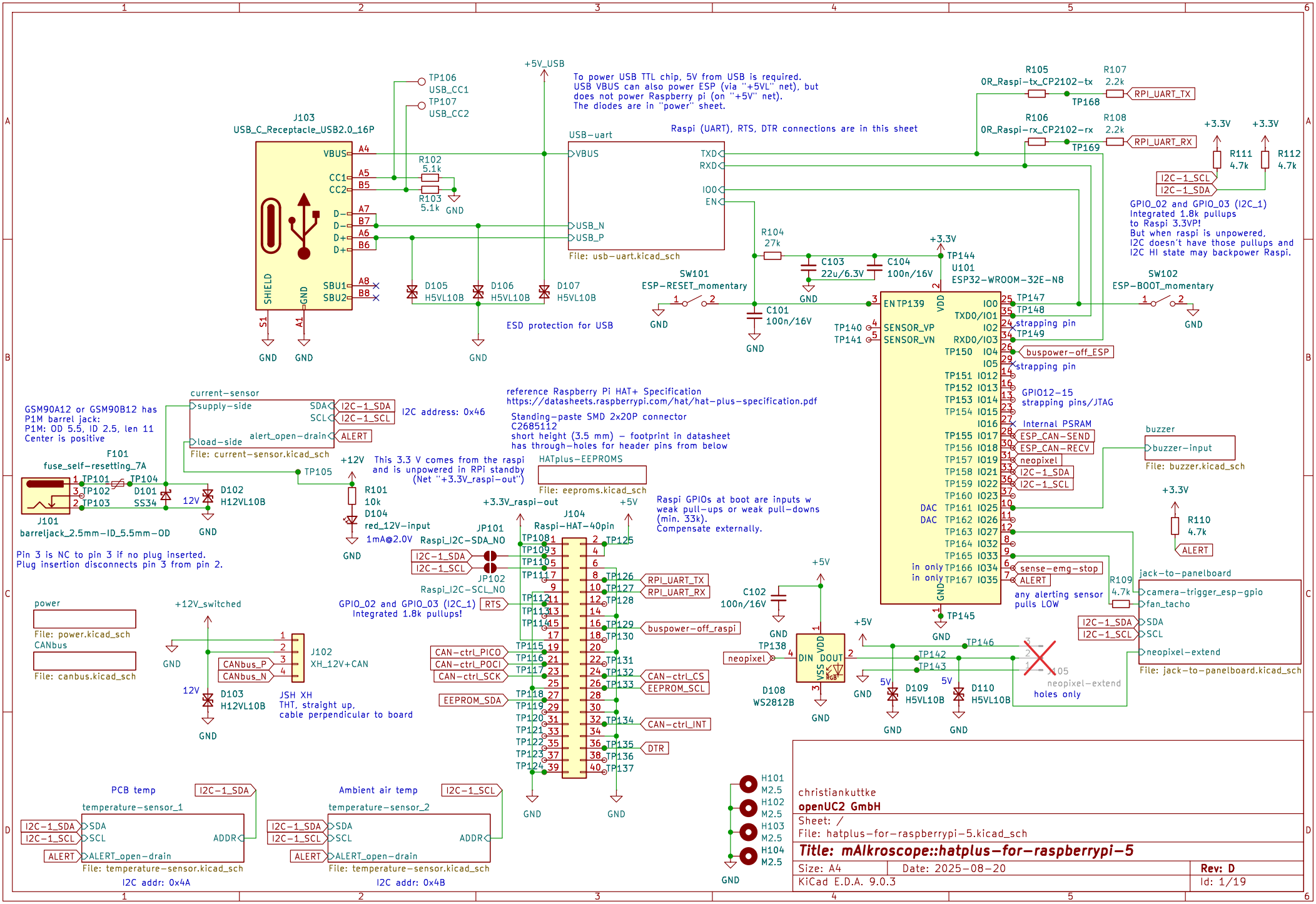
J103
USB_C_Receptacle_USB2.0_16P
TP106
USB_CC1
TP107
USB_CC2
+5V_USB
To power USB TTL chip, 5V from USB is required.
USB VBUS can also power ESP (via "+5VL" net), but
does not power Raspberry pi (on "+5V" net).
The diodes are in "power" sheet.
R102
5.1k
R103
5.1k
USB-uart
Raspi (UART), RTS, DTR connections are in this sheet
File: usb-uart.kicad_sch
R105
OR_Raspi-tx_CP2102-tx
R107
2.2k
RPI_UART_TX
TP168
R106
OR_Raspi-rx_CP2102-rx
R108
2.2k
RPI_UART_RX
TP169
+3.3V
R111
4.7k
R112
4.7k
I2C-1_SCL
I2C-1_SDA
GPIO_02 and GPIO_03 (I2C_1)
Integrated 1.8k pullups
to Raspi 3.3VP!
But when raspi is unpowered,
I2C doesn't have those pullups and
I2C HI state may backpower Raspi.
D105
H5VL10B
D106
H5VL10B
D107
H5VL10B
ESD protection for USB
SW101
ESP-RESET_momentary
SW102
ESP-BOOT_momentary
R104
27k
C103
22u/6.3V
C104
100n/16V
C101
100n/16V
U101
ESP32-WROOM-32E-N8
strapping pin
buspower-off_ESP
GPIO12-15
strapping pins/JTAG
Internal PSRAM
ESP_CAN-SEND
ESP_CAN-RECV
neopixel
sense-emg-stop
any alerting sensor
pulls LOW
current-sensor
File: current-sensor.kicad_sch
I2C address: 0x46
GSM90A12 or GSM90B12 has
P1M barrel jack:
P1M: OD 5.5, ID 2.5, len 11
Center is positive
F101
fuse_self-resetting_7A
J101
barreljack_2.5mm-ID_5.5mm-OD
Pin 3 is NC to pin 3 if no plug inserted.
Plug insertion disconnects pin 3 from pin 2.
D101
SS34
D102
H12VL10B
R101
10k
D104
red_12V-input
1mA@2.0V
This 3.3 V comes from the raspi
and is unpowered in RPi standby
(Net "+3.3V_raspi-out")
reference Raspberry Pi HAT+ Specification
https://datasheets.raspberrypi.com/hat/hat-plus-specification.pdf
Standing-paste SMD 2x20P connector
C2685112
short height (3.5 mm) - footprint in datasheet
has through-holes for header pins from below
HATplus-EEPROMS
File: eeproms.kicad_sch
JP101
Raspi_I2C-SDA_NO
JP102
Raspi_I2C-SCL_NO
J104
Raspi-HAT-40pin
Raspi GPIOs at boot are inputs w
weak pull-ups or weak pull-downs
(min. 33k).
Compensate externally.
GPIO_02 and GPIO_03 (I2C_1)
Integrated 1.8k pullups!
RTS
RPI_UART_TX
RPI_UART_RX
buspower-off_raspi
CAN-ctrl_PICO
CAN-ctrl_POCI
CAN-ctrl_SCK
CAN-ctrl_CS
EEPROM_SCL
EEPROM_SDA
CAN-ctrl_INT
DTR
power
File: power.kicad_sch
CANbus
File: canbus.kicad_sch
+12V_switched
J102
XH_12V+CAN
CANbus_P
CANbus_N
D103
H12VL10B
JSH XH
THT, straight up,
cable perpendicular to board
C102
100n/16V
D108
WS2812B
neopixel
D109
H5VL10B
D110
H5VL10B
X105
neopixel-extend
holes only
buzzer
buzzer-input
File: buzzer.kicad_sch
R110
4.7k
ALERT
R109
4.7k
jack-to-panelboard
camera-trigger_esp-gpio
fan_tacho
I2C-1_SDA
I2C-1_SCL
SDA
SCL
neopixel-extend
File: jack-to-panelboard.kicad_sch
PCB temp
temperature-sensor_1
I2C addr: 0x4A
Ambient air temp
temperature-sensor_2
I2C addr: 0x4B
H101
M2.5
H102
M2.5
H103
M2.5
H104
M2.5
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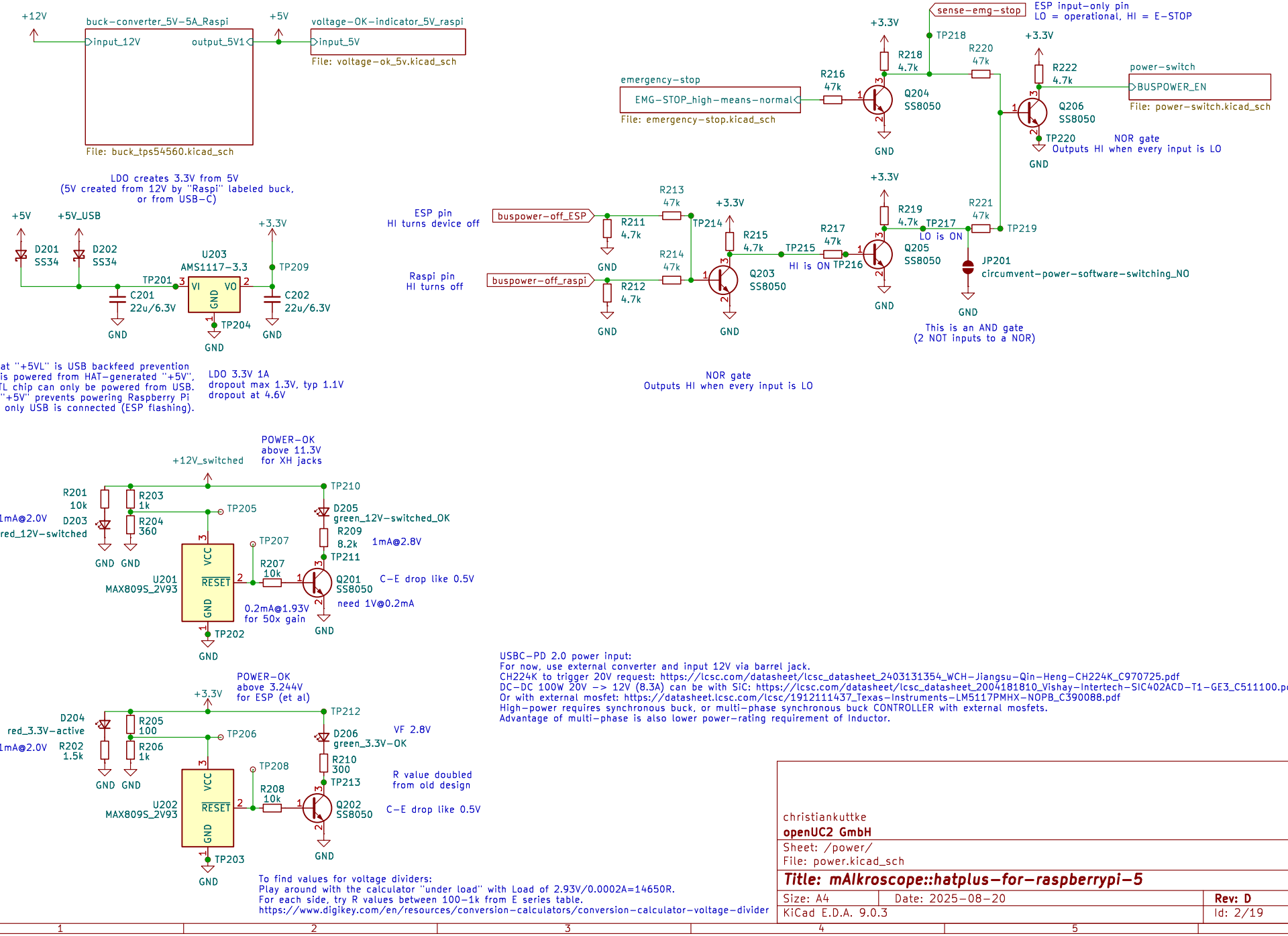
openUC2 GmbH
Sheet: /
File: hatplus-for-raspberrypi-5.kicad_sch
Title: mAlkroscope::hatplus-for-raspberrypi-5
Size: A4
Date: 2025-08-20
Rev: D
KiCad E.D.A. 9.0.3
Id: 1/19


+12V
buck-converter_5V-5A_Raspi
input_12V
output_5V1
+5V
voltage-OK-indicator_5V_raspi
input_5V
File: voltage-ok_5v.kicad_sch
File: buck_tps54560.kicad_sch
sense-emg-stop
ESP input-only pin
LO = operational, HI = E-STOP
+3.3V
TP218
R218 4.7k
R220 47k
R222 4.7k
power-switch
BUSPOWER_EN
File: power-switch.kicad_sch
emergency-stop
EMG-STOP_high-means-normal
File: emergency-stop.kicad_sch
R216 47k
Q204 SS8050
Q206 SS8050
TP220
NOR gate
Outputs HI when every input is LO
GND
LDO creates 3.3V from 5V
(5V created from 12V by "Raspi" labeled buck,
or from USB-C)
+5V
+5V_USB
D201 SS34
D202 SS34
U203 AMS1117-3.3
TP201
TP209
TP204
C201 22u/6.3V
C202 22u/6.3V
Diode at "+5VL" is USB backfeed prevention
when ESP is powered from HAT-generated "+5V",
and USB-TTL chip can only be powered from USB.
Diode at "+5V" prevents powering Raspberry Pi
if only USB is connected (ESP flashing).
LDO 3.3V 1A
dropout max 1.3V, typ 1.1V
dropout at 4.6V
ESP pin
HI turns device off
Raspi pin
HI turns off
buspower-off_ESP
buspower-off_raspi
R213 47k
R211 4.7k
R214 47k
R212 4.7k
TP214
R215 4.7k
TP215
HI is ON
R217 47k
TP216
Q203 SS8050
R219 4.7k
TP217
LO is ON
R221 47k
TP219
Q205 SS8050
JP201
circumvent-power-software-switching_NO
This is an AND gate
(2 NOT inputs to a NOR)
NOR gate
Outputs HI when every input is LO
POWER-OK
above 11.3V
for XH jacks
+12V_switched
R201 10k
1mA@2.0V
D203 red_12V-switched
R203 1k
R204 360
TP205
TP207
R207 10k
U201 MAX809S_2V93
VCC
RESET
GND
TP202
TP210
D205 green_12V-switched_OK
R209 8.2k
1mA@2.8V
TP211
Q201 SS8050
C-E drop like 0.5V
need 1V@0.2mA
0.2mA@1.93V
for 50x gain
POWER-OK
above 3.244V
for ESP (et al)
D204 red_3.3V-active
R202 1.5k
R205 100
R206 1k
TP206
TP208
R208 10k
U202 MAX809S_2V93
TP203
TP212
D206 green_3.3V-OK
VF 2.8V
R210 300
TP213
Q202 SS8050
R value doubled
from old design
C-E drop like 0.5V
To find values for voltage dividers:
Play around with the calculator "under load" with Load of 2.93V/0.0002A=14650R.
For each side, try R values between 100-1k from E series table.
https://www.digikey.com/en/resources/conversion-calculators/conversion-calculator-voltage-divider
USBC-PD 2.0 power input:
For now, use external converter and input 12V via barrel jack.
CH224K to trigger 20V request: https://lcsc.com/datasheet/lcsc_datasheet_2403131354_WCH-Jiangsu-Qin-Heng-CH224K_C970725.pdf
DC-DC 100W 20V -> 12V (8.3A) can be with SiC: https://lcsc.com/datasheet/lcsc_datasheet_2004181810_Vishay-Intertech-SIC402ACD-T1-GE3_C511100.pdf
Or with external mosfet: https://datasheet.lcsc.com/lcsc/1912111437_Texas-Instruments-LM5117PMHX-NOPB_C390088.pdf
High-power requires synchronous buck, or multi-phase synchronous buck CONTROLLER with external mosfets.
Advantage of multi-phase is also lower power-rating requirement of Inductor.
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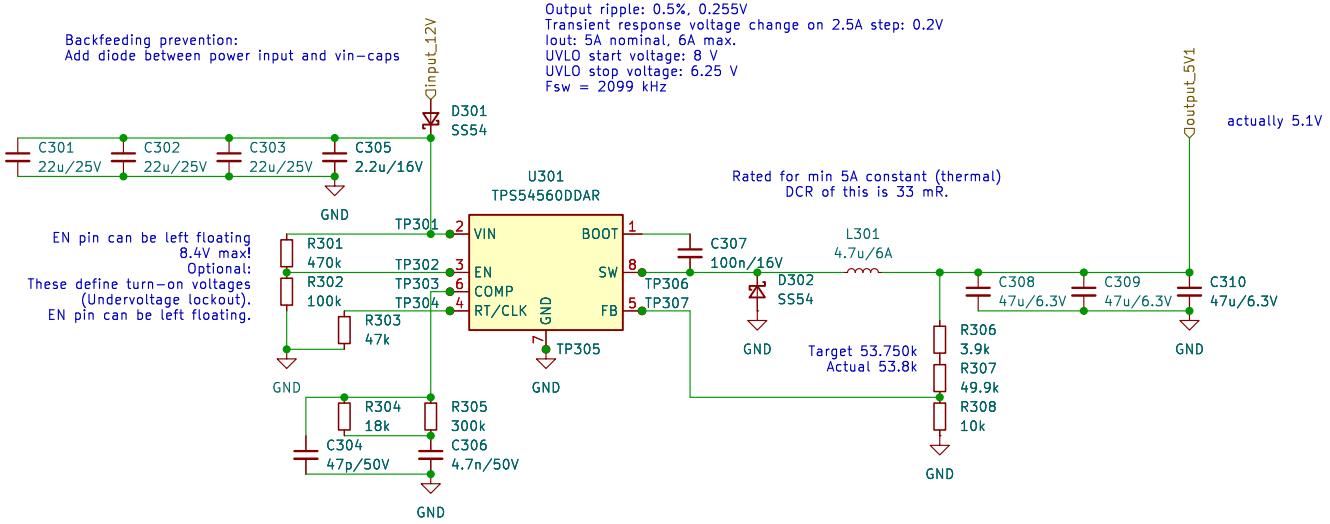
Sheet: /power/
File: power.kicad_sch
Title: mAIkroscope::hatplus-for-raspberrypi-5
Size: A4
Date: 2025-08-20
Rev: D
KiCad E.D.A. 9.0.3
Id: 2/19

Design guide: Use application example in datasheet, but also use TI's
SLVC452
TPS54360 and TPS54361 Family Design Excel Tool
https://www.ti.com/tool/download/SLVC452

Our implementation spec:
Vin: 12V nominal, 10–20V acceptable
Vout: 5.1V
Output ripple: 0.5%, 0.255V
Transient response voltage change on 2.5A step: 0.2V
Iout: 5A nominal, 6A max.
UVLO start voltage: 8 V
UVLO stop voltage: 6.25 V
Fsw = 2099 kHz



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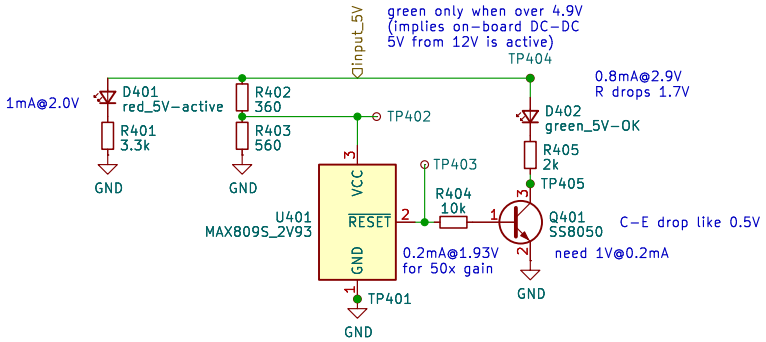
Sheet: /power/buck–converter_5V–5A_Raspi/
File: buck_tps54560.kicad_sch

Title: mAIkroscope::hatplus–for–raspberrypi–5

Size: A4	Date: 2025–08–20	**Rev: D**
KiCad E.D.A. 9.0.3		Id: 3/19



To find values for voltage dividers:
Play around with the calculator "under load" with Load of 2.93V/0.0002A=14650R.
For each side, try R values between 100-1k from E series table.
https://www.digikey.com/en/resources/conversion-calculators/conversion-calculator-voltage-divider

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Sheet: /power/voltage-OK-indicator_5V_raspi/
File: voltage-ok_5v.kicad_sch

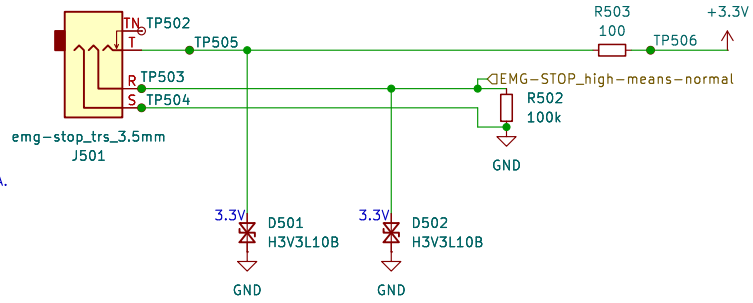
Title: mAIkroscope::hatplus-for-raspberrypi-5

Size: A4	Date: 2025-08-20	**Rev: D**
KiCad E.D.A. 9.0.3		Id: 4/19

On remote box:
EMG-STOP button NC connecting T and R
LED illumination between T and S

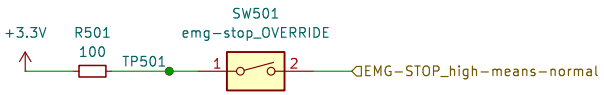
Power budget for external box:
33 mA at 3.3V
Transistor drive with 4.7K before base needs 1mA max
20 mA LED drive leaves 2V for transistor drive at 0.4mA.
Maybe reduce transistor base series resistance?

Faulty connection example:
Insert of stereo headphones
Current goes from tip through speaker to Sleeve.
Between Sleeve and Ring are resistance of transistor
and second speaker coil.



Override: Disable e-stop, make always-on.

Override: Tried to avoid implementing it,
but it's better than the whole thing not
working in the field, when the jack is
broken or the red button is missing/stolen.
This particular dipswitch has a recessed
switch (requires pointy object) and is
covered with Kapton tape so accidental
or negligent actuation is impossible.



When the headphone jack's R (net EMG-STOP_high-means-normal)
is shorted to GND, this override is ineffective and the
device stays off.

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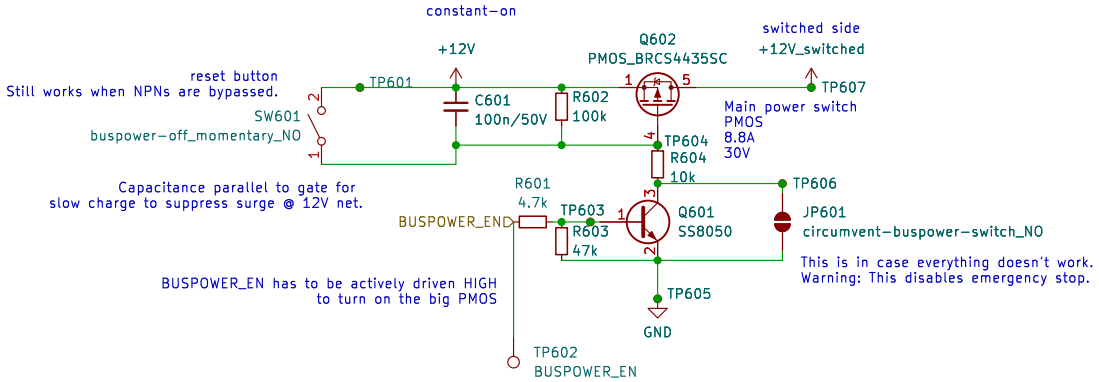
Sheet: /power/emergency-stop/
File: emergency-stop.kicad_sch

Title: mAIkroscope::hatplus-for-raspberrypi-5

Size: A4	Date: 2025-08-20	**Rev: D**
KiCad E.D.A. 9.0.3		Id: 5/19



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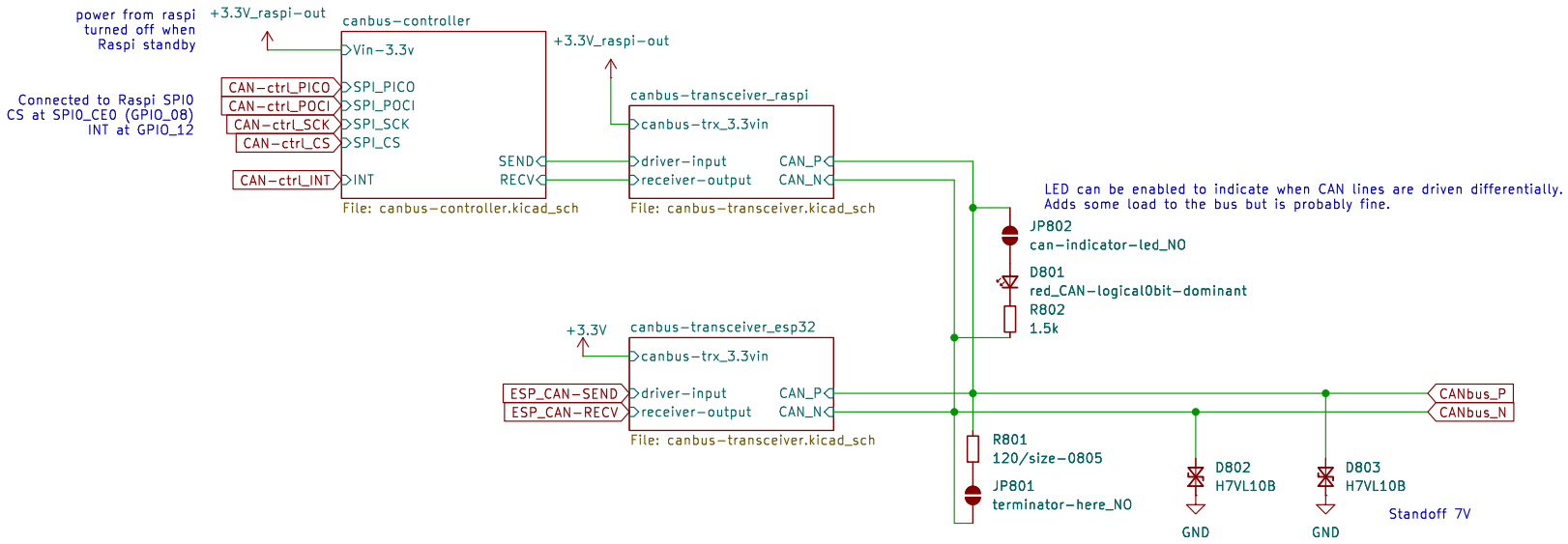
Sheet: /power/power−switch/
File: power−switch.kicad_sch

Title: mAIkroscope::hatplus−for−raspberrypi−5

Size: A4	Date: 2025−08−20	**Rev: D**
KiCad E.D.A. 9.0.3		Id: 6/19



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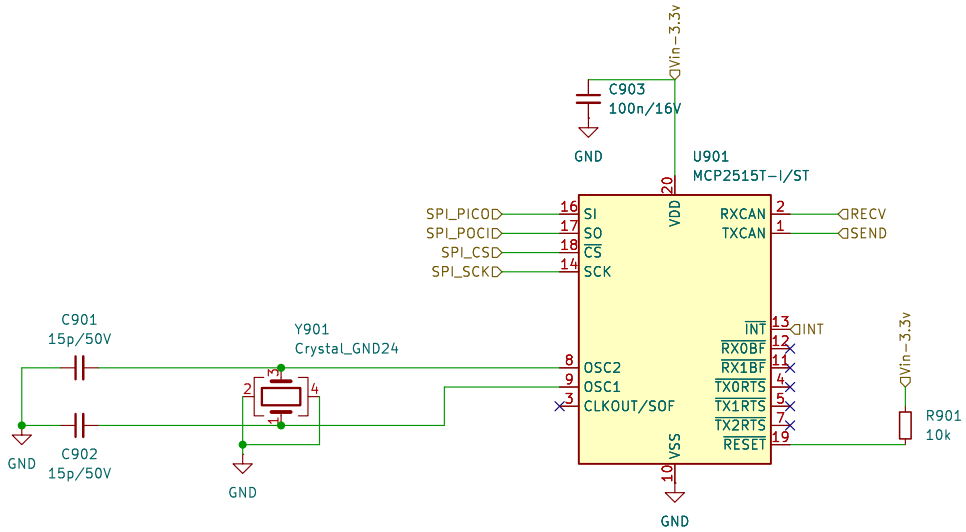
Sheet: /CANbus/
File: canbus.kicad_sch

Title: mAIkroscope::hatplus-for-raspberrypi-5

Size: A4	Date: 2025-08-20	**Rev: D**
KiCad E.D.A. 9.0.3		Id: 8/19

References: Waveshare RS485 + CAN HAT, mcp2515 devkit



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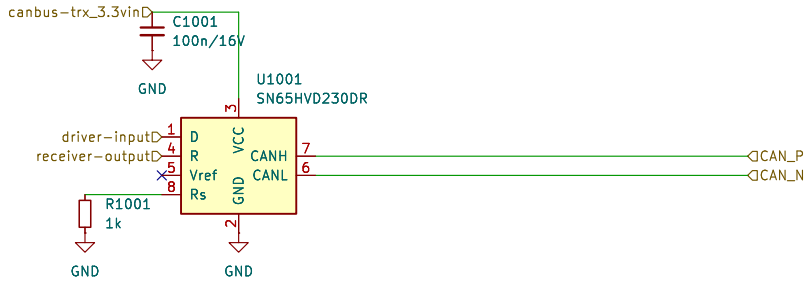
Sheet: /CANbus/canbus-controller/		
File: canbus-controller.kicad_sch		
Title: mAIkroscope::hatplus-for-raspberrypi-5		
Size: A4	Date: 2025-08-20	**Rev: D**
KiCad E.D.A. 9.0.3		Id: 9/19

This referenced the waveshare RS485 CAN HAT https://files.waveshare.com/upload/1/1d/RS485_CAN_HAT_Schematic.pdf



Vref is output of VCC/2.
But recessive CAN bus
bias voltage is higher
(2.3V comply ISO 11898-2)

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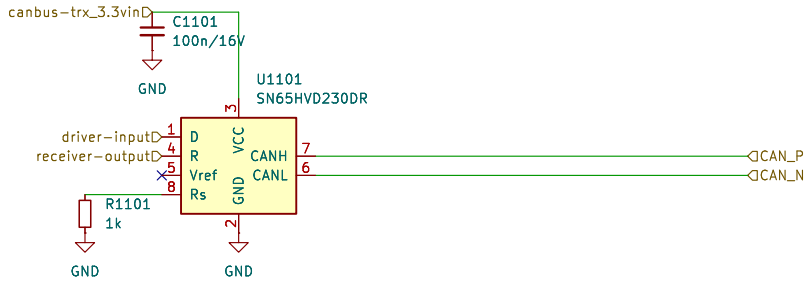
Sheet: /CANbus/canbus-transceiver_raspi/
File: canbus-transceiver.kicad_sch

Title: mAIkroscope::hatplus-for-raspberrypi-5

Size: A4	Date: 2025-08-20	**Rev: D**
KiCad E.D.A. 9.0.3		Id: 10/19

This referenced the waveshare RS485 CAN HAT https://files.waveshare.com/upload/1/1d/RS485_CAN_HAT_Schematic.pdf



Vref is output of VCC/2.
But recessive CAN bus
bias voltage is higher
(2.3V comply ISO 11898-2)

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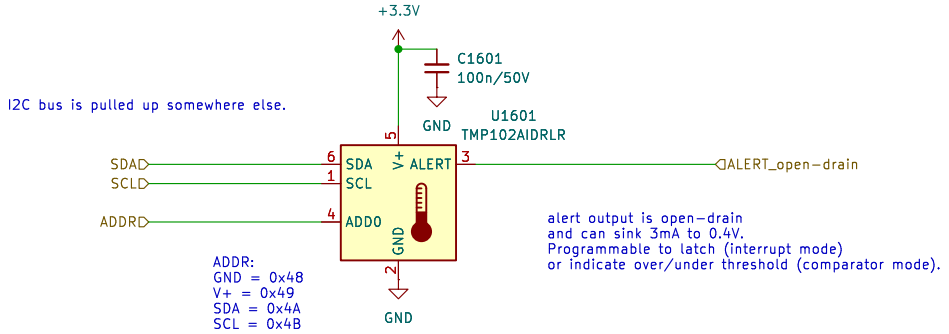
Sheet: /CANbus/canbus-transceiver_esp32/
File: canbus-transceiver.kicad_sch

Title: mAIkroscope::hatplus-for-raspberrypi-5

Size: A4	Date: 2025-08-20	**Rev: D**
KiCad E.D.A. 9.0.3		Id: 11/19

Component placement optimization to measure ambient air vs. component temperature:
Temperature sensors: PCB guidelines for surface mount devices
https://www.ti.com/lit/an/snoa967a/snoa967a.pdf



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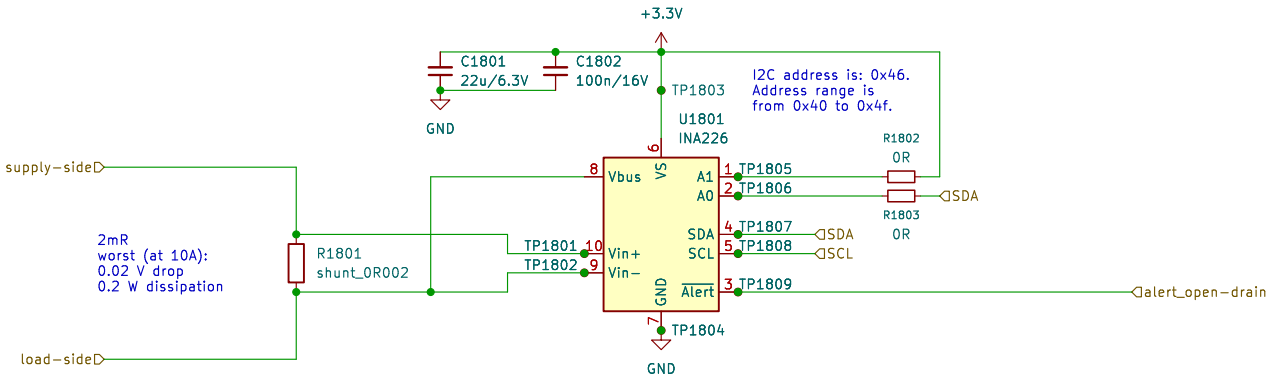
Sheet: /temperature-sensor_1/		
File: temperature-sensor.kicad_sch		
Title: mAIkroscope::hatplus-for-raspberrypi-5		
Size: A4	Date: 2025-08-20	**Rev: D**
KiCad E.D.A. 9.0.3		Id: 16/19



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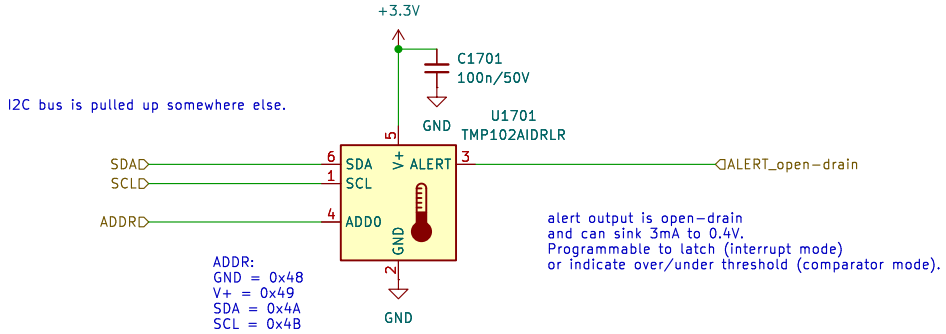
Sheet: /current−sensor/
File: current−sensor.kicad_sch

Title: mAIkroscope::hatplus−for−raspberrypi−5

Size: A4	Date: 2025−08−20	**Rev: D**
KiCad E.D.A. 9.0.3		Id: 18/19

Component placement optimization to measure ambient air vs. component temperature:
Temperature sensors: PCB guidelines for surface mount devices
https://www.ti.com/lit/an/snoa967a/snoa967a.pdf



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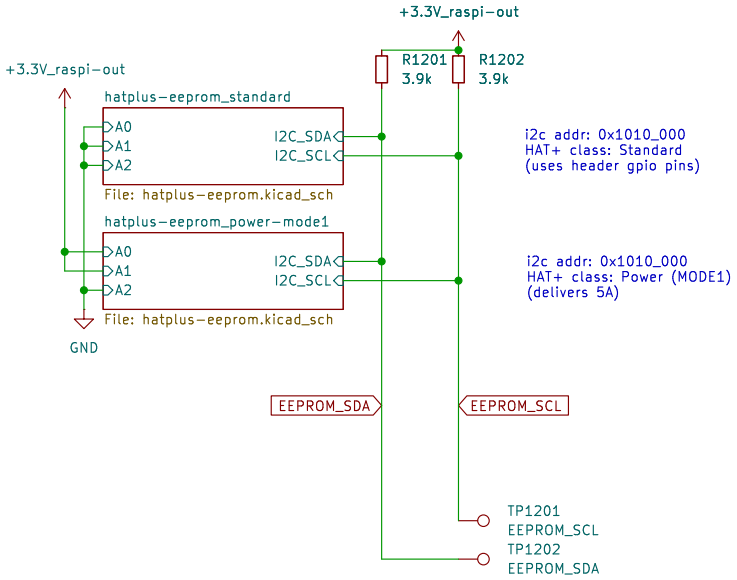
Sheet: /temperature-sensor_2/		
File: temperature-sensor.kicad_sch		
Title: mAIkroscope::hatplus-for-raspberrypi-5		
Size: A4	Date: 2025-08-20	**Rev: D**
KiCad E.D.A. 9.0.3		Id: 17/19



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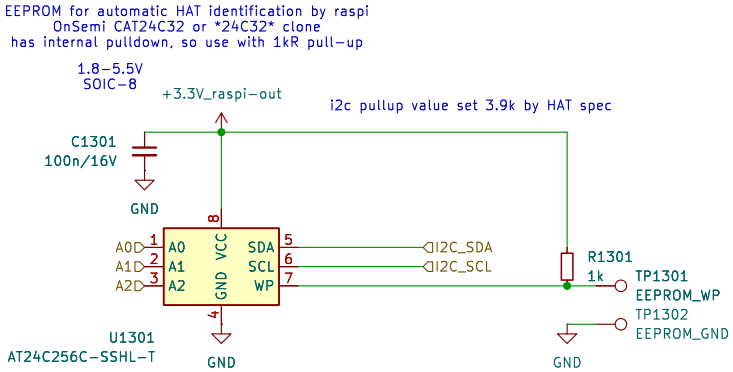
Sheet: /HATplus-EEPROMS/
File: eeproms.kicad_sch

Title: mAIkroscope::hatplus-for-raspberrypi-5

Size: A4	Date: 2025-08-20	**Rev: D**
KiCad E.D.A. 9.0.3		Id: 12/19



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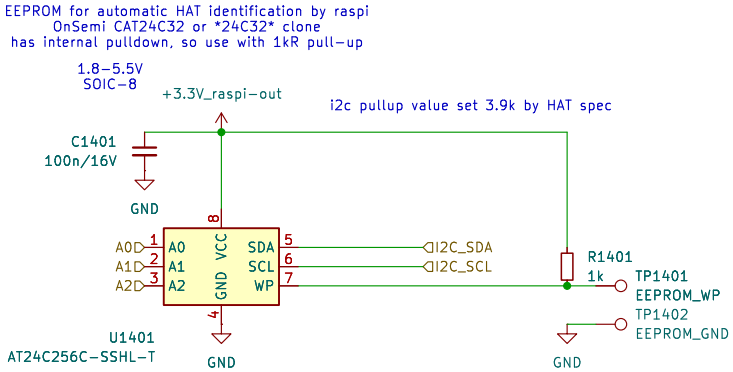
Sheet: /HATplus-EEPROMS/hatplus-eeprom_standard/		
File: hatplus-eeprom.kicad_sch		
Title: mAIkroscope::hatplus-for-raspberrypi-5		
Size: A4	Date: 2025-08-20	**Rev: D**
KiCad E.D.A. 9.0.3		Id: 13/19



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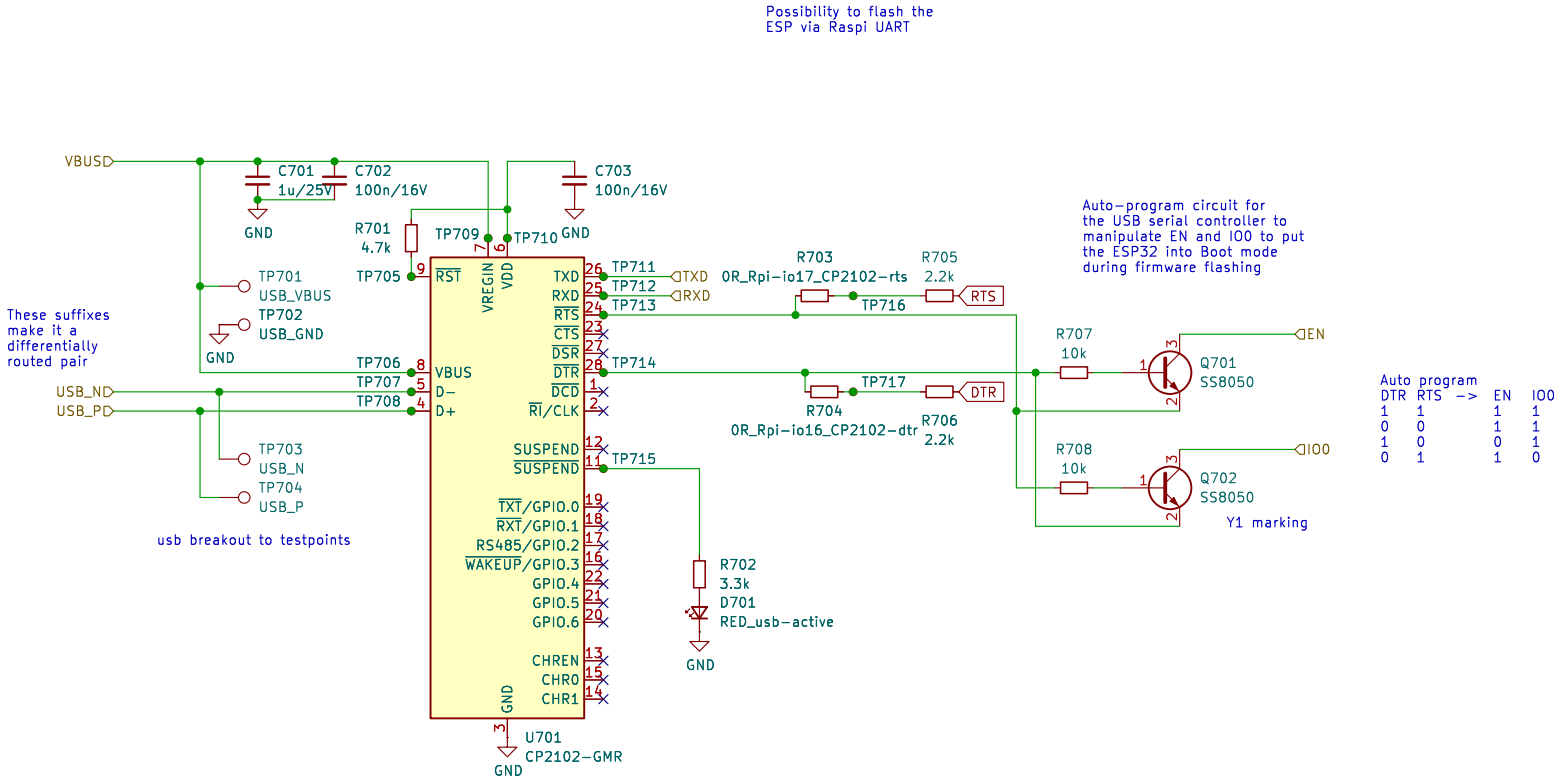
Sheet: /HATplus-EEPROMS/hatplus-eeprom_power-mode1/
File: hatplus-eeprom.kicad_sch

Title: mAIkroscope::hatplus-for-raspberrypi-5

Size: A4	Date: 2025-08-20	**Rev: D**
KiCad E.D.A. 9.0.3		Id: 14/19



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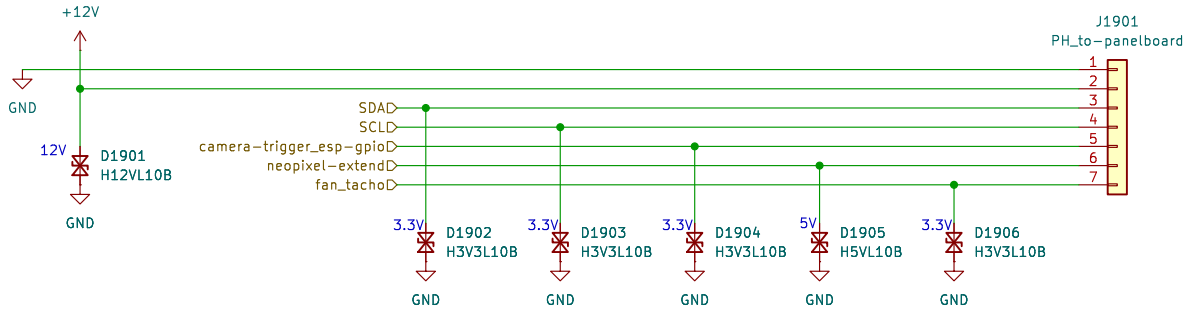
Sheet: /USB-uart/
File: usb-uart.kicad_sch

Title: mAIkroscope::hatplus-for-raspberrypi-5

Size: A4	Date: 2025-08-20	**Rev: D**
KiCad E.D.A. 9.0.3		Id: 7/19

Electronics on Panelboard:
- Generate 3.3V STEMMA from 12v
- Generate 5V Neopixel from 12V
- Camera trigger GPIO to high-side LED switch



Jack for cable to panelboard
(Max. 70mm wide, elbowed jacks, one-sided,
not high, maybe HAT form factor):
- Trig output to SMA for HIK
- Neopixel-extend "RGBA" male (recessed) + holes
- STEMMA +STEMMA QT

Pins from HAT to panelboard:
- SDA
- SCL
- neopixel-extend
- Camera trigger
- GND
- 12V to generate other voltages
(- 3.3V stemma
(- 5V neopix

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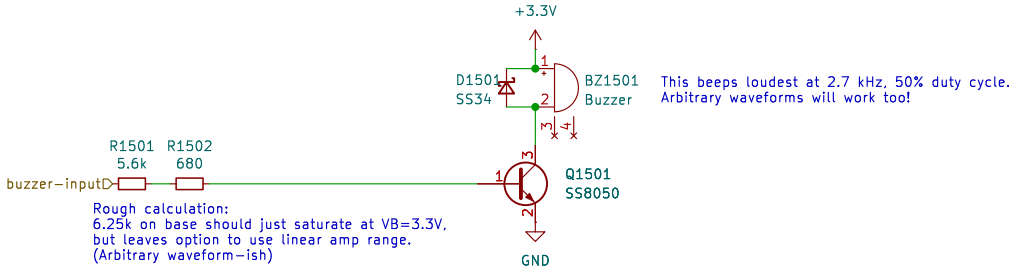
openUC2 GmbH		
Sheet: /jack-to-panelboard/		
File: jack-to-panelboard.kicad_sch		
Title: mAIkroscope::hatplus-for-raspberrypi-5		
Size: A4	Date: 2025-08-20	**Rev: D**
KiCad E.D.A. 9.0.3		Id: 19/19



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Size: A4	Date: 2025-08-20	**Rev: D**
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