Tillitis TK1

USB C
(load/run apps)

USB C Plug

USB ESD diodes

CH552 Microcontroller

USB 2.0 Full Speed

TX
RX
RTS
CTS

GPIO x4

App FPGA

LED out

GPIO

GPIO x4

RGB LED

Cap sensor

GPIO pins

Touch pad

SPI Flash

Config SPI

Test pads
(for programming)

3.3V LDO

2.5V LDO

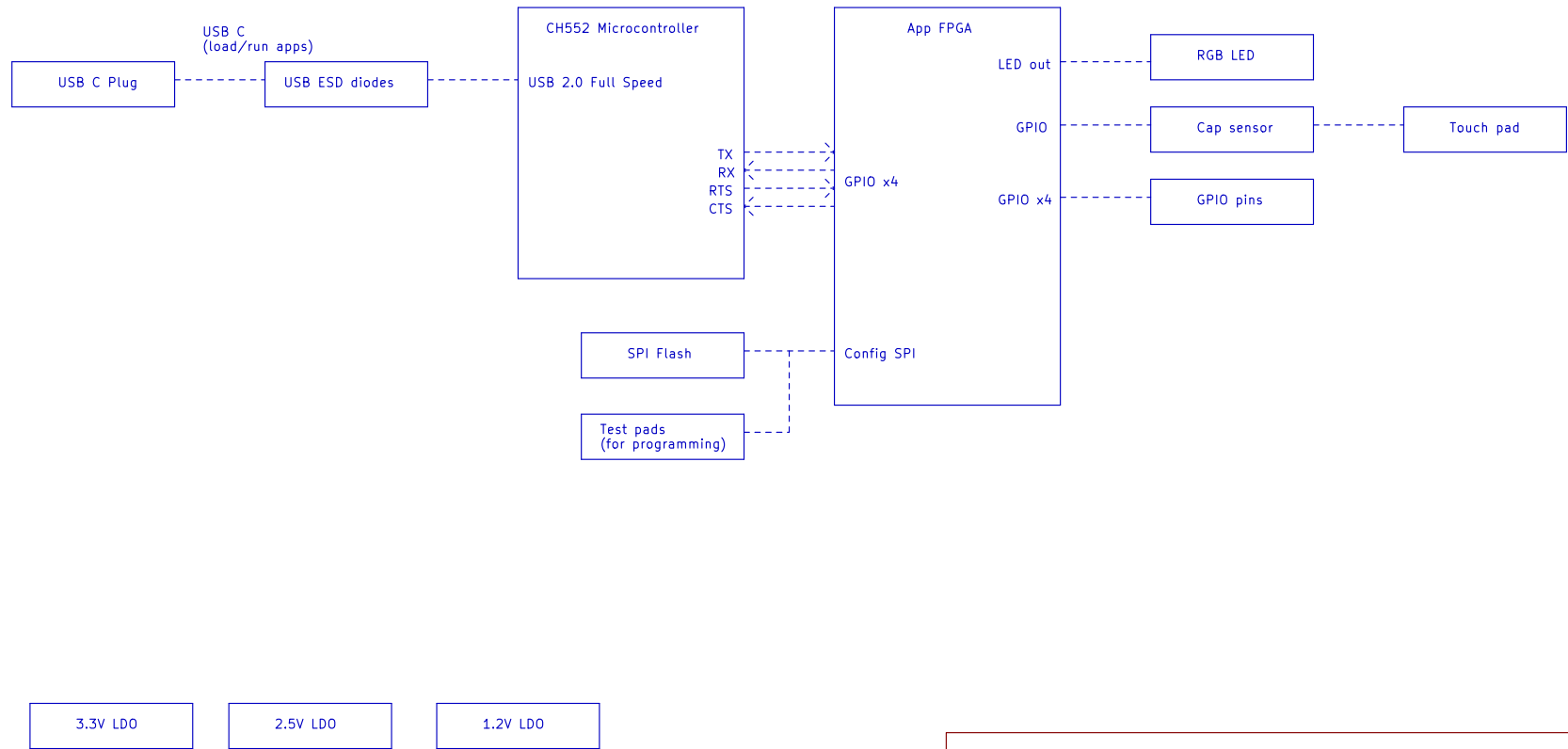1.2V LDO

Application FPGA

File: application_fpga.kicad_sch

USB to Serial converter

File: usb_to_serial.kicad_sch

Power Supply

File: powersupply.kicad_sch

Sheet: /
File: tk1.kicad_sch

Title: TK1

Size: A4 | Date: 2021-09-29 | **Rev: V1**

KiCad E.D.A. kicad (6.0.4) | Id: 1/4

Application FPGA

SPI boot flash

+3.3V

C23 0.10uF
GND

+3.3V
R23 10k

U8
W25Q80DVUXIE

APP_ICE_SS — CS
CLK
VCC
DI(IO0)
DO(IO1)
IO2
IO3
GND
EXP

+3.3V
R24 10k

APP_ICE_SCK

GND

+3.3V
R25 10k

+3.3V
R26 10k

APP_ICE_MISO
APP_ICE_MOSI
APP_FLASH_WP
APP_FLASH_HOLD

Note: Any generic SPI flash with >1Mbit capacity is acceptable.

Capacitive sensor

+3.3V

C26 0.10uF
GND

C8 1uF

TOUCH_PAD

R30 2k

C27 1pF

GND

U10
PT2043AT6

VDD
TCH
AHLB
TOG
QC
VSS

TOUCH_EVENT

GND   GND   GND

Note: Tune C27 for sensitivity

Mode setting

TOG	AHLB	Mode
0	0	Syncronous, active high
0	1	Syncronous, active low
1	0	Toggle, power-on state = 0
1	1	Toggle, power-on state = 1

U6 — ICE40UP5K-SG48ITR

+1V2

C16 0.10uF   C20 0.10uF
GND

+1V2
FB3
BLM18KG300TN1D
APP_+1.2_PLL

C25 10uF   C17 0.10uF
GND

+2V5

C18 0.10uF
GND

+3.3V

C19 0.10uF
GND

VCC (5)
VCC (30)
VCCPLL (29)
VPP_2V5 (24)
GND (49)
VCCIO_0 (33)

SPI_VCCIO1 (22) — +3.3V C21 0.10uF GND

IOB_32a_SPI_SO (14) — APP_ICE_MISO
IOB_33b_SPI_SI (17) — APP_ICE_MOSI
IOB_34a_SPI_SCK (15) — APP_ICE_SCK
IOB_35b_SPI_SS (16) — APP_ICE_SS

CRESET (8) — APP_CRESET
CDONE (7) — APP_CDONE

IOB_13b (6) — TOUCH_EVENT
IOB_16a (9)
IOB_18a (10)
IOB_20a (11)
IOB_22b (12)
IOB_23b (21)
IOB_24a (13)
IOB_25b_G3 (20)
IOB_29b (19)
IOB_31b (18)

Bank 1

INTERFACE_TX — IOT_36b (25)
IOT_37a (23)
INTERFACE_CTS — IOT_38b (27)
INTERFACE_RX — IOT_39a (26)
INTERFACE_RTS — IOT_41a (28)
IOT_42b (31)
IOT_43a (32)
IOT_44b (34)
IOT_45a_G1 (37)
IOT_46b_G0 (35)
APP_GPIO1 — IOT_48b (36)
IOT_49a (43)
APP_GPIO2 — IOT_50b (38)
IOT_51a (42)

Bank 0

Bank 2

VCCIO_2 (1) — +3.3V C22 0.10uF GND

IOB_0a (46) — APP_GPIO4
IOB_2a (47)
IOB_3b_G6 (44)
IOB_4a (48)
IOB_5b (45) — APP_GPIO3
IOB_6a (2)
IOB_8a (4)
IOB_9b (3)

APP_LED_RED — RGB0 (39)
APP_LED_GREEN — RGB1 (40)
APP_LED_BLUE — RGB2 (41)

Programming test points

TP12 APP_ICE_SCK — APP_ICE_SCK
TP13 APP_ICE_SS — APP_ICE_SS
TP14 APP_ICE_MOSI — APP_ICE_MOSI
TP15 APP_ICE_MISO — APP_ICE_MISO
TP16 APP_CRESET — APP_CRESET
TP17 APP_CDONE — APP_CDONE
TP5 APP_GND — GND

FPGA signal notes:
* APP_ICE* pins are fixed and cannot be changed
* APP_LED* pins can be swapped within their group
* All other pins are generic GPIO, and can be reassigned as needed.

Status LED

+3.3V

D3
LED_ARGB

R16 1k — APP_LED_RED
R17 1k — APP_LED_GREEN
R18 1k — APP_LED_BLUE

Extra GPIO

TP18 APP_GPIO1 — APP_GPIO1
TP19 APP_GPIO2 — APP_GPIO2
TP20 APP_GPIO3 — APP_GPIO3
TP21 APP_GPIO4 — APP_GPIO4

Boot strapping resistors

+3.3V
R20 10k
APP_CRESET

+3.3V
R19 10k
APP_CDONE

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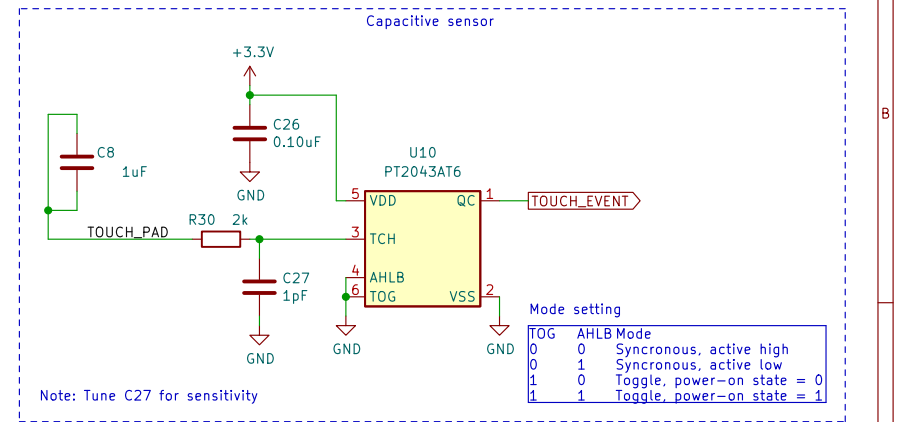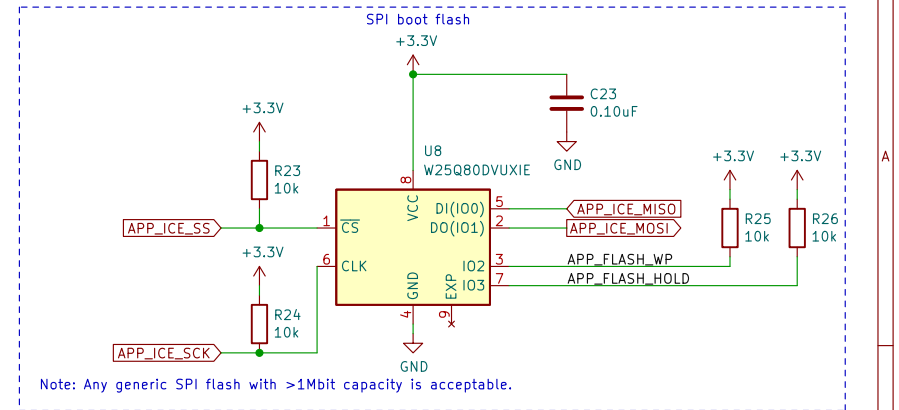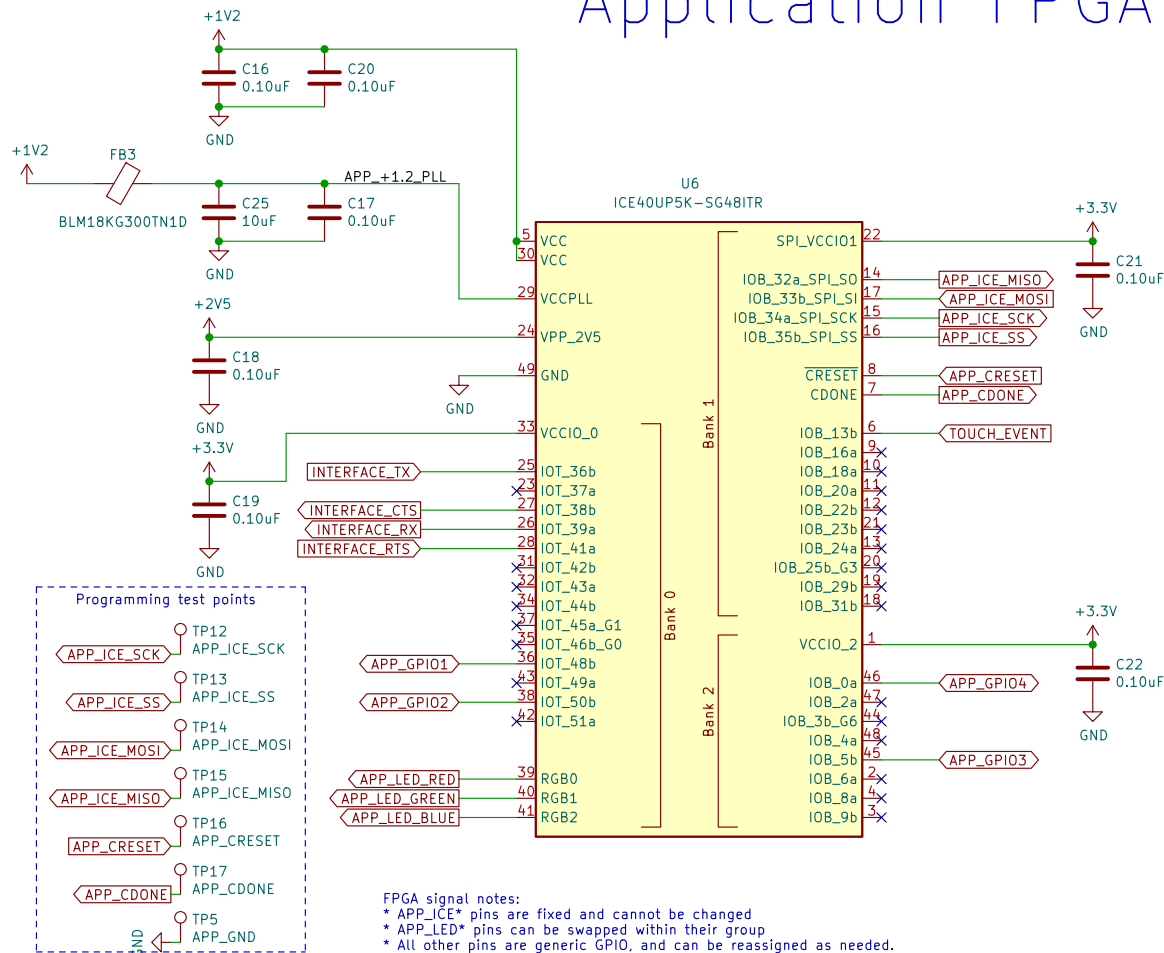
Sheet: /Application FPGA/
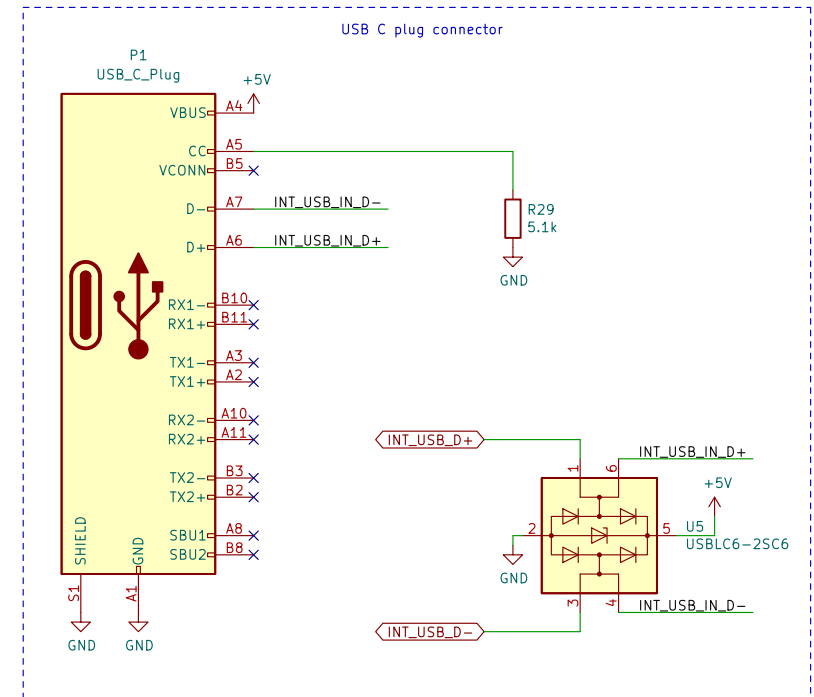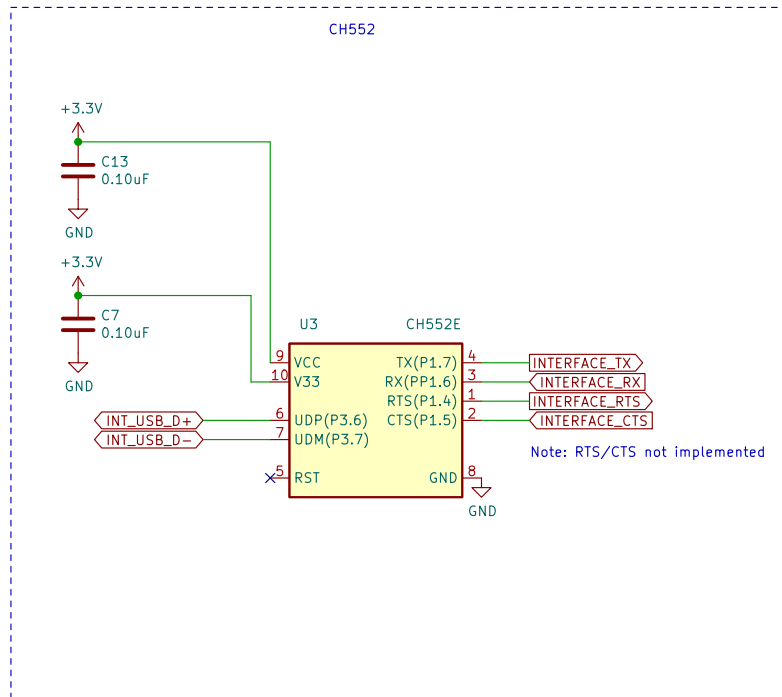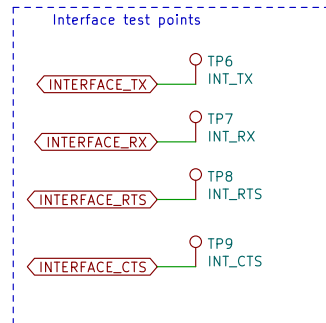File: application_fpga.kicad_sch

Title: Application FPGA

Size: A4   Date: 2021-09-29   Rev: V1
KiCad E.D.A. kicad (6.0.4)   Id: 2/4

USB-to-Serial Interface

Interface test points

INTERFACE_TX	TP6 INT_TX
INTERFACE_RX	TP7 INT_RX
INTERFACE_RTS	TP8 INT_RTS
INTERFACE_CTS	TP9 INT_CTS

CH552

+3.3V
C13 0.10uF
GND

+3.3V
C7 0.10uF
GND

U3 CH552E

Pin	Signal		Pin	Signal
9	VCC	TX(P1.7)	4	INTERFACE_TX
10	V33	RX(PP1.6)	3	INTERFACE_RX
		RTS(P1.4)	1	INTERFACE_RTS
6	UDP(P3.6)	CTS(P1.5)	2	INTERFACE_CTS
7	UDM(P3.7)			
5	RST	GND	8	GND

INT_USB_D+
INT_USB_D−

Note: RTS/CTS not implemented

USB C plug connector

P1 USB_C_Plug

+5V

Signal	Pin
VBUS	A4
CC	A5
VCONN	B5
D−	A7 → INT_USB_IN_D−
D+	A6 → INT_USB_IN_D+
RX1−	B10
RX1+	B11
TX1−	A3
TX1+	A2
RX2−	A10
RX2+	A11
TX2−	B3
TX2+	B2
SBU1	A8
SBU2	B8

SHIELD
S1 GND
A1 GND

R29 5.1k
GND

INT_USB_D+ → INT_USB_IN_D+
INT_USB_D− → INT_USB_IN_D−

U5 USBLC6−2SC6
+5V
GND

The CH552 is loaded with a TTY ACM firmware, to act as a USB−to−Serial converter

Due to the processor speed, not all baud rates are accurate. Here are the baud rates achieved for common settings:

Setting	Actual	% error
9600	9615.38	0.16%
14400	14492.75	0.64%
19200	19230.77	0.16%
38400	38461.54	0.16%
57600	58823.53	2.12%
100000	100000	0.00%
115200	125000	8.51%
128000	142857.14	11.61%
256000	333333.33	30.21%
1000000	1000000	0.00%

Note: RTS/CTS lines are not implemented in the device firmware, but are included in the hardware design in case they need to be implemented. The intent is to use them in the 'modern' sense: Each receiving device asserts it's RTS signal as long as it is able to receive at least one byte of data on it's RX line, and clears it when it is not able to receive data. Each transmitting device will check their RTS input before transmitting on their TX line.

Sheet: /USB to Serial converter/
File: usb_to_serial.kicad_sch
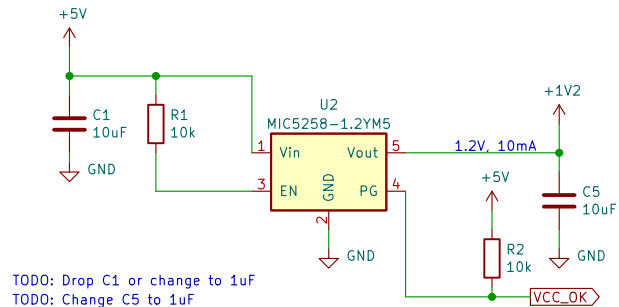**Title: USB−to−Serial Interface**
Size: A4 | Date: 2021−09−29 | **Rev: V1**
KiCad E.D.A. kicad (6.0.4) | Id: 3/4

Power Supply

1.2V regulator, supplies VCC and VCC_PLL

+5V

C1
10uF

R1
10k

GND

U2
MIC5258-1.2YM5

1 Vin Vout 5

3 EN   PG 4

2 GND
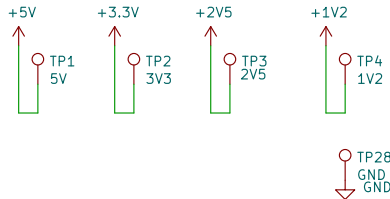
GND

1.2V, 10mA

+1V2

+5V

C5
10uF

R2
10k

GND

VCC_OK

TODO: Drop C1 or change to 1uF
TODO: Change C5 to 1uF
(changes per datasheet minimum recommendations)
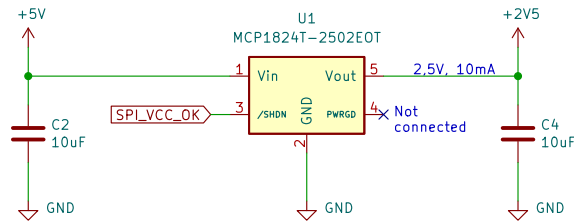
3.3V regulator, supplies VCCIO

+5V

C6
10uF

GND

VCC_OK

U9
NCP752BSN33T1G

1 IN   OUT 5

3 EN   PG 4

2 GND

GND

+5V

R22
10k

SPI_VCC_OK

+3.3V

C3
10uF

GND
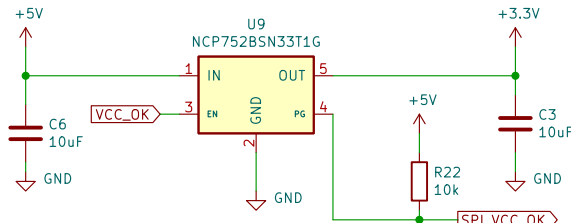
TODO: Change C6 to 1uF
TODO: Change C3 to 1uF
(changes per datasheet minimum recommendations)

Regulator for 2.5V supply from 5V USB

+5V

C2
10uF

GND

SPI_VCC_OK

U1
MCP1824T-2502EOT

1 Vin   Vout 5

3 /SHDN PWRGD 4

2 GND

GND

Not connected

2.5V, 10mA

+2V5

C4
10uF

GND

TODO: Change C2 to 4.7uF
TODO: Change C4 to 1uF
(changes per datasheet minimum recommendations)

Power Supply Test Points

+5V

TP1
5V

+3.3V

TP2
3V3

+2V5

TP3
2V5

+1V2

TP4
1V2

TP28
GND
GND

Power LED

+2V5

D1
0402 indicator LED, blue

R3
1k

GND
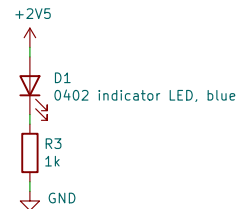
Note: Placed on 2.5V line, so that it only lights after all voltage rails are powered.

Power-on sequence:

1. External power (3.3V_IN) is applied.
2. U2 (1.2V regulator) turns on.
3. Once 1.2V output is stable, U1 releases its PG output, allowing VCC_OK to go high.
4. U9 (3.3V regulator) turns on.
5. Once the 3.3V output is stable, U9 releases its PG output, allowing SPI_VCC_OK to go high.
6. U31(2.5V regulator) turns on.
7. After a short time, the internal POR circuit in the ICE40 allows it to boot.

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Sheet: /Power Supply/
File: powersupply.kicad_sch

Title: Power Supply

Size: A4 | Date: 2021-09-29 | **Rev: V1**

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