# PCB Construction Notes – 11 March 2024

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## PCB Costs

### Board Size

142 mm x 110 mm = 15620 mm2 = 24.211048 sq in

### Trace Width and Copper Thickness

By formulas from IPC-2221, PCB Trace Width Calculator can estimate the width of copper PCB boards and the trace required under the given current, and at the same time keep the rise in trace temperature not to exceed the limit.

<https://www.pcbway.com/pcb_prototype/trace-width-calculator.html>

(See Table x)

|  |  |  |  |
| --- | --- | --- | --- |
| Current (I) (A) | Thickness (t) (oz/ft2) | Temperature Rise (TRise) (°C) | Trace Width (W) (mm) |
| 5 | 1 | 10 | 2.766 |
| 5 | 1 | 15 | 2.162 |
| 5 | 1 | 20 | 1.816 |
| 10 | 1 | 10 | 7.192 |
| 10 | 1 | 15 | 5.625 |
| 10 | 1 | 20 | 4.724 |
| 15 | 1 | 10 | 12.586 |
| 15 | 1 | 15 | 9.840 |
| 15 | 1 | 20 | 8.264 |
| 20 | 1 | 10 | 18.716 |
| 20 | 1 | 15 | 14.633 |
| 20 | 1 | 20 | 12.289 |
| 5 | 2 | 10 | 1.383 |
| 5 | 2 | 15 | 1.081 |
| 5 | 2 | 20 | 0.908 |
| 10 | 2 | 10 | 3.597 |
| 10 | 2 | 15 | 2.812 |
| 10 | 2 | 20 | 2.362 |
| 15 | 2 | 10 | 6.293 |
| 15 | 2 | 15 | 4.920 |
| 15 | 2 | 20 | 4.132 |
| 20 | 2 | 10 | 9.358 |
| 20 | 2 | 15 | 7.317 |
| 20 | 2 | 20 | 6.144 |

Table 1: PCB Trace Width Calculations

## PCB Manufacturers

### OSH Park

* US Based PCB Manufacturer
* Website located at: <https://oshpark.com/>
* Best service to use is **2 Layer 2ox 0.8 mm Service**
  + Details are located here: <https://docs.oshpark.com/services/two-layer-hhdc/>
  + Write-up: *A special stackup intended for a variety of high-power and low weight circuit designs. This service features a 0.032” (0.8mm) thick PCB, and includes 2oz (2.8mil, 70um) copper. That’s half the thickness of our Prototype service, and with twice the copper!*
  + $5 per square inch for 3 copies.
* Can use KiCad – the setup details for KiCad are located here:
  + <https://docs.oshpark.com/design-tools/kicad/>,
  + and <https://docs.oshpark.com/design-tools/kicad/kicad-design-rules/>
* The details to find this page are:
  + Go to: <https://oshpark.com/>
  + Select **Design Tool Help**
  + Select **KiCad Open Source**
  + Select **Design Rule Setup**
* One the PCB is designed in KiCad, do the following:
  + Open the design in KiCad
  + Open the PCB Editor
  + File → Fabrication Outputs → Gerbers
  + Select Generate Drill Files
  + Select Generate Drill File
  + Select Plot
  + The above will create the GERBER files needed for processing
  + Zip the file
  + Go to the OSH Park website: <https://oshpark.com/>
  + Select under “Lets get started!” the site **Browse For Files**

A screenshot of a computer

Description automatically generated

### PCBWay

* China PCB Prototype & Fabrication Manufacturer
* Website currently down: <https://www.pcbway.com/>
* PCB can be ordered via the KiCad plugin see: <https://www.pcbway.com/blog/News/PCBWay_Plug_In_for_KiCad_3ea6219c.html>
* This website can be also accessed as follows:
  + Go to: <https://www.pcbway.com/>
  + Go **Product & Capabilities**
  + Under **Online Tool** select **KiCad Plugin**
* Design the PCB in KiCad
* Open the PCB Editor
* Place and parts and connection in PCB Editor
* When finished select the PCB icon (in the right top corner)



* This will upload the PCB file to PCBWay and give you a quote.

A screenshot of a shipping list

Description automatically generated

## 2023 Schematics



Figure 1: 2023 Schematic of current regulator circuit from Handover Document.

A close-up of a device

Description automatically generated

Figure 2: The final circuit of prototype 1 current regulator.

|  |  |  |
| --- | --- | --- |
| Part | Description | Rating |
| HV9910C | The main chip that acts as the regulator. | 15V-450V, max temp of 125C |
| Resistor R1 | Resistor that connects to pin 8 of the chip (RT) | 240 k |
| Resistor R2 | Resistor that is used to step down the voltage to 5V | 18 k |
| R3 (potentiometer) | Help adjust the amount of current required. | 1k |
| Resistor R4 | Connected to the potentiometer | 18k |
| Resistor R5 |  | 17k |
| Resistor R6 | A surface mount style resistor | 50m |
| Resistor R7 | A surface mount styled resistor | 50m |
| Capacitor C1 \*(C2) | Connects to pin 6 of the chip (VDD) | 1 |
| Capacitor C2 \*(C3) | Connects to pin 7 (LD) of the chip | 0.1 |
| Capacitor C3 \*(C4) |  | 330 , 63V |
| Capacitor C4 \*(C5) | Connects to pin 1 (Vin) of the chip | 0.1 |
| Capacitor C5 \*(C6) | Added before current enters the panel | 1 |
| Zener diode |  | - |
| Switch | Normal 5V switch to activate the circuit | - |
| MOSFET | Used to connect the chip to the circuit and panel | 100V, 45A rating |
| Diode D2 | Schottky styled rectifier | 100V, 20A |
| Inductor L1 | Toroidal styled inductor | 380 |

Table 2: Parts used in the circuit with details of most parts.

\*(N.B Capacitor references in brackets denote those used in the 2023 schematic given in Figure 1.)

|  |  |  |  |
| --- | --- | --- | --- |
| **element14 Part Num.** | **Qty. ordered** | **Product description** | **Mnfr Part #** |
| [**2448503**](http://au.element14.com/jsp/search/productdetail.jsp?sku=2448503&CMP=i-55c5-00001622) | 10 | HV9910CLG-G UNIVERSAL HIGH BRIGHTNESS LED DRIVER | HV9910CLG-G |
| [**1200369**](http://au.element14.com/jsp/search/productdetail.jsp?sku=1200369&CMP=i-55c5-00001622) | 5 | OAR3 - R025FI RESISTOR, 1% 0R025 | OAR3 - R025FI |
| [**9566872**](http://au.element14.com/jsp/search/productdetail.jsp?sku=9566872&CMP=i-55c5-00001622) | 2 | LTO030FR0100JTE3 RES, 0R01, 5%, 30W, TO-220, THICK FILM | LTO030FR0100JTE3 |
| [**2675797**](http://au.element14.com/jsp/search/productdetail.jsp?sku=2675797&CMP=i-55c5-00001622) | 3 | MBR20100CT SCHOTTKY RECTIFIER, 20A, 100V, TO-220AB | MBR20100CT |
| [**2480793**](http://au.element14.com/jsp/search/productdetail.jsp?sku=2480793&CMP=i-55c5-00001622) | 5 | IPA086N10N3GXKSA1 MOSFET, N-CH, 100V, 45A, TO-220FP-3 | IPA086N10N3GXKSA1 |
| [**1864223**](http://au.element14.com/jsp/search/productdetail.jsp?sku=1864223&CMP=i-55c5-00001622) | 3 | MCAP115018062A-381MU INDUCTOR, 380UH, 20%, 2 PINS | MCAP115018062A-381MU |
| [**1643092**](http://au.element14.com/jsp/search/productdetail.jsp?sku=1643092&CMP=i-55c5-00001622) | 1 | ADB16 COPPER CLAD 1 SIDE 8/10 35µ, 100X160MM | ADB16 |
| [**2770338**](http://au.element14.com/jsp/search/productdetail.jsp?sku=2770338&CMP=i-55c5-00001622) | 1 | MC001810 HARD JUMPER WIRE, 22AWG, 140PC | MC001810 |
| [**1144713**](http://au.element14.com/jsp/search/productdetail.jsp?sku=1144713&CMP=i-55c5-00001622) | 5 | 50ZL100MEFC8X11.5 CAP, 100µF, 50V, 20% | 50ZL100MEFC8X11.5 |
| [**3796335**](http://au.element14.com/jsp/search/productdetail.jsp?sku=3796335&CMP=i-55c5-00001622) | 1 | MP008296 FUSE, AUTOMOTIVE, 15A, 80VDC | MP008296 |
| [**3796336**](http://au.element14.com/jsp/search/productdetail.jsp?sku=3796336&CMP=i-55c5-00001622) | 1 | MP008297 FUSE, AUTOMOTIVE, 20A, 80VDC | MP008297 |
| [**3796337**](http://au.element14.com/jsp/search/productdetail.jsp?sku=3796337&CMP=i-55c5-00001622) | 1 | MP008298 FUSE, AUTOMOTIVE, 25A, 80VDC | MP008298 |

Using these parts, the first prototype of the circuit was built, which can be seen below.

### Detailed cost

|  |  |  |
| --- | --- | --- |
| Part | Source | Cost |
| HV9910C | Element 14 | $ 0.80 |
| Resistor | Recycled part | $ 0.00 |
| Capacitor | Recycled part | $ 0.00 |
| Diode | Recycled part | $ 0.00 |
| Switch | Recycled part | $ 0.00 |
| MOSFET | Element 14 | $ 3.05 |
| Inductor | Element 14 | $ 7.07 |
| Copper clad board | Element 14 | $ 8.46 |
| Battery | Client | $ 500.00 |
| RF Eval Kit | Client | $ 170.00 |
| Raspberry Pi Touchscreen | Client | $ 130.00 |
| SmartiPi Touch 2 | Client | $ 55.00 |
| SmartiPi Touch 2 Back cover | Client | $ 22.00 |
| Polycarb enclosure | Client | $ 27.00 |
| RaspberryPi HDMI Cable | Client | $ 10.00 |
| MC4TO4MM Test lead | Client | $ 90.00 |
| Anderson Plug for battery | Client | $ 15.00 |
| RaspberryPi Power supply | Client | $ 17.00 |
| Lens small | Client | $ 45.00 |
| Lens large | Client | $ 85.00 |
| Raspberry Pi HQ camera | Client | $ 85.00 |
| 32 GB SD Card | Client | $ 25.00 |
| HQ Camera Mount | Client | $ 11.00 |
| FlexCable 1m | Client | $ 13.00 |
|  | Total | $ 1319.38 |

## Low Current Connectors

### Jaycar

4 Pin 0.156in Header with crimp pins - 3.96mm Pitch

$1.45

7A Rating

<https://www.jaycar.com.au/4-pin-0-156in-header-with-crimp-pins-3-96mm-pitch/>

4 Pin 0.156in Straight Locking Header with crimp pins - 3.96mm Pitch

$0.80

7A Rating

<https://www.jaycar.com.au/4-pin-0-156in-straight-locking-header-with-crimp-pins-3-96mm-pitch/p/HM3444>

2 Pin 0.156in Header with crimp pins - 3.96mm Pitch

$0.55

7A Rating

<https://www.jaycar.com.au/2-pin-0-156in-header-with-crimp-pins-3-96mm-pitch/p/HM3432>

2 Pin 0.156in Straight Locking Header with crimp pins - 3.96mm Pitch

$0.55

7A Rating

<https://www.jaycar.com.au/2-pin-0-156in-straight-locking-header-with-crimp-pins-3-96mm-pitch/p/HM3442>

### Element 14

MULTICOMP PRO MP008495Pin Header, Wire-to-Board, 3.96 mm, 1 Rows, 4 Contacts, Through Hole Straight, MP 396

$0.307

<https://au.element14.com/multicomp-pro/mp008495/conn-header-4pos-1row-3-96mm/dp/3817346>

MULTICOMP PRO MP008504Connector Housing, MP 396, Receptacle, 4 Ways, 3.96 mm

$0.12

<https://au.element14.com/multicomp-pro/mp008504/connector-housing-rcpt-4pos-3/dp/3817358>

MULTICOMP PRO MP008493Pin Header, Wire-to-Board, 3.96 mm, 1 Rows, 2 Contacts, Through Hole Straight, MP 396

$0.154

<https://au.element14.com/multicomp-pro/mp008493/conn-header-2pos-1row-3-96mm/dp/3817344>

MULTICOMP PRO MP008502Connector Housing, MP 396, Receptacle, 2 Ways, 3.96 mm

$0.057

<https://au.element14.com/multicomp-pro/mp008502/connector-housing-rcpt-2pos-3/dp/3817356>

MULTICOMP PRO MP008511Contact, MP 396, Socket, Crimp, 18 AWG, Tin Plated Contacts

$0.059

<https://au.element14.com/multicomp-pro/mp008511/contact-socket-22-18awg-crimp/dp/3817366>

## High Current Connectors and Terminals

Red High Quality Binding Post

$3.75

<https://www.jaycar.com.au/red-high-quality-binding-post/p/PT0460>

Black High Quality Binding Post

$3.75

<https://www.jaycar.com.au/black-high-quality-binding-post/p/PT0461>

10A 240V 3AG Panel Mount Fuse Holder Round

$3.95

<https://www.jaycar.com.au/10a-240v-3ag-panel-mount-fuse-holder-round/p/SZ2025>

## LINX RF Module

RXM-433-LR

DigiKey Part Number: RXM-433-LR-ND $27.80

<https://www.digikey.com.au/en/products/detail/te-connectivity-linx/RXM-433-LR/613947>

Mouser No:712-RXM-433-LR $27.43

<https://au.mouser.com/ProductDetail/TE-Connectivity-Linx-Technologies/RXM-433-LR?qs=K5ta8V%252BWhtaoLY5zsCmDpA%3D%3D>

DC-DC Converter

<https://www.digikey.com.au/en/products/detail/mornsun-america-llc/k78u03-500r3/16571471>

<https://www.mornsun-power.com/html/pdf/K78U03-500R3.html>

LICAL-DEC-MS001

<https://au.mouser.com/ProductDetail/TE-Connectivity-Linx-Technologies/LICAL-DEC-MS001?qs=K5ta8V%252BWhtZnQHot4PEmsw%3D%3D>

<https://www.digikey.com.au/en/products/detail/te-connectivity-linx/LICAL-DEC-MS001-T/5592212>