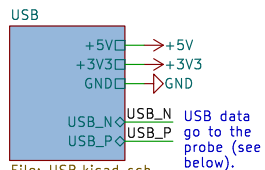


## USB

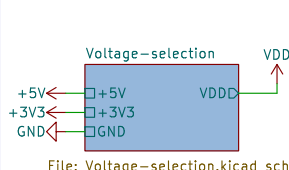
The USB-C connector provides the GND reference and 5V power, which is then converted into 3V3. The whole power circuitry is in this USB sheet.



File: USB.kicad\_sch

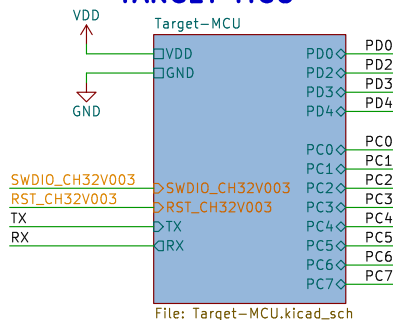
## VOLTAGE SELECTION

The Voltage Selection sheet takes the voltage levels as input and selects one of them to become VDD – the power level for the Target MCU and the IO Pin Headers.



File: Voltage-selection.kicad\_sch

## TARGET MCU

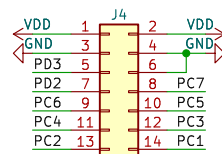
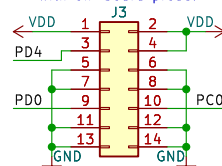


File: Target-MCU.kicad\_sch

## IO Pin Headers

All pins from the MCU are routed to these Pin Headers, except for:

- PA1 and PA2, used for crystal.
- PD1 and PD7, used for flashing.
- PD5 and PD6, used for UART-link with on-board probe.



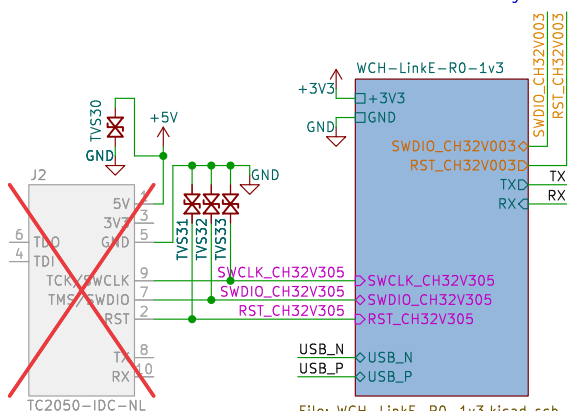
## WCH-LinkE-R0-1v3

The WCH-LinkE-R0-1v3 on-board probe must be flashed when used for the first time with an external probe, through J2:

- SWCLK\_CH32V305
- SWDIO\_CH32V305
- RST\_CH32V305

From then onwards, the USB signals give access to the on-board probe.

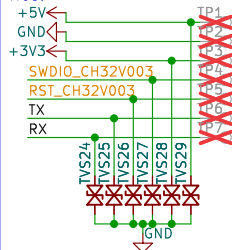
Signals SWDIO\_CH32V003 and RST\_CH32V003 flash and debug the target MCU. TX and RX provide a UART link to the target MCU.



File: WCH-LinkE-R0-1v3.kicad\_sch

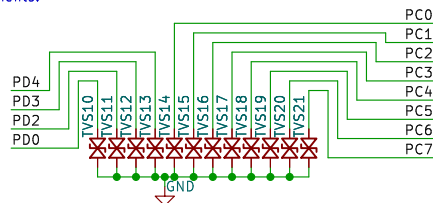
## Test Pads

Test Pads located between flash/debug probe and target MCU.



## IO protection

All IO pins from the Pin Headers first pass through these TVS diodes to protect the board against external voltage transients.



<https://github.com/Embeetle/tiny-scarab>

<https://embeetle.com/tiny-scarab>

**Embeetle**

Sheet: /

File: tiny-scarab.kicad\_sch

**Title: Tiny Scarab**

Size: A5

Date: 2024-01-30

KiCad E.D.A. kicad 7.0.10

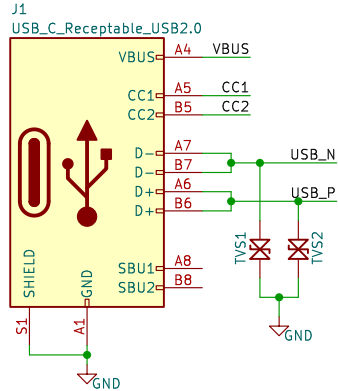
**Rev: 0.2**

Id: 1/5

# USB

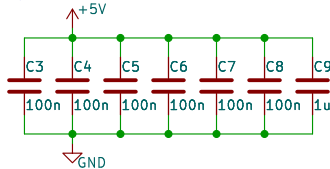
## Connector

This USB connector only provides the basic USB2.0 data signals. They are protected with TVS diodes right at the entrance.



## Capacitance

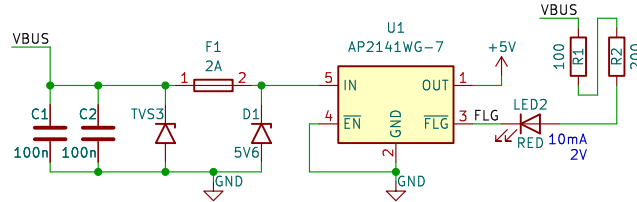
Provide plenty of capacitors on the 5V line. The capacitors below are placed just after the AP2141WG-7 chip overcurrent protection chip.



## VBUS Protection

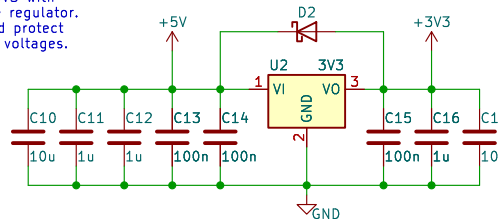
The incoming VBUS power first goes through a TVS diode to protect the board from transient voltages from the cable. Next, a fuse and zener diode work together to protect against permanent overvoltages: the zener shorts to GND such that the fuse burns.

Finally, chip AP2141WG-7 only lets 500mA pass through. In case of overcurrent, it will pull down its FLG pin which then lights up a red LED.



## 3V3 Conversion

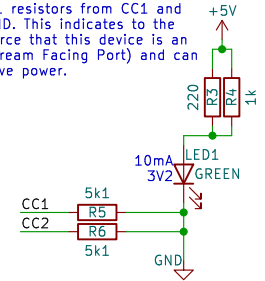
Convert 5V to 3V3 with a linear voltage regulator. Diode D6 should protect against reverse voltages.



## LED & Power Handshake

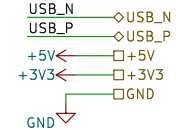
Indicate power presence with an LED.

Attach 5k1 resistors from CC1 and CC2 to GND. This indicates to the power source that this device is an UFP (Upstream Facing Port) and can thus receive power.



## Sheet Output

Export the USB data signals from this sheet, as well as all the power lines (power lines are global symbols, so exporting them is not strictly needed)



<https://github.com/Embeetle/tiny-scarab>  
<https://embeetle.com/tiny-scarab>

## Embeetle

Sheet: /USB/

File: USB.kicad\_sch

## Title: Tiny Scarab

Size: A5

Date: 2024-01-30

KiCad E.D.A. kicad 7.0.10

Rev: 0.2

Id: 2/5

# WCH-LinkE-R0-1v3

## Sheet Input

The WCH-LinkE-R0-1v3 on-board probe must be flashed when used for the first time with an external probe, through these signals:

- SWCLK\_CH32V305
- SWDIO\_CH32V305
- RST\_CH32V305

From then onwards, the USB signals give access to the on-board probe.

Diagram showing the connection of the on-board probe to the external probe. The connections are as follows:

- +3V3 to +3V3
- GND to GND
- SWCLK\_CH32V305 to SWCLK\_CH32V305
- SWDIO\_CH32V305 to SWDIO\_CH32V305
- RST\_CH32V305 to RST\_CH32V305
- USB\_N to USB\_N
- USB\_P to USB\_P

## Mode LEDs

The CH32V305FBP6 MCU outputs the LED\_CON signal to indicate if it works in ARM-mode or RISC-V-mode.

Diagram showing the connection of the Mode LEDs. The connections are as follows:

- LED3 (BLUE) to LED3
- LED4 (BLUE) to LED4
- LED\_CON to LED\_CON

## CH32V305FBP6

The CH32V305FBP6 is the heart of the WCH-LinkE-R0-1v3 on-board probe. It must be flashed through signals SWCLK\_CH32V305, SWDIO\_CH32V305 and RST\_CH32V305.

From then onwards, it gets its instructions from the USB signals USB\_N and USB\_P.

It outputs the following signals to flash and debug the target MCU:

- SWDIO\_CH32V003
- RST\_CH32V003
- TX
- RX

Note: Resistor R7 must be mounted after flashing the CH32V305FBP6 MCU.

## RST and IAP Buttons

The RST button resets the CH32V305FBP6 MCU, the IAP button brings it into IAP mode.

Diagram showing the connection of the RST and IAP Buttons. The connections are as follows:

- IAP to IAP
- RST to RST
- SW1 to SW1

## Crystal

12MHz crystal - the load capacitors might not be needed because the crystal provides the load itself.

Diagram showing the connection of the Crystal. The connections are as follows:

- XTAL1 to XTAL1
- XTAL2 to XTAL2
- ModeS to ModeS

## Sheet Output

Signals SWDIO\_CH32V003 and RST\_CH32V003 flash and debug the target MCU. TX and RX provide a UART link to the target MCU.

Diagram showing the connection of the Sheet Output. The connections are as follows:

- SWDIO\_CH32V003 to SWDIO\_CH32V003
- RST\_CH32V003 to RST\_CH32V003
- TX to TX
- RX to RX

<https://github.com/Embeetle/tiny-scarab>

<https://embeetle.com/tiny-scarab>

## Embeetle

Sheet: /WCH-LinkE-R0-1v3/

File: WCH-LinkE-R0-1v3.kicad\_sch

## Title: Tiny Scarab

Size: A5

Date: 2024-01-30

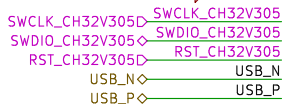
Rev: 0.2

KiCad E.D.A. kicad 7.0.10

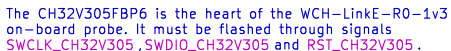
Id: 3/5

The WCH-LinkE-R0-1v3 on-board probe must be flashed when used for the first time with an external probe, through these signals:

- From then onwards, the USB signals give access to the on-board probe.



The CH32V305FBP6 MCU outputs the LED\_CON signal to indicate if it works in ARM-mode or RISC-V-mode.

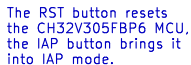


From then onwards, it gets its instructions from the USB signals USB\_N and USB\_P.

It outputs the following signals to flash and debug the target MCU:

- SWDIO\_CH32V003
- RST\_CH32V003
- TX
- RX

Note: Resistor R7 must be mounted after flashing the CH32V305FBP6 MCU.



- SWDIO\_CH32V003    ◇ SWDIO\_CH32V003  
RST\_CH32V003    ◇ RST\_CH32V003  
TX                ◇ TX  
RX                ◇ RX

<https://github.com/Embeetle/tiny-scarb>  
<https://embeetle.com/tiny-scarb>

Sheet: /WCH-LinkE-R0-1v3/  
File: WCH-LinkE-R0-1v3.kicad\_sch

**Title: Tiny Scarab**

Size: A5	Date: 2024-01-30
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Rev: 0.2  
Id: 3/5

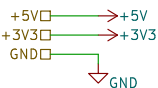
## VOLTAGE SELECTION

### Sheet Input

The input to this schematic sheet is  
all the voltage levels:

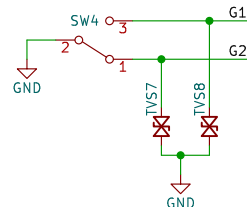
- > GND
- > +5V
- > +3V3

It's not strictly necessary to input them here, as they're global symbols.



## Slide Switch

The slide switch pulls either signal G1 or signal G2 to GND.



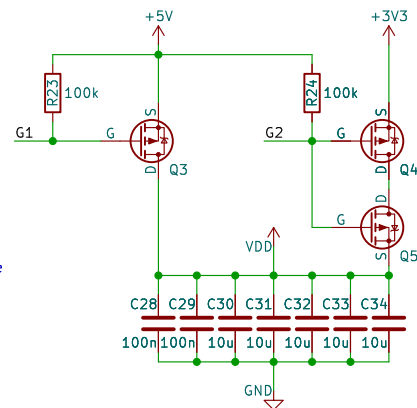
### Voltage Selection Circuit

This circuit connects VDD to either 5V or 3V3. When G1 is low, it makes PMOS Q4 conduct. When G2 is low, it makes PMOS Q5 and Q6 conduct.

PMOS Q5 and Q6 are in anti-series (notice how Q6 is differently oriented than Q5) such that the body diodes won't let the 5V flow into the 3V3 when Q4 is conducting and Q5 and Q6 are off.

The selected PMOS is DMP1045U-7.  
This PMOS has a low on-resistance.  
When the  $V_{GS} = 3V3$ , the resistance  
is less than  $40m\Omega$ .

This PMOS conducts 500mA without issues – it can actually go way higher.



## Sheet Output

The output of this sheet is the VDD voltage level. As it's a global symbol, it's strictly not necessary to output it here.



<https://github.com/Embeetle/tiny-scarab>

<https://embeetle.com/tiny-scarab>

## Embeetle

Sheet: /Voltage-selection/

File: Voltage-selection.kicad\_sch

**Title: Tiny Scarab**

Size: A5

Date: 2024-01-30

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Rev: 0.2

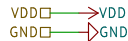
Id: 4/5

# TARGET MCU

## Sheet input

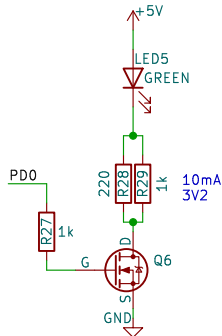
SWDIO\_CH32V003 and RST\_CH32V003 are the output SWDIO and RST signals from the flash/debug probe. They flash new firmware to the Target MCU.

TX and RX also come from the flash/debug probe. They set up a UART communication channel with the Target MCU.



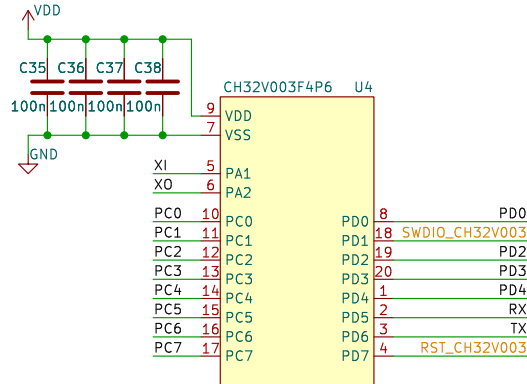
## User LED

The User LED is driven from a MOSFET connected to pin PD0.



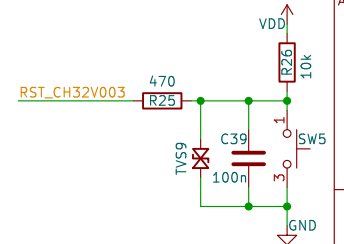
## CH32V003F4P6

The CH32V003F4P6 target is powered with 3V3 or 5V, depending on the state of SW4 (see Voltage-selection sheet).



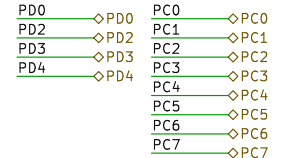
## Reset

RST\_CH32V003 is the output RST pin from the flash/debug probe (so it's the input RST pin for the Target MCU). With this switch, you can trigger a RST manually.



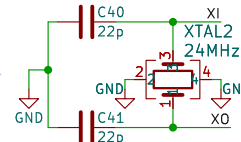
## Sheet Output

All the Target MCU pins are outputs from this sheet.



## Crystal

24MHz crystal – the load capacitors might not be needed because the crystal provides the load itself (not 100% sure).



<https://github.com/Embeetle/tiny-scarab>  
<https://embeetle.com/tiny-scarab>

## Embeetle

Sheet: /Target-MCU/  
File: Target-MCU.kicad\_sch

## Title: Tiny Scarab

Size: A5 Date: 2024-01-30  
KiCad E.D.A. kicad 7.0.10

Rev: 0.2  
Id: 5/5