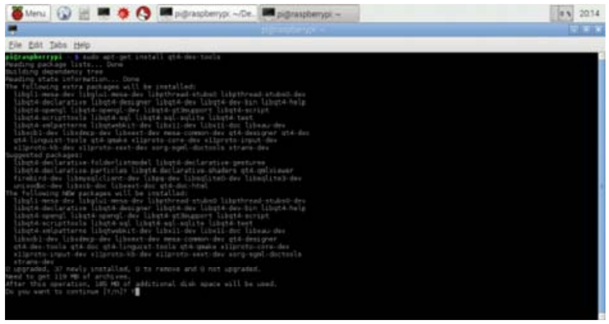


Having a hard time seeing the circuit? Click on the image for a closer look.

Pure Engineering's example code is a QT application so we'll need to get that dependency installed before we can compile it. Don't worry, it's easy to do. Make sure that the Pi has an Internet connection, and run the following command to install the QT dev tools:

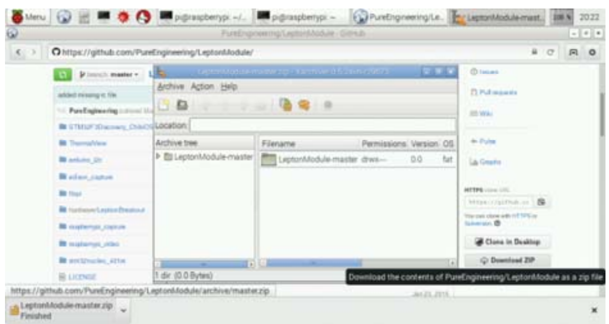
```
sudo apt-get install qt4-dev-tools
```

Which will look something like this…



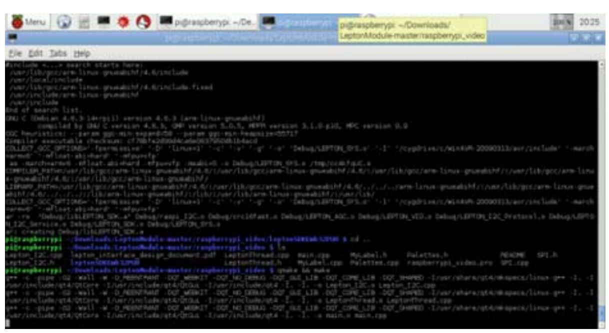
Once installation is complete, go to the Pure Engineering GitHub repo and retrieve the **…/software/raspberrypi_video** directory. If you're familiar with git, you can do this from the command line. For most people, it's just as easy to browse to the above link, and click "Download ZIP". You can download the file to whatever directory you like, then `cd` to that directory in Terminal, and unzip it using the following command:

```
unzip LeptonModule-master.zip
```



Now `cd` into the unzipped folder "**LeptonModule-master**" and the directory "**…/raspberrypi_video**". This directory contains all of the files you need to compile the example code. First, we need to "make" the Lepton SDK. Use the `cd` command to navigate to the "**…/software/raspberrypi_libs/LeptonSDKEmb32PUB**" directory and run the `make` command.

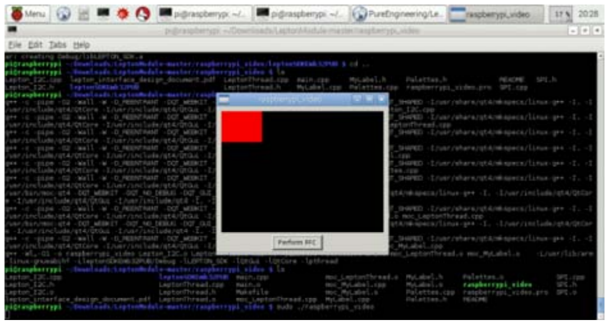
Once that process has completed, `cd` back out to the "**…/raspberrypi_video**" directory and run `qmake && make`:



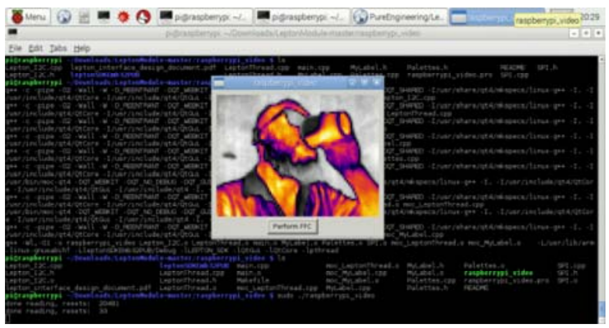
Congratulations! You've just compiled the example code, and you're ready to run it. Simply type the following into your command line:

```
sudo ./raspberrypi_video
```

Troubleshooting Tip: You may get an error like the one shown below: a red square in a blank window. If this is the case, *carefully* remove the Lepton module from the breakout board. That's right, pull it from the socket, while it's powered. Then (again, *very carefully*) pop it back into place. Images should start pouring in!



Aim the camera at something hot or step in front of it to begin viewing heat signatures!



Visualizing the insulating properties of my beard

Resources and Going Further

Now that you're successfully retrieving LWIR images from the Lepton module, you can dig into the example code and apply it to your own project!

For more information, check out the resources below:

- Breakout Board Schematic (PDF)
- Datasheet
    - FLIR Lepton (PDF)
    - FLIR Lepton w/ Radiometry (PDF)
- Raspberry Pi: Raspbian OS Download
- Mike's Electric Stuff: Reverse-Engineering the FLiR Lepton®
- Pure Engineering: Project Page
    - Lepton Module GitHub Repo – Library, Example Code, & Design Files. The example in this tutorial uses the code from this repository.
    - PyLepton (Python)
    - GetThermal Viewer (Linux & macOS)
    - FLIR's Lepton SDKs

        - 32-bit (ZIP)
        - 64-bit (ZIP)
    - Discussion Forum
- GroupGets: Product Page
- SparkFun Product Showcase
    - FLIR Lepton Camera Module
    - FLIR Lepton 2.5

Thermography has hundreds of applications. Spend some time just playing with the camera to see where you might find uses for it. Try piping the frames captured from your Lepton module into some computer vision software like SimpleCV! We'd love to see what you do with the FLiR Dev Kit so be sure to leave a comment and tell us all about it!

Need some inspiration for your next project? Check out some of these related tutorials:

Setting up Raspbian (and DOOM!)
How to load a Raspberry Pi up with Raspbian -- the most popular Pi Linux distribution. Then download, compile, install and run the classic: Doom.

Building Large LED Installations
Learn what it takes to build large LED installations from planning to power requirements to execution.

Raspberry Pi SPI and I2C Tutorial
Learn how to use serial I2C and SPI buses on your Raspberry Pi using the wiringPi I/O library for C/C++ and spidev/smbus for Python.

Setting Up the Pi Zero Wireless Pan-Tilt Camera
This tutorial will show you how to assemble, program, and access the Raspberry Pi Zero as a headless wireless pan-tilt camera.

MLX90614 IR Thermometer Hookup Guide

How to use the MLX90614 or our SparkFun IR Thermometer Evaluation Board to take temperatures remotely, over short distances.

Qwiic GRID-Eye Infrared Array (AMG88xx) Hookup Guide

The Panasonic GRID-Eye (AMG88xx) 8x8 thermopile array serves as a functional low-resolution infrared camera. This means you have a square array of 64 pixels each capable of independent temperature detection. It's like having thermal camera (or Predator's vision), just in really low resolution.

Or check out the FLiRPiCam project which includes a 3D printed enclosure files:

Enginursday: Designing a FLiR Pi Camera

JUNE 2, 2016

Enginursday: Linear Regulator Thermal Tests

AUGUST 25, 2016