USB-C & USB-PD

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USB-C

- Reversible connector
- Only one connector, no more A & B connectors
- USB-3.1 (10Gbit), but USB-2 is fine as well
- Alternate modes - Displayport, HDMI, Thunderbolt3, Audio
- Supports USB-PD
- Locking connector versions standardised
- Direction of power & data is negotiated between endpoints
  - Requires a micro, uses out of band control channels
- Rapidly becoming standard on laptops & (Android) smartphones

Connector

Artist renderings courtesy of Foxconn

USB Implementers Forum ©2014

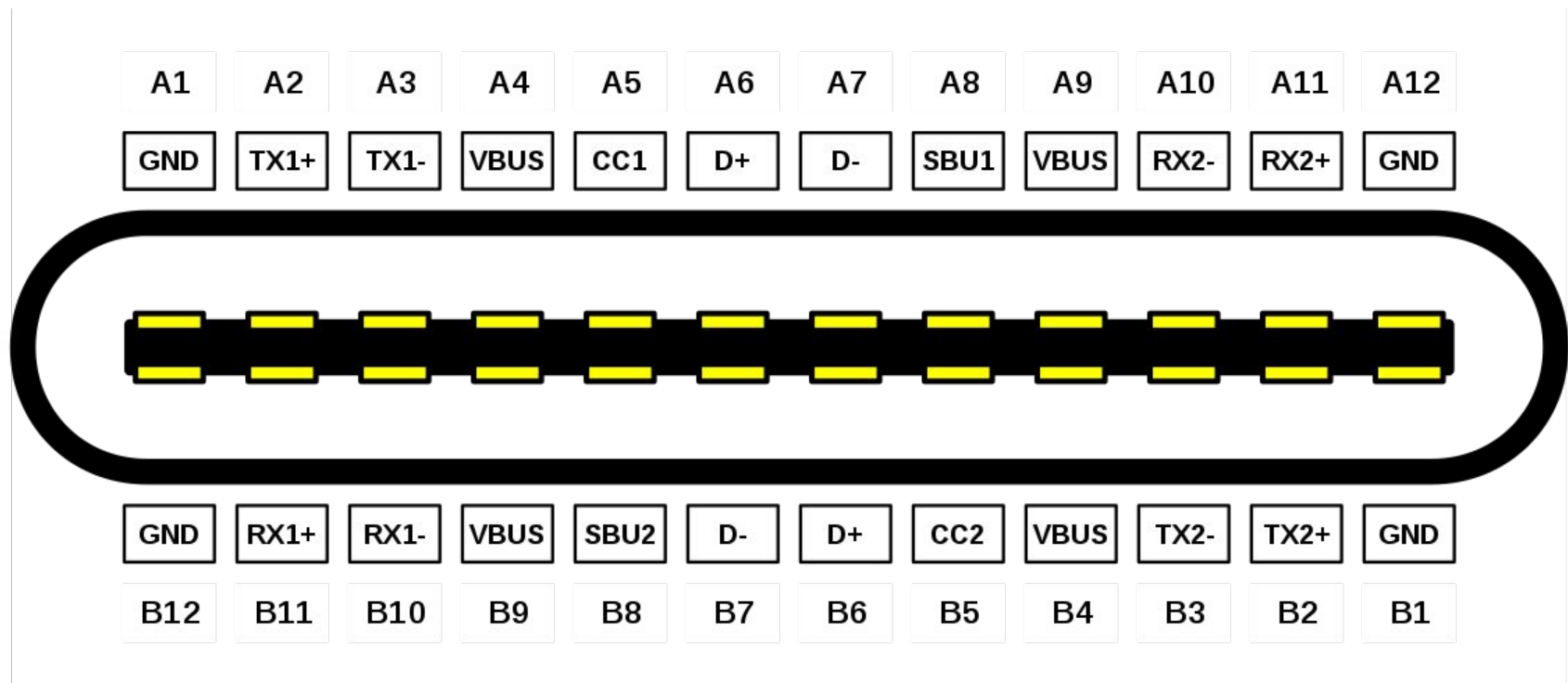USB Type-C™ Plug & Cable

TOP-MOUNT RECEPTACLE
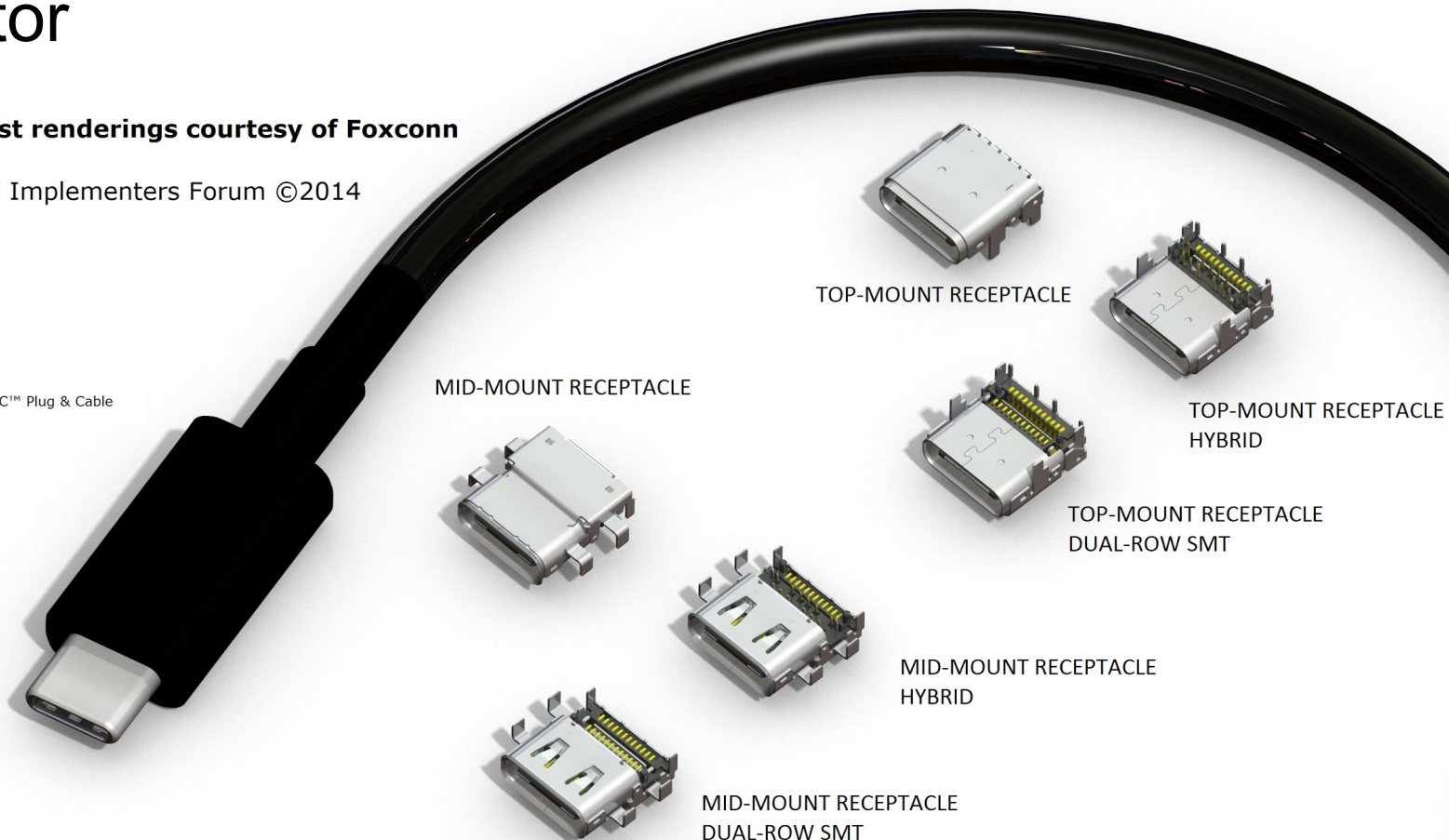
MID-MOUNT RECEPTACLE

TOP-MOUNT RECEPTACLE
HYBRID

TOP-MOUNT RECEPTACLE
DUAL-ROW SMT

MID-MOUNT RECEPTACLE
HYBRID

MID-MOUNT RECEPTACLE
DUAL-ROW SMT

Pinout

A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
GND	TX1+	TX1-	VBUS	CC1	D+	D-	SBU1	VBUS	RX2-	RX2+	GND

GND	RX1+	RX1-	VBUS	SBU2	D-	D+	CC2	VBUS	TX2-	TX2+	GND
B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1

USB-PD

- For > 2.5W via USB
- 5-20v, standard values 5v, 9v, 15v, 20v
- Up to 3A with standard cables, 5A with cables specifically "e-marked"
- Up to 100W (5A @ 20V)
- Endpoints negotiate

10.2.2 Normative Voltages and Currents

The voltages and currents a Source with a PDP of x Watts shall support are as defined in Table 10-2.

Table 10-2 Normative Voltages and Currents

PDP (W)	Current at 5V (A)	Current at 9V (A)	Current at 15V (A)	Current at 20V (A)
$0.5 \leq x \leq 15$	$x \div 5$			
$15 < x \leq 27$	3	$x \div 9$		
$27 < x \leq 45$	3	3	$x \div 15$	
$45 < x \leq 60$	3	3	3	$x \div 20$
$60 < x \leq 100$	3	3	3	$x \div 20$[1]
[1] Requires a 5A cable.				

Figure 10-1 illustrates the maximum current and power rails that a Source shall support at each voltage for a given PDP.

Figure 10-1 Source Power Rule Illustration
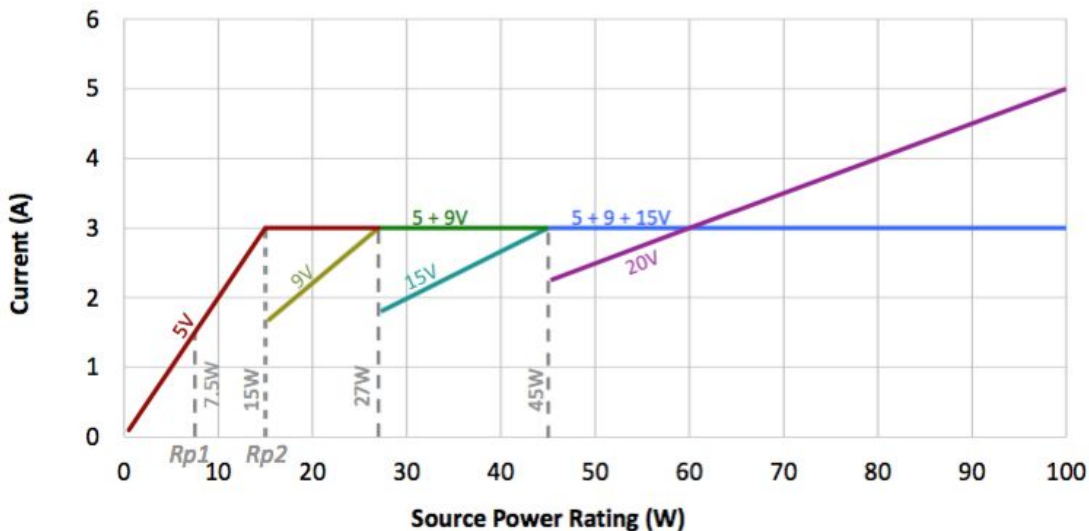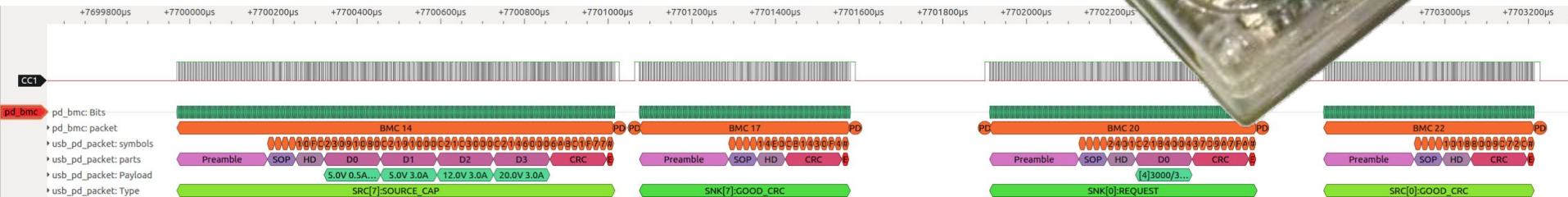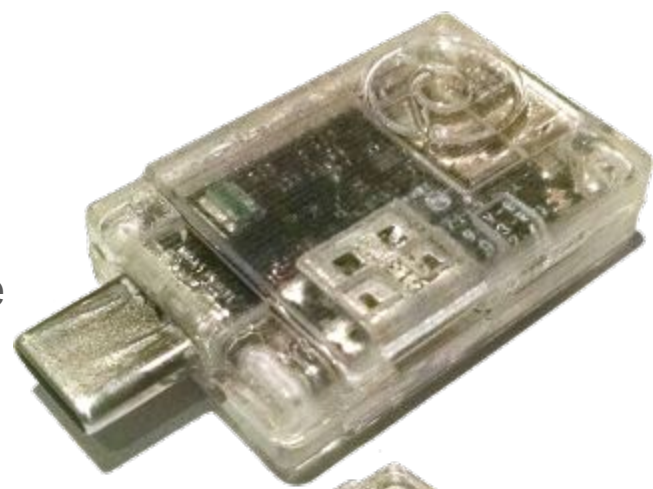
USB-PD port controllers

- TI - TPS6958x
- Cypress - EZ-PD CCGx
- And many others:
  - ST, ROHM, Fairchild, NXP, ...

Chromium "Twinkie"

A USB-PD sniffer from the Chromium project, works like a pre-wired logic analyzer using "sigrok" stack.

Very handy while debugging USB-PD devices (and seeing if you have a dodgy power supply)
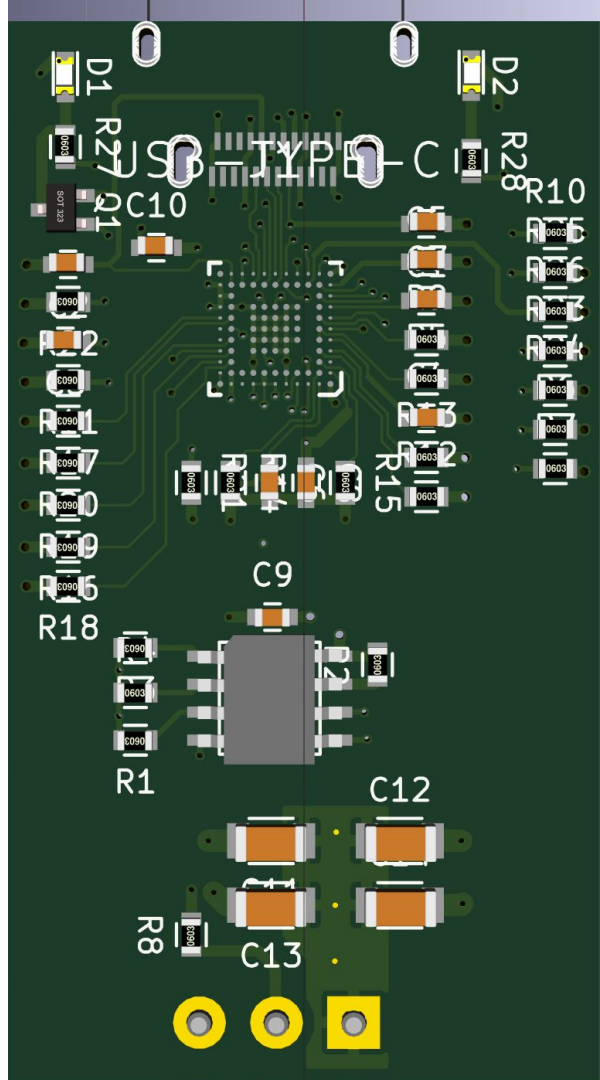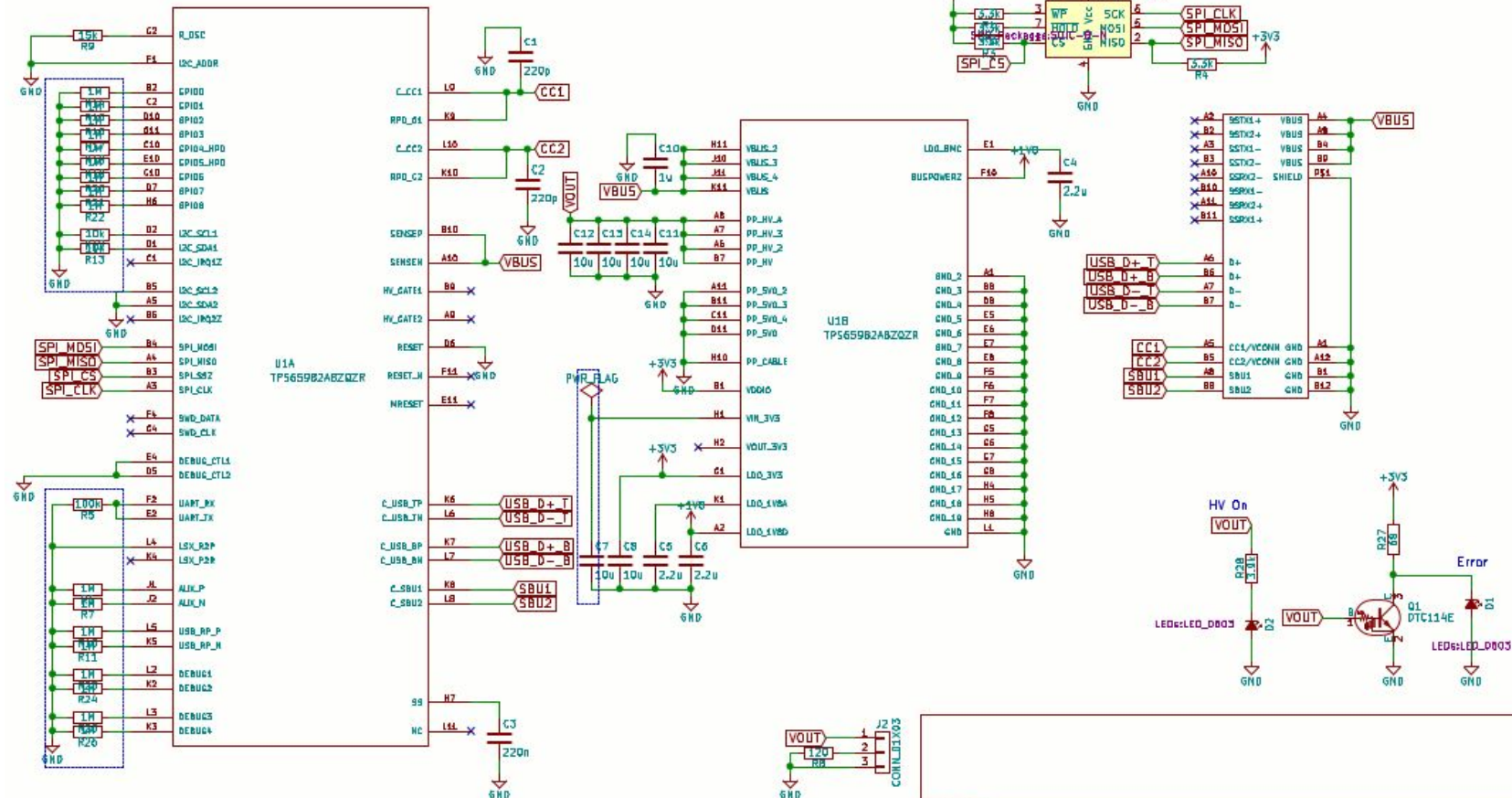
Sweet spots for USB-C

- Portable devices where reversible connector a win
- Portable devices needing 10-100W power
- Devices needing locking connectors
- Alternative to USB On-The-Go
- Alternative to micro-USB3
- USB+Power+Displayport/HDMI in a single cable
- Or anything needing 10g USB / Thunderbolt3

USB-C Thinkpad

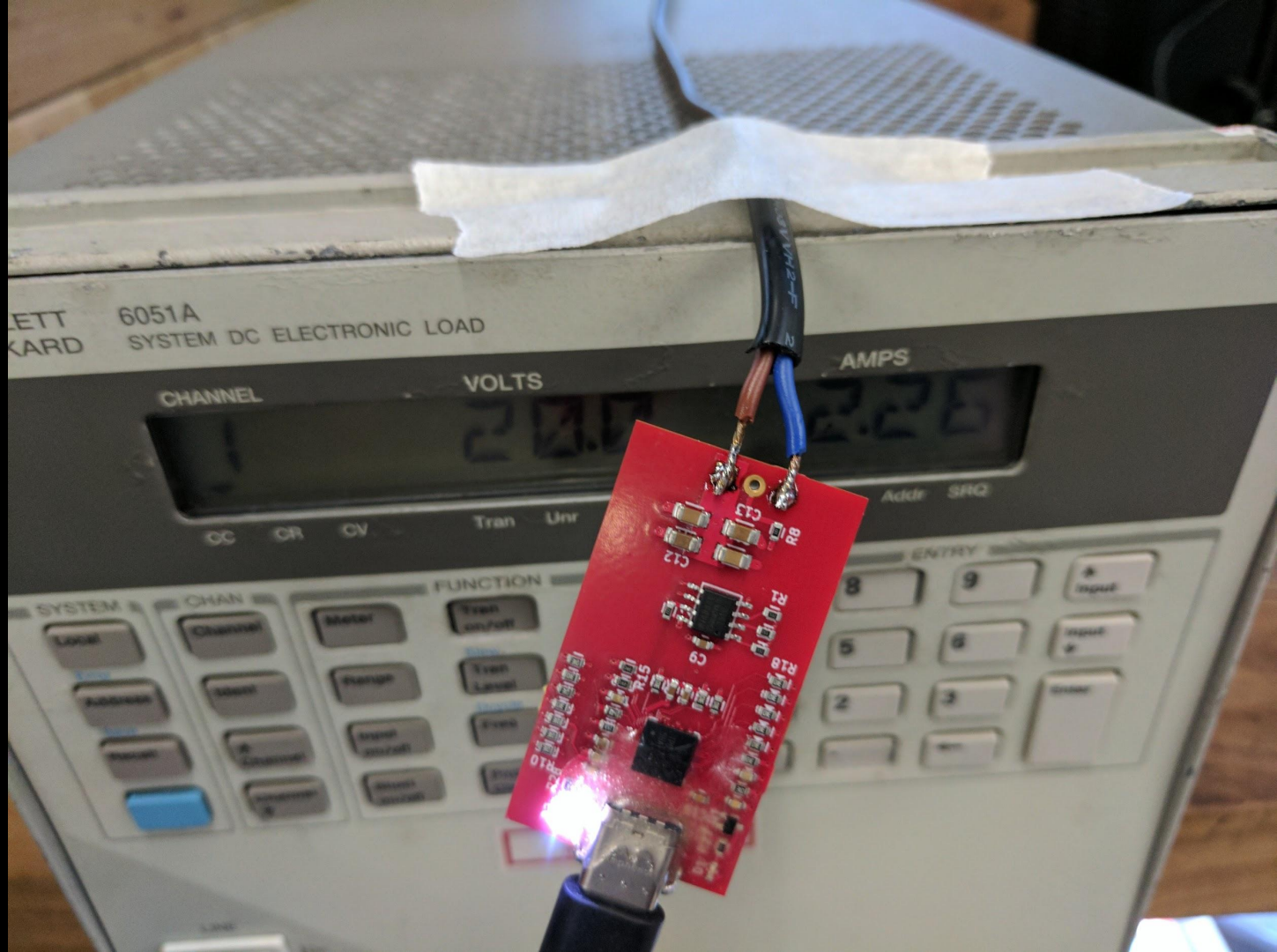Very slow personal project over 2016, adapter to charge "slim" connector thinkpads via USB-C.

- TI TPS65986 controller
- Only other active components: SPI flash, transistor for LED
- 4-layer board
- Designed in KiCad
- Fabricated by PCB.NG, ~US$30ea @QTY6

C9
0.1u
+3V3
GND

U2
25LC_EEPROM
5.3k
R3
WP   Vcc
GND   SCK
SCL/SDA   MOSI
GND   MISO
SPI_CS
5.3k
R4
GND
+3V3
SPI_CLK
SPI_MOSI
SPI_MISO

15k
R9
R_OSC
I2C_ADDR
GND

C1
220p
GND
C_CC1
RPD_d1
CC1

C10
1u
GND
VBUS_2
VBUS_3
VBUS_4
VBUS
GND

LDO_BNC
BUSPOWERZ
+1V8
C4
2.2u
GND

1M
R18
GPIO0
GPIO1
GPIO2
GPIO3
GPIO4_HPD
GPIO5_HPD
GPIO6
GPIO7
GPIO8
R22

10k
R13
I2C_SCL1
I2C_SDA1
I2C_IRQ1Z
GND

I2C_SCL2
I2C_SDA2
I2C_IRQ2Z
GND

SPI_MOSI
SPI_MISO
SPI_CS
SPI_CLK
SPI_MOSI
SPI_MISO
SPI_CS
SPI_CLK

U1A
TP6659B2ABZQZR

SWD_DATA
SWD_CLK
DEBUG_CTL1
DEBUG_CTL2
GND

100k
R5
UART_RX
UART_TX

LSX_R2P
LSX_P2R

1M
R7
AUX_P
AUX_N

1M
R11
USB_RP_P
USB_RP_N

1M
R24
DEBUG1
DEBUG2

1M
R26
DEBUG3
DEBUG4
GND

C_CC2
RPD_C2
CC2

C2
220p
GND
VOUT
VBUS

SENSEP
SENSEN
VBUS

HV_GATE1
HV_GATE2

RESET
RESET_N
NRESET
GND

C_USB_TP
C_USB_TN
USB_D+_T
USB_D-_T

C_USB_BP
C_USB_BN
USB_D+_B
USB_D-_B

C_SBU1
C_SBU2
SBU1
SBU2

99
NC
C3
220n
GND

C12 C13 C14 C14
10u 10u 10u 10u
GND

PP_HV_4
PP_HV_3
PP_HV_2
PP_HV

PP_5V0_2
PP_5V0_4
PP_5V0
PP_CABLE

VDDIO
VIN_3V3
VOUT_3V3
LDO_3V3
LDO_1V8A
LDO_1V8D

+3V3
GND

PWR_FLAG

+3V3
+3V3
+1V8
C7 C8 C5 C6
10u 10u 2.2u 2.2u
GND

U1B
TP6659B2ABZQZR

GND_2
GND_3
GND_4
GND_5
GND_6
GND_7
GND_8
GND_10
GND_11
GND_12
GND_13
GND_14
GND_15
GND_16
GND_17
GND_18
GND_19
GND

GND

SSTX1+   VBUS
SSTX2+   VBUS
SSTX1-   VBUS
SSTX2-   VBUS
SSRX2-   SHIELD
SSRX1-
SSRX2+
SSRX1+
VBUS

USB_D+_T   D+
USB_D+_B   D+
USB_D-_T   D-
USB_D-_B   D-

CC1   CC1/VCONN GND
CC2   CC2/VCONN GND
SBU1   SBU1
SBU2   SBU2
GND

HV On
VOUT
R28
3.3k
LEDs:LED_0603
D2
VOUT
Q1
DTC114E
R27
68
Error
D1
LEDs:LED_0603
+3V3
VOUT
GND   GND   GND

VOUT
12V
R8
J2
CONN_01X03
GND

PWR_FLAG   PWR_FLAG   PWR_FLAG
VBUS   VOUT
GND

Not populated in TI Reference Design
Or otherwise likely unneeded

Sheet: /
File: Adapter-v1.sch
Title: USB-C Thinkpad Charger
Size: A4   Date: 2016-05-08   Rev: v1
KiCad E.D.A. kicad 4.0.2+dfsg1-stable   Id: 1/1

Questions?

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