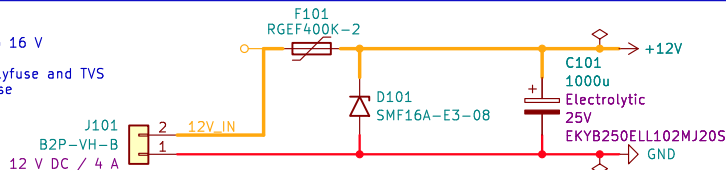


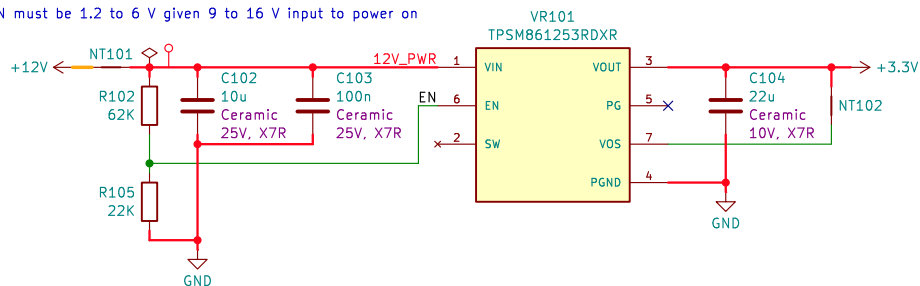
POWER INPUT

Input must be 9 to 16 V
Circuit protection
- Internal: 4 A polyfuse and TVS
- External: 5 A fuse



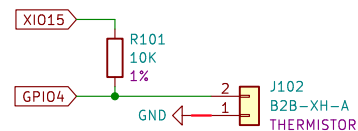
3.3 V BUCK CONVERTER

EN must be 1.2 to 6 V given 9 to 16 V input to power on



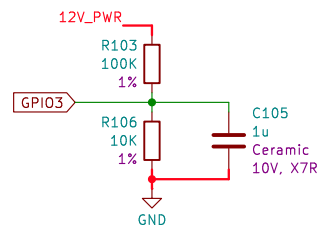
TEMPERATURE SENSOR

Built-in 10 K NTC thermistor, beta = 3950



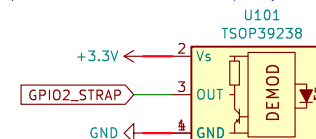
VOLTAGE SENSOR

Map to ESP32-C3 ADC range of 0 to 2.5 V



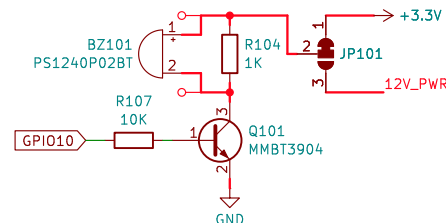
IR REMOTE RECEIVER

Operates on 38 kHz carrier frequency

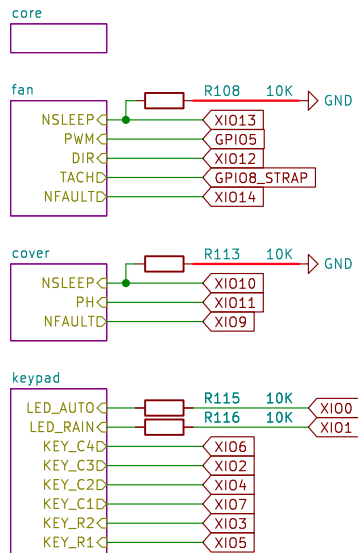


PIEZO BUZZER

Driven at 3.3 V for politeness (12 V will be louder)
Can be disabled in software or by cutting the solder jumper

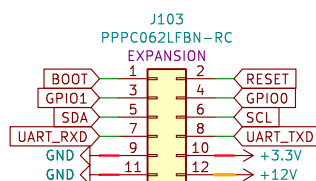


COMPONENTS



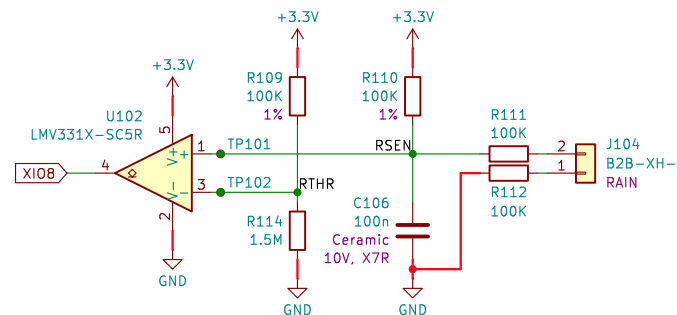
EXPANSION PORT

Header for accessories and factory programming
- GPIO0 and GPIO1 are free to be used for any purpose
- UART_RXD and UART_TXD provide the serial port
- SCL and SDA provide the I2C bus (QWIIC)
- RESET and BOOT are wired in parallel with their corresponding buttons (active when tied to ground)
- 12 V supply is unregulated, 1 A maximum current
- 3.3 V supply is regulated, 1 A maximum current



RAIN SENSOR

The rain sensor is only available on model 4500K; these components may be omitted for other models
It is simply a pair of electrodes that are exposed to the environment and whose impedance is about 0.5 to 1.2 Mohm when in contact with water or mist and open circuit when dry
The comparator pulls the output low when $V(RSEN) < V(RTHR) + V(OFFSET)$, where $V(OFFSET)$ is ± 5 mV for LMV331X



Sheet: /
File: minuett.kicad_sch

Title: Minuet Fan Controller

Size: A4

Date: 2025-02

KiCad E.D.A. 8.0.8

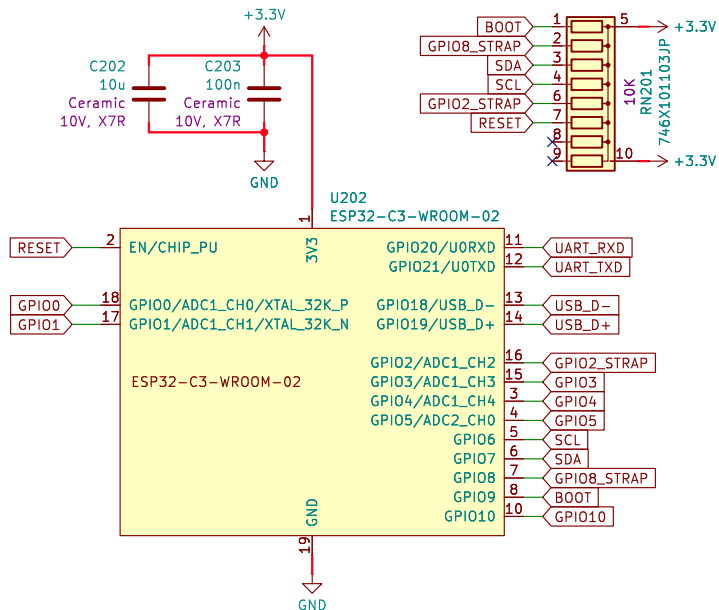
Rev: 2.0

Id: 1/5

MICROCONTROLLER

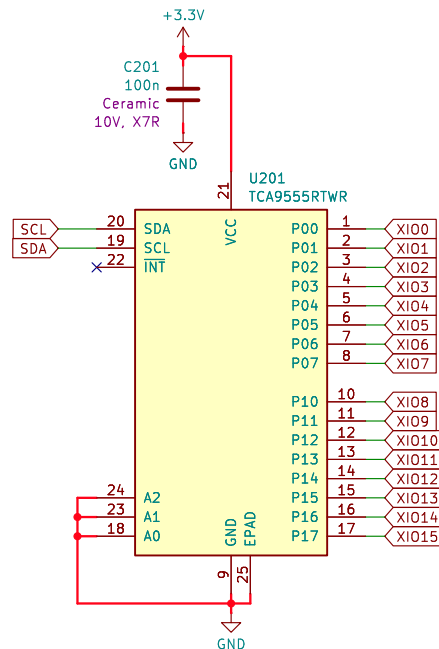
ESP32-C3 strapping pins

- GPIO2 don't care but recommended to pull up anyway to avoid glitches
- GPIO8 must be high for download mode, don't care for SPI mode
- GPIO9 boot select: low for download mode, high for SPI mode
- RESET forms an RC delay circuit with $R = 10 \text{ Kohm}$, $C = 1 \text{ uF}$ to ensure power supply stability



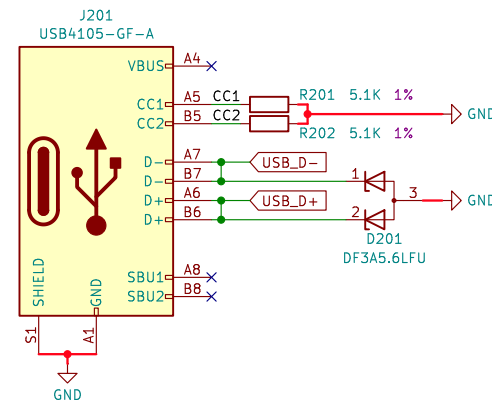
IO EXPANDER

XIO pins have internal 100 K pull-ups, configured as inputs at reset, cannot be set to Hi-Z, 50 mA push-pull output, 5 V tolerant



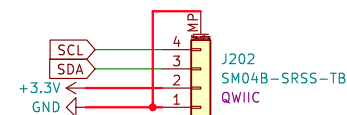
USB-C INTERFACE

ESP32-C3 only supports full-speed data rate (11 Mbps)



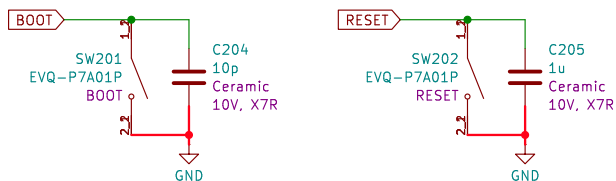
QWIIC INTERFACE

Host has pull-ups so accessories don't need their own



BUTTONS

Hold BOOT, press/release RESET, then release BOOT to enter the bootloader for firmware updates



Sheet: /core/
File: core.kicad_sch

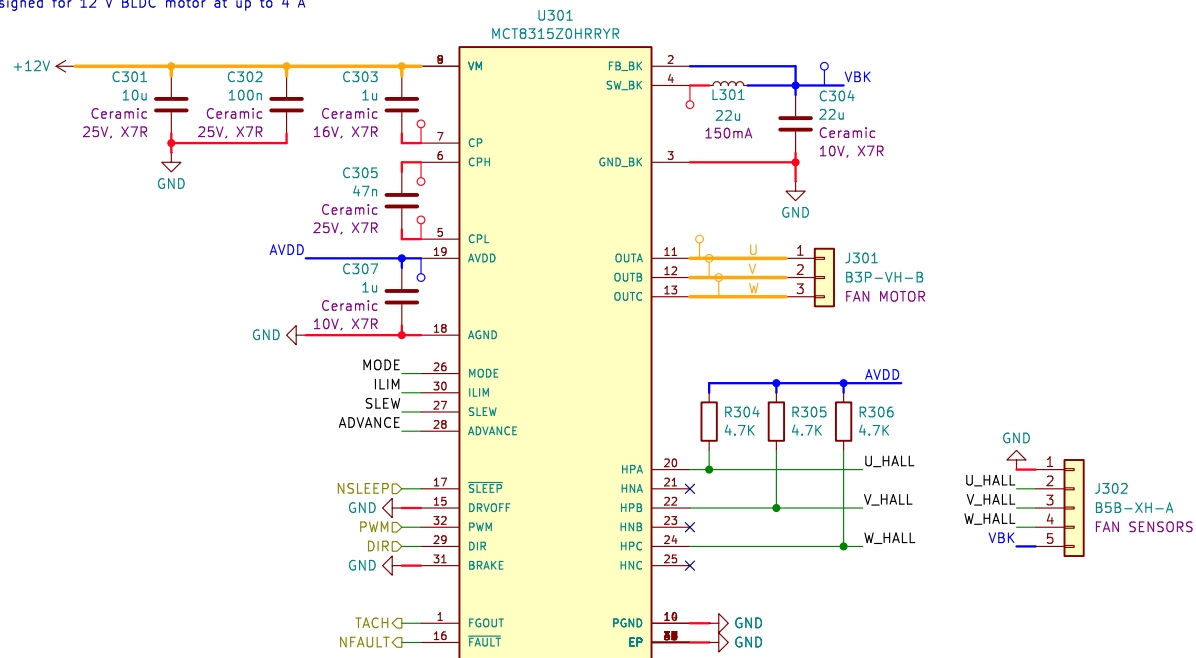
Title: Minuet Core

Size: A4 Date:
KiCad E.D.A. 8.0.8

Rev:
Id: 2/5

FAN MOTOR DRIVER

Designed for 12 V BLDC motor at up to 4 A

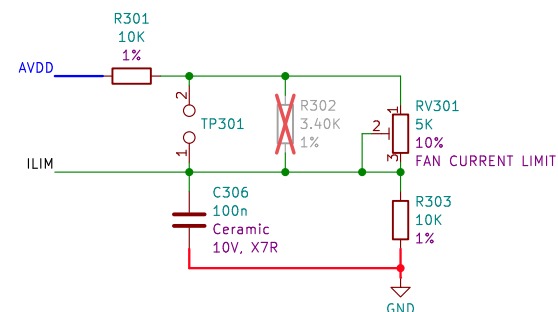


AVDD supplies 20 mA @ 3.3 V derived from VM when NSLEEP is active
SW_BK supplies 50 mA @ 5 V from a built-in buck converter
NFAULT is open-drain, must be high on reset to not enter test mode
TACH/FGOUT is open-drain, pulses with each hall sensor transition

Internal pull-down on NSLEEP, BRAKE, DIR, PWM, DRVOFF

CURRENT LIMIT

Increasing resistance of the setpoint increases the current limit



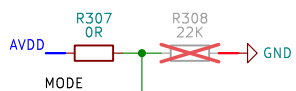
Current limit setting

- $V_{lim} = AVDD/2 - 0.08 \text{ V/A} * I_{lim}$, where $AVDD/2 = 1.65 \text{ V}$
- Disabled when $I_{lim} = 0 \text{ A}$
- Accuracy is 14% when $I_{lim} > 1 \text{ A}$
- $I_{lim} = 20.625 \text{ A} - 41.25 \text{ A/Kohm} * (10 \text{ Kohm} / (20 \text{ Kohm} + RV(\text{Kohm})))$

Approximate setpoints

- $I_{lim} = 0 \text{ A}$ (disabled) $\Rightarrow RV = 0 \text{ K}$
- $I_{lim} = 1.5 \text{ A} \Rightarrow RV = 1.58 \text{ K}$
- $I_{lim} = 2 \text{ A} \Rightarrow RV = 2.15 \text{ K}$
- $I_{lim} = 2.5 \text{ A} \Rightarrow RV = 2.80 \text{ K}$
- $I_{lim} = 3 \text{ A} \Rightarrow RV = 3.40 \text{ K}$
- $I_{lim} = 3.5 \text{ A} \Rightarrow RV = 4.12 \text{ K}$
- $I_{lim} = 4 \text{ A}$ (maximum) $\Rightarrow RV = 4.87 \text{ K}$

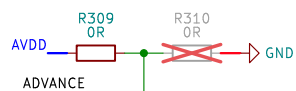
COMMUTATION MODE



Mode

- Type 2: tied to AGND via 22 Kohm resistor
 - digital hall input
 - asynchronous modulation
 - ASR & AAR disabled
- Type 4: Hi-Z
 - digital hall input
 - synchronous modulation
 - ASR & AAR disabled
- Type 7: tied to AVDD (default)
 - digital hall input
 - synchronous modulation
 - ASR & AAR enabled

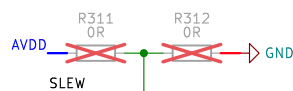
COMMUTATION ADVANCE



Commutation advance phase angle

- 0°: tied to AGND
- 4°: tied to AGND via 22 Kohm resistor
- 11°: tied to AGND via 100 Kohm resistor
- 15°: Hi-Z
- 20°: tied to AVDD via 100 Kohm resistor
- 25°: tied to AVDD via 22 Kohm resistor
- 30°: tied to AVDD (default)

SLEW RATE



Slew rate control

- 25 V/uS: tied to AGND
- 50 V/uS: Hi-Z (default)
- 100 V/uS: tied to AVDD via 47 Kohm resistor
- 200 V/uS: connected to AVDD

Sheet: /fan/
File: fan.kicad_sch

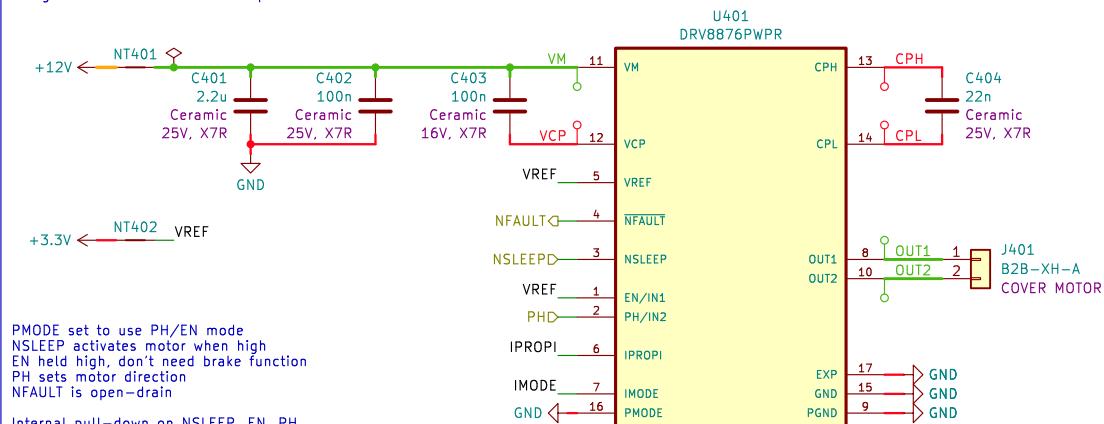
Title: Minuet Fan Motor Driver

Size: A4
KiCad E.D.A. 8.0.8

Date:
Rev:
Id: 3/5

COVER MOTOR DRIVER

Designed for 12 V DC motor at up to 2 A



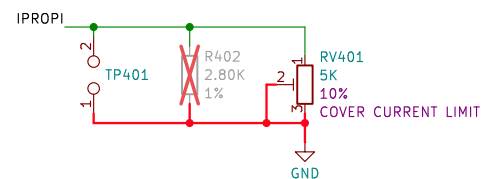
PMODE set to use PH/EN mode
NSLEEP activates motor when high
EN held high, don't need brake function
PH sets motor direction
NFAULT is open-drain

Internal pull-down on NSLEEP, EN, PH

CURRENT LIMIT

Increasing resistance of the setpoint decreases the current limit

Current limit mode 3
When Itrip or Iocp exceeded (motor stall), brake motor,
latch outputs off, and assert NFAULT until inputs change



Set overcurrent protection trip current
 $I_{trip} (A) = V_{ref} (V) / R_{ipropi} (\Omega) * 1000$
Given $V_{ref} = 3.3 V$, $R_{ipropi} = 2.8 K$, $I_{trip} = 1.18 A$

Must be set high enough to allow the motor to overcome
the resistance of opening the cover and low enough to
reliably detect stall at end of travel.

Sheet: /cover/
File: cover.kicad_sch

Title: Minuet Cover Motor Driver

Size: A4

Date:

KiCad E.D.A. 8.0.8

Rev:

Id: 4/5

