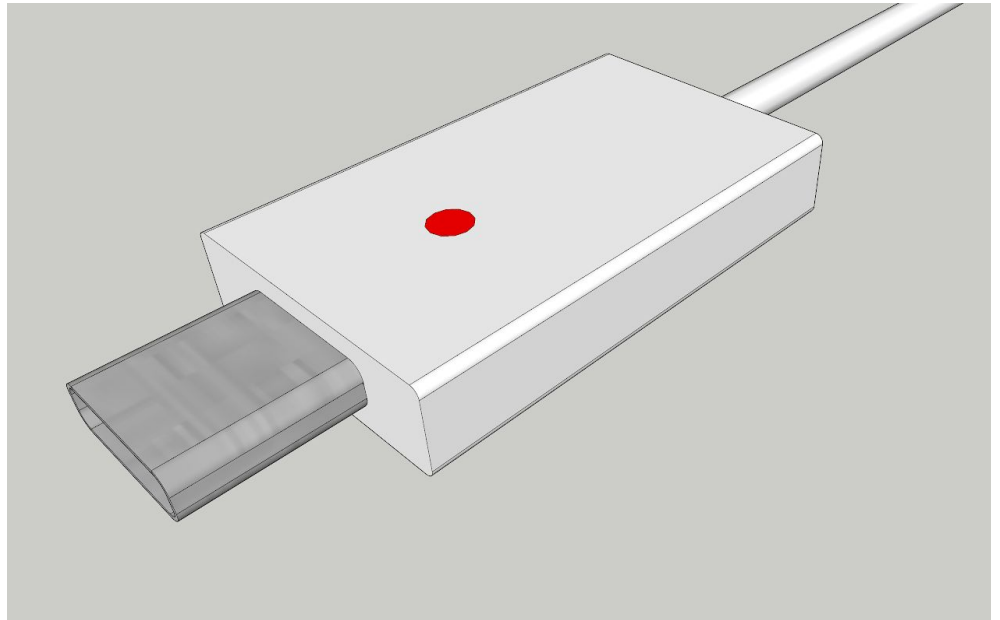


Surface-C

Designed by Noah
Sweilem

Charge a Surface Pro 3/4
or Book 1/2 with USB-C

- Not as bulky as the official adapter
- Automatic USB-PD® power negotiation
- Charge with up to 45W of power - more than the charger in the box*
- Low current detection with bright indicator
- Only \$69.99



* Applicable to Surface Pro 3/4 without discrete GPU only (36W charger in box)

Technical details

- USB® type-C with USB-PD. Operates in 3 modes**:
 - 12V @ 2A (24W)
 - 12V @ 3A (36W)
 - 15V @ 3A (45W)
- Texas Instruments® TPS-65986 USB-PD Controller
- Low current indicator LED
 - Lights when $V_{BUS} < 12V$ or when $I(V_{BUS}) < 2A$

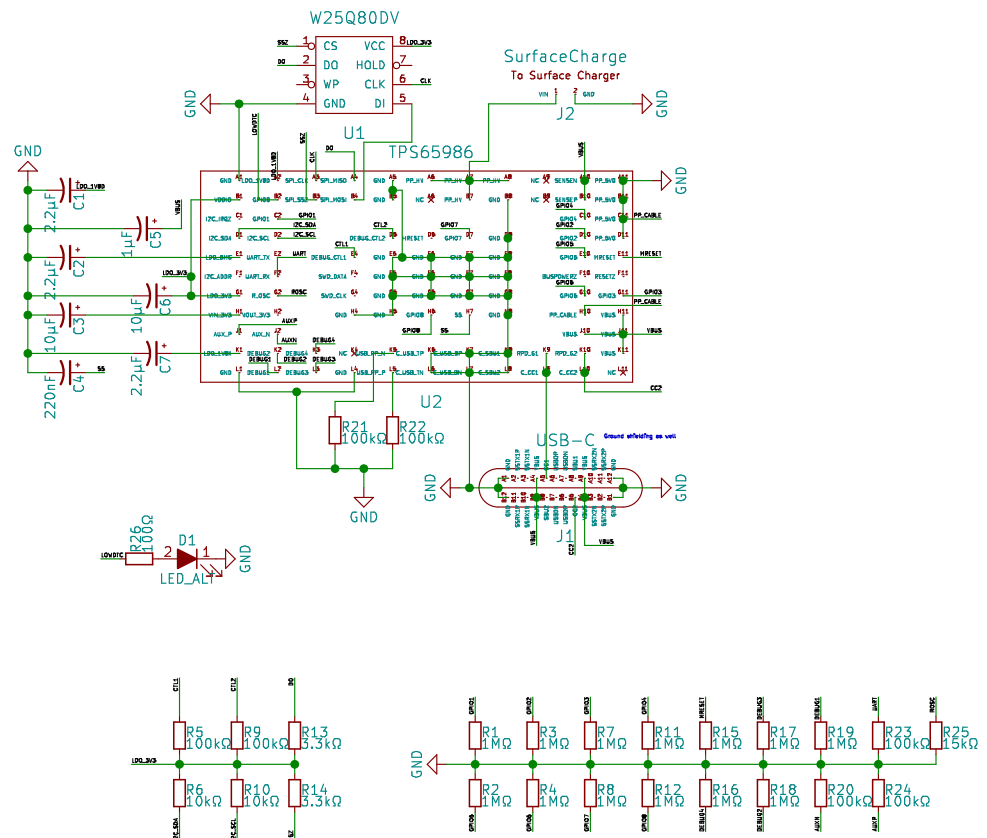
**Required PD mode 5V @ 2A mode triggers low current indicator since it cannot charge the Surface.

Bill of Materials

Designator	Value/MPN	Quantity	Package
C1, C2, C7	2.2μF	3	0402 SMD
C3, C6	10μF	2	0402 SMD
C4	220nF	1	0402 SMD
C5	1μF	1	0402 SMD
D1	RED	1	1206 SMD
J1	1054440001	1	N/A
R6, R10	10kΩ	2	0402 SMD
R1 - R4, R7 - R8, R11 - R12, R15 - R19	1MΩ	13	0402 SMD
R13, R14	3.3kΩ	2	0402 SMD
R5, R9, R20 - R24	100kΩ	7	0402 SMD
R25	15kΩ	1	0402 SMD
R26	100Ω	1	0402 SMD
U1	W25Q80DV	1	SOIC-8
U2	TPS65986	1	96pin BGA MICROSTAR JR.

Note: Currently, the TPS65986 is marked NRND by TI, however, the TPS65987D that succeeds it has an entirely different footprint. The TPS65987D may be used if a future revision is created.

Schematic Diagram



Surface-C

Sheet: /

File: Surface-C.sch

Title: Surface-C by Noah Sweilem

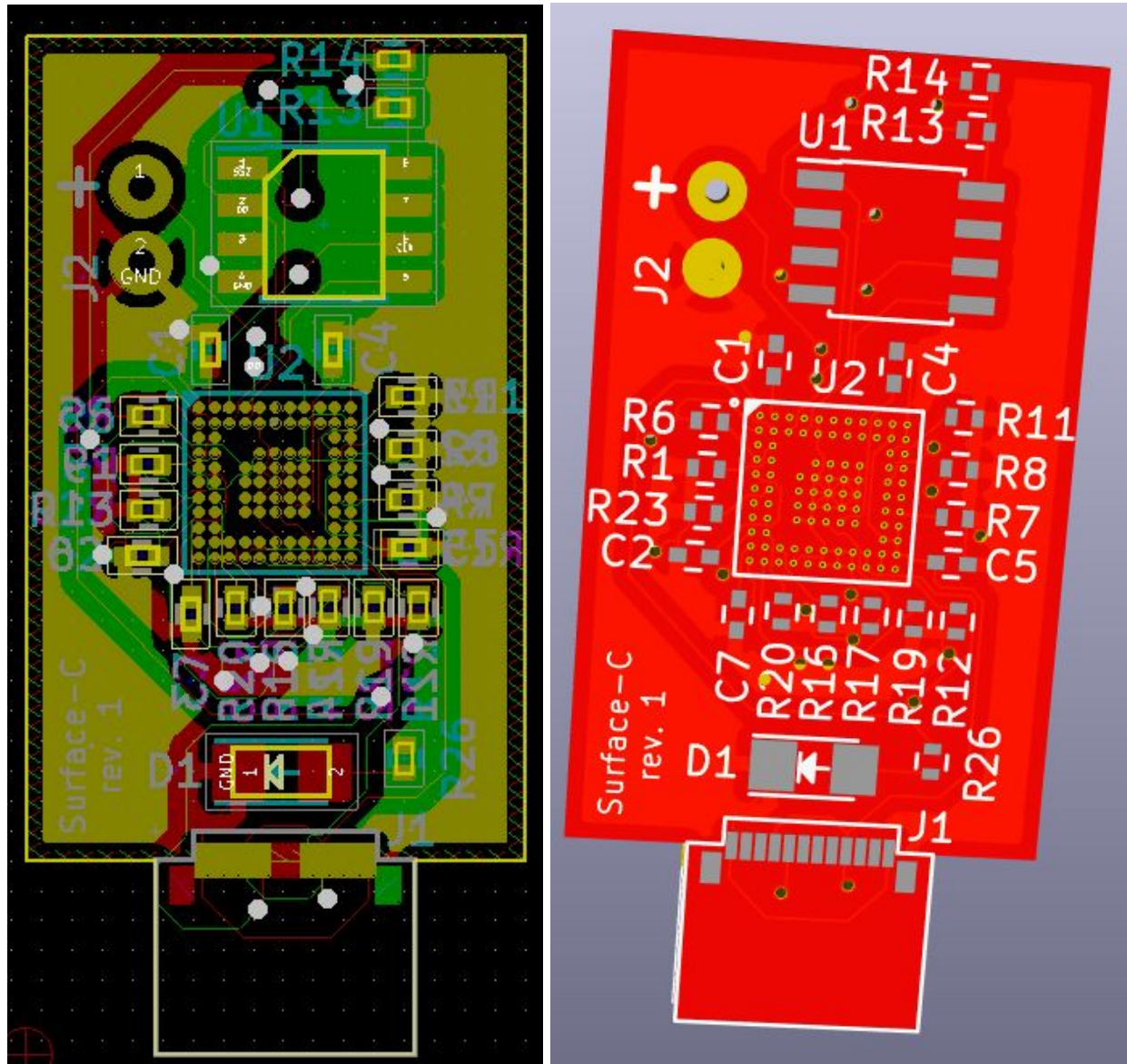
Size: USLetter Date: October 19, 2018

KiCad E.D.A. kicad 4.0.5+dfsg1-4

Rev:

Id: 1/1

Boardview + 3D board render



Design Process

Initially, my thoughts were to mimic the (then unreleased) official Microsoft adapter, but, as I was designing, I found it would be nearly impossible to source power from the Surface without an ugly multi-cable solution. Since I value the portability more than the function, I decided to drop the USB data and go for a charge-only adapter. From there, I was able to reduce the size of the board to create an almost normal-looking cable.

As for chip selection, I considered a lot of different chips. The first chip I considered was the TI TPS65982, but it required external MOSFETs, which would take up more space and add unnecessary cost. I considered brands other than TI, but eventually decided on the TPS65986, because of its small form factor, price, its use of an

easily-programmed SPI flash chip, and no-battery support, a critical feature no other reasonably-priced chip had.

Component count was another thing I had to take into account - I initially erred on the safe side and began cutting down on components later. The first component I removed was a 15 volt regulator - the TPS65986 already had over-volt protection in software, and any PD-compliant supply would have a safe 15V 3A supply available. Some other components I removed were an NPN transistor and resistors used to invert a digital signal; I later realized I could invert it in software.

The Surface-C's projected cost is \$69.99, \$10 cheaper than Microsoft's clunky, unreliable dongle.

Reflection

I think that this project was overall a success, but there are some things I'd like to improve.

If I were to make another revision of this board, here's what I'd change:

- Use the TPS65987D instead of the TPS65986 since it is near end-of-life
- Use resistor arrays instead of many small resistors (especially because there are many 1MΩ resistors)
- Add a programming header for the SPI chip
- Add two more LEDs -
 - An orange LED to indicate that charging is occurring,
 - A green LED to indicate that charging is finished (when current draw is low),
 - and the existing red LED to indicate that there isn't enough current to charge
 - In addition, use smaller LEDs with a common refractor
 - Possibly use one 3 pin multicolor LED
- Use larger traces and vias to reduce manufacturing risks

These optimizations would allow for a slimmer, cheaper board.

KiCAD Files + Gerbers

Find it all on GitHub at  [nununoisy/surface-c](https://github.com/nununoisy/surface-c)! (Feel free to submit a PR!)

Questions? Comments?

Contact me at noah.sweilem@gmail.com if you have any questions or would like to contact me.