Documentation for the clickyBoard

Download this document at github.com/SecretImbecile/clickyBoard

Contents

1 The clickyBoard

The *clickyBoard* is an add-on board for the Raspberry Pi computer (model B+ or later), which adds a simple switch and LED circuit for use in GPIO programming.

The clickyBoard has been designed to use Cherry MX series switches or compatible switches from other manufacturers, designed for use in keyboards that are widely available and cheaply purchased.

The board, through the Raspberry PI GPIO, provides four push-buttons inputs, as well as a single output through which you can control the four backlight LEDs under each key.

In addition to technical documentation, this document also includes a parts list and assembly guide, for users wishing to assemble their own clickyBoard from scratch, or kit form.

2 Parts Required

The following components are required to fully populate a clickyBoard:

- two $1k\Omega$ resistors
- four T1 (3mm) LEDs
- two/four resistors, of a value determined in subsection 2.2
- one TO-220 package logic level power MOSFET
- four Cherry MX compatible switches
- a female 40-pin connector for the Raspberry Pi GPIO header[1]

2.1 Mechanical Keyboard Switches

The clickyBoard has mounting holes for MX series or compatible switches. These are switches designed for use in premium computer keyboards, which are widely available, along with compatible keycaps.

Figure 1: A Cherry MX Blue switch

If you require quick delivery, the german manufactured *Cherry MX* series of switches are more readily available from several on-line retailers. In the United Kingdom, one possibility would be a computer hardware retailer like kustompcs.co.uk. In the US and internationally, wasdkeyboards.com specialises in mechanical keyboard parts. Cherry switches are likely to cost around £1 per switch.

If you're willing to wait for shipping from China, there are several manufacturers that make compatible switches, notably *Gateron* and *Kailh* switches. Gateron switches can be purchased on eBay for as little as 10 for £1.

There are several types of MX switch available, denoted by the colour of their centre plunger, as shown in Figure 1. We recommend blue coloured switches, for full authentic clickiness, but others are available. If possible, opt for 'PCB mount' switches (sometimes referred to as '5-pin'), as these have additional plastic pegs which will somewhat improve stability on the PCB.

[1] a 2×20 header with $2.54mm$ $(0.1")$ pitch

Switch Colour	Click	Tactile Bump	Heavy Spring
Blue	✓	✓	
Green	✓	✓	✓
Brown		✓	
Clear		✓	✓
Red			
Black			✓

2.2 LED and Resistor Choice

To fit within the housing of an MX compatible switch, a 3mm (T1) LED must be chosen.

To provide ample current, the LEDs on the clickyBoard are powered through the Raspberry Pi's 5 volt supply, with the LEDs arranged in two parallel series, as shown in Figure 2.

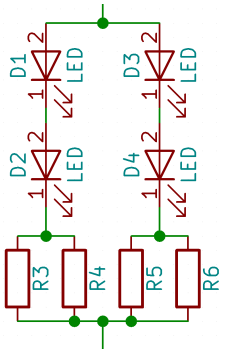


Figure 2: Wiring schematic for the four resistor sockets

The required resistance for the circuit can be calculated using the standard formula, where V_s is the supply voltage, and V_f is the forward voltage of the chosen LED.

$$R = \frac{V_s - V_f}{I}$$

As each half has two LEDs in series, the forward voltage used is double the value of a single LED. For the $2V$ $20mA$ LEDs used in the schematic, the resistance was calculated as follows.

$$R = \frac{5V - (2 \times 2V)}{20 \times 10^{-3}} = 50\Omega$$

The circuit can therefore be completed with two 50Ω resistors. Two additional spaces are provided, so four 100Ω resistors could be used if they are more readily available.

3 Assembly Guide

Soldering Basics

This guide will assume that the reader is familiar with basic soldering techniques. The components on the clickyBoard are all through-hole components, so it may be a suitable board for a novice solderer. Be aware that the 40-pin GPIO header can be tricky, especially with an old soldering iron, or thick gauge solder wire.

With that said, here are some resources for learning to solder. Video tutorials are well suited for soldering, as you'll need to be able to identify a good solder joint from a bad one.

- *Soldering basics and choosing a cheap soldering iron* (00:00–12:00), bigclive-dotcom — `https://www.youtube.com/watch?v=aIab66EgfHM`
- *EEVblog #183 - Soldering Tutorial Part 2*, EEVblog — `https://www.youtube.com/watch?v=fYz5nIHH0iY`

Resistors

For convenience, we always solder components from lowest height to highest, to maintain a steady PCB on which to work. Begin by soldering the two $1k\Omega$ resistors in slots `r1` and `r2`.

Next, solder the resistors for the LED array that you chose in subsection 2.2 into the sockets `r3`–`r6`. If you are using two resistors, ensure the circuit is completed1 in accordance to Figure 2.

MOSFET

Bend the legs of your TO-220 package MOSFET to a 90 degree angle and place it in the socket so that the large metal tab is flush with the PCB, then solder the three pins. You can optionally solder the tab to the plated mounting hole.

If you are **not** using a MOSFET to control the LEDs, you should jumper the two outermost pins with a piece of insulated wire or an $\approx 0\Omega$ resistor. Ensure that the jumper wire does not short with the centre contact pad.

Switches & LEDs

Erratum: LED pad direction

Please note that the solder pads for the LEDs are reversed. By convention, the square solder pad indicates the positive side of a diode. However, because of an update to the *KiCad* software, the pins in the component library were reversed. You should therefore solder the (longer) **positive** lead of the LEDs into the **circular** pads.

> *...all diodes in KiCad's standard libraries have seen their pin numbers swapped. This is to be in line with most other software and the IPC standard as well, which states that cathode should be pin 1.*[2]

Switch assembly

In MX style switches, the 3mm LED sits in a slot at the bottom of the switch, and the leads are fed through holes in the switch housing. It is recommended to place the LED in the switch, then inserting that complete assembly into the board to solder.

Ensure that the polarity of the LED is correct, and the switch is sitting flush with the board with the plastic peg(s) in their respective holes, then solder the connections of both the switch and LED.

40-pin GPIO header

To complete the *clickyBoard*, solder the 40-pin female header to the board, with the female socket on the reverse side of the board.

If you choose not to solder all of the pins, the following pins are required (GPIO board pinout numbering): `1 4 9 11 12 13 15 16`, omitting `11` if a MOSFET was not used.

[2] `https://forum.kicad.info/t/important-announcement-diode-pins-swapped-in-standard-kicad-libraries/820`

4 Example Code

The clickyBoard provides the following GPIO devices (all pins are GPIO board numbers):

- LED brightness control through pin **11**
- switch inputs through pins **12**, **13**, **15**, and **16**

The switch inputs require the internal GPIO pull-down resistors in the Raspberry Pi to be enabled. enable them by setting up the pins with the `pull_up_down` parameter set to `GPIO.PUD_DOWN`.

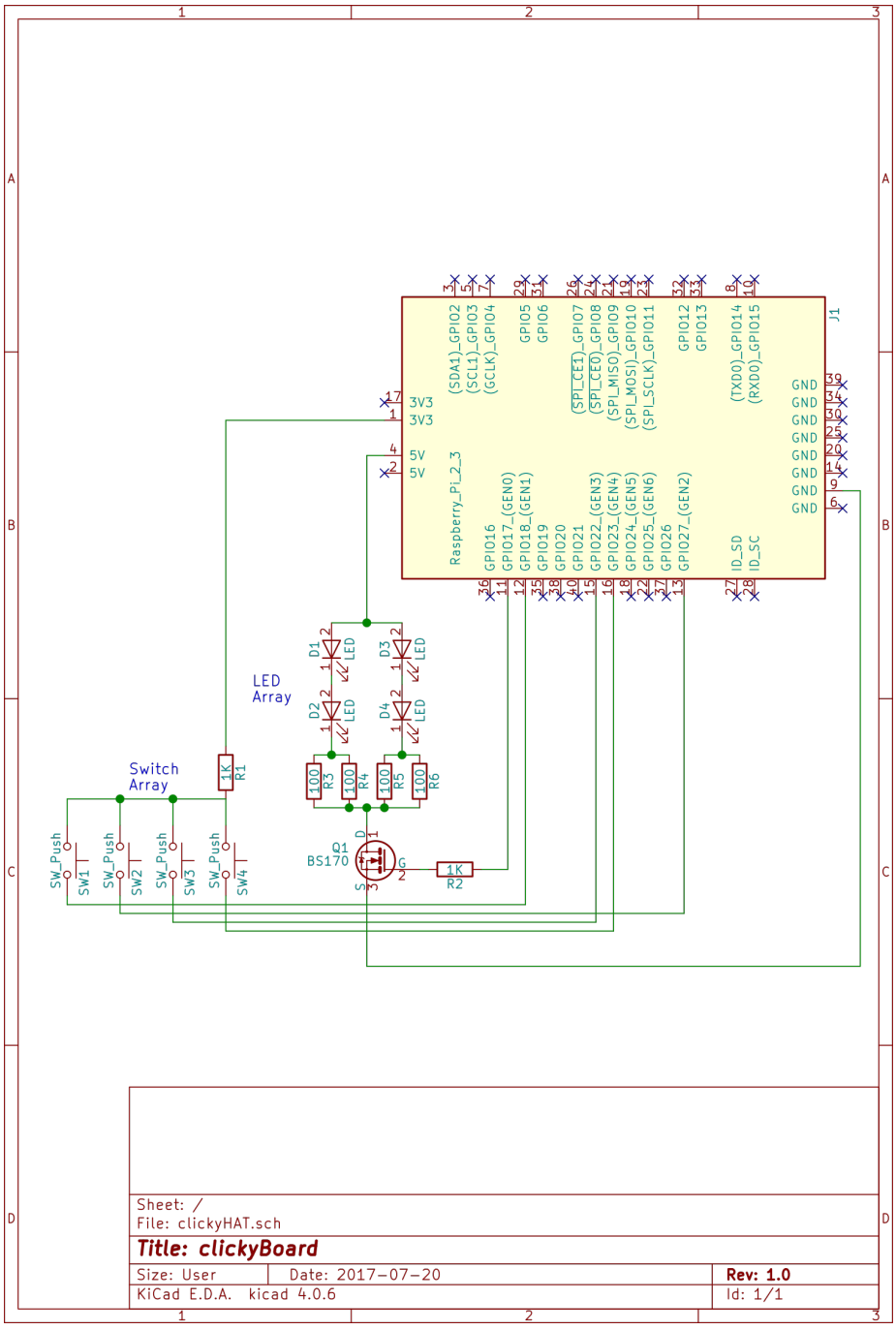
The following example Python program will demonstrate the functionality of the clickyBoard. (note that `GPIO.cleanup()` is not run following this program)

clickyboardtest.py

```
1  import RPi.GPIO as GPIO
2  import time
3
4  # Setup Pins
5  GPIO.setmode(GPIO.BOARD)
6
7  GPIO.setup(11, GPIO.OUT)
8  GPIO.setup(12, GPIO.IN, pull_up_down=GPIO.PUD_DOWN)
9  GPIO.setup(13, GPIO.IN, pull_up_down=GPIO.PUD_DOWN)
10 GPIO.setup(15, GPIO.IN, pull_up_down=GPIO.PUD_DOWN)
11 GPIO.setup(16, GPIO.IN, pull_up_down=GPIO.PUD_DOWN)
12
13 # Setup Backlight
14 pwm = GPIO.PWM(11, 60)
15 pwm.start(100)
16
17 while True:
18         #Create a count of the buttons being pressed
19         buttons_pressed = 0
20
21         if GPIO.input(12) == GPIO.HIGH:
22                 buttons_pressed += 1
23         if GPIO.input(13) == GPIO.HIGH:
24                 buttons_pressed += 1
25         if GPIO.input(15) == GPIO.HIGH:
26                 buttons_pressed += 1
27         if GPIO.input(16) == GPIO.HIGH:
28                 buttons_pressed += 1
29
30         #Reduce PWM brightness based on number of buttons
31         pwm.ChangeDutyCycle(100 - (25 * buttons_pressed))
32
33         time.sleep(0.1)
```

5 Technical Documentation

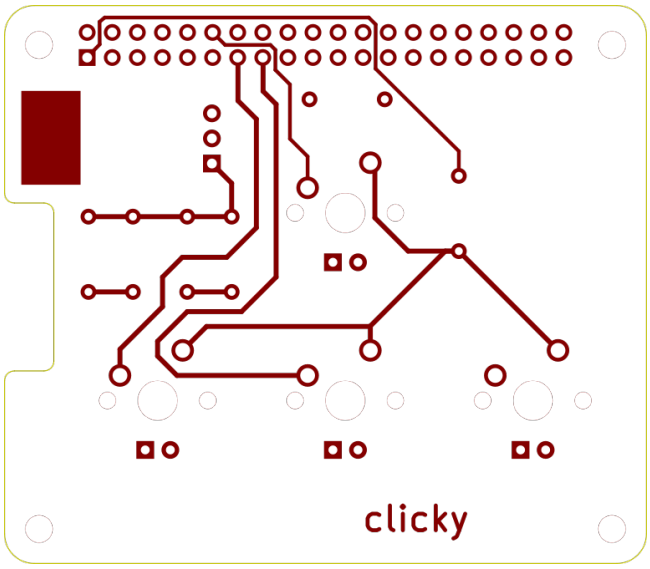
5.1 Schematic design for the clickyBoard



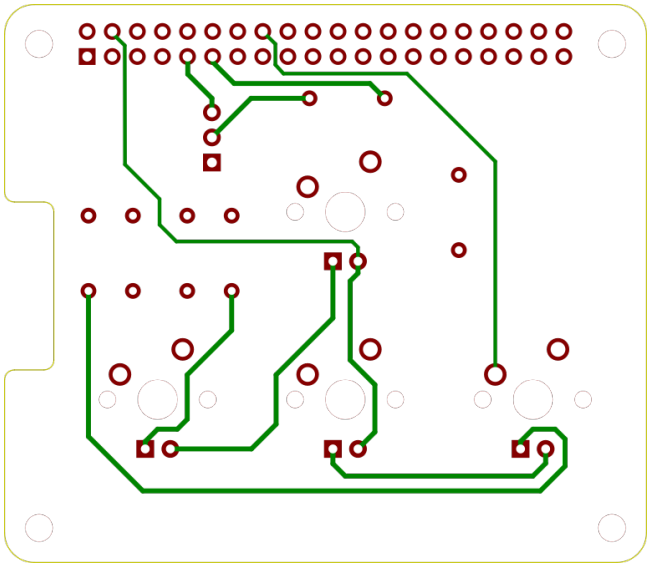
5.2 PCB layout for the clickyBoard

Gerber outputs (with additional layers) are available on the github repo.

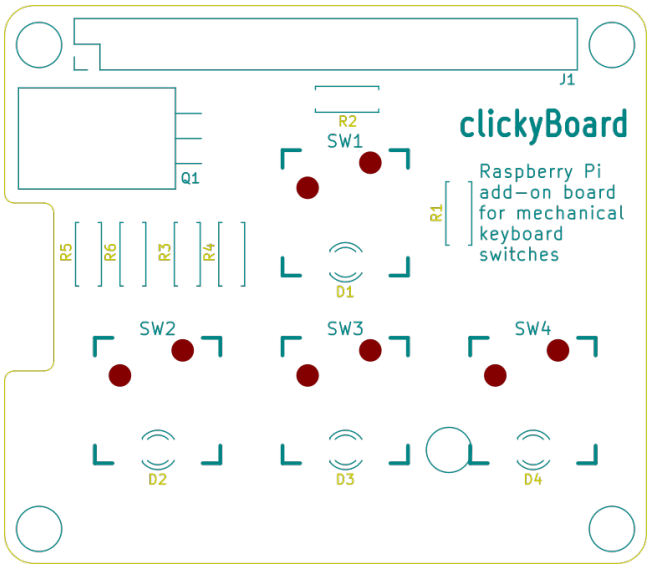
Front Copper



Back Copper



Front Silkscreen



5.3 Design rules for PCB

The design rules used for this PCB were as follows.

Clearance	Track Width	Via Size	Silkscreen line thickness
$0.2mm$	$> 0.375mm$	n/a	$> 0.15mm$

6 License

The complete hardware design for the clickyBoard, including the files made available on the clickyBoard Github repo and all documentation, are released in accordance with the Open Source Hardware (OSHW) Definition, under the **Creative Commons Attribution-ShareAlike 4.0 International (CC BY-SA 4.0)** license.

Every effort has been made to comply with the OSHW statement of principles. If you feel any aspect of the OSHW priciples have been neglected, please raise the issue with the creator (a github issue report would be suitable).