

Camera Gimbal

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Project Overview and Name

- We wanted to make a phone/GoPro camera gimbal for taking videos. It would have 2 stepper motors and a gyroscope/accelerometer to track/keep the phone orientation to the ground while applying adjustments using the motors to maintain this desired output.
- Power management —> ~12+V battery, Step down LDO
- Compute - ESP32 - SOLO microcontroller
- Digital - Digital accelerometer/gyroscope over SPI
- Actuation - 2 1.8 degree stepper motors

BOM

Instructions

Fill in the cells with the YELLOW highlight. Do not edit red cells. Fill out the Digi-Key part # OR the Mouser part #, DO NOT fill out both. Choose the cheapest distributor that has the part in stock. If the part is not in stock by the time we order parts, there is a risk that we will not purchase it.

Total Price for Project
\$ 73.55

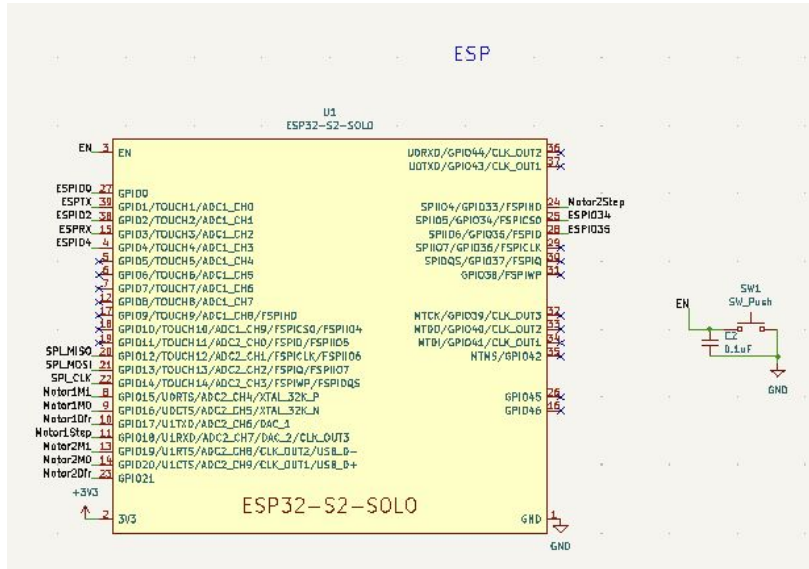
Component	Qty (for 1 board)	Manufacturer Part #	Digi-key Part#/SKU	Other Part#/SKU	Price/unit (\$)	Purchase URL	Reference Designator	Description (Include component value if applicable)	Datasheet Link	Multiple	Total Qty	Total Price/part (\$)
Microcontroller	1	ESP32-02-SOLO-2-N4R2	1965-ESP32-02-SOLO-2-N4R2-ND		4.93	https://www.digkey.com/en/products/detail/aspressai-systems/ESP32-02-SOLO-2-N4R2-15591866	U1	ESP32 SOLO	https://www.espressif.com/sites/default/files/documentation/esp32_	0	0	0
1uF Capacitor	1	CL21B104KACNNC	1276-1099-1-ND		0.1	https://www.digkey.com/en/products/detail/samsung-electro-mechanics/CL21B104KACNNC/2086757	C2	0.1uF Ceramic Capacitor	https://media.digkey.com/pdf/Data%20Sheets/Samsung%20PDFs/	1	1	0.1
Push Button	1	XMR2144CT-ND	OXN10244CT-ND		0.44	https://www.digkey.com/en/products/detail/s-krm5221ng-LFS/21754837e-hnlgTCB-dwNF38KYvCY9DwAAgMQGUQR64Xy4	SW1		https://www.dawidsh.com/media/14793m2.pdf	1	1	0.44
IMU	1	BMX06	826-1002-1-ND		10.7	https://www.digkey.com/en/products/detail/bosch-sensortec/BMI088/3634936	U2	Bosch IMU	https://www.bosch-sensortec.com/media/bosch-sensortec/downloads/	1	1	10.7
100nF Capacitor	2	CL21B104KBPWNE	1276-6506-1-ND		0.17	https://www.digkey.com/en/products/detail/samsung-electro-mechanics/CL21B104KBPWNE/6505090	C9/C10	CL21B104KBPWNE	http://www.samsungsem.com/kr/support/products-search/mcc/CL21	2	2	0.17
Stepper Motor	2			STEPPERONLINE-Amazon	11.99	https://www.amazon.com/STEPPERONLINE-Dipolar-Stepper-22-5oz-Coupler/dp/B08PNC6T9G/refr_1_3?order=JBKR-IEQYU151&keywds=span&ie=UTF-8	NOT ON BOARD	Nema 17 short body	https://www.stepperonline.com/download/17H5G-10245.pdf	2	2	11.99
18650 LiPo Battery	1			DQGG 4-Pack 3.7v 18650	24.99	https://www.amazon.com/DQGG-Rechargeable-Battery-5EFNB0C68F1e4Flashlights-Headlights/dp/B0B4VSHK4N/refr_1_1?rd_rd_r3=UUP7X8UM&keywds=NOT ON BOARD	NOT ON BOARD	18650 LiPo Battery		1	1	24.99
USB C Receptacle	1	USB4110-GF-A	2073-USB4110-GF-A-1-ND		1.34	https://www.digkey.com/en/products/detail/gct/USB4110-GF-A/10384547	J2	USBC connector receptacle	https://gct.co/files/drawings/us4110.pdf	1	1	1.34
100 Resistor	1	CROG6085J100R	A129233CT-ND		0.45	https://www.digkey.com/en/products/detail/he-connectivity-amp-connectors/CROG6085J100R/6642960	R1	100 Ohm Resistor	https://www.te.com/commerce/DocumentDelivery/DDEController?&	1	1	0.45
47 5k Resistor	1	CRCV060547K0LINEAP	04147K1ACT-ND		0.25	https://www.digkey.com/en/products/detail/vishay-dale/CRC/0303547K0LINEAP/2222394	R3	47 kOhm Resistor	https://www.vishay.com/docs/293433/crcv060547k0.pdf	1	1	0.25
22 1k Resistor	1	CRCV060522K0LINEAP	64142K1ACT-ND		0.25	https://www.digkey.com/en/products/detail/vishay-dale/CRC/0303522K0LINEAP/2222392	R2	22 kOhm Resistor	https://www.vishay.com/docs/293433/crcv060522k0.pdf	1	1	0.25
Protection Diodes	3	SPV5610AHTO	F2715CT-ND		0.88	https://www.digkey.com/en/products/detail/infineon-technologies/SPV5610AHTO/1154322	D3/D4/D5	Diode for USB connector ground	https://www.infineon.com/assets/datasheets/rs/0/spv5610a.pdf	3	3	0.88
LDO	1	TLV704330BVT	295-27946-1-ND		1.3	https://www.digkey.com/en/products/detail/texas-instruments/TLV704330BVT/2441464	U4	Voltage Regulator	https://www.ti.com/general/docs/suppproductinfo.tsp?distid=108&	1	1	1.3
100 Resistor	1	CROG6085J100R	A129233CT-ND		0.45	https://www.digkey.com/en/products/detail/he-connectivity-amp-connectors/CROG6085J100R/6642960	R4	100 Ohm Resistor	https://www.te.com/commerce/DocumentDelivery/DDEController?&	1	1	0.45
22uF Capacitor	1	CL21A226MQQNNNG	1276-6460-1-ND		0.13	https://www.digkey.com/en/products/detail/samsung-electro-mechanics/CL21A226MQQNNNG/3694438	C1	22 uF Capacitor	https://media.digkey.com/pdf/Data%20Sheets/Samsung%20PDFs/	1	1	0.13
1uF Capacitor	1	CL21B105KAPWNE	1276-1096-1-ND		0.1	https://www.digkey.com/en/products/detail/samsung-electro-mechanics/CL21B105KAPWNE/3868724	C3	1uF Capacitor	https://media.digkey.com/pdf/Data%20Sheets/Samsung%20PDFs/	1	1	0.1
Schottky Diode	1	B6S20W5-7-F	B6S20W5-FDICT-ND		0.37	https://www.digkey.com/en/products/detail/diodes-incorporated/B6S20W5-7-F/775830	D1	Schottky Diode for battery connector	https://www.diodes.com/assets/Datasheets/9330235.pdf	1	1	0.37
H-Bridge/Motor Controller IC	2	DRV8846RGET	296-37986-1-ND		3.41	https://www.digkey.com/en/products/detail/texas-instruments/DRV8846RGET/4548345	U5/U6	H-Bridge/Motor Controller IC	https://www.ti.com/general/docs/suppproductinfo.tsp?distid=108&	2	2	3.41
10uF Capacitor	2	CL21A106KOONNNE	1276-1096-1-ND		0.1	https://www.digkey.com/en/products/detail/samsung-electro-mechanics/CL21A106KOONNNE/2886754	C4/C7	10uF Capacitor	https://media.digkey.com/pdf/Data%20Sheets/Samsung%20PDFs/	2	2	0.1
1uF Capacitor	1	CL21B104KACNNC	1276-1099-1-ND		0.1	https://www.digkey.com/en/products/detail/samsung-electro-mechanics/CL21B104KACNNC/2086757	C6/C8	1 uF Capacitor	https://media.digkey.com/pdf/Data%20Sheets/Samsung%20PDFs/	2	2	0.1
22uF Capacitor	2	CL21A226MQQNNNG	1276-6460-1-ND		0.13	https://www.digkey.com/en/products/detail/samsung-electro-mechanics/CL21A226MQQNNNG/3694438	C9/C11	22 uF Capacitor	https://media.digkey.com/pdf/Data%20Sheets/Samsung%20PDFs/	2	2	0.13
500m Resistor	4	RL1215-R5F-6	RL125-R5FCT-ND		0.29	https://www.digkey.com/en/products/detail/suamco/RL1205-R5F-5/F547351	R7/R8/R9/R10	500 mOhm Resistor	https://www.suamco.co.jp/en/comm/pdf/catalog_parts08_en_p	4	4	0.29
Motor Connector	3	Molex 207778-0004		Mouser# 538-207778-0004	7.45	https://www.mouser.com/ProductDetail/Molex/207778-0004?qs=2528B6Imu59h7KZ1Tn12a2hyQhJ3D3D	NOT ON BOARD	Molex connectors	https://www.mouser.com/datasheet/2/276/1/2877760004_CRIMP_J	3	3	7.45
USB to UART Bridge	1	CP2102-GM	336-1180-6-ND		5.06	https://www.digkey.com/en/products/detail/aliexpress/CP2102-GM/896958	U3	UART Bridge	https://www.silabs.com/documents/public/data-sheets/CP2102-9.p	1	1	5.06
Transistor	2	BC847C-13F	BC847C-13FDICT-ND		0.21	https://www.digkey.com/en/products/detail/siliconix-incorporated/BC847C-13-F/4471657	O1/O2	NPN Transistors	https://www.siliconix.com/assets/Datasheets/bs11118.pdf	2	2	0.21
16k Resistor	2	RMCF0805J110K0			0.1	https://www.digkey.com/en/products/detail/si-pole-electronics-inc/RMCF0805J110K0/1757762	RS6/R6	16k Ohm Resistor	https://www.select.com/catalog/view/mf_mmp.pdf	2	2	0.1
LED	1	HSMD-C173	516-3071-1-ND		1.17	https://www.digkey.com/en/products/detail/broadcom-limited/HSMD-C173/1235197	D6	led Indicator light	https://docs.broadcom.com/docs/AV92-5977EN	1	1	1.17
Female Headers 4pt	2	PPPC413LFBN-RC	87037-ND		0.47	https://www.digkey.com/en/products/detail/sullins-conductor-solutions/PPPC413LFBN-RC/810176	J3/J4	4 pin female header	https://media.digkey.com/pdf/Data%20Sheets/Sullins%20PDFs/Fa	2	2	0.94
Female Headers 3pt	1	PPPC13LFBN-RC	87036-ND		0.42	https://www.digkey.com/en/products/detail/sullins-conductor-solutions/PPTC613LFBN-RC/810143	J1	3 pin female header	https://media.digkey.com/pdf/Data%20Sheets/Sullins%20PDFs/Fa	1	1	0.42
Male Header	1	2PH1-08-UD	2957-2PH1-08-UD-ND		0.26	https://www.digkey.com/en/products/detail/adam-tech/2PH1-08-UD/9304493	J5/J6	8 pin male header	https://app.adam-tech.com/products/download/data_sheet290457	1	1	0.26

the cheapest distributor that has the part in stock. If the part is not in stock by the time we order parts, there is a risk that we will not purchase it.							Total Price for Pro	
							\$ 78.48	
Price/unit (\$)	Purchase URL	Reference Designator	Description (Include component value if applicable)	Datasheet Link	Multiple	Total Qty	Total Price/part (\$)	
4.93	https://www.digikey.com/en/products/detail/espressif-systems/ESP32-S2-SOLO-2	U1	ESP32 SOLO	https://www.espressif.com/sites/default/files/documentation/esp32-	1	1	4.93	
0.1	https://www.digikey.com/en/products/detail/samsung-electro-mechanics/CL21B10C	C2	0.1 uF Ceramic Capacitor	https://media.digikey.com/pdf/Data%20Sheets/Samsung%20PDFs	1	1	0.1	
0.44	https://www.digikey.com/en/products/detail/c-k/KMR221NG-LFS/2176483?s=N414	SW1		https://www.cswitches.com/media/1479/kmr2.pdf	1	1	0.44	
10.7	https://www.digikey.com/en/products/detail/bosch-sensortec/BMI088/8634936	U2	Bosch IMU	https://www.bosch-sensortec.com/media/boschsensortec/download	1	1	10.7	
0.17	https://www.digikey.com/en/products/detail/samsung-electro-mechanics/CL21B10C	C9/C10	CL21B104KBFWPNE	http://www.samsungsem.com/kr/support/product-search/mlcc/CL2	2	2	0.17	
11.99	https://www.amazon.com/STEPPERONLINE-Bipolar-Stepper-22-6oz-Extruder/dp	NOT ON BOARD	Neema 17 short body	https://www.omc-stepperonline.com/download/17HS08-1004S.pdf	2	2	11.99	
24.99	https://www.amazon.com/DQGG-Rechargeable-Battery%EF%BC%88Flat-flashlight	NOT ON BOARD	18650 LiPo Battery		1	1	24.99	
1.34	https://www.digikey.com/en/products/detail/gct/USB4110-GF-A/10384547	J2	USC_C connector receptacle	https://gct.co/files/drawings/usb4110.pdf	1	1	1.34	
0.45	https://www.digikey.com/en/products/detail/te-connectivity-amp-connectors/CRGS	R1	100 Ohm Resistor	https://www.te.com/commerce/DocumentDelivery/DDEController?	1	1	0.45	
0.25	https://www.digikey.com/en/products/detail/vishay-dale/CRCW080547K0JNEAHF	R3	47 kOhm Resistor	https://www.vishay.com/docs/20043/crcwhpe3.pdf	1	1	0.25	
0.25	https://www.digikey.com/en/products/detail/vishay-dale/CRCW080522K0JNEAHF	R2	22 kOhm Resistor	https://www.vishay.com/docs/20043/crcwhpe3.pdf	1	1	0.25	
0.88	https://www.digikey.com/en/products/detail/littelfuse-inc/SP0503BAHTG/1154322	D3/D4/D5	Diode for USB connector ground	https://www.littelfuse.com/~media/electronics/datasheets/tvs_diod	3	3	0.88	
1.3	https://www.digikey.com/en/products/detail/texas-instruments/TLV70433DBVT/24	U4	Voltage Regulator	https://www.ti.com/general/docs/suppproductinfo.tsp?distld=10&g	1	1	1.3	
0.45	https://www.digikey.com/en/products/detail/te-connectivity-amp-connectors/CRGS	R4	100 Ohm Resistor	https://www.te.com/commerce/DocumentDelivery/DDEController?	1	1	0.45	
0.13	https://www.digikey.com/en/products/detail/samsung-electro-mechanics/CL21A22C	C1	22 uF Capacitor	https://media.digikey.com/pdf/Data%20Sheets/Samsung%20PDFs	1	1	0.13	
0.1	https://www.digikey.com/en/products/detail/samsung-electro-mechanics/CL21B10C	C3	1uF Capacitor	https://media.digikey.com/pdf/Data%20Sheets/Samsung%20PDFs	1	1	0.1	
0.37	https://www.digikey.com/en/products/detail/diodes-incorporated/B0520WS-7-F/77	D1	Schottky Diode for battery connector	https://www.diodes.com/assets/Datasheets/ds30235.pdf	1	1	0.37	
3.41	https://www.digikey.com/en/products/detail/texas-instruments/DRV8846RGET/49	U5/U6	H-Bridge/Motor Controller IC	https://www.ti.com/general/docs/suppproductinfo.tsp?distld=10&g	2	2	3.41	
0.1	https://www.digikey.com/en/products/detail/samsung-electro-mechanics/CL21A10C	C4/C7	10 uF Capacitor	https://media.digikey.com/pdf/Data%20Sheets/Samsung%20PDFs	2	2	0.1	
0.1	https://www.digikey.com/en/products/detail/samsung-electro-mechanics/CL21B10C	C5/C8	0.1 uF Capacitor	https://media.digikey.com/pdf/Data%20Sheets/Samsung%20PDFs	2	2	0.1	
0.13	https://www.digikey.com/en/products/detail/samsung-electro-mechanics/CL21A22C	C6/C11	22 uF Capacitor	https://media.digikey.com/pdf/Data%20Sheets/Samsung%20PDFs	2	2	0.13	
0.29	https://www.digikey.com/en/products/detail/susumu/RL1220S-R50-F/567251	R7/R8/R9/R10	500 mOhm Resistor	https://www.susumu.co.jp/common/pdf/in_catalog_partition08_en.p	4	4	0.29	
7.45	https://www.mouser.com/ProductDetail/Molex/207778-0004?qs=%252B6g0mu59	NOT ON BOARD	Molex connectors	https://www.mouser.com/datasheet/2/276/1/2077780004_CRIMP	3	3	7.45	
5.06	https://www.digikey.com/en/products/detail/silicon-labs/CP2102-GM/696598	U3	UART Bridge	https://www.silabs.com/documents/public/data-sheets/CP2102-9.p	1	1	5.06	
0.21	https://www.digikey.com/en/products/detail/diodes-incorporated/BC847C-13-F/44	Q1/Q2	NPN Transistors	https://www.diodes.com/assets/Datasheets/ds11108.pdf	2	2	0.21	
0.1	https://www.digikey.com/en/products/detail/stackpole-electronics-inc/RMCF0805J	R5/R6	10k Ohm Resistor	https://www.seielect.com/catalog/sei-rmcf_rmcp.pdf	2	2	0.1	
1.17	https://www.digikey.com/en/products/detail/broadcom-limited/HSMQ-C170/12351	D5	led indicator light	https://docs.broadcom.com/docs/AV02-0977EN	1	1	1.17	
0.47	https://www.digikey.com/en/products/detail/sullins-connector-solutions/PPPC041J	J3/J4	4 pin female header	https://media.digikey.com/pdf/Data%20Sheets/Sullins%20PDFs/Fe	2	2	0.94	
0.42	https://www.digikey.com/en/products/detail/sullins-connector-solutions/PPTC031J	J1	3 pin female header	https://media.digikey.com/pdf/Data%20Sheets/Sullins%20PDFs/Fe	1	1	0.42	
0.26	https://www.digikey.com/en/products/detail/adam-tech/2PH1-08-UA/9830483	J5/J6	8 pin strip	https://app.adam-tech.com/products/download/data_sheet/200457	1	1	0.26	

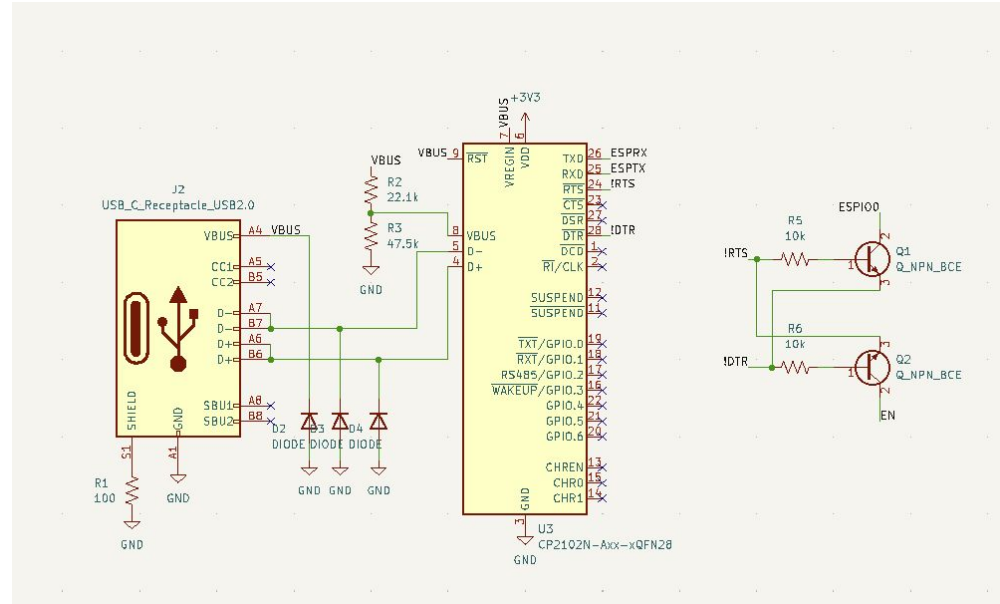
BOM

- Most expensive parts:
 - Stepper motors —> \$11.99 (per)
 - LiPo batteries —> \$24.99 (4 count)
 - Molex connectors —> \$7.99 (4 count)
 - IMU (accelerometer, gyroscope, etc.) —> \$10.70 (per)
- Total cost per board:
 - (If every part is ordered) —> \$78.48

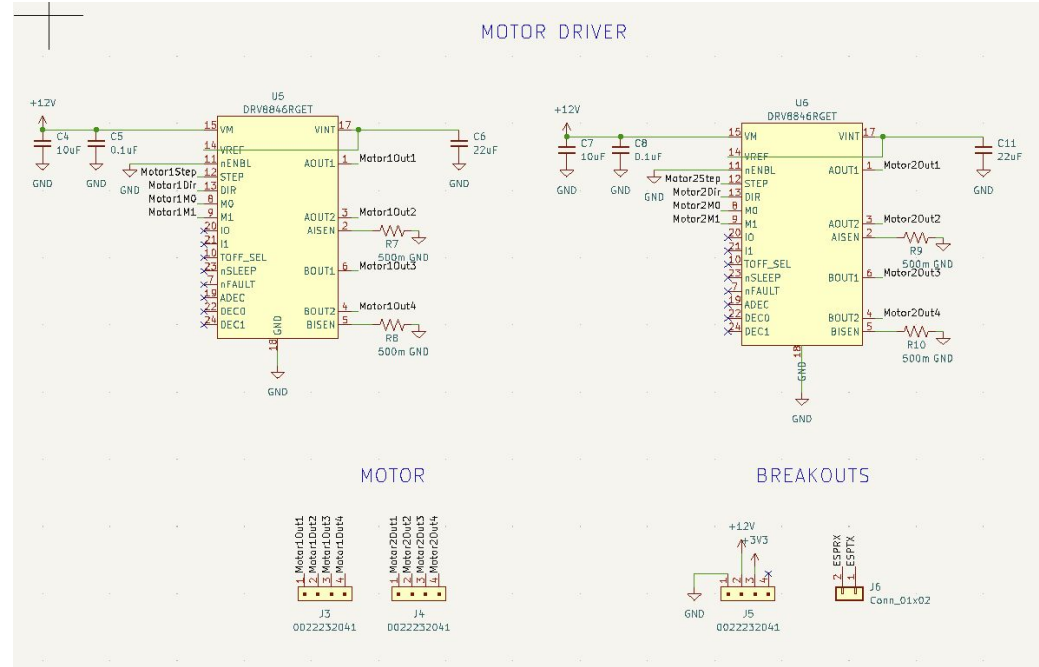
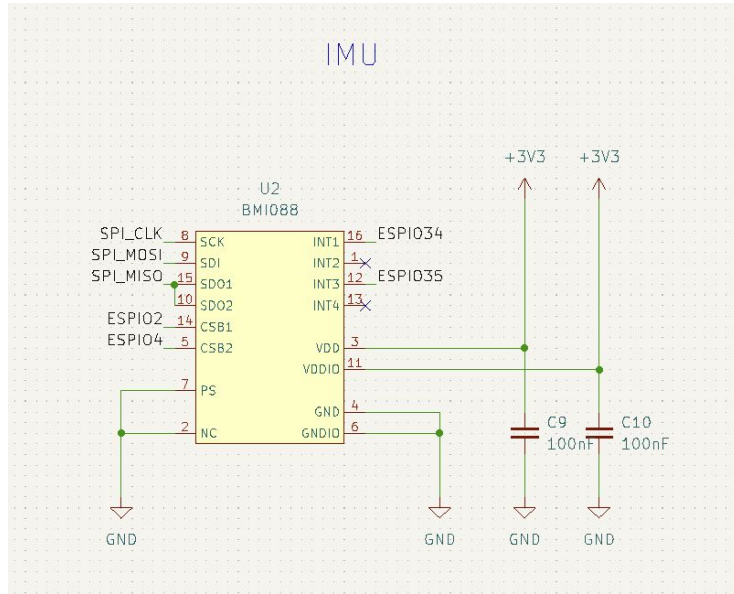
Schematic: ESP32 - S2 - SOLO



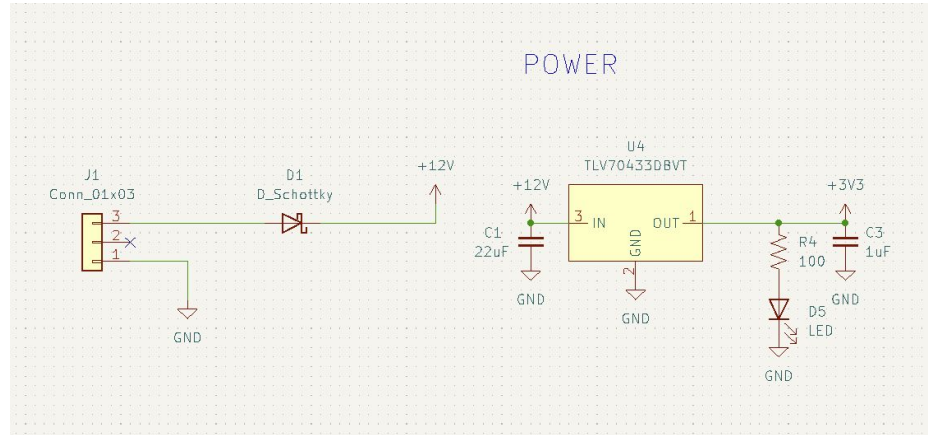
USB_C Connector & UART Bridge



Schematic: ICs



Schematic: Power



Layout

2.5 x 3 in

Breakouts

