801 T-USB testing board

This testing board hosts the 801 T-USB daughter board.

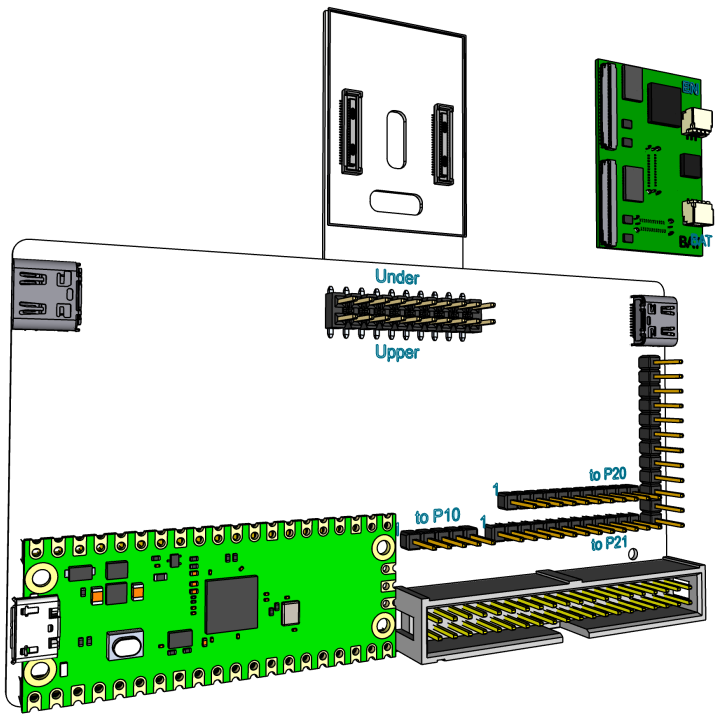
The 801 is a bridge board that connects daughter boards. 801 T-USB is one such daughter board.

The T-USB daughterboard has three functions

- Supply the system with power
- Provide data signals in the system over two USB-C connectors
- Manage autonomous system functions and waking state

The T-USB board exposes two vertical USB-C sockets and connects to the carrier board through two 50 pin B2B connectors. These are routed ultimately through two USB-C connectors on the testing board.

The testing board can also be used to test the bridge board. For this purpose there are two plugs on the underside that connect directly to the sockets on the upperside apart from the VSOM pins.



Board Components

- 2 * Hirose DF40-50DS-0.4V mated height 1.5mm Mouser - JLCPCB socket
- 2 * HD3SS3220 10-Gbps USB 3.1 Type-C 2:1 mux with DRP Controller Mouser
- 2 * USB-C connectors DX07S024JA1R1300 or DX07S024JJ2R1300 - Mouser
- 1 * TSM-110-01-L-DV 2*10 pin Header
- 2 * Samtec TSW-120-14-T-S Header 20 pin
- 3 * Samtec TSW-116-14-T-S Header 16 pin - Mouser

The Samtec single row headers are for reference, but alternate header pins can be soldered on later.

Open notes

Step up voltage 3.5V -> 5V

Testing staged power and data enable when plugging in the module.

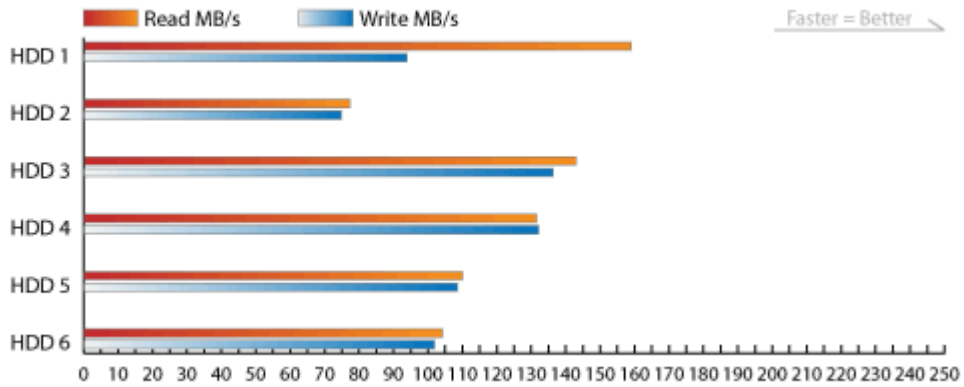
Chip enable when plugged in. 100ms delay.

Testing with the board

Testing cases

- Routing UART over breakout connectors
- VSOM load test
- Interrupt triggering
- Requesting system standby
- Detecting system standby
- Triggering system reset
- Detecting system reset
- Powering dev board from T-USB power output
- Simulating CONN_EN signal
- High voltage USB-C (20V / 12V / 9V) power supplies never produces more than 5V SYS_PWR when connected.
- If one USB port receives power (5V) the other port can deliver power (5V).
- VSOM is 3.45V to 4.4V regardless of charger
- If a Apple Dedicated Charger 5V(1A BC1.2) is connected the board can draw 1A
- If a CDP(5V, 1A) compatible charger is connected the board can draw 1A
- If a CDP(5V, 3A) compatible charger is connected the board can draw 3A
- If power is connected to USB the battery can charge
- If no power is connected the system is battery powered
- USB 3.0 data signal can be passed through from T-USB OTG to testing board OTG, and reverse min. 250MB/sec
- USB 3.0 data signal can be passed through from T-USB Host to testing board Host, and reverse min. 250MB/sec
- USB 2.0 data signal can be passed through from T-USB OTG to testing board OTG, and reverse min. 35MB/sec
- USB 2.0 data signal can be passed through from T-USB Host to testing board Host, and reverse min. 35MB/sec
- Power and Data works through T-USB ports with 300 cm cable length.
- USB signal jitter within accepted range (see USB 3.0 Electrical Compliance Methodology)

Sample USB 3.0 data rates



USB Testing Matrix

USB-Type testing matrix

Product Type	Testing Required						
	USB-C CabCon	USB-C EPC	USB PD	USB-C Functional	USB-C IOP	USB-C Source Power	USB 3.1 and 2.0
Cable	X	X	X				
Charger & Battery Pack			X	X	X	X	X
Host & Hub				X	X	X	X
PD Host & PD Hub			X	X	X	X	X
Host Alt Mode Only			X	X	X		
Device				X	X		X
PD Device			X	X	X		X
OTG	Not compatible with USB Type-C						

Ideal testing equipment for USB 3.0 are Loopback Plugs.

Testing articles,

- What's new in USB Power Delivery 3.0
- A first look at USB 3.1 performance
- Here's how fast USB 3.1 is in the real world

LEDs

LEDs will test specific situations and test cases

- Battery STAT (BAT_STAT - BAT_LDO), see battery charger spec
- Battery power good (PWR_CHARGE above 4.3V), see battery charger spec
- VSOM power on any of the regular VSOM pins (upper 36..48)
- VSOM voltage on regular VSOM pins are >4.5V
- VCC_RTC provides power (rated at ~2V)
- Power on Reset POR_B_3P3
- System powered on, PMIC_ON_REQ raised high
- System powering down, PMIC_STBY_REQ raised high
- VSOM_LOCK powered (upper)
- Each of the VSOM corners 1, 1, 26, 26 (upper) supplies power

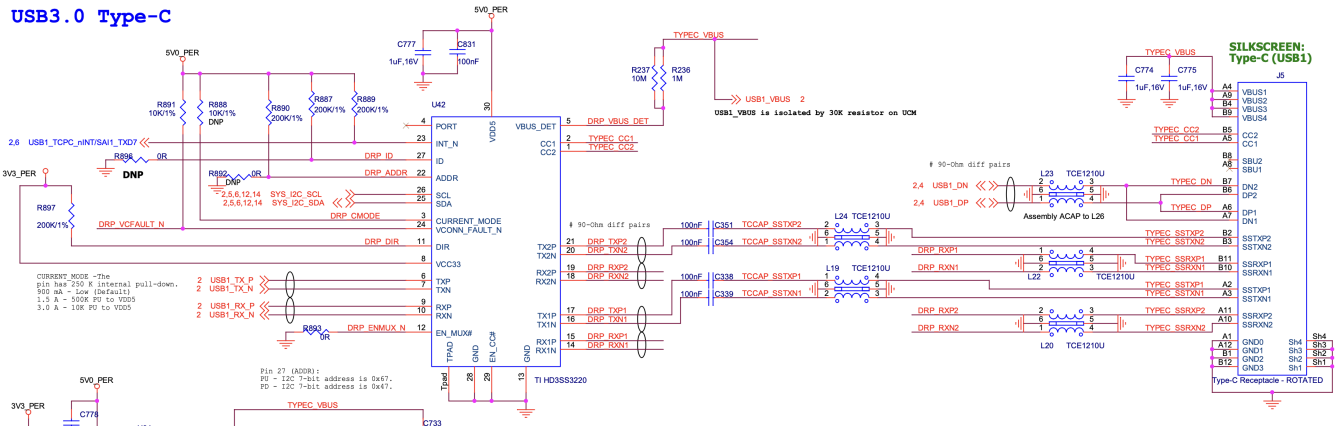
POR_B_3P3, PMIC_ON_REQ and PMIC_STBY_REQ would potentially only be raised high for a very short interval. I suppose a capacitor can be added to ensure that the LED is powered long enough for it to be visible.

Connecting the Board

Signals passed to USB-C connectors

The T-USB board connects to two separate USB 2.0+3.0 signal sources via the 50 pin connectors. In order to test the T-USB board the testing board has supply the equivalent signals it should be possible to connect the two sets of signals via two USB-C connectors. Since USB-C is polarity ambivalent a HD3SS3220 chip is added between each of the USB-C connectors and the 50 pin connectors.

An example of connecting USB 2+3 signals to USB-C via a HD3SS3220 can be seen here.



The USB 2/3 data lines are connected to the 50 pin connectors on both the upperside and underside of the PCB.

Here are the 50 pin connector pins routed to USB-C connectors via the HD3SS3220:

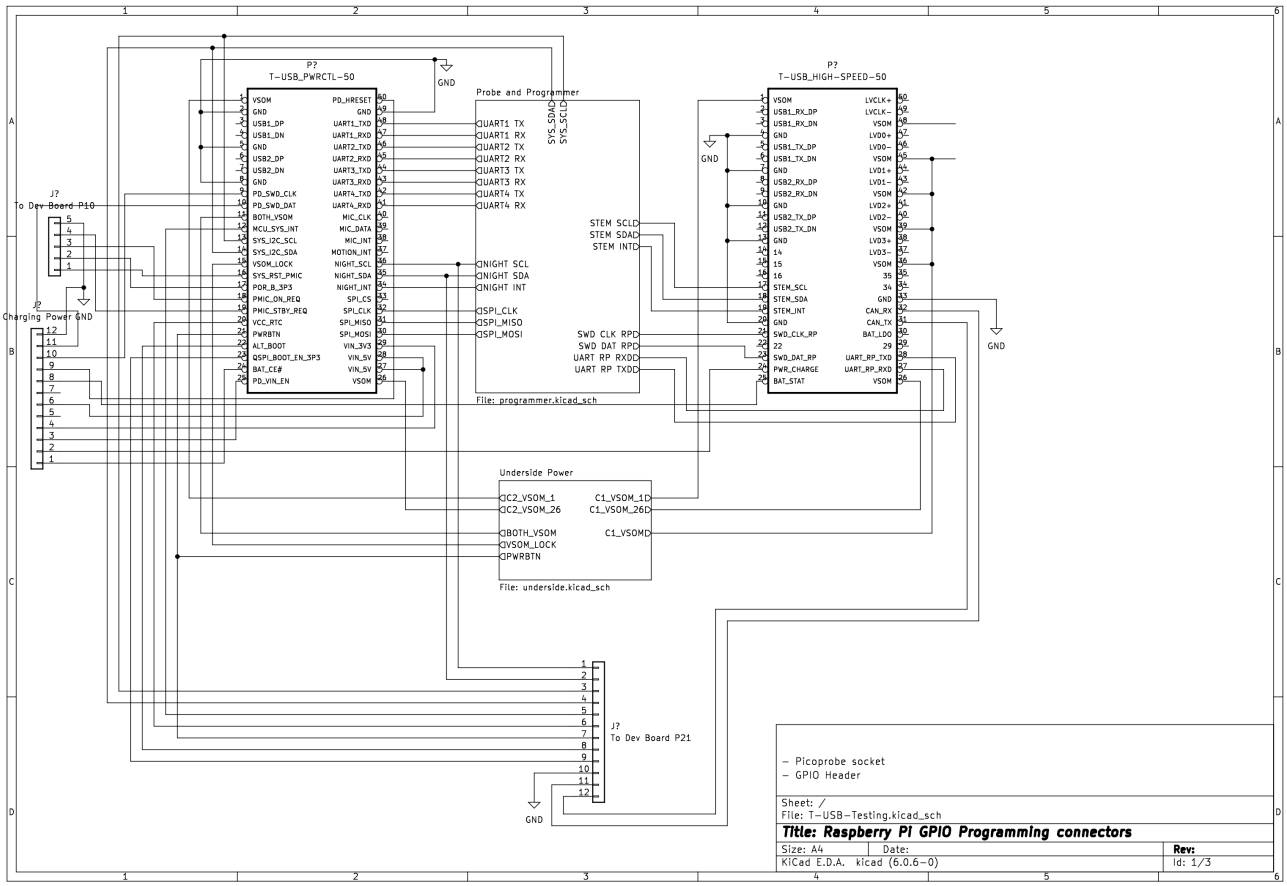
Connector 1 high-speed data

Pin	Code	Type	Details	Voltage
2	USB1_RX_DP	USB	USB1 RX D+	
3	USB1_RX_DN	USB	USB1 RX D-	
4	GND	Power	Ground	
5	USB1_TX_DP	USB	USB1 TX D+	
6	USB1_TX_DN	USB	USB1 TX D-	
7	GND	Power	Ground	
8	USB1_RX_DP	USB	USB2 RX D+	
9	USB1_RX_DN	USB	USB2 RX D-	
10	GND	Power	Ground	

Pin	Code	Type	Details	Voltage
11	USB1_TX_DP	USB	USB2 TX D+	
12	USB1_TX_DN	USB	USB2 TX D-	
13	GND	Power	Ground	

Connector 2 PD controller

Pin	Code	Type	Details	Voltage	Misc
3	USB1_DP	USB	USB1 D+		
4	USB1_DN	USB	USB1 D-		
5	GND	Power	Ground		
6	USB2_DP	USB	USB2 D+		
7	USB2_DN	USB	USB2 D-		
8	GND	Power	Ground		



Underside 50 pin plugs VSOM connection header

This header breaks out the power pins from the underside 50 pin connectors. It allows connecting or disconnecting power pins selectively to the same pin on the upperside connector. These pins on the 50 pin

connectors are not connected to the upperside directly. This connector sits next to the Upperside VSOM connection header to allow easy 1-to-1 connection. C1 refers to Connector 1 high-speed data.

Under Power (10 pins)

Pin	50 Conn	Code	Type	Details	Voltage	Misc
1	1	C1_VSOM_1	Enable	Corner VSOM pin on C1	3.45V - 4.5V	
2	1	C2_VSOM_1	Enable	Corner VSOM pin	3.45V - 4.5V	
3	26	C1_VSOM_26	Enable	Corner VSOM pin on C1	3.45V - 4.5V	
4	26	C2_VSOM_26	Enable	Corner VSOM pin	3.45V - 4.5V	
5	11	BOTH_VSOM	Enable	Signal from bridge board that VSOM is connected on both sides	3.45V - 4.5V ?	
6	15	VSOM_LOCK	Power	Main power for board, if mechanical lock shorted	3.45V - 4.5V	Mech. lock
7	21	PWRBTN	Boot	Power button trigger		
8	48	C1_VSOM	Power	C1 power (36, 39, 42, 45)	3.45V - 4.5V	
9	49	GND	Power	Ground		
10	49	GND	Power	Ground		

Upperside 50 pin sockets VSOM connection

This header breaks out the power pins from the upperside 50 pin connectors. It allows connecting or disconnecting power pins selectively to the same pin on the underside connector. These pins on the 50 pin connectors are not connected to the underside directly. The breakout enables testing partial insertion of the sockets. If pins are not bridged between the upperside and underside connectors, the power is not passed between the under- and uppperside. C1 refers to Connector 1 high-speed data.

Upper Power (10 pins)

Pin	50 Conn	Code	Type	Details	Voltage	Misc
1	1	C1_VSOM_1	Enable	Corner VSOM pin on C1	3.45V - 4.5V	
2	1	C2_VSOM_1	Enable	Corner VSOM pin	3.45V - 4.5V	

Pin	50 Conn	Code	Type	Details	Voltage	Misc
3	26	C1_VSOM_26	Enable	Corner VSOM pin on C1	3.45V - 4.5V	
4	26	C2_VSOM_26	Enable	Corner VSOM pin	3.45V - 4.5V	
5	11	BOTH_VSOM	Enable	Signal from bridge board that VSOM is connected on both sides	3.45V - 4.5V ?	
6	15	VSOM_LOCK	Power	Main power for board, if mechanical lock shorted	3.45V - 4.5V	Mech. lock
7	21	PWRBTN	Boot	Power button trigger		
8	48	C1_VSOM	Power	C1 power (36, 39, 42, 45)	3.45V - 4.5V	
9	49	GND	Power	Ground		
10	49	GND	Power	Ground		

Signals for two 50 pin connectors from dev board (9 + 10 + 5 pins)

50 pins for PD Controller and Data -> Dev Board P20 (11 pins)

Pin	50 Conn	Code	Type	Details	Voltage	Misc
1	48	UART1_TXD	UART	P1.72 UART1 Tx		P20.9
2	47	UART1_RXD	UART	P1.19 UART1 Rx		P20.11
3	46	UART2_TXD	UART	UART2 Tx		P20.1
4	45	UART2_RXD	UART	UART2 Rx		P20.3
5	44	UART3_TXD	UART	P1.61 UART3 Tx		P20.2
6	43	UART3_RXD	UART	P1.21 UART3 Rx		P20.4
7	42	UART4_TXD	UART	UART4 Tx		P20.8
8	41	UART4_RXD	UART	UART4 Rx		P20.10
9	17	I2C3_SCL	I2C	STEM SCL		P20.33
10	18	I2C3_SDA	I2C	STEM SDA		P20.34
11		GND	Power	Ground		

50 pins for PD Controller / Data -> Dev Board P21 + direct connects (12 pins)

Pin	50 Conn	Code	Type	Details	Voltage	Misc

Pin	50 Conn	Code	Type	Details	Voltage	Misc	
1	36	NIGHT SCL	I2C	I2C6 SCL		P21.2	GP19 I2C1.
2	35	NIGHT SDA	I2C	I2C6 SDA		P21.4	GP18 I2C1.
3	18	SYS I2C SCL	I2C			P21.7	GP15 I2C1.
4	19	SYS I2C SDA	I2C			P21.5	GP14 I2C1.
5	12	MCU_SYS_INT	IRQ	Interrupt signal (GPIO4_IO19)		P21.30 P1.60	
6	20	VCC_RTC	Power	Low power mode supply	1.8V	RTC connector	
7	21	PWRBTN	Boot	Power button trigger		Direct on power button	
8	22	ALT_BOOT	Boot	Alternate boot		Direct on alt boot button	
9	23	QSPI_BOOT_EN_3P3	Boot	SPI boot		P21.18	
10		GND	Power	Ground			
11	32	CAN_RX		CAN1_RX		P21.12	
12	31	CAN_TX		CAN1_TX		P21.14	

50 pins for PD Controller -> Dev Board P10 (5 pins)

Pin	50 Conn	Code	Type	Details	Voltage	Misc
1	16	SYS_RST_PMIC	Reset	SoM PMIC reset input pin. Internally pulled up with LDO1 power rail. Once low, PMIC resets		P10.9
2	17	POR_B_3P3	Reset	Power On reset from SoM PMIC		P10.7
3	18	PMIC_ON_REQ	Reset	PMIC ON signal sent to SoM from T-USB. When raised high, the SoM starts power on sequence.		P10.5
4	19	PMIC_STBY_REQ	Reset	Standby mode input from T-USB to SoM. When high, SoM enters STANDBY mode.		P10.3

Pin	50 Conn	Code	Type	Details	Voltage	Misc
5		GND	Power	Ground		

Raspberry Pi GPIO header

A GPIO header connector is placed on the testing board to allow adding a RPi for testing/programming and chaining other boards over SDIO/SPI/I2C busses.

The pinout,

Left side	Function	Pin	Pin	Function	Right side
When VSOM fully connected	3V3	1	2	5V	When VSOM fully connected
STEM_SDA	SDA	3	4	5V	When VSOM fully connected
STEM_SCL	SCL	5	6	GND	
STEM_INT	INT	7	8	TxD	UART2 TxD
	GND	9	10	RxD	UART2 RxD
		11	12	SWD	SWDCLK for T-USB
SDIO DAT3 / GPIO2_IO18	SDIO	13	14	SWD	SWDIO for T-USB (GND)
SDIO CLK / GPIO2_IO13	SDIO	15	16	SDIO	SDIO CMD / GPIO2_IO14
	3V3	17	18	SDIO	SDIO DAT0 / GPIO2_IO15
ECSPI2_MOSI / GPIO5_IO11	MOSI	19	20	GND	
ECSPI2_MISO / GPIO5_IO12	MISO	21	22	SDIO	SDIO DAT1 / GPIO2_IO16
ECSPI2_SCLK / GPIO5_IO10	SCLK	23	24	SPI CE0	ECSPI2_SS0/GPIO5_IO13
	GND	25	26	SCL	NIGHT SCL
SYS I2C	SYS SDA	27	28	SCL	SYS I2C
NIGHT_INT	INT	29	30	(GND)	
NIGHT_SDA	SDA	31	32	TxD	UART4 TX
UART4 RX	RxD	33	34	JTAG	GND
		35	36	JTAG	
SDIO DAT2 / GPIO2_IO17	SDIO	37	38	CAN2	
(GND on RPi)		39	40	CAN2	

SWDIO MIC DAT MIC CLK HUMAN DAT RP UART RX/TX

RP Power on RP Bootsel

Raspberry Pi Pico Socket

A socket is added for adding a RPi Pico which will be running Picoprobe debugging firmware

The pinout,

Code	All	T-USB	Cam	Probe	Description	Function	SoM Dev Board
GP00					UART_RP_TXD for debugging	F2 UART0	-
GP01					UART_RP_RXD for debugging	F2 UART0	-
GP02	x				STEM INT Sensor / Expander IRQ		
GP03	x				NIGHT INT Sensor IRQ		
GP04	x				SYS I2C SDA	F3 I2C0	P1.97
GP05	x				SYS I2C SCL	F3 I2C0	P1.99
GP06		MIC_CLK		Probe SWCLK	VM3011 or SWD		
GP07		MIC_DATA		Probe SWDIO	VM3011 or SWD		
GP08		UART1 Tx		UART2 Tx		F2 UART1	P20.1
GP09		UART1 Rx		UART2 Rx		F2 UART1	P20.3
GP10	x	SDIO CLK		SDIO CLK	SDIO CLK / SPI_CLK	F1 SPI1	
GP11	x	SDIO CMD		SDIO CMD	SDIO CMD / SPI_MOSI or TX	F1 SPI1	
GP12		UART3 Tx		UART4 Tx		F2 UART0	P20.2 / P1.61
GP13		UART3 Rx		UART4 Rx		F2 UART0	P20.4 / P1.21
GP14	x	SDIO DAT1	DAT1	SDIO DAT1	SDIO DATA 1	F0 GPIO	
GP15	x	SDIO DAT2	DAT2	SDIO DAT2	SDIO DATA 2	F0 GPIO	

Code	All	T-USB	Cam	Probe	Description	Function	SoM Dev Board
GP16			DAT0	Probe UART TX		F3 I2C0	-
GP17			DAT4	Probe UART RX		F3 I2C0	-
GP18	x				Night I2C6 SDA	F3 I2C1	P21.4
GP19	x				Night I2C6 SCL	F3 I2C1	P21.2
GP20	x				STEM SDA	F3 I2C0	-
GP21	x				STEM SCL	F3 I2C0	-
GP22	x	SDIO DAT3	DAT3	SDIO DAT3	SDIO DATA 3	F8 CLOCK GPIN1	
GP23			MCLK		- Reserved for Speaker I2S SDO (Dev buck mode)	F8 CLOCK GPOUT1	
GP24			VSYNC		- Reserved for Speaker I2S BCK (Dev VBUS voltage)		
GP25			HREF		- Reserved for Speaker I2S LRCK / MIC_CLK (Dev LED)		
GP26		BODY_DAT			Reserved Human Body analog signal	Fx ADC	
GP27		MiC_INT DOUT			Reserved Voltage / Analog Sensor or Digital	Fx ADC	
GP28	x	SDIO DAT0		SDIO DAT0	SDIO DATA0 / SPI_MISO or RX	F1 SPI1	
GP29					SPI_CS, reserved, do not connect (Lipo Dev Voltage)	F1 SPI1	
USB_DM		Stem USB D-		Probe D-	USB 2.0 D-		
USB_DP		Stem USB D+		Probe D+	USB 2.0 D+		

Code	All	T-USB	Cam	Probe	Description	Function	SoM Dev Board
USB_VDD				Not used			

Pico:

GPIO29 – in ADC mode (ADC3), used to measure VSYS/3 GPIO25 – connected to on-board LED GPIO24 – VBUS sense (high if VBUS is present, else low) GPIO23 – Controls the on-board SMPS Power Save pin

Pico W:

GPIO29 OP/IP wireless SPI CLK/ADC mode (ADC3) to measure VSYS/3 GPIO25 OP wireless SPI CS - when high also enables GPIO29 ADC pin to read VSYS GPIO24 OP/IP wireless SPI data/IRQ GPIO23 OP wireless power on signal

Considered revisions:

TPS65988 SPI Controller Interface loads patches during bootup. The SPI interface should be hooked up to either the Picoprobe or the Stem MCU.

Breakout of Experimental Charging Pins

From 50 pins for PD Controller / Data -> Charging power (12 pins)

Pin	50 Conn	Code	Type	Details	Voltage	Misc
1	24	BAT_CE#	Charger	Charge Enable Active-Low Input. Connect to a high logic level to place the battery charger in standby mode.		
2	24	PWR_CHARGE	Power	Internal charging power		
3	25	PD_VIN_EN		Enable VIN_5V/3V3 from PWR_SYS (TBD)		
4	29	VIN_3V3		Supply for TPS64988 circuitry and I/O. Current 50 mA	3.3V	
5	34	SPI_3V3	Power	Power to the flash chip. Bridge connects to VIN_3V3	3.3V	
6	28	VIN_5V	Power	System 5V power source (PPHV1, PPHV2, PP1_CABLE, PP2_CABLE). 500 mA.	5V	
7						
8	25	BAT_STAT	Battery	Internal charging status for testing		

Pin	50 Conn	Code	Type	Details	Voltage	Misc
9	50	PD_HRESET	PD	PD Controller HRESET (High)		
10	9	PD_SWD_CLK	PD	Debugging PD Controller		
11	9	PD_SWD_DAT	PD	Debugging PD Controller		
12		GND	Power	Ground		

Signals **NOT** broken out from 50 pin connectors

These signal pins are however connected between the upperside and underside.

Pin	Code	Type	Details	Voltage
50	LVCLK+	LVDS	LVDS CLK+	
49	LVCLK-	LVDS	LVDS CLK-	
47	LVD0+	LVDS	LVDS D0+	
46	LVD0-	LVDS	LVDS D0-	
44	LVD1+	LVDS	LVDS D1+	
43	LVD1-	LVDS	LVDS D1-	
41	LVD2+	LVDS	LVDS D2+	
40	LVD2-	LVDS	LVDS D2-	
38	LVD3+	LVDS	LVDS D3+	
37	LVD3-	LVDS	LVDS D3-	