MEZS7-1S-4SPDPowerBank

Bidirectional PD Power Bank Solution with Fully Integrated Buck-Boost Charger for 1-Cell to 4-Cell in Series Battery Packs

DESCRIPTION

The MEZS7-1S-4SPDPowerBank is a solution module for PD applications with the MP2651 and CCG3PA, supporting PD3.0 and BC1.2 protocols. The MP2651 is a buck-boost charger designed for battery packs with 1 cell to 4 cells in series. The device supplies a wide 3V to 21V voltage range at the IN pin in source mode. It is compliant with USB PD specifications. The CCG3PA is a Cypress PD controller that handles the PD protocol.

The MEZS7-1S-4SPDPowerBank contains a DRP USB Type-C port. When an adapter is inserted, the port acts as a UFP to charge the battery with a maximum 5A charge current. When a load is inserted, the port acts as a DFP to power the USB from the battery.

PERFORMANCE SUMMARY (1)

Specifications are at T_A = 25°C, unless otherwise noted.

Parameters	Conditions	Value
Input voltage (V_{IN}) range		4V to 22V
Battery charge regulation voltage (V_{BATT_REG})		8.4V (I^2C-configurable)
Fast charge current	V_{IN} = 9V to 20V	5A (I^2C-configurable)
Output voltage in source mode (V_{IN_SRC})		3V to 21V
Charge typical efficiency	V_{IN} = 20V, V_{BATT} = 8V, I_{CC} = 5A	94.2%
Charge peak efficiency	V_{IN} = 12V, V_{BATT} = 8V, I_{CC} = 3A	96.33%
Source mode typical efficiency	V_{BATT} = 7.4V, V_{IN_SRC} = 20V, I_{IN_SRC} = 1.5A	93.5%
Source mode peak efficiency	V_{BATT} = 8.4V,V_{IN_SRC} = 12V, I_{IN_SRC} = 1.5A	96.37%
Switching frequency		600kHz (I^2C-configurable)

Note:

1) Refer to the MP2651 datasheet for details.

MPL Optimized Performance with MPS Inductor MPL-AL5030 Series

EVALUATION BOARD

LxWxH (8.9cmx8.9cmx0.16cm)

Board Number	MPS IC Number
MEZS7-1S-4SPDPowerBank	MP2651GVT

QUICK START GUIDE

The MEZS7-1S-4SPDPowerBank is a reference design using the MP2651 for PD applications, and it includes a DRP USB Type-C port. Its layout accommodates most commonly used capacitors. The charge current is preset to 5A, and the charge-full voltage is preset to 8.4V for a Li-ion battery with 2 cells in series. In reverse source mode, the output is preset to 5V/3A. All of the charging/discharging parameters are set by the CCG3PA. The user can also download their own codes to the CCG3PA through the board's configuration header.

1. Connect the battery terminal to:
   a. Positive (+): VBATT
   b. Negative (-): GND
2. If using a battery simulator, preset the battery voltage between 0V and 8.4V, then turn it off. Connect the battery simulator's ports to:
   a. Positive (+): VBATT
   b. Negative (-): GND
3. Ensure that the battery voltage is present (if using a battery simulator, keep the simulator on).
4. For charge mode testing, connect the USB Type-C port to an adapter with a USB Type-C to Type-C cable or USB Type-A to USB Type-C cable. Charge mode should start automatically, and the charge current is adjusted according to the PD protocol communication result between the adapter and board.
5. For source mode testing, connect the devices to a USB Type-C port with a USB Type-C to Type-C cable, USB Type-C to Micro-B cable, or a USB Type-C to lighting cable. Source mode should start automatically and provide the required voltage to the devices.

   Figure 1 shows the measurement equipment set-up.

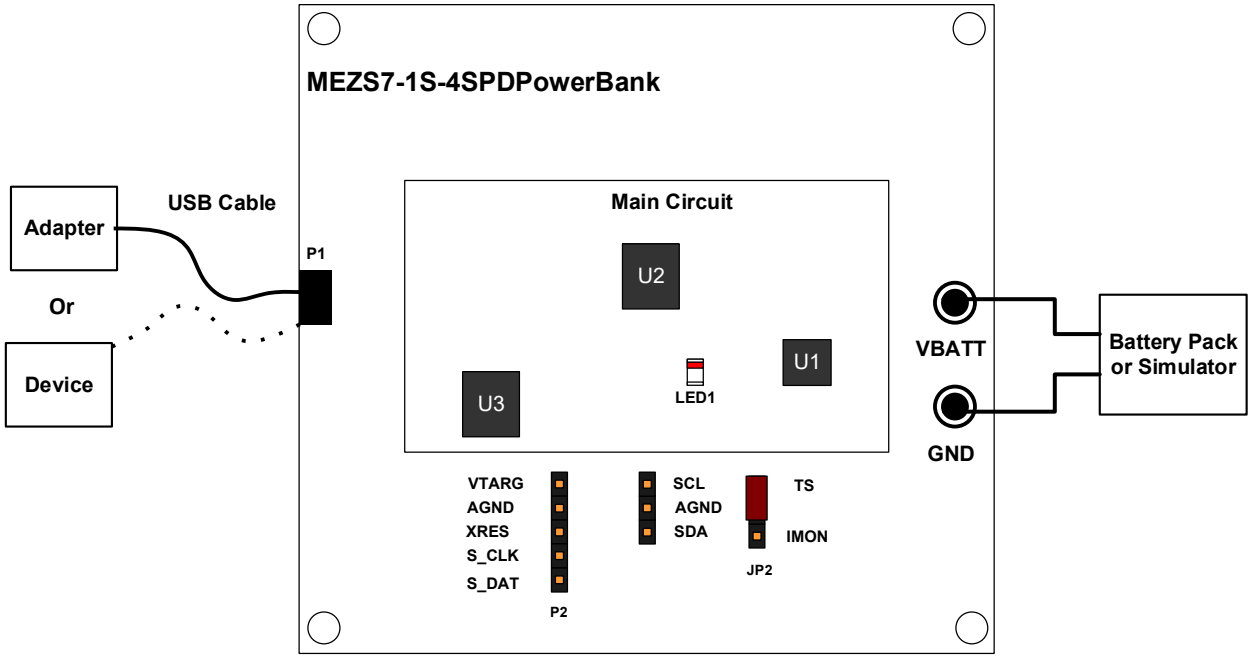


Figure 1: Measurement Equipment Set-Up

EVALUATION BOARD SCHEMATIC

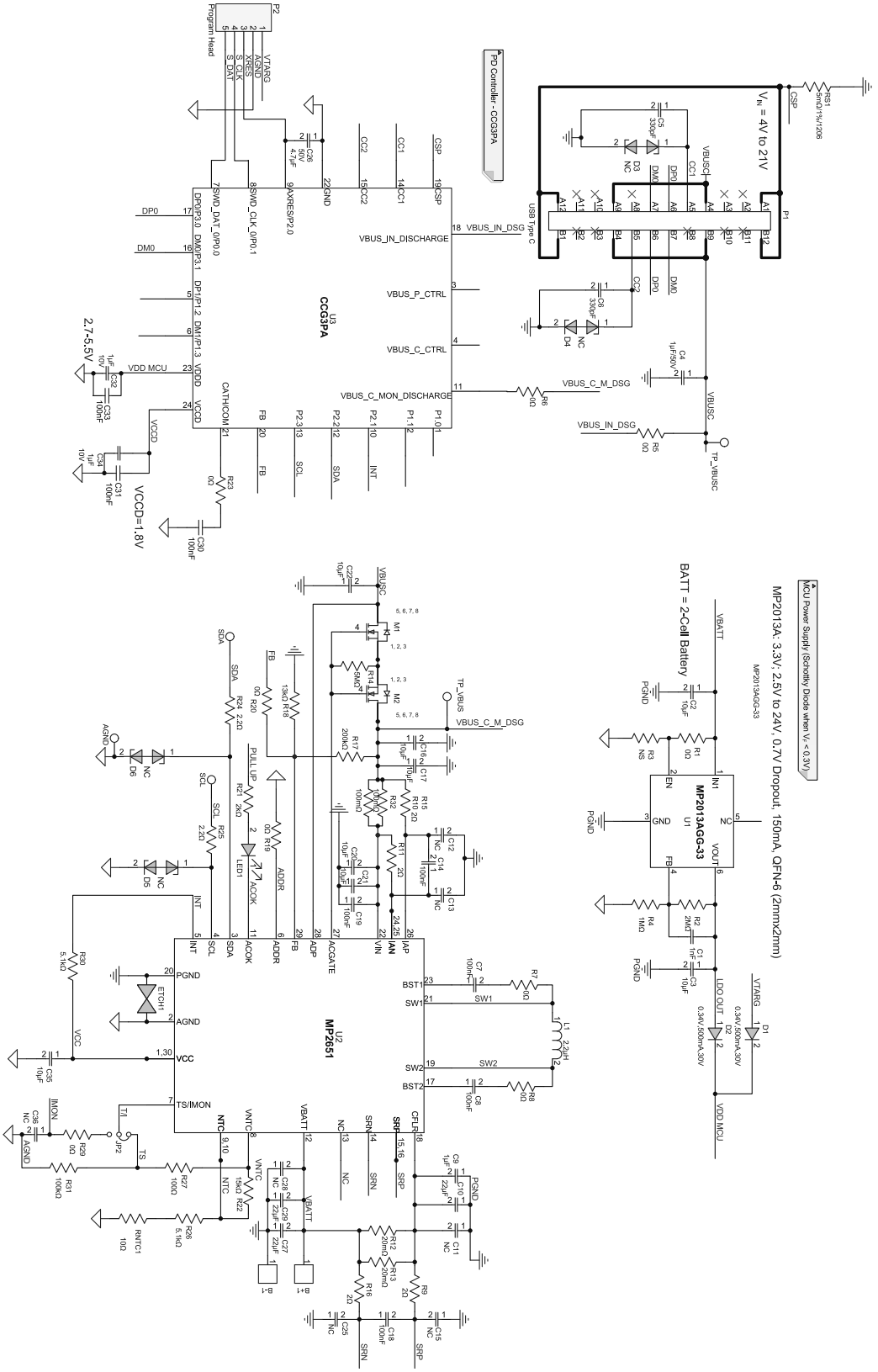


Figure 2: Evaluation Board Schematic

MEZS7-1S-4SPDPOWERBANK BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
4	C10, C11, C27, C28	22µF	Ceramic capacitor, 25V, X5R	0805	Murata	GRM21BR61E226ME44L
7	C2, C3, C16, C17, C20, C21, C22	10µF	Ceramic capacitor, 25V, X5R	0805	Murata	GRM21BR61E106KA73
3	C4, C32, C34	1µF	Ceramic capacitor, 50V, X5R	0603	Murata	GRM188R61H105KAAL
2	C26, C35	4.7µF	Ceramic capacitor, 25V, X5R	0603	Murata	GRM188R61E475KE11D
2	C9, C19	1µF	Ceramic capacitor, 25V, X7R	0402	Murata	GRM155R61E105KA12
7	C7, C8, C14, C18, C30, C31, C32	100nF	Ceramic capacitor, 25V, X7R	0603	Wurth	885012206071
1	C1	1nF	Ceramic capacitor, 50V, X7R	0603	TDK	C1608X7R1H102K
2	C5, C6	330pF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H331KA01D
8	C12, C13, C15, C25, C36, C29, C40, C41	NC				
2	R4, 'R14	1MΩ	Film resistor, 1%	0603	Yageo	RC0603FR-071ML
1	R21	2kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-072KL
2	R26, R30	5.1kΩ	Film resistor, 5%	0603	Yageo	RC0603JR-075K1L
9	R1, R5, R6, R7, R8, R23, R19, R20, R29	0Ω	Film resistor, 5%	0603	Yageo	RC0603JR-070RL
1	R2	2MΩ	Film resistor, 5%	0603	Yageo	RC0603JR-072ML
1	R17	200kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07200KL
1	R18	13kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0713KL
1	R22	15kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0715KL
2	R27, R31	100kΩ	Film resistor, 5%	0603	Yageo	RC0603JR-07100KL
1	RNTC1	10kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0710KL
6	R9, R16, R10, R11, R24, R25	2Ω	Film resistor, 5%	0603	LIZ	CR0603JA02R0G
1	RS1	5mΩ	Film resistor, 1%	1206	Yageo	PA1206FRF070R005L
4	R12, R13, R15, R32	20mΩ	Film resistor, 1%	1206	Cyntec	RL1632H-R020-FN

MEZS7-1S-4SPDPOWERBANK BILL OF MATERIALS *(continued)*

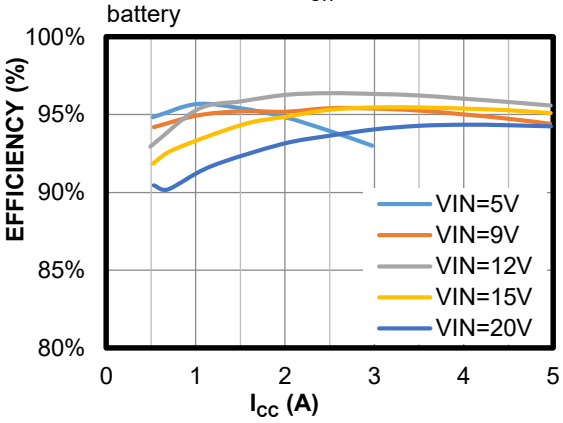
Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	P1	5A	USB Type-C connector	SMD	YaLian	93579102
2	M1, M2	30V, 20A	N-channel MOSFET	PowerPAK-1212-8	Vishay	SISA14DN-T1-GE3
2	D1, D2	20V, 0.5A	Schottky diode	SOD-123	Diodes	B0520LW-7-F
4	D3, D4, D5, D6	NC	NC			
1	LED1	Green	Green LED	0805	Bai Hong	BL-HGE35A-AV-TRB
1	U3	24.5V	PD controller	QFN-24 (4mmx4mm)	Cypress	CYPD3171-24LQXQ
1	U1	MP2013A	LDO	QFN-6 (2mmx2mm)	MPS	MP2013AGG
1	U2	MP2651	Charger IC	TQFN-30 (4mmx5mm)	MPS	MP2651GVT-0000
1	L1	1.5μH	Inductor, 1.5μH, 9.7mΩ, 9A	SMD	MPS	MPL-AL5030-1R5

SOLUTION MODULE TEST RESULTS

Performance curves and waveforms are tested on the solution module. C_{IN} = 5 x 10µF + 1 x 1µF, C_{CFLR} = 2 x 22µF + 1 x 1µF, C_{BATT} = 2 x 22µF, L = 1.5µH (10mΩ), T_A = 25°C, unless otherwise noted.

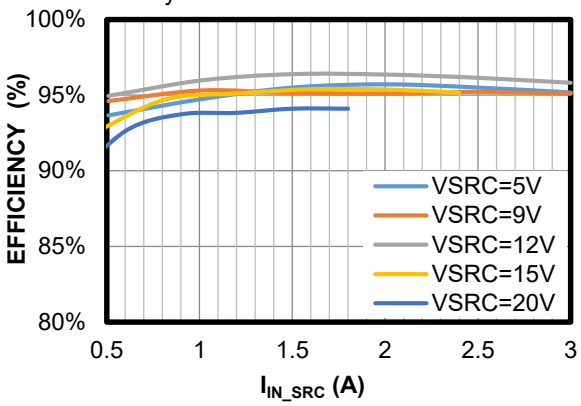
Efficiency vs. I_{CC}

Charge mode, V_{BATT} = 8V, V_{IN} = 5V, 9V, 12V, 15V, or 20V, f_{SW} = 600kHz , 2-cell battery



Efficiency vs. I_{IN_SRC}

Source mode, V_{BATT} = 8.4V, V_{SRC} = 5V, 9V, 12V, 15V, or 20V, f_{SW} = 600kHz, 2-cell battery

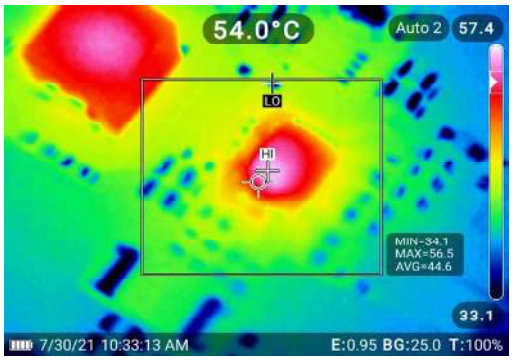


SOLUTION MODULE TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. C_{IN} = 5 x 10µF + 1 x 1µF, C_{CFLR} = 2 x 22µF + 1 x 1µF, C_{BATT} = 2 x 22µF, L = 1.5µH (10mΩ), f_{SW} = 600kHz, 2-cell battery, T_A = 25°C, unless otherwise noted.

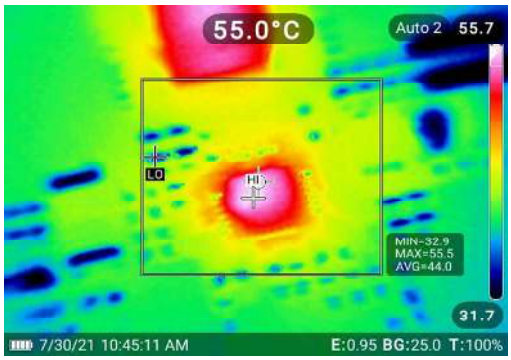
Thermal Performance

Charge mode: V_{IN} = 20V, V_{BATT} = 8.2V, I_{CC} = 5A, no forced airflow, T_{CASE} = 56.5°C



Thermal Performance

Source mode: V_{BATT} = 8.2V, V_{IN_SRC} = 20V, I_{IN_SRC} = 1.8A, no forced airflow, T_{CASE} = 55.5°C

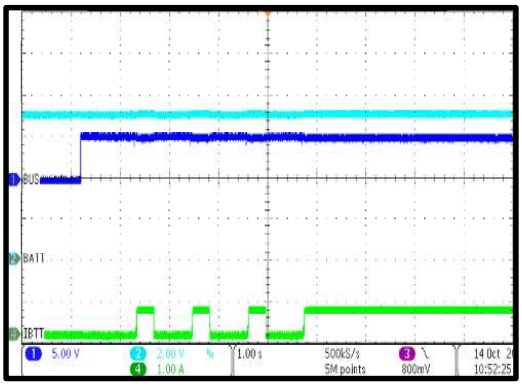


SOLUTION MODULE TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. C_{IN} = 5 x 10µF + 1 x 1µF, C_{CFLR} = 2 x 22µF + 1 x 1µF, C_{BATT} = 2 x 22µF, L = 1.5µH (10mΩ), f_{SW} = 600kHz, 2-cell battery, T_A = 25°C, unless otherwise noted.

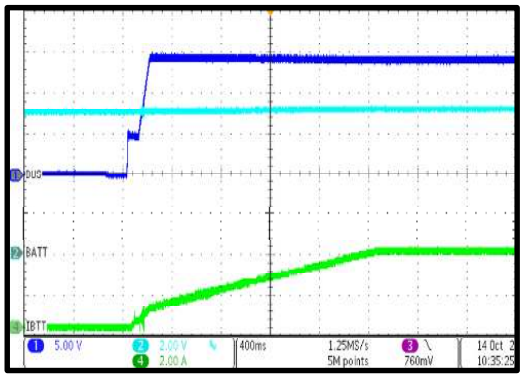
Sink Mode (BC 1.2)

V_{BATT} = 7V, I_{CHG} = 5A, use the USB 3.0 port as the input



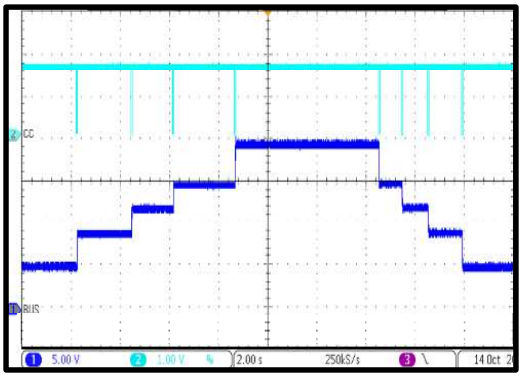
Sink Mode (PD Adapter)

V_{BATT} = 7V, I_{CHG} = 5A, use the PD adapter (max 15V/2A) as the input



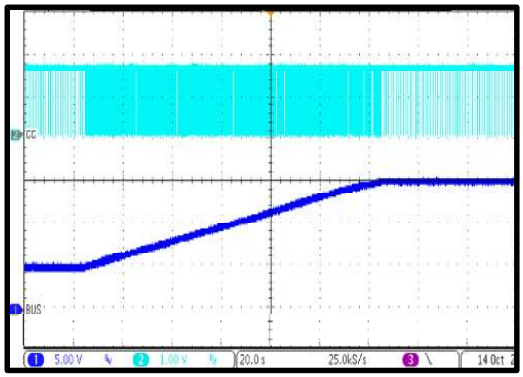
Source Mode (PD2.0)

V_{BATT} = 8V, V_{OTG} = 5V to 9V to 12V to 15V to 20V, test with a PD tester



Source Mode (PD 3.0)

V_{BATT} = 8V, V_{OTG} = 3.3V to 16V with 20mV/step, test with PD tester



PCB LAYOUT

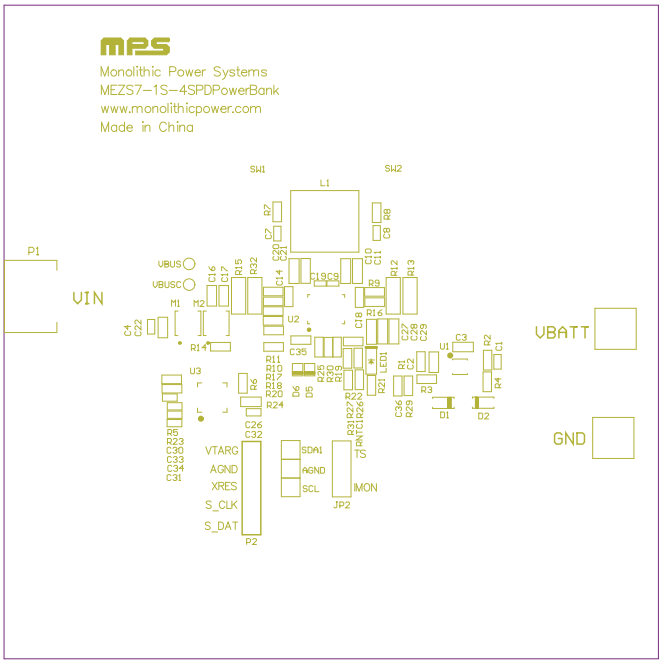


Figure 3: Top Silk

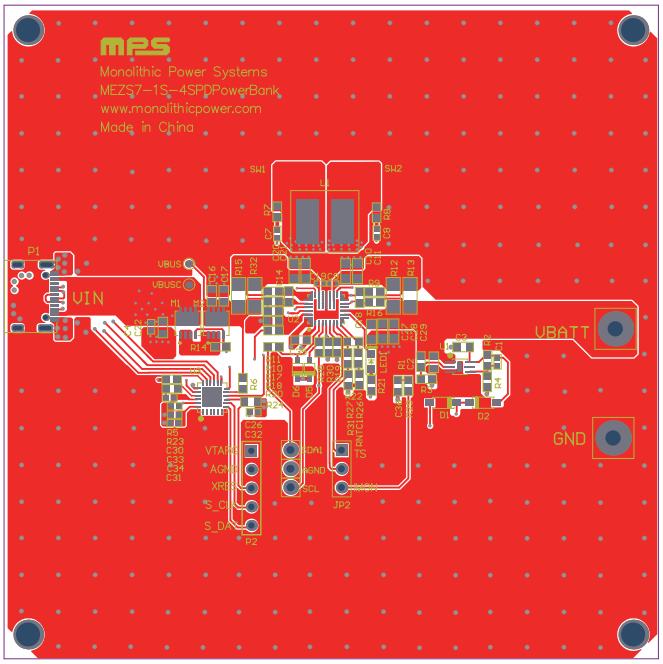


Figure 4: Top Layer

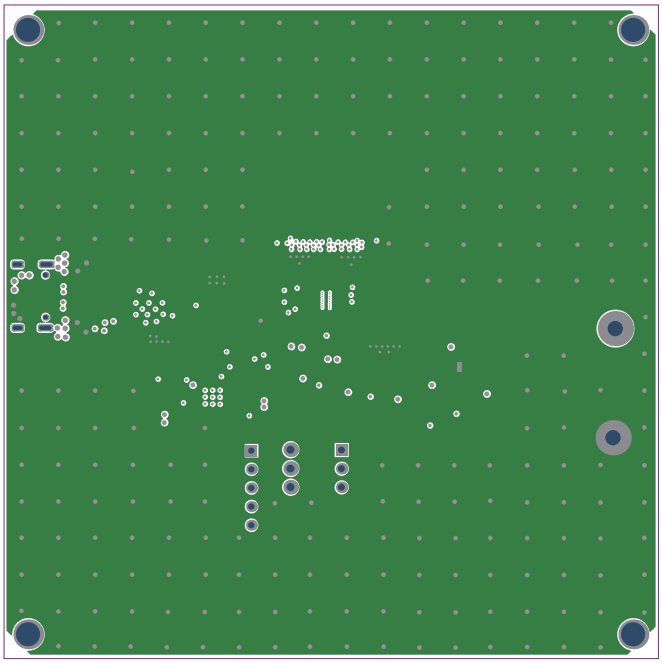


Figure 5: Mid-Layer 1

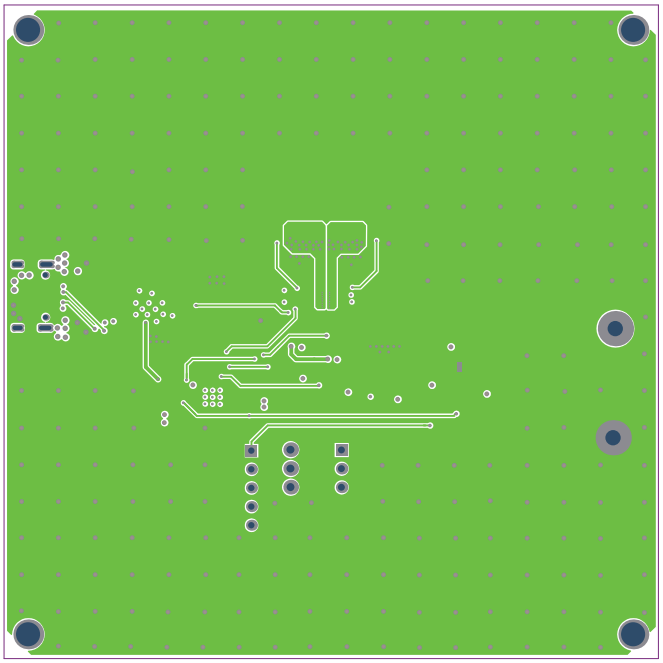


Figure 6: Mid-Layer 2

PCB LAYOUT *(continued)*

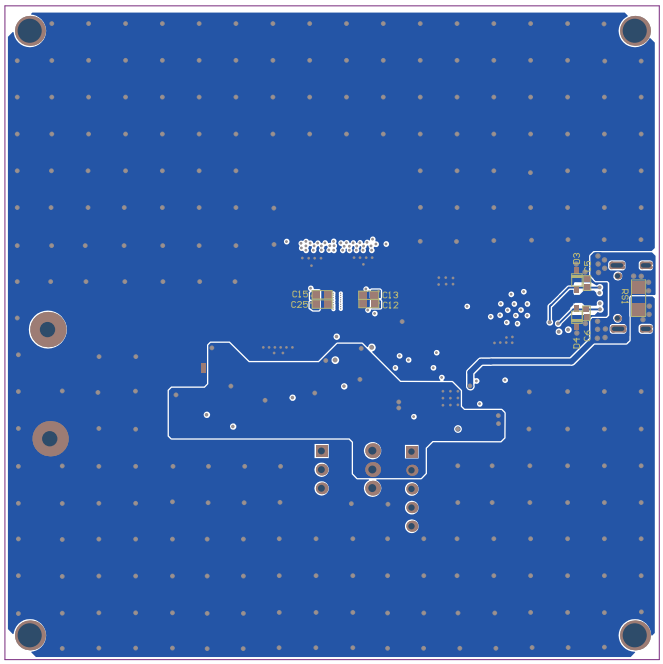


Figure 7: Bottom Layer

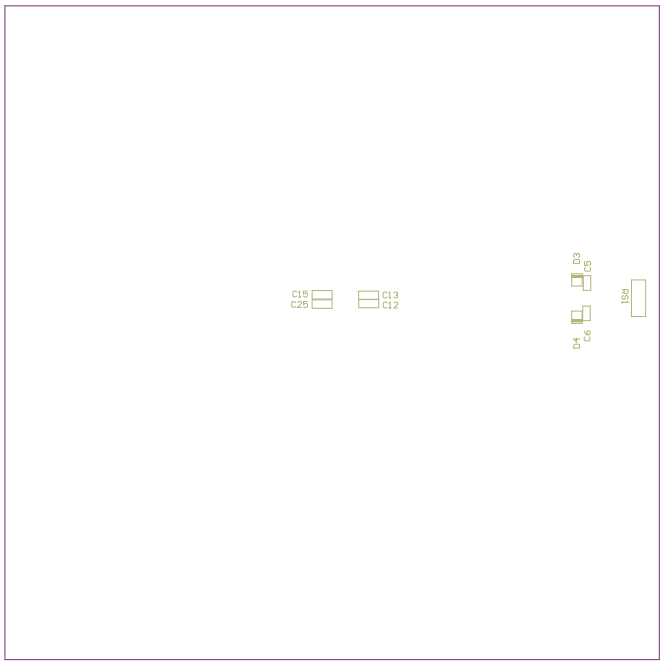


Figure 8: Bottom Silk

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	4/20/2022	Initial Release	-