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Setting Up LIRC on the RaspberryPi

Jan 6th, 2013 | Comments

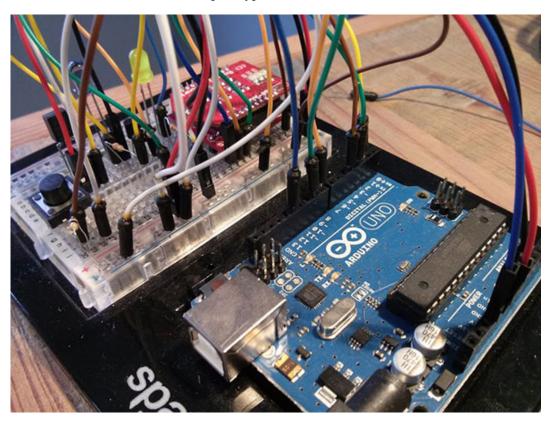
June 8th 2013 Update: I have completed a soldered circuit prototype, complete with a full parts list and high resolution build pictures. Please read <u>Open Source Universal Remote - Parts & Picturse</u> to learn more.

March 9th 2013 Update: I have formalized the schematic and parts list that I'm using and have made it available on <u>Upverter</u>. Please read <u>RaspberryPi IR Schematic for LIRC</u> for more details.

March 4th Update: I've written a follow up post that describes how to control your RaspberryPi universal remote from the web. Please check out <u>Controlling LIRC from the web</u> for instructions on how to install and configure the software.

Preface

In July 2012 I wrote a post called <u>Universal remote experiments</u> about creating a web controlled universal remote from the electronics up. The first platform I started with was an Arduino Uno. After much experimentation I learned that asking an Arduino to maintain a WiFi connection, maintain a TCP socket with a host computer, and send/receive IR signals was a bit much. With the limited memory and storage I had a hard time managing memory and keeping the system stable. I was, however, able to build a functional prototype:



At the end of that post I had decided to rebuild the project on a RaspberryPi. I chose the RaspberryPi because I wanted a single device to host a web server in addition to being able to handle the IR transmitting and receiving. Given that the RaspberryPi runs Linux I could rely on it's stable TCP/IP implementation and use open source software packages like nginx and NodeJS to build a web application.

This post will serve as 'part two' of that project and cover how to install and configure LIRC on a RaspberryPi.

LIRC - Linux Infrared Remote Control

<u>LIRC</u> is a mature and stable open source library that provides the ability to send and receive IR commands. Thanks to the contributions of <u>ar0n</u>, LIRC support is now included by default in the latest version of Raspbian OS. If you'd like to see the details of the RaspberryPi GPIO integration check out the <u>pull request</u> he opened for it a while back.

Setting up LIRC on the RaspberryPi

Getting LIRC setup on the RaspberryPi is significantly easier now than it was six months ago.

You must be running on the latest firmware and OS for this guide to work. If you're new to the RaspberryPi, or you haven't upgraded to the latest firmware and OS, I recommend following my RaspberryPi Quickstart guide to get your RaspberryPi up and running on the latest OS and firmware.

First, we'll need to install and configure LIRC to run on the RaspberryPi:

```
sudo apt-get install lirc
```

You have to modify two files before you can start testing the receiver and IR LED. I modified these files based on a thread I found on the RaspberryPi forums. If you would like to read more about these changes please check out the <u>LIRC GPIO</u> <u>driver for homebrew adapter</u> thread. In particular, read through the posts by <u>rudiratlos</u> on page five, as he posts his configuration files.

Add this to your /etc/modules file:

```
lirc_dev
lirc_rpi gpio_in_pin=23 gpio_out_pin=22
```

Change your /etc/lirc/hardware.conf file to:

```
# /etc/lirc/hardware.conf
# Arguments which will be used when launching lircd
LIRCD_ARGS=" - - uinput"
# Don't start lircmd even if there seems to be a good config file
# START LIRCMD=false
# Don't start irexec, even if a good config file seems to exist.
# START IREXEC=false
# Try to load appropriate kernel modules
LOAD MODULES=true
# Run "lircd --driver=help" for a list of supported drivers.
DRIVER="default"
# usually /dev/lirc0 is the correct setting for systems using udev
DEVICE="/dev/lirc0"
MODULES="lirc_rpi"
# Default configuration files for your hardware if any
LIRCD CONF=""
LIRCMD CONF=""
```

Now restart lined so it picks up these changes:

```
sudo /etc/init.d/lirc stop
sudo /etc/init.d/lirc start
```

January 25th 2015: Marc W. in the comments pointed out that in the 3.18.x RaspberryPi firmware you must modify one additional file for the lirc-rpi kernel extension to be loaded:

Edit your /boot/config.txt file and add:

dtoverlay=lirc-rpi,gpio in pin=23,gpio out pin=22

Reboot your RaspberryPi after making this change.

Wiring up the IR transceiver

June 8th 2013 Update: I've finished a more permanent build and documented the process in my <u>Open Source Universal</u> <u>Remote - Parts & Picturse</u> blog post.

March 9th 2013 Update: I have formalized the schematic and parts list that I'm using and have made it available on <u>Upverter</u>. Please read <u>RaspberryPi IR Schematic for LIRC</u> for more details.

To send and receive IR signals from your RaspberryPi you'll need to wire up an IR LED and an IR receiver and tell LIRC where to find them. Here are the parts I purchased for my own project:

- 940nm IR LED 20deg 20 degree viewing angle. Bright and tuned to 940nm wavelength
- 940nm IR LED 40deg 40 degree viewing angle. Bright and tuned to 940nm wavelength.
- 38khz IR Receiver Receives IR signals at remote control frequencies
- PN2222 Transistor Transistor to help drive IR LED
- 10k Ohm resistor Resistor that goes between rPi GPIO and the PN2222 transistor

If you don't already have wires and a breadboard to prototype with, you may be interested in:

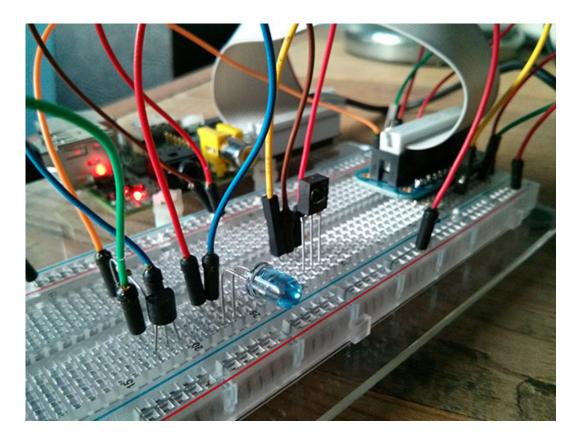
- Mounting plate + breadboard A mounting plate + breadboard for your RaspberryPi
- Adafruit Pi Cobbler Breakout Kit Breakout kit for getting the GPIO pins onto the breadboard
- Breadboard wire bundle Bundle of wires to use in the breadboard

For this project I wired up the IR LED to GPIO pin 22 and the IR Receiver to GPIO pin 23. You'll see that mentioned in the /etc/modules file above.

Please check out these diagrams for information and schematics about how to wire everything up:

- RasperryPi IR Schematic for LIRC My own schematic, which I've been using myself.
- RaspberryPi lirc rpi Contains hardware and schematics for the raspberryPi
- TV-B-Gone Schematic Info on wiring up IR leds / receivers
- GPIO pinout for RaspberryPi GPIO pinout diagram

Here's a picture of my initial schematic (<u>view the updated one here</u>) wired up to my RaspberryPi with all of the components tested and working:



Testing the IR receiver

Testing the IR receiver is relatively straightforward.

Run these two commands to stop lircd and start outputting raw data from the IR receiver:

```
sudo /etc/init.d/lirc stop
mode2 -d /dev/lirc0
```

Point a remote control at your IR receiver and press some buttons. You should see something like this:

```
space 16300
pulse 95
space 28794
pulse 80
space 19395
pulse 83
space 402351
pulse 135
space 7085
pulse 85
```

space 2903

If you don't, something is probably incorrectly configured. Triple check that you've connected everything properly and haven't crossed any wires. I highly recommend referring to the schematics I linked to above. There is also some trouble shooting advice in the RaspberryPi Forum thread I linked to above. Finally - you may want to do this in a dark room. I found that my desk lamp and overhead light would cause the IR receiver to think it was receiving valid signals.

Testing the IR LED

You're going to need to either find an existing LIRC config file for your remote control or use your IR receiver to generate a new LIRC config file. In my case I created a new LIRC config file. To do this, read the documentation on the <u>irrecord</u> application that comes with LIRC.

When using irrecord it will ask you to name the buttons you're programming as you program them. Be sure to run irrecord --list-namespace to see the valid names before you begin.

Here were the commands that I ran to generate a remote configuration file:

```
# Stop lirc to free up /dev/lirc0
sudo /etc/init.d/lirc stop
```

```
# Create a new remote control configuration file (using /dev/lirc0) and save the output to ~/lircd.conf
irrecord -d /dev/lirc0 ~/lircd.conf

# Make a backup of the original lircd.conf file
sudo mv /etc/lirc/lircd.conf /etc/lirc/lircd_original.conf

# Copy over your new configuration file
sudo cp ~/lircd.conf /etc/lirc/lircd.conf

# Start up lirc again
sudo /etc/init.d/lirc start
```

Once you've completed a remote configuration file and saved/added it to /etc/lirc/lircd.conf you can try testing the IR LED. We'll be using the <u>irsend</u> application that comes with LIRC to facilitate sending commands. You'll definitely want to check out the documentation to learn more about the options irsend has.

Here are the commands I ran to test my IR LED (using the "yamaha" remote configuration file I created):

```
# List all of the commands that LIRC knows for 'yamaha'
irsend LIST yamaha ""

# Send the KEY_POWER command once
irsend SEND_ONCE yamaha KEY_POWER

# Send the KEY_VOLUMEDOWN command once
irsend SEND_ONCE yamaha KEY_VOLUMEDOWN
```

I tested that this was working by pointing the IR led at my Yamaha receiver and testing whether I could turn it on and adjust the volume.

Success!

That's it! You've now successfully installed and configured LIRC on your RaspberryPi. You can add additional remote control configuration files to your /etc/lirc/lircd.conf file to control multiple remotes.

Resources

Here's a few resources to explore if you'd like to learn more:

- <u>lirc</u> LIRC home page
- RaspberryPi lirc rpi GPIO driver ar0n's lirc_rpi page
- LIRC GPIO driver for homebrew adapter
- TV-B-Gone Schematic

My next steps

The next step for my web controlled universal remote project is going to be finding or creating remote files for all of the IR devices in my house. Once I've gathered all of those files together and placed them in the lircd.conf file I'll begin work on the web application server.

I'll cover all of that in a future post.

Questions? Comments?

Please let me know if you have any questions or run into any trouble while running through these steps. All of these steps were tested and working on the date this post was published.

Posted by Alex Bain Jan 6th, 2013 raspberrypi



« RaspberryPi Quickstart Use your RaspberryPi to power a company dashboard »

Comments





Join the discussion...



Taavi • 2 years ago Hi Alex,

Thank you for your good instructions to set up IR -communication with Raspberry.

I did as in your instructions, but when I write: "sudo /etc/init.d/lirc start" -command I will get following messages:

"No valid /etc/lirc/lircd.conf has been found..

Remote control support has been disabled..

Refonfigure LIRC or manually replace /etc/lirc/lircd.conf to enable.."

After this when I try to start IR reception nothing happens. Raspberry doesn't detect anything. When I look to lircd.conf file there seems to be only some comments. Should there be some commands? Any help? Thanks in advance!

5 ^ V • Reply • Share >



abhilaksh → Taavi • 2 years ago

Hey. You'll need to upgrade the firmware on your pi - there's a link in alex's post that takes you through the process. :)

```
Reply • Share >
```



Dan → abhilaksh • a year ago

I have encountered the same problem but I have the latest firmware. Any ideas?

```
Reply • Share >
```



alexbain Mod → Dan · a year ago

Sounds like you still need to use irrecord to program in your remote controls? An invalid lirc configuration file would prevent lirc from starting.

What error message are you getting?



Dan → alexbain • a year ago

Hi Alex,

I was having the same problems as Taavi. When I ran "mode2 -d /dev/lirc0" I got a permission denied error and when I added sudo I just got nothing. Turns out I had the IR receiver wired backwards. I probably misinterpreted your schematic (I'm pretty new at all this) but I think you have the VCC and OUT pins reversed (Also using a TSOP38238). So basically I had the software side working properly, just a couple crossed wires on the hardware side.

Working great now! Thanks for your reply!

```
1 ^ V · Reply · Share >
```



Aprel • a year ago

For anyone doing an IR emitter/blaster project: a timing bug in the RaspPi kernel breaks irsend. This bug was reported in Feb 2014 and was patched in May 2014, but it will still be some time before the fix is incorporated into the stable release.

If the output of `uname -rv` contains a date between Jan 2014 and May 2014, and/or you're having problems with irsend, you must update to the latest kernel. Run `sudo apt-get update` `sudo apt-get upgrade` and `sudo rpi-update` (in that order), and then reboot.

Here's the issue on github: https://github.com/raspberrypi...

```
2 ^ | V • Reply • Share >
```



alexbain Mod → Aprel • a year ago

Thank you for posting this. I had no idea, and one or two people have definitely reported problems.



nilesh gohel • a year ago

thanks for the info. in your web site

i have done all the step

but last 4 step are not run

```
1 ^ V • Reply • Share >
```



san • 2 years ago

Hi Alex,

Thanks for this detailed information on LIRC configuration. I wanted to have lirc on my Pandaboard ES. Searched for modules lirc_panda but found nothing.

Pandaboard running "Linux home 3.4.0-1490-omap4 #8-Ubuntu SMP PREEMPT Tue Apr 2 17:22:09 UTC 2013 armv7l armv7l GNU/Linux"

I am not sure is there any special configuration required.

Thanks for your instructions.

```
1 ^ V • Reply • Share >
```



alexbain Mod → san • 2 years ago

Hi San,

I don't have a Pandaboard so I'm not sure what it would take to get LIRC working. You'll probably need some kind of low level device driver that LIRC can use to communicate with an IR transceiver over GPIO pins.

If you figure it out, please share the solution!

```
Reply • Share >
```



Pirion • 3 years ago

I follow your tuto and I have a problem.

when I use irw my IR receiver understand my remote.

But when want send signal with my IR led with:

Irsend SEND_ONCE SONY STANDBY nothing append, my TV don't poweroff.

At first I think my led doesn't work so I use a camera and the led blink.

Have you got some idea?



Pirion → Pirion → 3 years ago

it seem that my ir led it's always switch on



alexbain Mod → Pirion → 3 years ago

Interesting. I'm not sure why that's happening. It's possible that the command LIRC has stored for standby is wrong, or something is amiss with the LEDs? Has it ever worked, and what transistor/FET are you using to switch the LED with?



Sanjay • 7 months ago

So I got my receiver to work fine and that's looking good but I can't seem to get my irsend stuff to work. I honestly have no idea where the problem is happening (hardware or software) but I do get the feeling that my problem is happening on the pi output (I don't think it is but I don't have a reliable way of checking tonight). I've checked my circuit quite a few times through and upgraded my RPi firmware (that seemed to be a common problem from irsend) but I have no idea what to try next. I was wondering if you had any troubleshooting tips for either the hardware or the Pi? Any help is greatly appreciated as I just don't know how to test my IR LEDs to see if the hardware circuit is working (would the LEDs be pulsed long enough to be visible if I were to temporary swap out for color LEDs? I guess there would have to be a current consideration if I were to do that). So yeah, just any advice to track down any problems would be great!:) Thanks!

1 ^ V • Reply • Share >



Sanjay → Sanjay • 7 months ago

So I swapped in a regular LED just for the hell of it to see if it would blink when I tried irsend and it did. So I'm thinking that its sending the signals fine but for some reason, they aren't being received. Do you have any ideas on how to "boost" reception? Some people in the comments mentioned sending the signal twice in the config file but I don't really know how to do that.



Sanjay → Sanjay → 7 months ago

So I figured it out by reading some of the Raspberry Pi forums. To anyone using the Pi 2 and LIRC, make sure you enter the command 'rpi-update' as well. Otherwise, you won't be able to utilize the transmit functions of LIRC (your output pin will put out very sporadic impulses instead of a true IR signal).

1 ^ V • Reply • Share >



Alan Yang → Sanjay • 7 months ago

Hey dude, thank you so much for posting this... I was seeing the same thing as you and for hours I fretted over my wiring and such. Then I saw this post and following your instructions, it worked for me. You've saved me many hours, Cheers!

Reply • Share >



Sanjay → Alan Yang • 7 months ago

Of course! Glad I could help!

Reply • Share >



noblestreet → Sanjay • 7 months ago

Hi Sanjay,

Do you have a schematic for the working setup? I have searched the web and followed quite a couple of setup ups, but you are the first i read that has a working IR blaster with a PI 2. I followed Alex his post but i have a NPN instead of the PNP.

Your help will be very much appriciated.

thanks

Arnaud



noblestreet → Sanjay • 7 months ago

Hi Sanjay, I just got it to work on the PI2. Im using this setup (the LED in the link is should be hocked up the other way around) http://blog.riyas.org/2014/01/...

Thanks for you posts. It gave me the help i needed to fix it.

Reply • Share >



RPiNewbie • 5 days ago

Very cool idea! There are a few questions lingering in my mind though...

- 1. Just to confirm, this project DOES need to have the IR LED to point at the aircon receiver, isn't it?
- 2. If yes, then how is it possible to make the RPi work as a universal remote, I mean, if say, I record the remote buttons of

my TV too, in addition to the aircon, then i'll have to move the IR LED connected to my RPi, which is currently pointing to the aircon receiver, instead to the receiver of the TV, isn't it?



Sam • 23 days ago

Hey Alex,

Hopefully I'm not to late to the party, most things are working, but only once. If I try successfully, then stop

"sudo /etc/init.d/lirc stop"

and then start back up again with

"mode2 -d /dev/lirc0"

I'm given

"mode2: could not open /dev/lirc0

mode2: default_init(): Device or resource busy"

If needed I'm running a Pi b+ with whatever the latest firmware/software is.

any ideas? it's a miracle I got this far :)



Hagai Weinberg • a month ago

hi alex

thank u for the guide.

a try this with my pi and i success to recird and send my tv control

buy i try to irecord my air condition control, i get the conf but the air contition no power on.

can u help me?



Frederik Vagner Paiva • a month ago

Have you abandoned this project? I am curious to know how to turn my raspberry into a universal controller. I would like to know how do you send commands to another device.

```
Reply • Share >
```



kalaiyarasan • 3 months ago

Hi Alex.

I followed the tutor. i am not able to fire transmitter

i am getting following error

"

irsend: command failed: myRemote KEY_PAUSE

irsend: transmission failed"

Can you please help me reagrding this?

thanks,

kalai



SkyerCorp → kalaiyarasan • 2 months ago

I am also getting the same error. Have you been able to find a solution?



kalaiyarasan → SkyerCorp • 2 months ago

it means lircd.conf file is not having valid configuration.

Generate lircd.conf as described in log.

ш.

if you want to generate conf file using irrecord. below link will help you

http://www.ocinside.de/html/mo...

```
Reply • Share >
```



André Zibaia da Conceição • 4 months ago

Hi Alex,

First of all, thank you for your work on this! It is a very useful project!

Then, my problem: I am as newbie as newbie gets in what concerns electronics. I spent all day yesterday trying to build this project, but I could not do it...

I managed to get the IR receiver working, (the "mode2 -d /dev/lirc0" returns the IR pulse data) but I cannot get the IR emitter to work.

I used a breadboard and a V1 Raspberry Pi, tried all the possible configurations but, to every irsend command, the result is "transmission failed".

I don't think it is a software problem (after all, the receiver works) and I believe all the components are working, but I simply cannot get the thing to work...

Please find attached some pictures of my setup. Am I doing anything wrong? I am sure I am, but I cannot figure what. Can you please help me?

Thanks a lot and regards.

see more



BeeJayF • 4 months ago

Hello Alex!

1st off - thanks for the great tutorial - it worked just flawlessly with my old Pi 1.

As I tried it on my new Pi2 - same wiring - same modifications you mentioned in the /boot/config.txt and /etc/modules - the receiver still works well - but the IR LED will not fire - no matter what input file I use.

I checked the wiring using a simple python script making the LED blink - it's blinking just fine - but with lirc - nothing. Do you have any suggestions? Your help would be highly appreciated!

Thanks in advance, BJF



BeeJayF ⋅ 4 months ago

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I checked the wiring using a simple python script making the LED blink - it's blinking just fine - but with lirc - nothing. Do you have any suggestions? Your help would be highly appreciated!

Thanks, BJF

∧ | ∨ • Reply • Share >



alexbain Mod → BeeJayF • 2 months ago

Have you checked the LIRC configuration to be sure you've set the transmitter to use the right GPIO pin?

Reply • Share >



Arishy • 4 months ago

My problem is I do not have the original IR remote. An old Universal IR remote I had (Lost it too !!); has a SETUP key that you keep pressing until the device under test is switched off or on This way that little remote DISCOVERED the

protocol used by the device under test.

Can one emulate such function and let LARC spell out the unknown IR protocol then build a file for it. Am I pushing my luck here ???



Prashanth AB • 5 months ago

Hi Alex,

Thank you for the IR remote configuration tutorial. It was great and helped me a lot in my creation for a configuration files for TV and AC individually. However i am facing problems when I create configuration files for TV and AC simultaneously. Is it possible to control 2 different devices with the same LIRC package, if so can you please guide me how to do it. I really want to be able to control both my AC and TV simultaneously. Or please suggest any other technique which follows a completely different method to achieve the same.

Thanks in advance.



Jens → Prashanth AB • 5 months ago

To record a device you need a sperate config file. Afterwards just copy and paste the recorded "remote" paragraph (from begin remote to end remote) to your main config file. Then reload the daemon.

```
Reply • Share >
```



Prashanth AB → Jens • 5 months ago

but do you think 2 remotes of different frequencies can be contained in the same config file without changes in the hardware.conf file or any other files ?

```
Reply • Share >
```



alexbain Mod → Prashanth AB • 5 months ago

I believe so, yeah. Try it out and let us know how it goes.

```
Reply • Share >
```



Jens → Prashanth AB • 5 months ago

Of course I cannot guarantee you anything, bit feel free to try. It worked in my case with even more than two devices.

```
∧ | ∨ • Reply • Share >
```



Vinay Date → Jens • 3 months ago

It has worked in my case as well. But remote codes for one of the devices, are getting stuck in, sort of, a buffer. When I push irsend for another remote, they get flushed. Thus one irsend (for good behaving device) makes both devices to act. (The errant device receiving the earlier irsend, which it did not respond to, immediately)

```
Reply • Share >
```



Robert Arifin • 6 months ago

Can anyone help me? I I already installed the lirc and try to make the circuit using npn transistor. I also already record using the record command. My questions are :Why my ir led didn't want to turn on even though I use irsend command? I already tried using idle 3 program to turn on the transistor manually and it works.



alexbain Mod → Robert Arifin • 2 months ago

Is your LIRC configuration file setup to use the right GPIO pin for transmitting?



Jens • 8 months ago

Hello everybody,

I'd like to contribute something here, too. I wanted to control infrared devices as well as 433 MHz sockets from my phone. For the past year I've programed a client server application for raspberry pi and android to do that. Maybe some of you guys would take a look at it.

This is also based on Alex's instructions. So if you'd like to use infrared devices you still need to complete above steps. Switching devices from the command line has to work before you think about installing it.

http://server47.de/homecontrol...

(if you have the CAcert root certificate installed you can also use http://server47.de/homecontrol...

Read the documentation first. It certainly is NOT a one-click-installer, but requires quite some effort until it's running. The page has a board for questions, comments, etc..

Best regards,

Jens



alexbain Mod → Jens • 2 months ago

That's great, thanks for sharing this!



Mohamad Itani • 8 months ago

Hi Alex,

Thank you for your good instructions to set up IR -communication with Raspberry.

I am facing some problems when dealing with IRW. For some reason, mode2 is working but on IRW is not!!

Any help plz

```
Reply • Share >
```



alexbain Mod → Mohamad Itani • 2 months ago

What are the errors you're getting? You may also want to post to the LIRC mailing list.

```
Reply • Share >
```



J ⋅ 9 months ago

The irsend application link doesn't work? Having trouble finding info about the app

```
Reply • Share >
```



alexbain Mod > J • 9 months ago

I contacted the email at the bottom of lirc.org mentioning that the irsend page is 404ing. Hopefully they fix it soon.



Tony Goodhew • 9 months ago

Thanks for a LIRC install that works! I've found lirc to be the most difficult install yet! (It's so much harder to get working with a PI than an Arduino!)

I've been running irw to test the input and all the keys produce the correct output, with a bit of overrun onto the next line. I'm sure I can cope with this later.

My next problem is how to get Python to pick up the string of characters so that I can process the input.

How do you do this? I've no idea.

```
Reply • Share >
```



Marc W • 9 months ago

Hi.

for anyone wondering why LIRC does not work anymore after updating the raspberry firmware to 3.18.x using rpi-update:

Add this to your /boot/config.txt:

dtoverlay=lirc-rpi,gpio_in_pin=23,gpio_out_pin=22

After that, reboot your Raspberry Pi and everything should be okay. :) (See http://raspberrypi.stackexchan...

I wasted a lot of time today figuring out why the lirc_rpi module was missing and could not be inserted again until I found this solution, so I hope this saves you some time if someone has the same problem.

Apart from that: Great tutorial!

Marc



alexbain Mod → Marc W • 9 months ago

Aha, thanks for adding this! I've updated the post with this information.



Benjamin • 10 months ago

Hey Alex,

is there a possability to include a libary for 433 Mhz Transmitter? (For Example with One-Click Turn On the TV (IR) + Turn On Receiver (IR) + Select Channel (IR) + Turn On the lights (433)

I tried to use "pilight" but there it's not possible to use LIRC

What you do you think about?

Benjamin

Reply • Share >

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8 comments • 3 years ago

Max Ancolla — Thank you for the time you dedicate in writing this really useful guide.

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1 comment • 2 years ago

Te la meto en el abeto — Brilliant!

Undefined Macro: AC_PROG_LIBTOOL

1 comment • 3 years ago

Bryan — Thanks - saved me some time :)

RaspberryPi IR Schematic for LIRC

34 comments • 3 years ago

Adam — Hi, Thanks for the great posts! It's something I've been waiting to do for a long time. However, I was wondering how many LED's you can power at once, as I ...





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