

# ANAVI Infrared pHAT

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Convert Your Raspberry Pi to Powerful Remote Control

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The software examples are released under MIT and the rest of the software is available under GPLv3.

It is possible that the pictures in this manual differ from the latest revision of the board.

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There is no warranty for the design materials and the components used to create ANAVI Infrared pHAT. They are considered suitable only for ANAVI Infrared pHAT.

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## CHAPTER 1: Overview

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### Introduction

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ANAVI Infrared pHAT is an open source hardware Raspberry Pi add-on board with IR receiver, transmitter, UART and 3 I2C slots for sensors. ANAVI Infrared pHAT was started as a hobby project by Leon Anavi in January 2017. The project allows you to convert your Raspberry Pi into a smart remote control using the open source software LIRC.

ANAVI Infrared pHAT is designed with the free and open source electronics design automation suite [KiCAD](#). No soldering is required. You can assemble ANAVI Infrared pHAT to your Raspberry Pi with your bare hands.

Anavi is fully compatible with the Raspbian GNU/Linux distribution and open source sample applications are provided.

### Features

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ANAVI Infrared pHAT Raspberry Pi HAT includes:

- IR LED
- IR photo sensor
- Slots for up to 3 plug and play I2C sensors

### Supported Raspberry Pi Versions and Models

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ANAVI Infrared pHAT is compatible with the following Raspberry Pi versions and models:

- [Raspberry Pi 4 Model B](#)
- [Raspberry Pi 3 Model B](#)
- [Raspberry Pi 2 Model B](#)
- [Raspberry Pi 0](#)
- [Raspberry Pi 0 W](#)
- [Raspberry Pi Model B+](#)
- [Raspberry Pi Model A+](#)

ANAVI Infrared pHAT is **NOT** compatible with the earlier 26-pin models of Raspberry Pi 1 Model B & A's.

### Target Market

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ANAVI Infrared pHAT is a Raspberry Pi HAT suitable for existing Raspberry Pi customers interested in home automation, software development and Internet of Things. The board is appropriate for embedded programming enthusiasts, GNU/Linux gadget fans, students as well as web and/or mobile app developers. The main usage of the board is embedded software development and controlling IR devices without the urge of understanding perfectly the hardware.

## Board Version

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Revision 1.0 of ANAVI Infrared pHAT was used while writing this document. It is possible that it is outdated so it is always recommended to check the latest sources from the GitHub page of the board.

# CHAPTER 2: Getting Started

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## Electrostatic Warning

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ANAVI Infrared pHAT is shipped in a protective antistatic bag. The HAT as well as the Raspberry Pi must **NOT** be exposed to high electrostatic potentials. A grounding strap or similar protective device should be worn when handling the board. Avoid touching the component pins or any other metallic element.

## Requirements

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In order to setup ANAVI Infrared pHAT the following items are required:

- Compatible Raspberry Pi
- microSD card with compatible image
- USB power supply

Additionally you may attach USB mouse, keyboard, HDMI monitor or addition peripheral devices to your Raspberry Pi. It is recommended to use 2.5A (2500mA) power supply.

## Supported Peripherals

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ANAVI Infrared pHAT Raspberry Pi HAT has an infrared receiver and an infrared transmitter. Up to 3 I2C sensors can be also easily attached to the pHAT.

### Sensors

The officially supported I2C sensor modules by ANAVI Infrared pHAT are:

- Temperature and barometric pressure (BMP180)
- Temperature and humidity (HTU21)
- Light (BH1750)

You may also attach any other I2C sensors but you will have to take care of their software integration.

### Temperature Sensor

The official temperature sensor for ANAVI Infrared pHAT is BMP180. This is I2C sensor capable of measuring both temperature and barometric pressure.

Using 4 Dupont jumper wires connect BMP180 to one of the 3 I2C slots on ANAVI Infrared pHAT as follows:

BMP180	ANAVI Infrared pHAT
VIN	3.3V
GND	GND
SCL	SCL
SDA	SDA

### Humidity Sensor

The official humidity temperature for ANAVI Infrared pHAT is HTU21 (SHT21). This is I2C sensor capable of measuring both humidity and temperature.

Using 4 Dupont jumper wires connect HTU21 to one of the 3 I2C slots on ANAVI Infrared pHAT as follows:

HTU21	ANAVI Infrared pHAT
VIN	3.3V
GND	GND
SCL	SCL
SDA	SDA

## Light Sensor

The official light I2C sensor for ANAVI Infrared pHAT is BH1750.

Using 4 Dupont jumper wires connect BH1750 to one of the 3 I2C slots on ANAVI Infrared pHAT as follows:

BH1750	ANAVI Infrared pHAT
VCC	3.3V
GND	GND
SCL	SCL
SDA	SDA

## Assembly

You can assemble ANAVI Infrared pHAT and mount it on your Raspberry Pi with your bare hands following the steps below:

- Ensure that your Raspberry Pi is compatible with ANAVI Infrared pHAT.
- Power off your Raspberry Pi.
- Gently mount ANAVI Infrared pHAT on the 40 pin header of your Raspberry Pi.
- Add sensors to your ANAVI Infrared pHAT.
- Optionally, you may also mount two or four brass M2.5 standoffs to keep your Pi HAT snug on your Raspberry Pi while also keeping the two boards separated.
- That's all, now you are ready to go!

## Powering ANAVI Infrared pHAT

ANAVI Infrared pHAT is Raspberry Pi HAT therefore it is powered through Raspberry Pi. It is recommended to use the [official Raspberry Pi Power Supply](#) or another 2.5A USB power supply from reputable retailer.

# CHAPTER 3: Software

## Installation

In order to work correctly, ANAVI Infrared pHAT requires an up-to-date kernel, I2C to be enabled, and a few libraries to get started. After booting microSD card with **Raspbian**, open a terminal and follow the steps below:

- Ensure your APT package list is up-to-date:

```
sudo apt-get update
```

- Install additional applications, libraries and other tools needed by ANAVI Infrared pHAT

```
sudo apt-get install -y git i2c-tools vim
```

## Enable I2C

Follow the steps below to enable I2C which is required by the sensors for ANAVI Infrared pHAT

- Open a terminal or login remotely via SSH to your Raspberry Pi and type in the following command:

```
sudo raspi-config
```

- Select **Interfacing Options > I2C** and enable it.
- Reboot the board.

## Serial Debugging

Follow the steps below to enable serial debugging through USB to serial cable:

- Open a terminal or login remotely via SSH to your Raspberry Pi and type in the following command:

```
sudo raspi-config
```

- Select **Interfacing Options > Serial** and enable it.
- Reboot the board.
- Plug the USB to serial cable and connect your Raspberry Pi to your PC. The **RX** line of the cable should go to **TX** line of **UART** on ANAVI Infrared pHAT. The **TX** line of the cable should go to the **RX** line of **UART** on ANAVI Infrared pHAT. The **GND** wire should go to the **GND** line of **UART** on ANAVI Infrared pHAT.
- Type in the following command on your computer if you are using GNU/Linux distribution to access ANAVI Infrared pHAT. Alternatively if your OS is Microsoft Windows use [putty](#).

The recommended USB to UART serial modules for ANAVI Infrared pHAT are any with CP2102 or [Olimex USB-Serial-Cable-F](#). All Infrared kits include CP2102 which out of the box on GNU/Linux distributions. Drivers for MS Windows and Mac OS X are [available at silabs.com](#).

## Examples

Sample applications written in Python and the C programming language are provided for ANAVI Infrared pHAT under MIT license in GitHub. All examples have been tested on **Raspbian**.

Open a terminal and execute the follow the steps by step instructions to install all dependencies and to get the source code:

- Install dependencies:

```
sudo apt-get update
sudo apt-get install -y git git-core vim python-dev python-rpi.gpio wiringpi i2c-tools
```

- Download the examples for ANAVI Infrared pHAT

```
cd ~
git clone https://github.com/AnaviTechnology/anavi-examples.git
cd anavi-examples
```

## Sensors

It is mandatory to enable **I2C** to use any of the sensors supported by ANAVI Infrared pHAT.

### Temperature Sensor (BMP180)

Follow the steps below to use the BMP180 I2C temperature and barometric pressure sensor with ANAVI Infrared pHAT:

- Connect BMP180 to any of the I2C slots on ANAVI Infrared pHAT using male to female Duport jumper wire.
- Type in the following command and verify that the address of the sensor is listed:

```
sudo i2cdetect -y 1
```

- Type in the following commands to build and run the sample application that display temperature and barometric pressure:

```
cd ~/anavi-examples/sensors/BMP180/c/
make
./BMP180
```

- Verify that the output is similar to (the exact values depend on the atmospheric condition):

```
pi@raspberrypi:~/anavi-examples/sensors/BMP180/c $ ./BMP180
BMP180 Sensor Module
Temperature 28.6 C
Pressure 991.57 hPa
```

### Humidity Sensor (HTU21D)

Follow the steps below to use the HTU21D I2C temperature and humidity sensor with ANAVI Infrared pHAT:

- Connect HTU21D to any of the I2C slots on ANAVI Infrared pHAT using male to female Duport jumper wire.
- Type in the following command and verify that the address of the sensor is listed:

```
sudo i2cdetect -y 1
```

- Type in the following commands to build and run the sample application that display temperature and humidity:

```
cd ~/anavi-examples/sensors/HTU21D/c/  
make  
./HTU21D
```

- Verify that the output is similar to (the exact values depend on the atmospheric condition):

```
pi@raspberrypi:~/anavi-examples/sensors/HTU21D/c $ ./HTU21D  
HTU21D Sensor Module  
25.64C  
118.99%rh
```

## BH1750 Light Sensor Module

Follow the steps below to use the BH1750 I2C light sensor with ANAVI Infrared pHAT:

- Connect BH1750 to any of the I2C slots on ANAVI Infrared pHAT using male to female Dupont jumper wires.
- Type in the following command and verify that the address of the sensor is listed:

```
sudo i2cdetect -y 1
```

- Type in the following commands to build and run the sample application that display luminous emittance:

```
cd ~/anavi-examples/sensors/BH1750/c/  
make  
./BH1750
```

- Verify that the output is similar to (the exact values depend on the atmospheric condition):

```
pi@raspberrypi:~/anavi-examples/sensors/BH1750/c $ ./BH1750  
BH1750 Sensor Module  
Light: 418 Lux
```

## Infrared and LIRC

ANAVI Infrared pHAT has built-in infrared receiver and transmitter. [LIRC](#) (Linux Infrared Remote Control) is popular open source application for sending and receiving data over infrared on GNU/Linux distributions. This chapter provides guidelines how to enable ANAVI Infrared pHAT infrared receiver and transmitter on **Raspbian** and to use LIRC.

In 2019 `lirc_rpi`, the Linux kernel module provided with Raspbian before, was replaced with `gpio-ir` and `gpio-ir-tx`. This tutorial is updated for Raspbian Buster. If you need to setup ANAVI Infrared pHAT on an older version of Raspbian, for example from 2018-04-18, please [have a look at the old user's manual](#).

## Setting up LIRC

Perform the steps below to build LIRC from source, to patch it and to enable the infrared receiver and transmitter on ANAVI Infrared pHAT:

- Install dependencies

```
sudo su -c "grep '^deb ' /etc/apt/sources.list | sed 's/^deb/deb-src/g' > /etc/apt/sources.list.d/deb-src.list"  
sudo apt update  
sudo apt install -y vim devscripts dh-exec doxygen expect libasound2-dev libftdi1-dev libsystemd-dev libudev-dev libusb-1.0-0-dev li
```

- Download LIRC source code

```
mkdir ~/lirc-src  
cd ~/lirc-src  
apt source lirc
```

- Apply a patch to fix LIRC for Raspberry Pi

```
wget https://raw.githubusercontent.com/neuralassembly/raspi/master/lirc-gpio-ir-0.10.patch  
patch -p0 -i lirc-gpio-ir-0.10.patch  
cd lirc-0.10.1  
debuild -uc -us -b
```

- Install LIRC (built on the previous step)

```
cd ~/lirc-src
sudo apt install -y ./liblirc0_0.10.1-6.2~deb10u1_armhf.deb ./liblircclient0_0.10.1-6.2~deb10u1_armhf.deb ./lirc_0.10.1-6.2~deb10u1_
```

- Edit `/etc/lirc/lirc_options.conf` and make sure that driver and device are set as:

```
driver      = default
device     = /dev/lirc1
```

**NOTE:** Device `/dev/lirc1` is the receiver and device `/dev/lirc0` is the transmitter. Initially `/dev/lirc1` is used to scan a remote control. After that the configuration has to be updated to `/dev/lirc0` and LIRC daemon must be restarted with `sudo systemctl restart lircd` in order to send infrared commands.

- Edit `/boot/config.txt` (with `sudo` or as root) and configure kernel extensions by adding the following line to the end of the file:

```
dtoverlay=gpio-ir,gpio_pin=18
dtoverlay=gpio-ir-tx,gpio_pin=17
```

- Reboot Raspberry Pi:

```
sudo shutdown -r 0
```

## Using IR Receiver

Follow the steps below to verify that the IR receiver is working as expected:

- Stop LIRC systemd service:

```
sudo systemctl stop lircd
```

- Start outputting raw data from the IR receiver

```
mode2 -d /dev/lirc1
```

- Point a remote control at the IR receiver on ANAVI Infrared pHAT and press its buttons. If the IR receiver is configured successfully you will see similar output:

```
space 3662230
pulse 2428
space 594
pulse 1201
space 596
pulse 1230
space 595
pulse 1209
space 590
pulse 1204
```

## Using IR LED

Follow the steps below to create LIRC configuration file and test the infrared transmitter:

- Stop LIRC systemd service

```
sudo systemctl stop lircd
```

- List all available names for buttons supported by LIRC:

```
irrecord --list-namespace
```

- Type in the following command to create new LIRC control configuration file and follow the on screen instructions to scan a remote control:

```
irrecord -d /dev/lirc1 ~/lircd.conf
```

Example configuration output with name hifi:

Using driver default on device /dev/lirc1

irrecord - application for recording IR-codes for usage with lirc  
Copyright (C) 1998,1999 Christoph Bartelmus(lirc@bartelmus.de)

This program will record the signals from your remote control  
and create a config file for lircd.

A proper config file for lircd is maybe the most vital part of this  
package, so you should invest some time to create a working config  
file. Although I put a good deal of effort in this program it is often  
not possible to automatically recognize all features of a remote  
control. Often short-comings of the receiver hardware make it nearly  
impossible. If you have problems to create a config file READ THE  
DOCUMENTATION at <https://sf.net/p/lirc-remotes/wiki>

If there already is a remote control of the same brand available at  
<http://sf.net/p/lirc-remotes> you might want to try using such a  
remote as a template. The config files already contains all  
parameters of the protocol used by remotes of a certain brand and  
knowing these parameters makes the job of this program much  
easier. There are also template files for the most common protocols  
available. Templates can be downloaded using `irdb-get(1)`. You use a  
template file by providing the path of the file as a command line  
parameter.

Please take the time to finish the file as described in  
<https://sourceforge.net/p/lirc-remotes/wiki/Checklist/> an send it  
to `<lirc@bartelmus.de>` so it can be made available to others.

Press RETURN to continue.

Checking for ambient light creating too much disturbances.  
Please don't press any buttons, just wait a few seconds...

No significant noise (received 0 bytes)

Enter name of remote (only ascii, no spaces) :hifi  
Using hifi.lircd.conf as output filename

Now start pressing buttons on your remote control.

It is very important that you press many different buttons randomly  
and hold them down for approximately one second. Each button should  
generate at least one dot but never more than ten dots of output.  
Don't stop pressing buttons until two lines of dots (2x80) have  
been generated.

Press RETURN now to start recording.

.....  
Got gap (45034 us)}

Please keep on pressing buttons like described above.

.....

Please enter the name for the next button (press <ENTER> to finish recording)  
KEY\_POWER

Now hold down button "KEY\_POWER".

Please enter the name for the next button (press <ENTER> to finish recording)

Checking for toggle bit mask.

Please press an arbitrary button repeatedly as fast as possible.  
Make sure you keep pressing the SAME button and that you DON'T HOLD

the button down!.  
If you can't see any dots appear, wait a bit between button presses.

Press RETURN to continue.  
.....Cannot find any toggle mask.  
You have only recorded one button in a non-raw configuration file.  
This file doesn't really make much sense, you should record at least two or three buttons to get meaningful results. You can add more buttons next time you run irrecord.

Successfully written config file hifi.lircd.conf

- Backup the original LIRC configuration file:

```
sudo mv /etc/lirc/lircd.conf /etc/lirc/lircd-backup.conf
```

- Load the new configuration file, for example:

**NOTE: The name of configuration depends on the selected name of remote. Please adapt the command below depending on your name of remote!**

```
sudo mv hifi.lircd.conf /etc/lirc/lircd.conf
```

- Switch LIRC configurations to the device for transmitting. Edit again `/etc/lirc/lirc_options.conf` and make sure that driver and device are set as:

```
driver      = default
device      = /dev/lirc0
```

**NOTE:** In this case the device is `/dev/lirc0`.

- Launch LIRC systemd service again:

```
sudo systemctl start lircd
```

- List all saved keys, for example:

**NOTE: Please adapt the command below depending on your name of remote!**

```
irsend LIST hifi ""
```

- - Test the configuration file by sending recorded IR command, for example POWER (please note the exact command may vary for different LIRC configuration files, IR devices and IR remote controls):

**NOTE: Please adapt the command below depending on your name of remote!**

```
irsend SEND_ONCE hifi KEY_POWER
```

**NOTE: Please keep in mind that in rare cases some devices might require codes to be sent in short bursts, for example:**

```
irsend send_once hifi KEY_POWER KEY_POWER KEY_POWER
```

## Device Tree Overlays

Device Tree (DT) in Linux is a description of the hardware in a system. The DT overlay adds a number of optional elements.

The EEPROM of ANAVI Infrared pHAT contains DT overlay with description of the peripheral devices on the HAT. After adding Anavi to your Raspberry Pi and booting it you should have some new filesystem nodes at `/proc/device-tree/hat`:

```
pi@raspberrypi:~ $ ls -l /proc/device-tree/hat/
total 0
-r--r--r-- 1 root root  4 Feb 15 00:27 name
-r--r--r-- 1 root root 20 Feb 15 00:27 product
-r--r--r-- 1 root root  7 Feb 15 00:27 product_id
-r--r--r-- 1 root root  7 Feb 15 00:27 product_ver
-r--r--r-- 1 root root 37 Feb 15 00:27 uuid
-r--r--r-- 1 root root  6 Feb 15 00:27 vendor
```



The information provided in these filesystem nodes helps you to identify ANAVI Infrared pHAT vendor, version, product name, etc. For example:

```
pi@raspberrypi:~ $ cat /proc/device-tree/hat/product
ANAVI Infrared pHAT

pi@raspberrypi:~ $ cat /proc/device-tree/hat/vendor
ANAVI
```

More information about device trees, overlays and parameters are available at [the official Raspberry Pi documentation](#).

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## CHAPTER 4: ANAVI IoT GNU/Linux Distribution

Anavi IoT GNU/Linux distribution is still *under construction*. It is built using the **Yocto Project** and **OpenEmbedded** and features daemon that sends data from the sensors and receives messages through the lightweight machine-to-machine communication protocol **MQTT**. There is also a responsive HTML5 web interface developed with jQuery Mobile and **Node.js** API. For more details visit:

- [anaviflexd](#)
- [meta-anavi](#)
- [anavi-api](#)
- [anavi-ui](#)

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## CHAPTER 5: Schematics

### Pinout

The components of ANAVI Infrared pHAT utilize the following pins on Raspberry Pi:

Component	Pins
I2C	3, 5
EEPROM	27, 28
IR LED	11
IR receiver	12
UART	1, 8, 9, 10

### I2C

The sensors that can be connected to ANAVI Infrared pHAT communicate with a host microcontroller via a communications standard called **I2C** (Inter-Integrated-Circuit). I2C uses two wires, labelled SDA (Serial Data) and SCL (Serial Clock). To function properly, I2C requires a pullup resistor on each of those lines therefore ANAVI Infrared pHAT includes two 4.7kohm resistors labelled as R6 and R7. If for one reason or another you need to disable the I2C pullup resistors remove R6 and R7.

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## CHAPTER 6: Frequently Asked Questions (FAQ)

### May I use ANAVI Infrared pHAT with other operating systems?

Yes, you can use ANAVI Infrared pHAT with other GNU/Linux distributions and even other operating systems but some porting efforts might be required.

### May I use other I2C sensors with ANAVI Infrared pHAT?

Yes, you can use other I2C sensors with ANAVI Infrared pHAT but you should take care for their drivers and software support.

### May I use non-I2C sensors with ANAVI Infrared pHAT?

No.

Can I remotely control ANAVI Infrared pHAT from a web browser on my smartphone, tablet, or laptop?