SOLEIL

Advanced power and sleep control board for Raspberry Pi

Dec. 1 2024

Version v0.2

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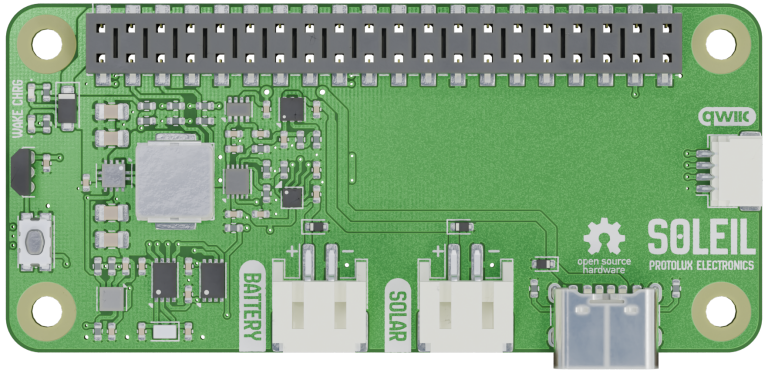


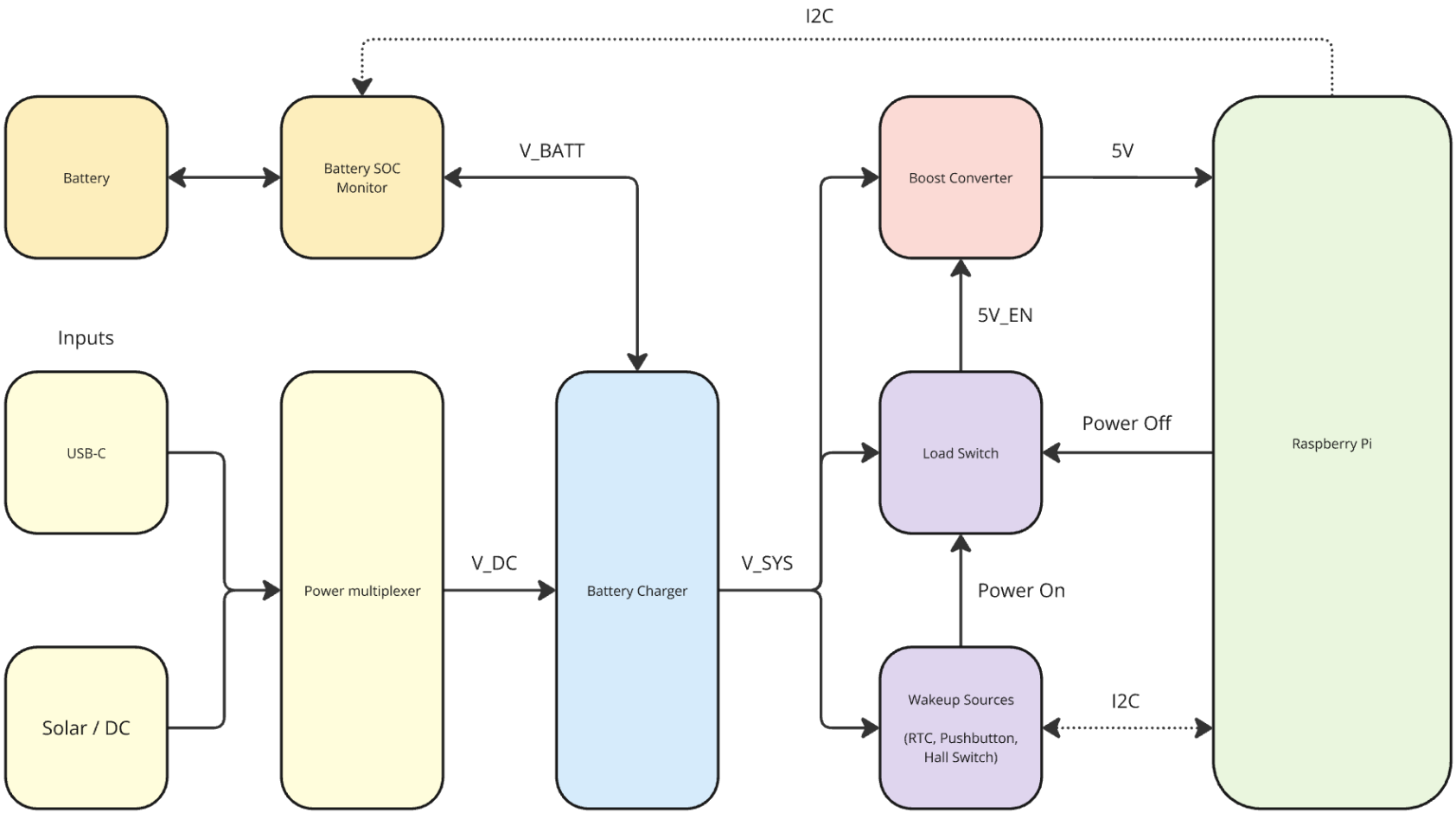
A power management system for Nerves, featuring low-power sleep mode, USB and solar battery charging, manual wake-from-sleep and support for NervesHub

Designed by Gus Workman

Sheet: /
File: soleil.kicad_sch

Title: Soleil

Size: A4	Date: 2024-12-01	**Rev:**
KiCad E.D.A. 9.0.0		Id: 1/11



Block diagram of Soleil

Designed by Gus Workman

Sheet: /Block Diagram/
File: block_diagram.kicad_sch

Title: Soleil

Size: A4	Date: 2024-12-01	**Rev:**
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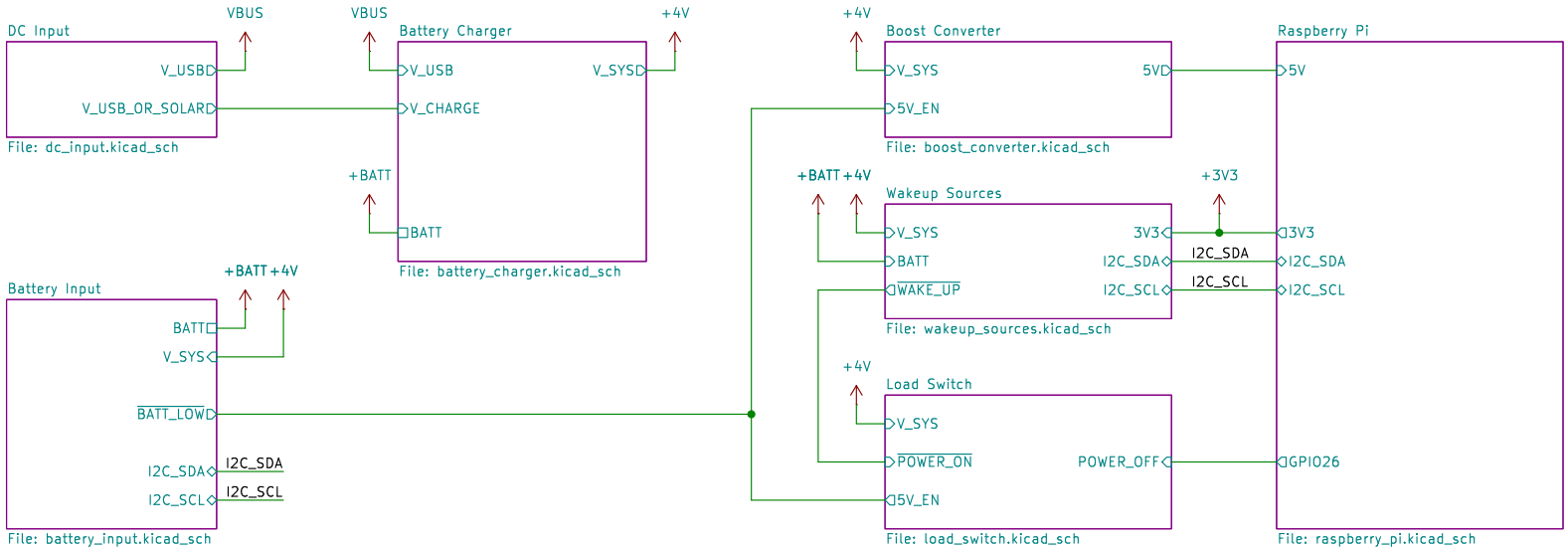


High level architecture of Soleil

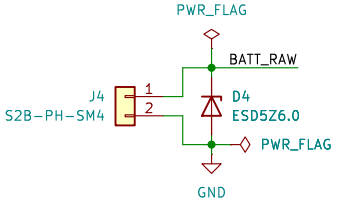
Designed by Gus Workman

Sheet: /Architecture/
File: architecture.kicad_sch

Title: Soleil

Size: A4	Date: 2024-12-01	**Rev:**
KiCad E.D.A. 9.0.0		Id: 3/11

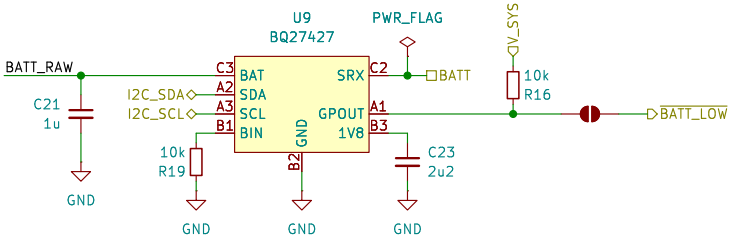
Battery Connector



Design Note:

The polarity and type of connector was chosen to support Adafruit lithium polymer batteries

Battery Fuel Gauge



Design Notes:

- I2C address is 0x55
- GPOUT must not be left left floating, 10k pullup recommended
- Do not let the I2C lines float when RPi is powered off
- Iq is 50uA, 9uA in sleep mode
- Auto sleep when low current (< 10 mA)

The value of GPOUT depends on the OpConfig[BATLOWEN] bit:
- OpConfig[BATLOWEN] == 0, SOC_INT function is selected (default)
- OpConfig[BATLOWEN] == 1, BAT_LOW function is selected

Battery connector, ESD protection, and fuel gauge

Designed by Gus Workman

Sheet: /Architecture/Battery Input/
File: battery_input.kicad_sch

Title: Soleil

Size: A4	Date: 2024-12-01	**Rev:**
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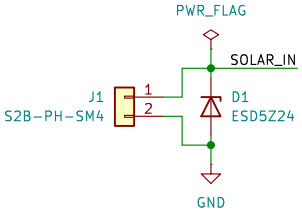
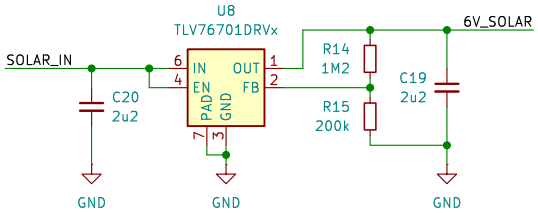
DC/Solar Connector



Design Note:

SOLAR_IN supports solar panels up to 16V

DC/Solar 6V LDO

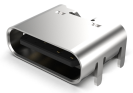


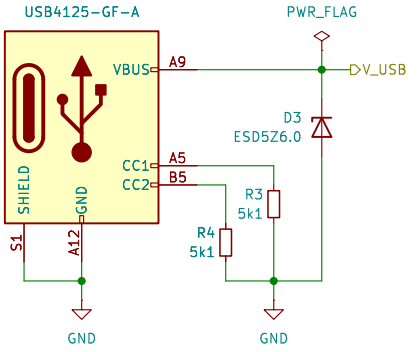
Design Notes:

The TLV767 linear regulator is used to lower voltages greater than 6V to the maximum voltage supported by the power multiplexer. For DC_IN < 6V, the output voltage tracks the input voltage.

- V_DC regulates to 5.6V
- V_dropout is 0.4V @ 500mA
- I_out up to 1A
- Iq is 50uA, 1.5 uA in shutdown

USB Connector

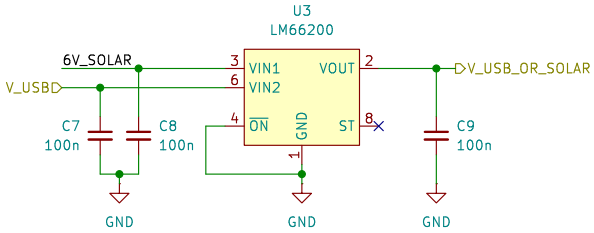




Design Note:

5k1 resistors on CC1 and CC2 to negotiate up to 1.5A @ 5V with USB power delivery sources

DC Power Multiplexer



Design Notes:

LM66200 performs power multiplexing, acting as two ideal diodes with cathodes tied together.

- Input voltages between 1.6V – 6.0V
- Up to 2.5A per channel
- Iq is 1.3uA when powered from VIN1

DC/Solar input connector, USB-C connector, ESD protection, DC input LDO, and power multiplexer

Designed by Gus Workman

Sheet: /Architecture/DC Input/
File: dc_input.kicad_sch

Title: Soleil

Size: A4	Date: 2024-12-01	**Rev:**
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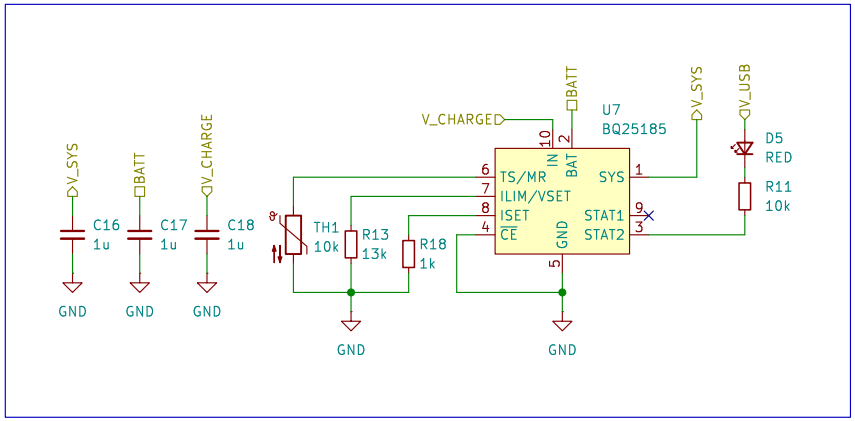
Battery Charger



Design Notes:

The BQ25185 is a lithium battery charger with dynamic power path management which makes it suitable for use with solar panels. SYS output is regulated and will be between 3.8V – 4.5V

- Input current limit of 1A (for both charging and powering system)
- Charge voltage set to 4.2V
- Disabled battery temperature monitoring (future version can connect TS/MR pin to NTC)
- Fast charge current set to 500mA
- Iq is 4uA in battery-only mode
- STAT2 open drain, low when charging. LED will light up while charging from USB

Battery charger and supporting circuitry

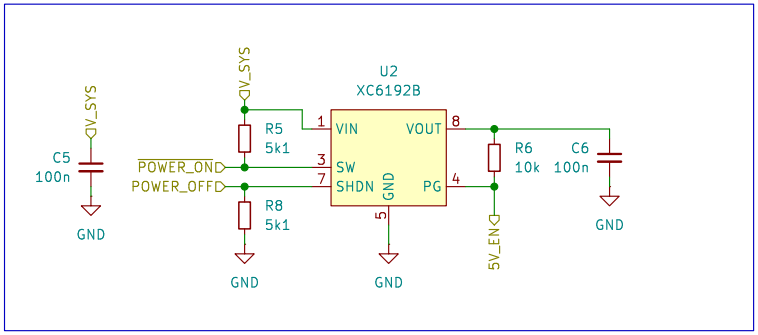
Designed by Gus Workman

Sheet: /Architecture/Battery Charger/
File: battery_charger.kicad_sch

Title: Soleil

Size: A4	Date: 2024-12-01	**Rev:**
KiCad E.D.A. 9.0.0		Id: 6/11

Load Switch



Design Notes:

XC6192B is an extreme low-power load switch with integrated button controller. When SW is pulled low, it enables VOUT. When SHDN is pulled low, it asserts low on PG and disables VOUT

- Iq is 10nA in shutdown
- POWER_ON pulled up, assert low to enable power output
- POWER_OFF pulled down, assert high to disable power output

Load switch and supporting circuitry

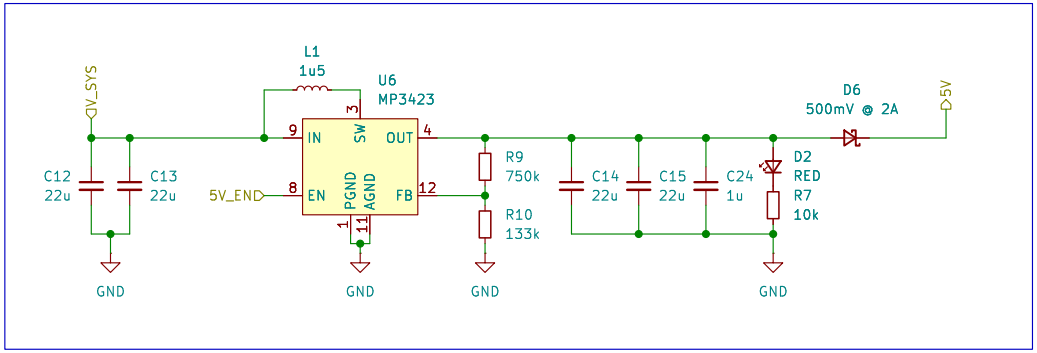
Designed by Gus Workman

Sheet: /Architecture/Load Switch/
File: load_switch.kicad_sch

Title: Soleil

Size: A4	Date: 2024-12-01	**Rev:**
KiCad E.D.A. 9.0.0		Id: 7/11

5V Boost Converter



Design Notes:

MP3423 is a 600kHz boost converter which operates between 1.9V – 5.5V with peak switching current of 9A and a high efficiency of up to 98%

- Boost to 5.35V, up to 3A
- 5.35V = 0.807 * (1 + R1 / R2)
- R1 should be > 600k
- Use low ESR capacitors
- Inductor should have low DCR and high peak current (up to 9A)
- Enabled when EN > 1.2V
- Iq is 43uA when enabled, 0.1uA in shutdown
- Diode dropout is about 350mV @ 200mA (the approximate idle current of RPi Zero 2W)

5V boost converter circuitry

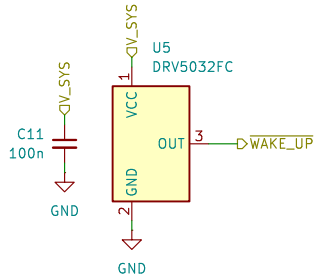
Designed by Gus Workman

Sheet: /Architecture/Boost Converter/
File: boost_converter.kicad_sch

Title: Soleil

Size: A4	Date: 2024-12-01	**Rev:**
KiCad E.D.A. 9.0.0		Id: 8/11

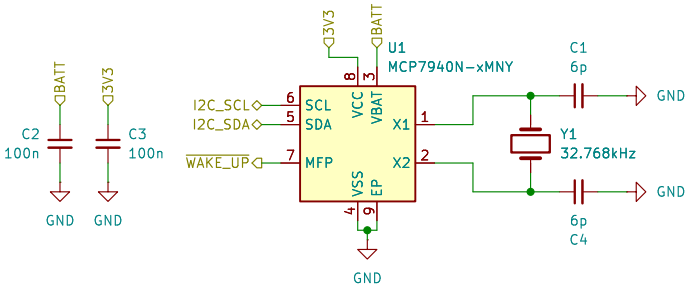
Hall Switch



Design Notes

- Open drain output
- 20 Hz refresh rate
- Iq is 1.3uA

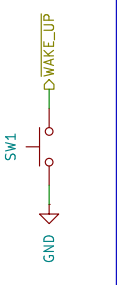
Real Time Clock



Design Notes:

- I2C address is 0x6F
- Iq is 0.925uA on battery backup
- Open drain alarm output on MFP is enabled in battery backup mode

Pushbutton



Open-drain wakeup sources

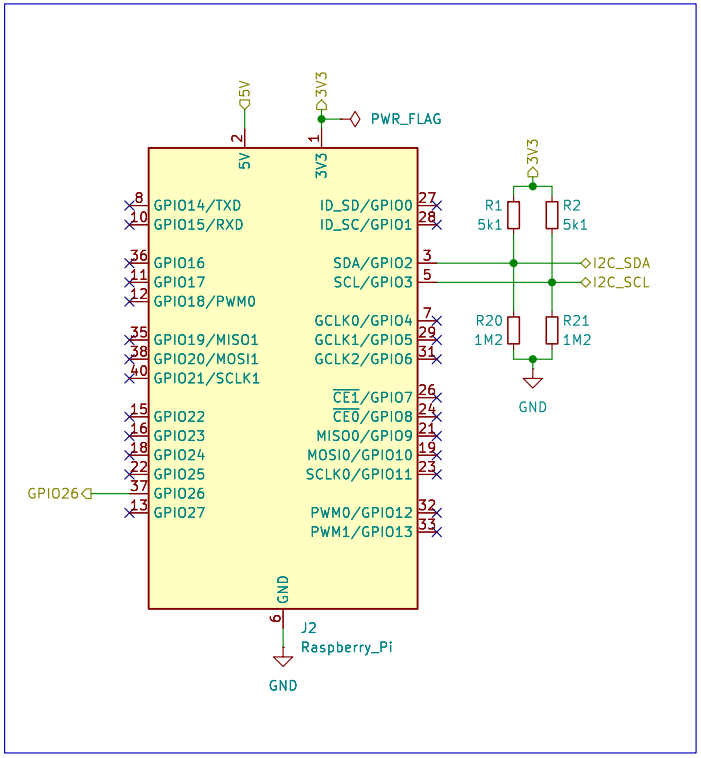
Designed by Gus Workman

Sheet: /Architecture/Wakeup Sources/
File: wakeup_sources.kicad_sch

Title: Soleil

Size: A4	Date: 2024-12-01	**Rev:**
KiCad E.D.A. 9.0.0		Id: 9/11

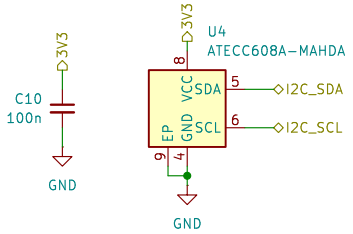
Raspberry Pi



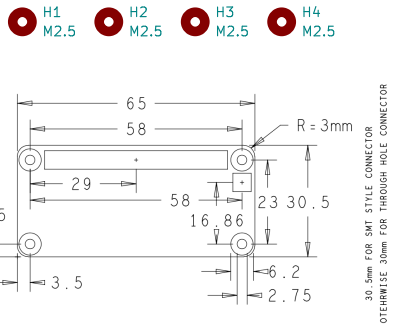
Design Notes:

- Raspberry Pi is powered by 5V, onboard regulator supplies 3.3V to board
- I2C pull up to 3.3V only when Pi is powered
- Weak pull-downs on I2C to prevent floating when sleeping
- GPIO26 is used for gpio-poweroff device tree overlay

NervesKey



Mounting Holes



Raspberry Pi, NervesKey and mechanical spec

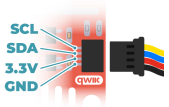
Designed by Gus Workman

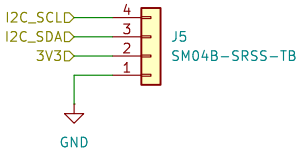
Sheet: /Architecture/Raspberry Pi/
File: raspberry_pi.kicad_sch

Title: Soleil

Size: A4	Date: 2024-12-01	**Rev:**
KiCad E.D.A. 9.0.0		Id: 10/11

Qwiic Connector





Qwiic connector. Add your custom I2C sensors here!

Designed by Gus Workman

Sheet: /Architecture/Qwiic/
File: qwiic.kicad_sch

Title: Soleil

Size: A4	Date: 2024-12-01	**Rev:**
KiCad E.D.A. 9.0.0		Id: 11/11