# 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) |

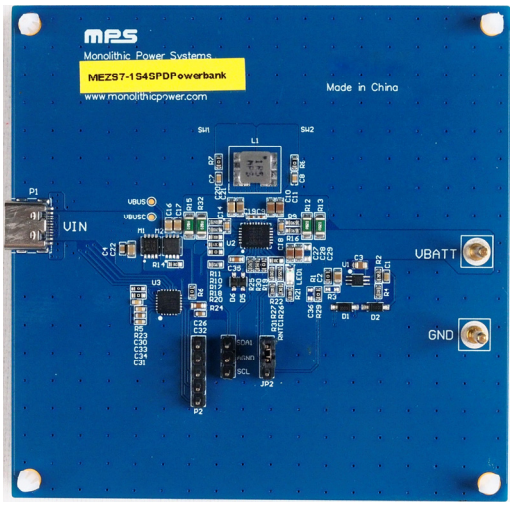
**Note:**

1) Refer to the MP2651 datasheet for details.

MPL Optimized Performance with MPS Inductor MPL-AL5030 Series


MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2022 MPS. All Rights Reserved.

# EVALUATION BOARD




**LxWxH (8.9cmx8.9cmx0.16cm)**

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


MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2022 MPS. All Rights Reserved.

## 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.

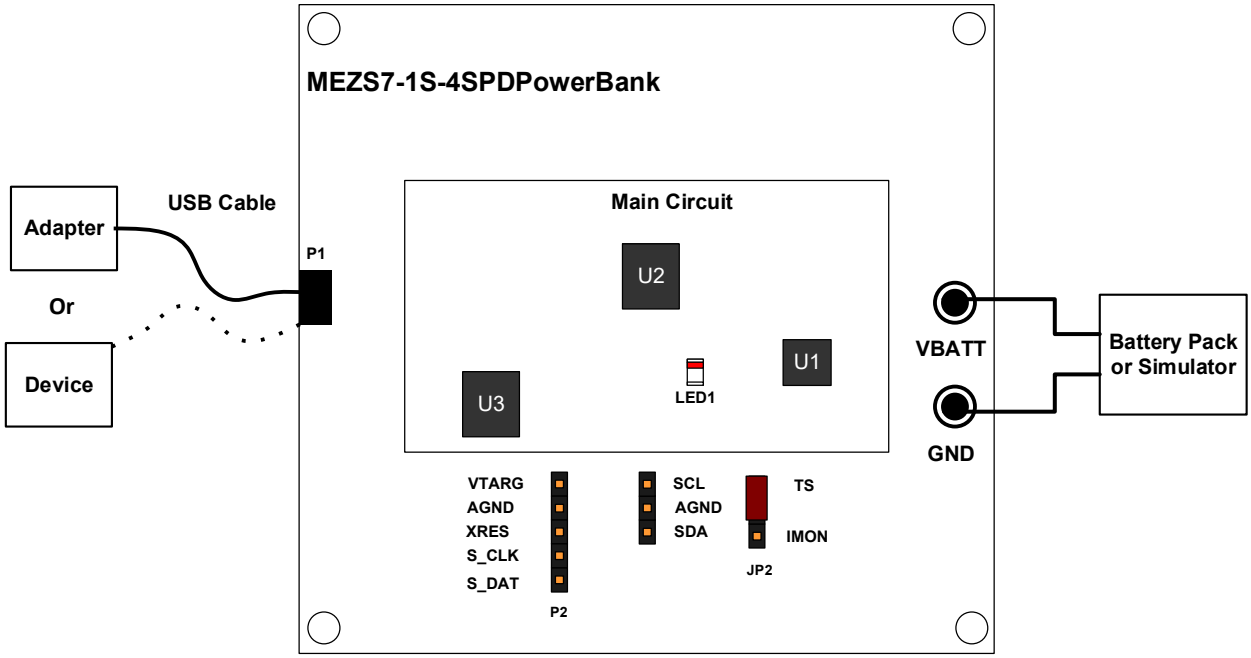



**Figure 1: Measurement Equipment Set-Up**


MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2022 MPS. All Rights Reserved.

# EVALUATION BOARD SCHEMATIC

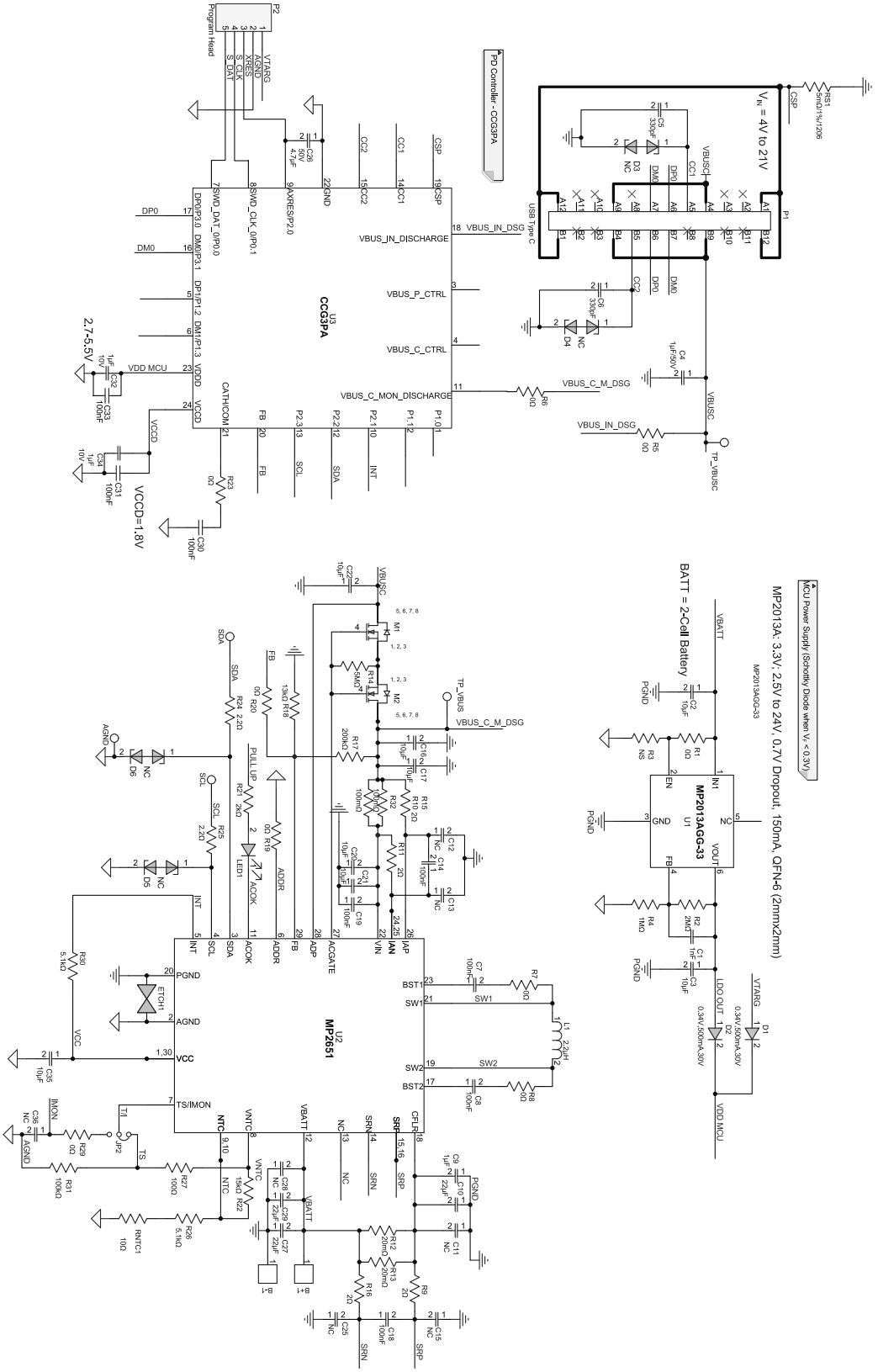



**Figure 2: Evaluation Board Schematic**


MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2022 MPS. All Rights Reserved.

## 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 |


MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2022 MPS. All Rights Reserved.

## 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 |

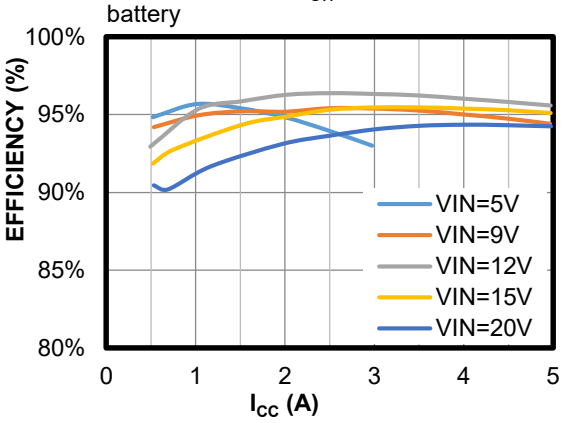

MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2022 MPS. All Rights Reserved.

## 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.**

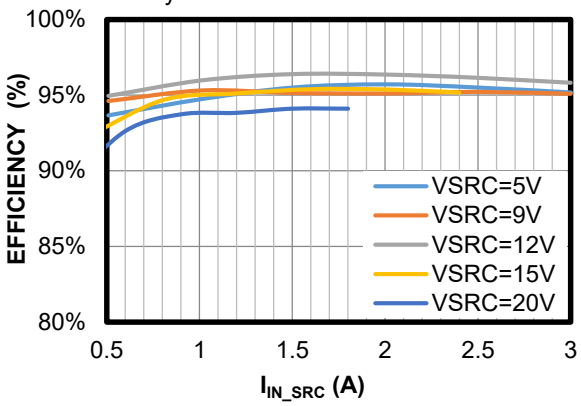
**Efficiency vs. $I_{CC}$**

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





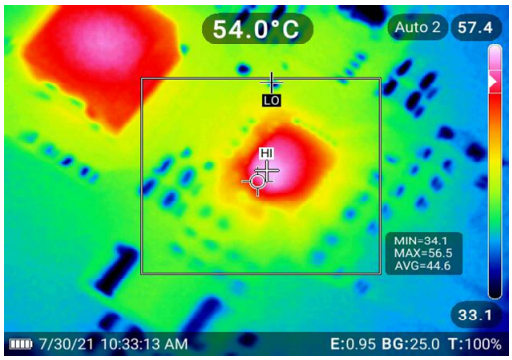
MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2022 MPS. All Rights Reserved.

## 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.**

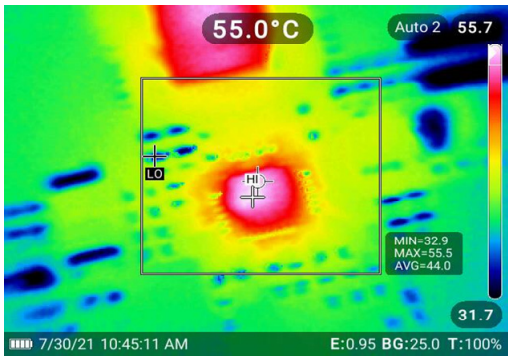
### Thermal Performance

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





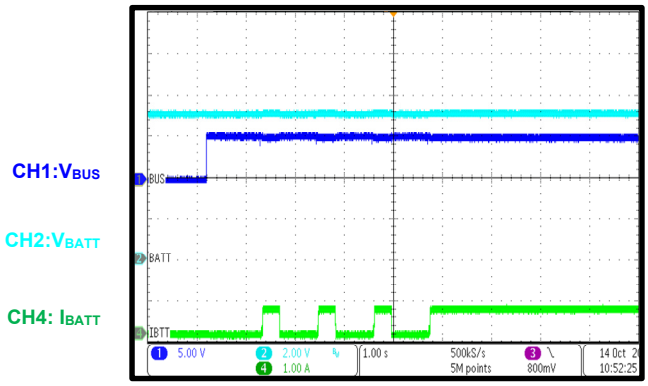
MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2022 MPS. All Rights Reserved.

## 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.**

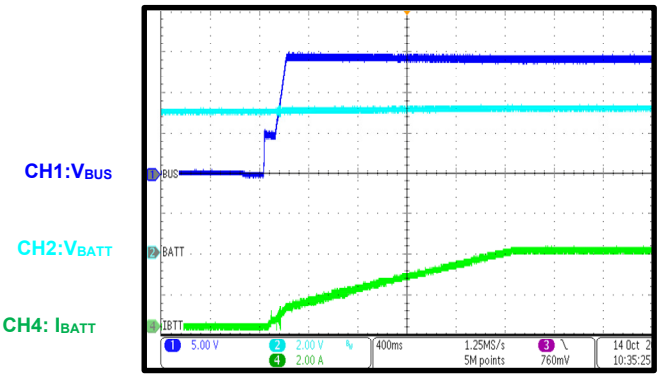
### Sink Mode (BC 1.2)

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



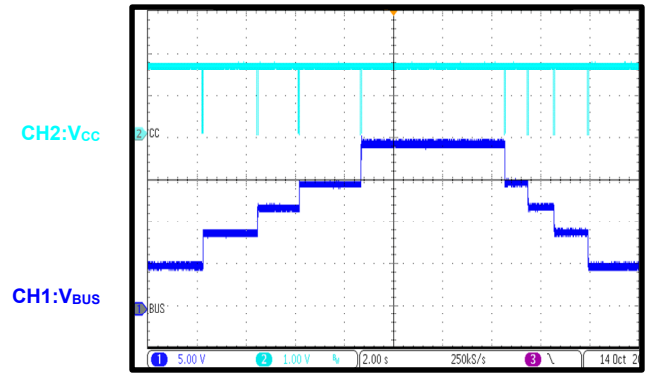

### Sink Mode (PD Adapter)

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



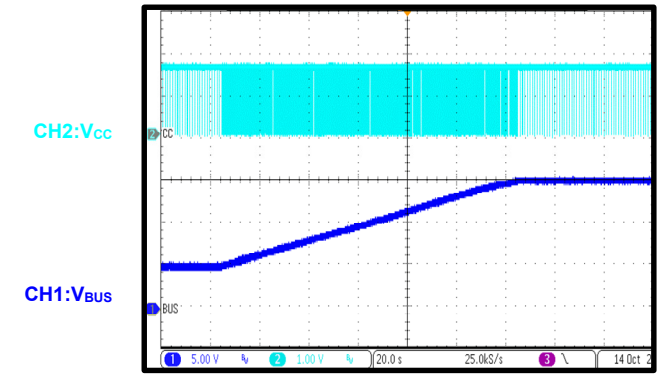

### Source Mode (PD2.0)

$V_{BATT}$ = 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





MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2022 MPS. All Rights Reserved.

# PCB LAYOUT

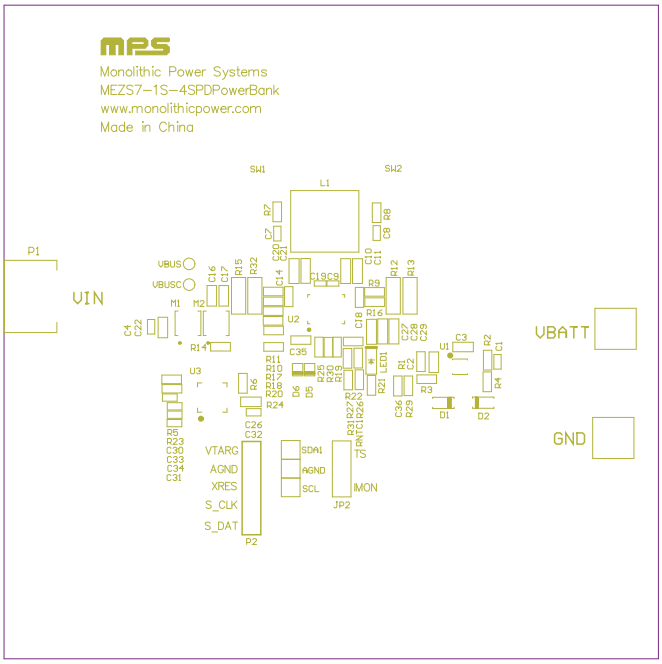



Figure 3: Top Silk

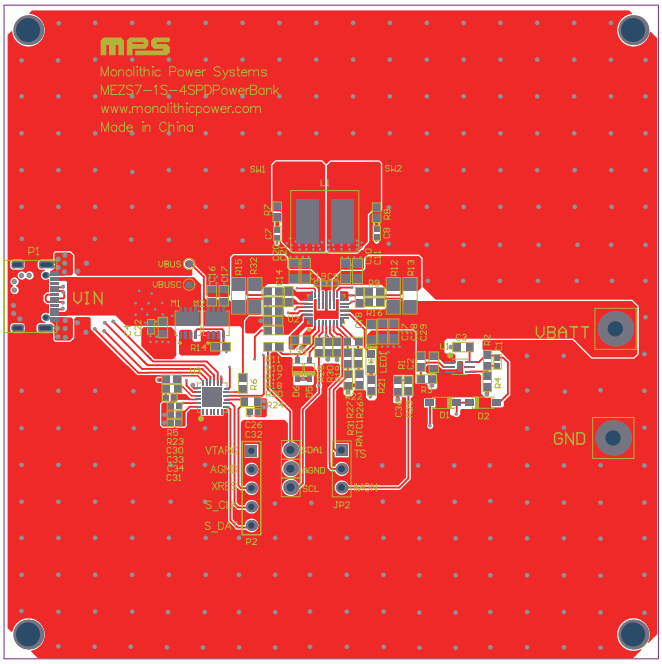



Figure 4: Top Layer

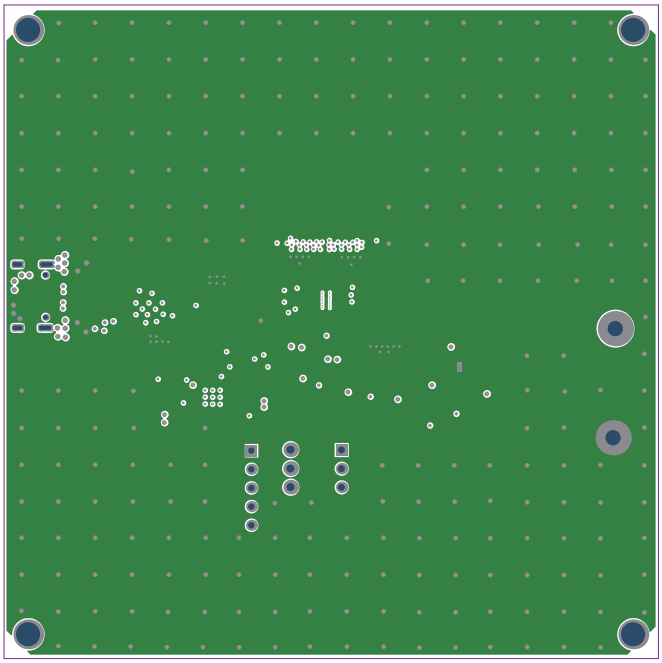


Figure 5: Mid-Layer 1

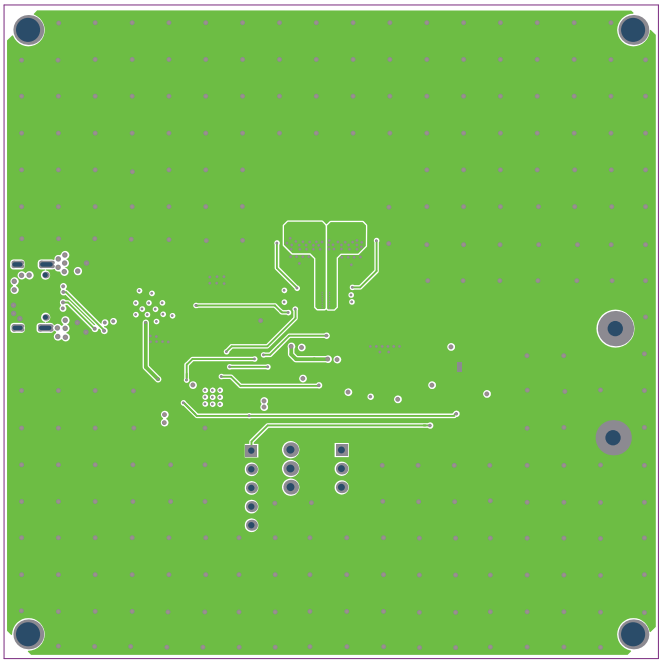


Figure 6: Mid-Layer 2


MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2022 MPS. All Rights Reserved.

## PCB LAYOUT *(continued)*

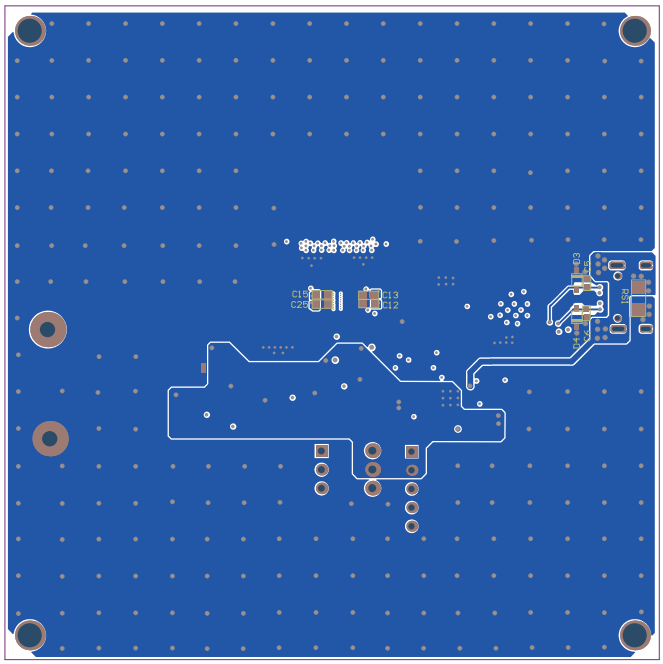


**Figure 7: Bottom Layer**

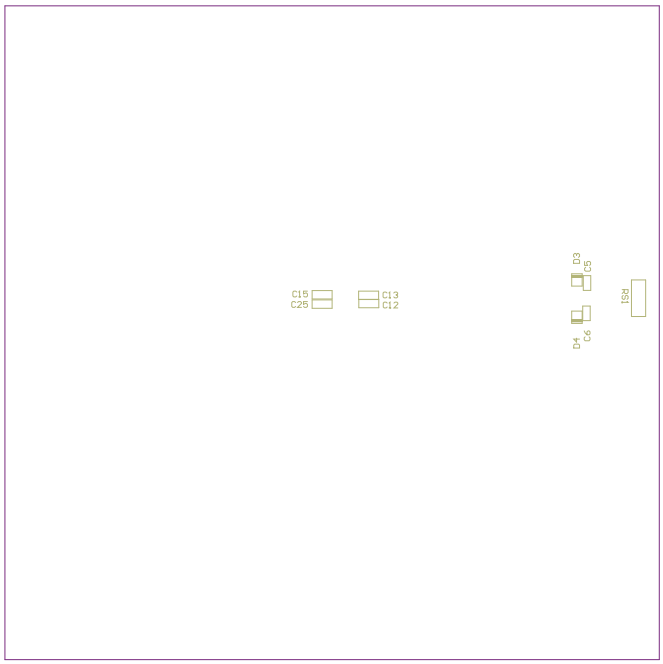


**Figure 8: Bottom Silk**


MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2022 MPS. All Rights Reserved.

## REVISION HISTORY

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

**Notice:** The information in this document is subject to change without notice. Please contact MPS for current specifications. Users should warrant and guarantee that third-party Intellectual Property rights are not infringed upon when integrating MPS products into any application. MPS will not assume any legal responsibility for any said applications.


MPS Proprietary Information. Patent Protected. Unauthorized Photocopy and Duplication Prohibited.
© 2022 MPS. All Rights Reserved.