EV2762A-V-00A

6A Buck or Boost Charger with NVDC Power Managment and USB OTG for 2 Cells in Series Batteries Evaluation Board

DESCRIPTION

The EV2762A-V-00A is an evaluation board for the MP2762A, a highly integrated buck or boost charger IC with narrow-voltage DC (NVDC) power path management and USB On-the-Go (OTG) for battery packs with two cells in series. All power MOSFETs are integrated to provide an easy-to-use, compact system solution.

The IC can accept a wide range of input voltages for charging, with a maximum of 21V. The device has two operating modes during the charging process: boost charging mode and buck charging mode. In boost charging mode, two buck phases are in parallel, and the high-side MOSFET is always on in each phase. In buck charging mode, two interleaving buck phases simplify inductor selection by allowing for a smaller profile and reduced output current ripple.

The MP2762A provides a 4.75V to 5.5V input voltage range in USB OTG mode. The device utilizes a single-phase buck converter to provide 5V/3A from the battery pack.

The MP2762A is available in a QFN-30 (4mmx5mm) package.

ELECTRICAL SPECIFICATIONS

Parameter	Symbol	Value	Units
Input voltage	V_{IN}	4 to 21	V
Battery charge voltage regulation	V_{BATT_REG}	8.4, I²C-configurable	V
Fast charge current	I_{CC}	1, I²C-configurable	A
Input voltage clamp limit	V_{IN_MIN}	4.5, I²C-configurable	V
Input current limit	I_{IN_LIM}	1.5, I²C-configurable	A
OTG output voltage	V_{IN_OTG}	5, I²C-configurable	V
OTG output current limit	I_{OLIM}	1, I²C-configurable	A

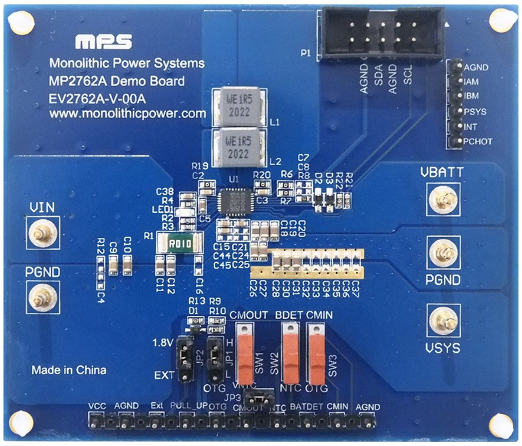
FEATURES

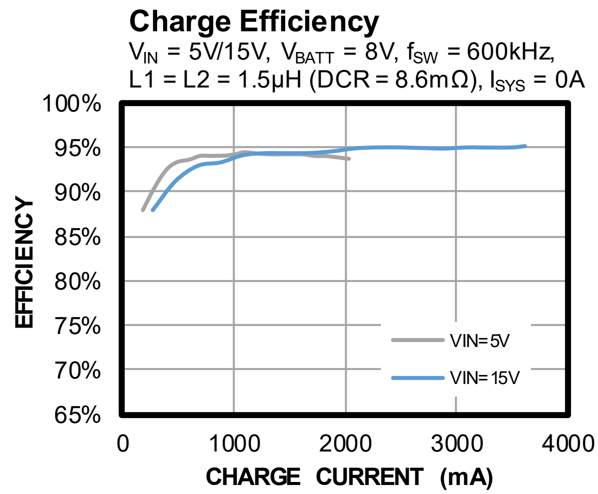
- Buck or Boost Charger For 2 Cells In Series Battery Pack
- NVDC Power Management
- 4V to 21V Operating Input Voltage Range
- Up to 28V (20ns) Sustainable Input Voltage
- Dual-Phase Interleaving in Buck Charging Mode
- I^2C Interface for Setting Charging Parameters and Status Reporting
- System Power Indication via the PSYS Pin
- Input Current and Battery Current Monitoring via the IAM/IBM Pin
- Robust Charging Protections Including Battery Temperature Protection, Battery Over-Voltage Protection (OVP), System OVP, and a Configurable Safety Charge Timer
- Thermal Regulation and Thermal Shutdown
- 600kHz, 800kHz, or 1MHz Configurable Switching Frequency for Each Phase
- Up to 5V/3A USB On-the-Go (OTG)
- Short-Circuit Protection (SCP) in OTG Mode
- Available in a QFN-30 (4mmx5mm) Package

APPLICATIONS

- Smartphones with Two Cells in Series
- Bluetooth Speakers
- Portable Gimbals

EV2762A-V-00A EVALUATION BOARD





LxWxH (8.72cmx7.5cmx0.16cm)

Board Number	MPS IC Number
EV2762A-V-00A	MP2762AGV

QUICK START GUIDE

The EV2762A-V-00A is designed for the MP2762A, a buck or boost charger that charges dual-cell battery packs with NVDC and USB On-the-Go (OTG) functionality. Its layout accommodates most commonly used capacitors. The default function of this board is preset for charger mode, and the full-charge voltage is preset to 8.4V for dual-cell battery packs. In charge mode, the MP2762A can work in buck or boost mode, according to the input and battery voltage.

Table 1 lists details regarding charge mode.

Table 1: Charge Mode

V_{IN} (V)	Cell Count	Switcher Mode
5	2	Boost
9	2	Buck
12		
15		
20		

Table 2 lists details regarding OTG mode.

Table 2: OTG Mode

V_{IN} (V)	Cell Count	Switcher Mode
5	2	Buck

Evaluation Platform Preparation

Follow the steps below to set up the evaluation platform:

1. Ensure a computer is available with at least one USB port and a USB cable. The MP2762A evaluation software must be properly installed.

2. Ensure that the USB to I^{2}C communication kit (EVKT-USBI2C-02) is present (see Figure 1).

Figure 1: USB to I^{2}C Communication Kit

3. To enable the software, double-click on the “MP2762A Evaluation Kit” .exe file to run the MP2762A evaluation software. The software supports the Windows XP and Windows 7 operating systems.

   The MP2762A evaluation kit.exe file can be downloaded from MPS website.

Original Test Set-Up for the MP2762A

1. Attach the input voltage to the VIN pin, and attach the input ground to the PGND pin (see Figure 2).
2. Attach the load terminals to:
   a. Positive (+): SYS
   b. Negative (-): PGND
3. Attach the battery terminals to:
   a. Positive (+): BATT
   b. Negative (-): PGND

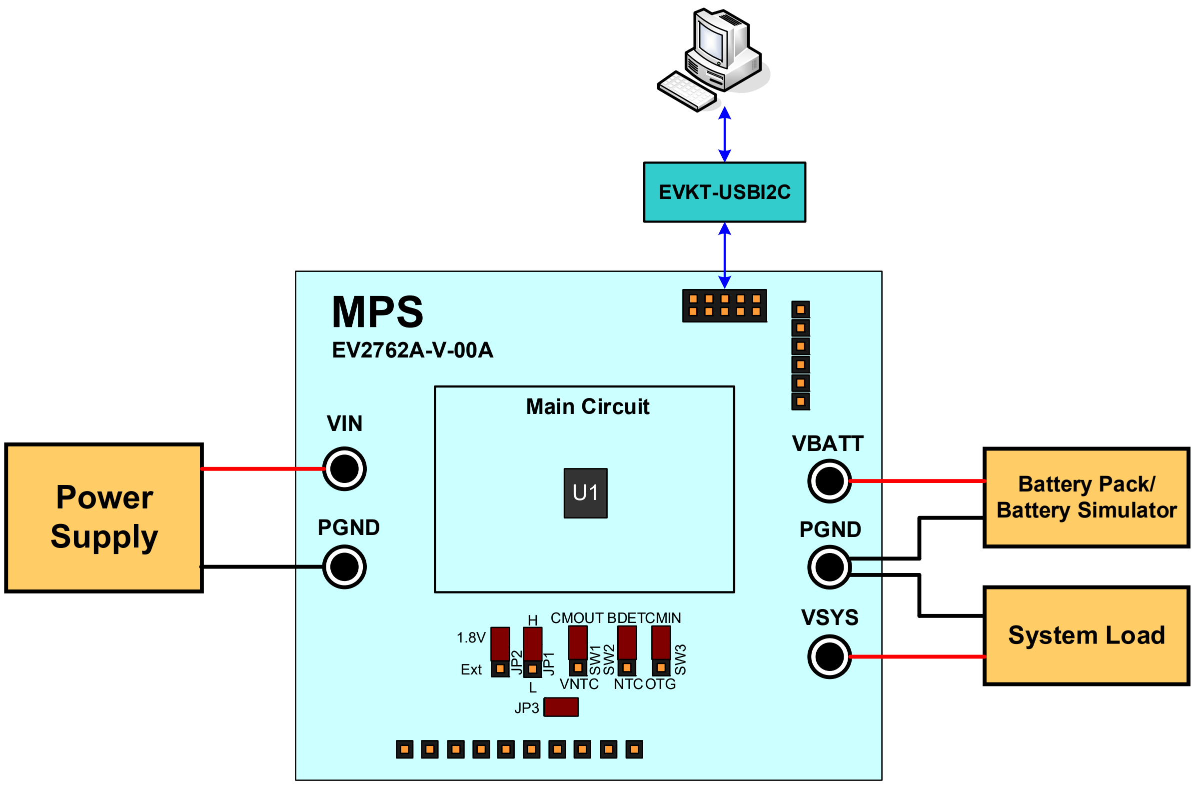


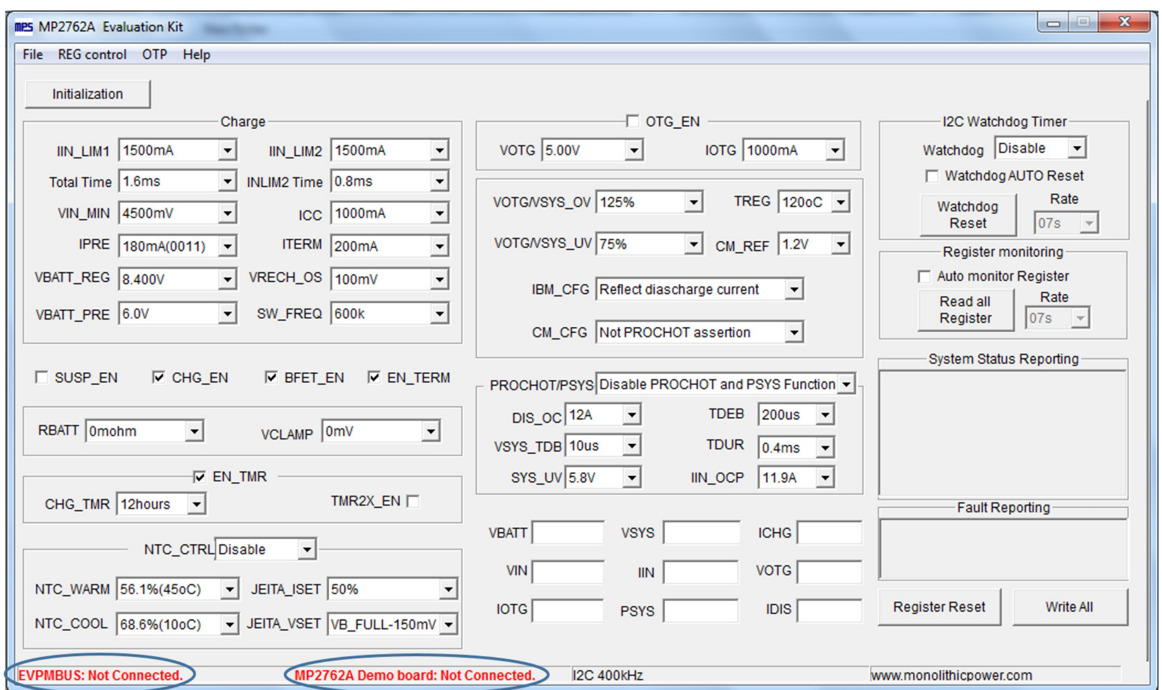
Figure 2: Test Set-Up for the MP2762A

Table 3 lists the jumper connections.

Table 3: Jumper Connections

Jack	Description	Factory Setting
SW1, SW2, SW3	Dual-purpose pin configuration. If SW1, SW2, and SW3 are all pulled down, SW1 acts as VNTC, SW2 acts as NTC, and SW3 acts as OTG. If SW1, SW2, and SW3 are pulled up, SW1 acts as CMOUT, SW2 acts as BATDET, and SW3 acts as CMIN. SW1, SW2, and SW3 must be connected in the same direction.	SW1, SW2, and SW3 are pulled down (SW1 = VNTC, SW2 = NTC, SW3 = OTG)
JP1	OTG pin setting. Pull JP1 low to disable OTG mode. Set the related register and pull JP1 high to enable OTG.	Pull JP1 high, OTG_EN (REG08H, bit[5]) = 1
JP2	Selects the pull-up voltage. Pull JP2 up to 1.8V or to an external power source. If an external power source is selected, add the external power source (e.g. 3.3V) from EXT to AGND.	Pull JP2 up to 1.8V
JP3	Battery detection resistor connection. If connect JP3 to a 10kΩ resistor, the battery is detected as present. Set REG08H, bit[2] to 0, then pull SW1, SW2, and SW3 up to enable the battery detection	Connect JP3 to a 10kΩ resistor

4. Turn the computer on and launch the MP2762A evaluation software. Figure 3 shows the main software window.



Indicates the connection between the communication interface and the computer

Indicates the connection between the communication interface and the evaluation board

Figure 3: MP2762A Evaluation Software

Procedure

Ensure that all connections between the computer, communication interface, and the EV2762A-V-00A are successful (see Figure 4).

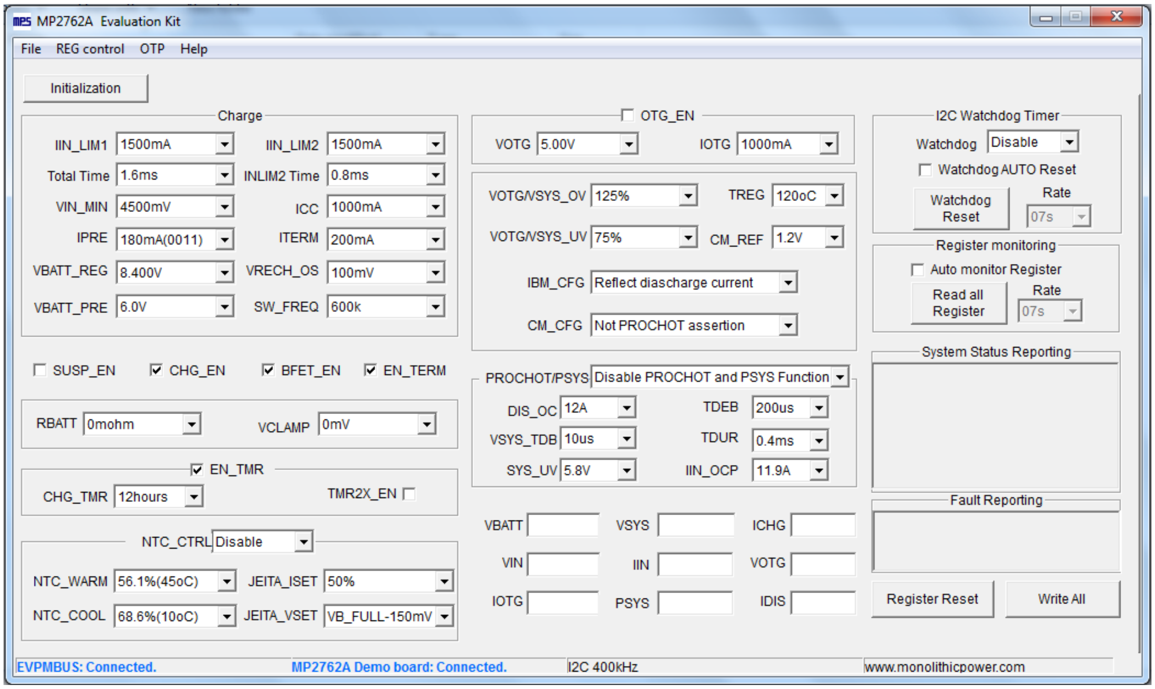


Figure 4: Successful MP2762A Evaluation Software Connection

Charge Function

1. Preset the output voltages of the input power supply and battery simulator before turning on any instrument.
2. Set the charge mode parameters by following the steps below:
    a. Plug the battery in or turn on the battery simulator. Ensure that the EVKT-USBI2C-02 is connected to both the computer and the evaluation board.
    b. Set the input current limit (see Figure 5).

Figure 5: Setting the Input Current Limit

Generally, set INLIM1 equal to INLIM2, and select the default timing.

c. Set the input voltage clamp limit (see Figure 6).

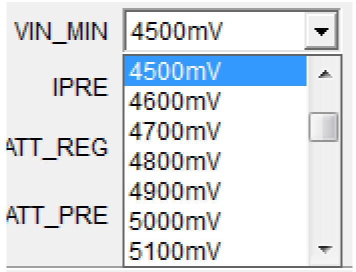


Figure 6: Setting the Input Voltage Clamp Limit

Generally, set the input voltage clamp limit to 4.5V.

d. Set the fast charge current (see Figure 7).

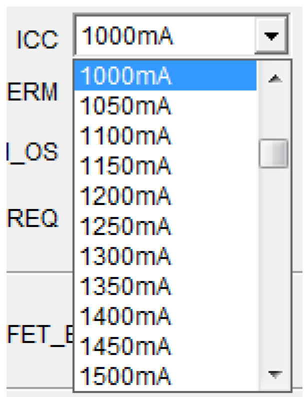


Figure 7: Setting the Fast Charge Current

e. Set the pre-charge current (see Figure 8).

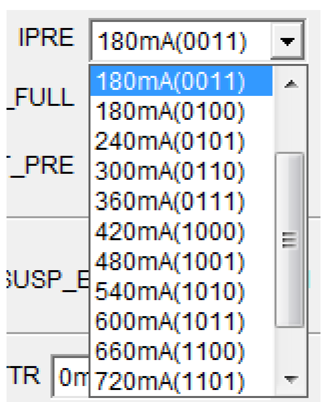


Figure 8: Setting the Pre-Charge Current

f. Set the charge termination current (see Figure 9).

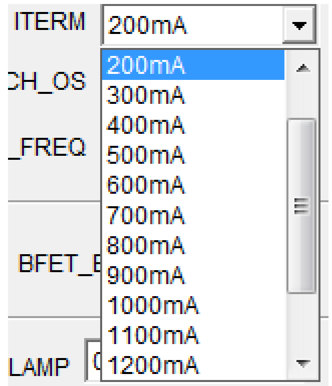


Figure 9: Setting the Charge Termination Current

g. Set the battery charge voltage regulation (see Figure 10).

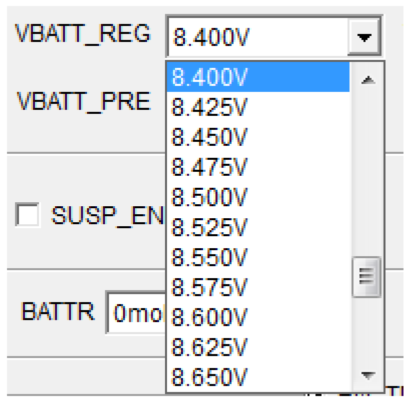


Figure 10: Setting the Battery Charge Voltage Regulation

h. Set the pre-charge to fast charge threshold (see Figure 11).

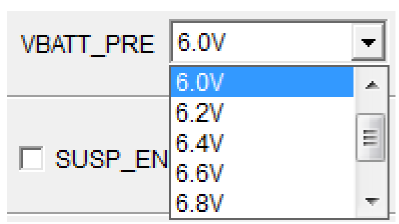


Figure 11: Setting the Pre-Charge to Fast Charge Threshold

i. Set the auto-recharge battery voltage threshold (see Figure 12).

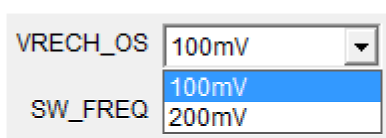


Figure 12: Setting the Auto-Recharge Battery Voltage Threshold

j. Set the switching frequency (see Figure 13).

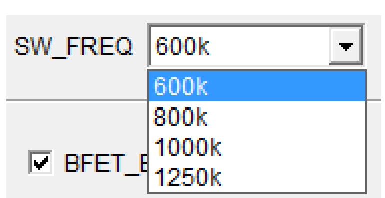


Figure 13: Setting the Switching Frequency

Generally, set the switching frequency to be between 600 kHz and 1000 kHz. It is not recommended to set the switching frequency to 1250 kHz.

k. Set the charge safety timer (see Figure 14).

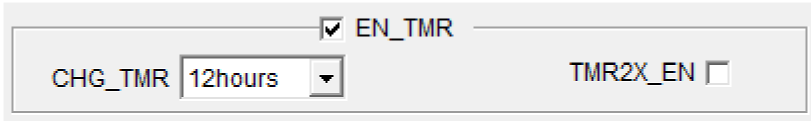


Figure 14: Setting the Charge Safety Timer

The parameter settings are listed below:

- EN_TMR (checked): enables the timer function.
- EN_TMR (unchecked): disables the timer function.
- CHG_TMR: determines the total time for the charge safety timer.
- TMR2X_EN (checked): enables the 2x timer function.
- TMR2X_EN (unchecked): disables the 2x timer function.

l. Set the NTC function (see Figure 15).

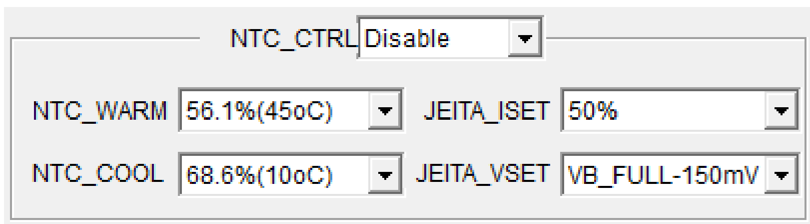


Figure 15: Setting the NTC Function

The parameter settings are listed below:

- NTC_CTRL: selects the NTC type.
- NTC_WARM: sets the NTC warm temperature threshold.
- NTC_COOL: sets the NTC cool temperature threshold.
- JEITA_ISET: sets the JEITA low temperature current.
- JEITA_VSET: sets the JEITA high temperature voltage.

3. Turn the input power supply on. The charge current should be set up.

OTG Function

1. Turn off and disconnect the power supply from VIN to PGND. Connect a load from VIN to PGND.
2. Set the jumper connections (see Table 3 on page 4).
3. Set the OTG mode parameters and enable the OTG function by following the steps below:
   a. Plug the battery in or turn the battery simulator on, and then ensure that the EVKT-USBI2C-02 is connected to the computer and evaluation board.
   b. Set the OTG output voltage (see Figure 16).

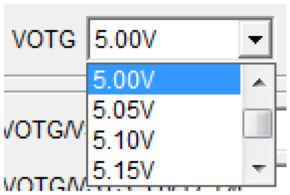


Figure 16: Setting the OTG Output Voltage

   c. Set the OTG output current limit (see Figure 17).

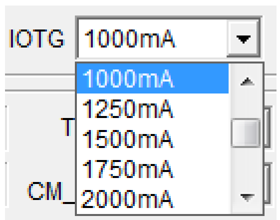


Figure 17: Setting the Output Current Limit.

   d. Enable or disable OTG mode (see Figure 18)

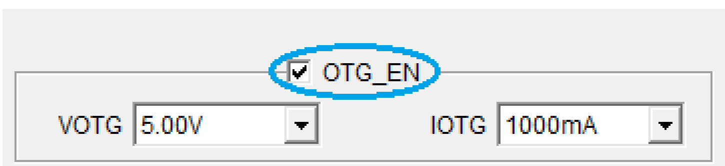


Figure 18: Configuring OTG Mode

The parameter settings are listed below:

- OTG_EN (checked): enable the OTG function.
- OTG_EN (unchecked): disable the OTG function.

4. Enable the OTG function and verify the voltage between VIN and PGND.

Other Settings

1. Select the inductors. If the power is below 65W, a smaller-value, 1µH inductor (e.g. HTEP32251B-1R0MIR-89, 1µH, DCR = 20mΩ, I_{SAT} = 7A) is recommended. If the power exceeds 65W, it is recommended to use inductors with a minimum 9A saturation current (e.g. 74437349015 from Worth, 1.5µH, DCR = 8.6mΩ, I_{SAT} = 14.5A).
2. Set the remaining I²C settings by following the steps below:
   a. Configure the charge mode (see Figure 19).

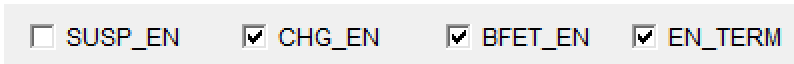


Figure 19: Charge Mode Configuration

The parameter settings are listed below:

- SUSP_EN (checked): switching is turned off.
- SUSP_EN (unchecked): switching is turned on.
- CHG_EN (checked): charging is enabled.
- CHG_EN (unchecked): charging is disabled.
- BFET_EN (checked): the BATTFET is on.
- BFET_EN (unchecked): the BATTFET is off.
- EN_BF (checked): the charge termination function is enabled.
- EN_BF (unchecked): the charge termination function is disabled.

   b. Set the charge mode battery impedance compensation (see Figure 20).

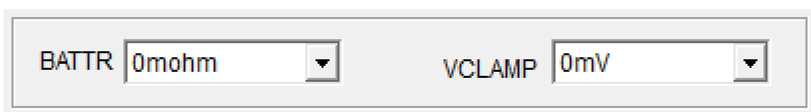


Figure 20: Setting the Charge Mode Battery Impedance Compensation

The parameter settings are described below:

- BATTTR: the resistance for battery impedance compensation.
- VCLAMP: The maximum allowed regulated voltage for battery impedance compensation.

   c. Set the PROCHOT and PSYS functions (see Figure 21).

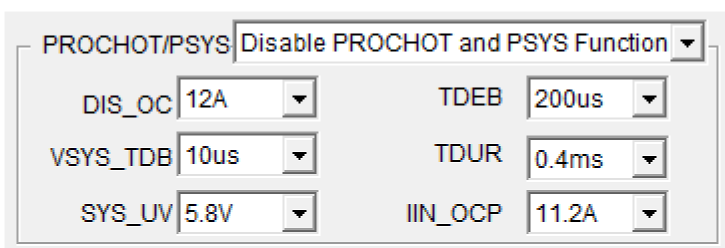


Figure 21: Setting the PROCHOT and PSYS Functions

The parameter settings are described below:

- PROCHOT/PSYS: Enable or disable the PROCHOT assertion and PSYS function.
- DIS_OC: sets the discharge over-current threshold for PROCHOT assertion.
- SYS_UV: sets the low system voltage threshold for PROCHOT assertion.
- IIN_OCP: sets the input over current threshold for PROCHOT assertion.

- VSYS_TDB: sets the denounce time before the PROCHOT asserts (for V_{SYS_UV} only).
- TDEB: sets the debounce time before the other PROCHOT asserts.
- TDUR: sets the duration time once the PROCHOT asserts.

d. Set other controls (see Figure 22).

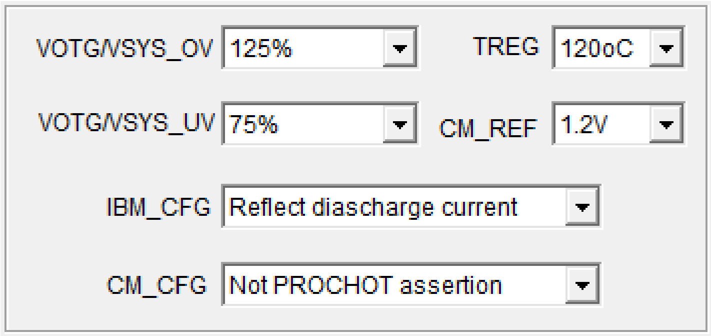


Figure 22: Setting the PROCHOT and PSYS Functions

The parameter settings are described below:

- VOTG/VSYS_OV: sets the over-voltage protection (OVP) threshold for V_{SYS} and V_{OTG}.
- VOTG/VSYS_UV: sets the under-voltage lockout (UVLO) threshold for V_{SYS} and V_{OTG}.
- IBM_CFG: the IBM pin reflects the charge current or the discharge current.
- CM_CFG: PROCHOT can assert if the independent comparator outputs low.
- TREG: sets the thermal regulation threshold.
- CM_REF: sets the reference for the independent comparator.

e. Set the watchdog parameters (see Figure 23).

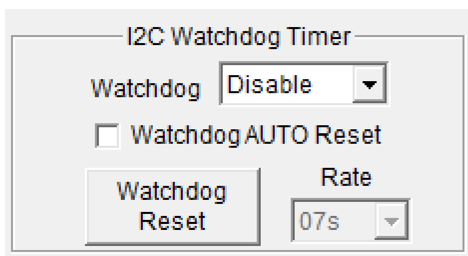


Figure 23: Setting the Watchdog Parameters

The parameter settings are described below:

- Watchdog: enable or disable the watchdog function.
- Watchdog AUTO Reset (checked): the GUI resets the watchdog automatically.
- Watchdog AUTO Reset (unchecked): the GUI does not reset the watchdog automatically.
- Watchdog Reset: click this button to reset the watchdog timer once.
- Rate: sets the interval time for the watchdog's automatic reset.

f. Set the voltages, currents and PSYS monitor (see Figure 24).

Figure 24: Setting the Voltages, Current, and PSYS Monitor

The textboxes indicate the ADC result of voltages, currents, and the calculation result of the system power.

g. Monitor the statuses and faults (see Figure 25). The textboxes report the status and faults.

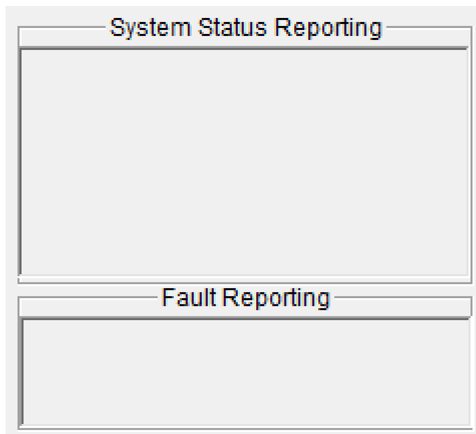


Figure 25: Setting the Voltages, Current, and PSYS Monitor

PCB Layout Guidelines

Efficient PCB layout is critical for specified noise, efficiency, and stability requirements. A minimum 4-layer PCB layout is recommended. For the best results, refer to Figure 26 and follow the guidelines below:

1. The VMAX_BST capacitor should be connected to PGND. Place one 100Ω resistor in series with the VMAX_BST capacitor.
2. Connect AGND and PGND to each decoupling capacitor via a single-point connection.
3. Connect SW2 to BST2, and place a BST capacitor directly on top of BST2. The internal path for BST2 is longer than BST1, so the two phases require additional leverage.
4. Place the VCC capacitor close to the VCC and AGND pins.
5. A Kelvin connection is required for the input current-sense resistor.
6. Place capacitors between VIN and PGND, and as close to these pins as possible.
7. Use CM and DM filters for the input current sense.

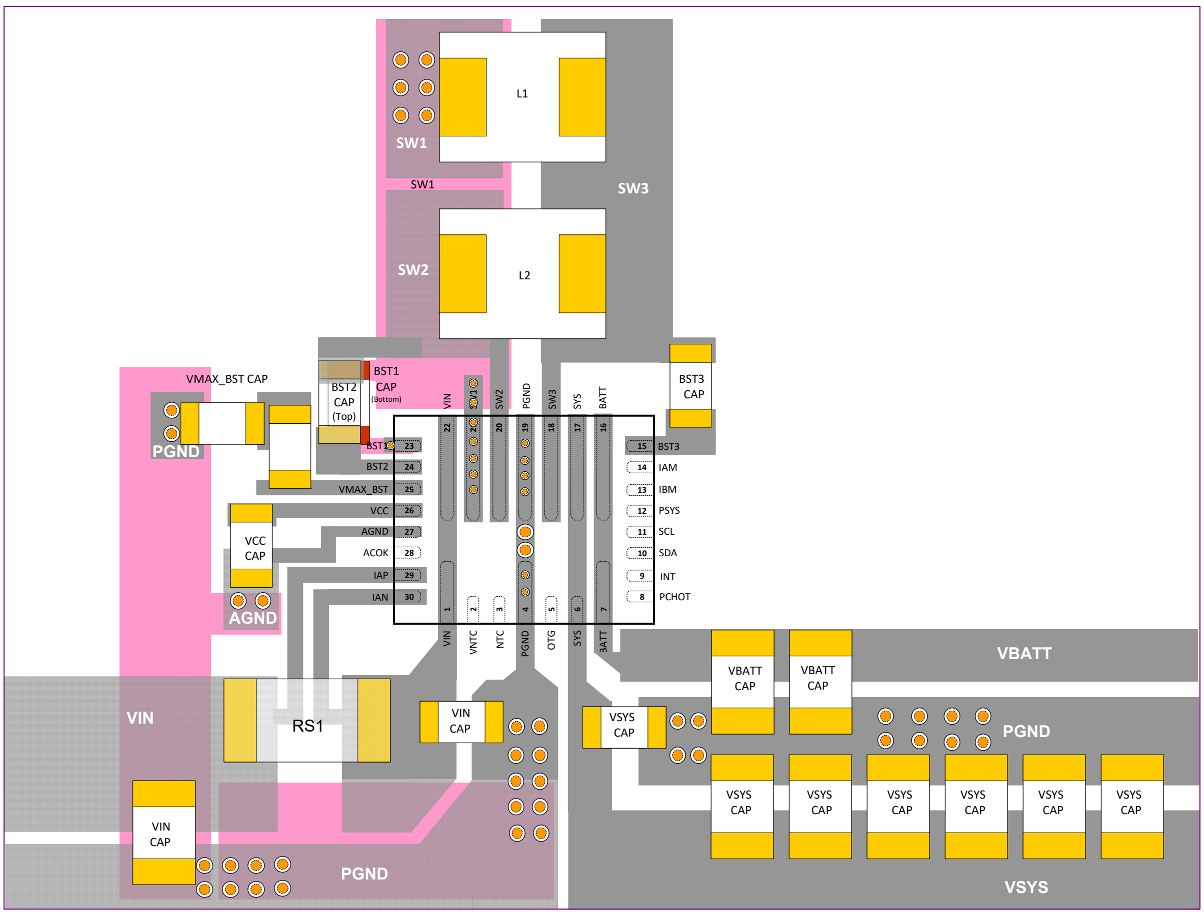


Figure 26: Recommended PCB Layout

EVALUATION BOARD SCHEMATIC

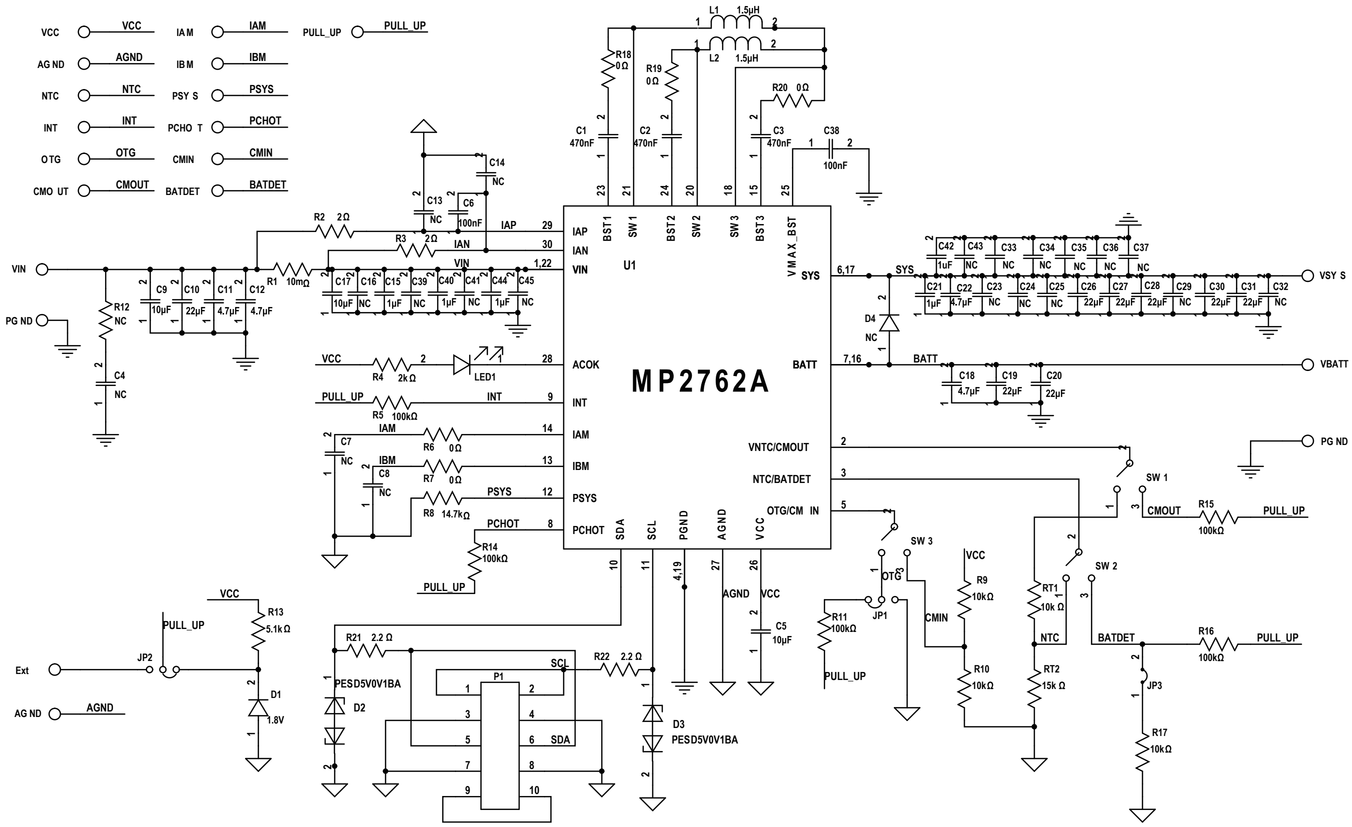


Figure 27: Evaluation Board Schematic

EV2762A-V-00A BILL OF MATERIALS

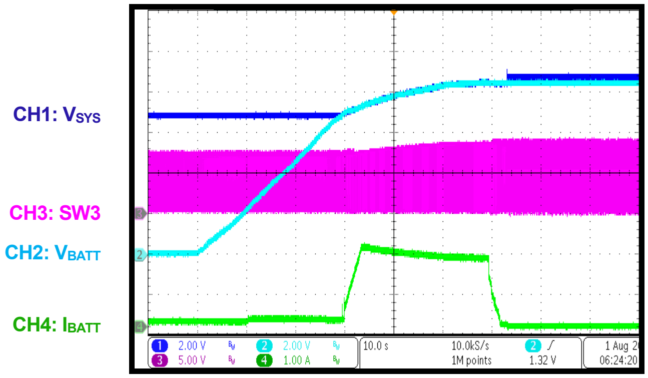
Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer P/N
3	C1, C2, C3	470nF	Capacitor, 25V, X5R	0603	Murata	GRM188R61E474KA12D
5	C15, C21, C40, C42, C44	1μF	Ceramic capacitor, 25V, X7R, 0603	0603	Murata	GRM188R71E105KA12D
1	C5	10μF	Ceramic capacitor, 25V, X5R	0603	Murata	GRM188R61E106MA73D
2	C9, C17	10μF	Capacitor, 25V, X5R	0805	Murata	GRM21BR61E106KA73
4	C11, C12, C18, C22	4.7μF	Capacitor, 25V, X7R	0805	Murata	GRM21BR71E475KA73L
8	C10, C19, C20, C26, C27, C28, C30, C31	22μF	Capacitor, 25V, X5R	0805	Murata	GRM21BR61E226ME44L
2	C6, C38	100nF	Capacitor, 50V, X7R	0603	Murata	GRM188R71H104KA93D
1	D1	8CMDZ1L 8TR	Diode, 1.8V, 500μA	SOD-323	Central Semiconductor	8CMDZ1L8TR-LF
2	D2, D3	PESD5V0 V1BA	ESD diode	SOD-323	NXP	PESD5V0V1BA
1	LED1	BL-HGE35A-TRB	Green LED	0805	BaiHong	BL-HGE35A-AV-TRB
2	L1, L2	1.5μH	Inductor, 1.5μH, 8.6mΩ, 14.5A	SMD	Wurth	74437349015
1	R1	10mΩ	Film resistor, 1%, 1W	2512	Cyntec	RL3264-6-R010-FN
2	R2, R3	2Ω	Film resistor, 5%	0603	Liz	CR0603JA02R0G
5	R6, R7, R18, R19, R20	0Ω	Resistor, 1%	0603	Yageo	RC0603FR-070RL
1	R4	2kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-072KL
5	R5, R11, R14, R15, R16	100kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07100KL
1	R8	14.7kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0714K7L
4	R9, R10, R17, RT1	10kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0710KL
2	R21, R22	2.2Ω	Film resistor, 1%	0603	Yageo	RC0603FR-072R2L
1	R13	5.1kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-075K1L
1	RT2	15kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0715KL
1	U1	MP2762A	Buck or boost charger	QFN-30 (4mmx5mm)	MPS	MP2762AGV

EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 5V, V_{BATT} = 0V to 8.4V, I_{CC} = 2A, I_{IN_LIM1} = I_{IN_LIM2} = 3A, V_{IN_MIN} = 4.5V, f_{SW} = 600kHz, L1 = L2 = 1.5µH, T_A = 25°C, unless otherwise noted.

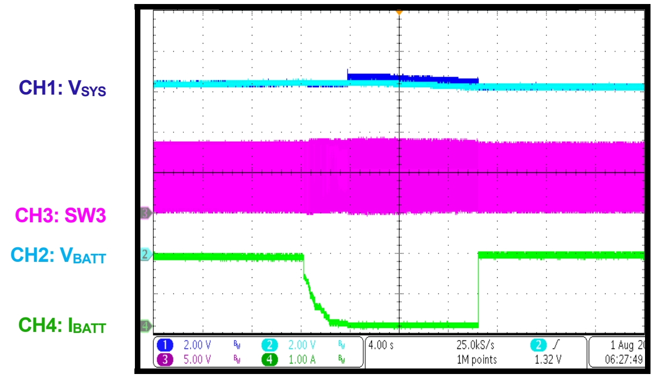
Battery Charge Curve

V_{IN} = 5V, V_{BATT_PRE} = 6.8V, V_{BATT_REG} = 8.4V



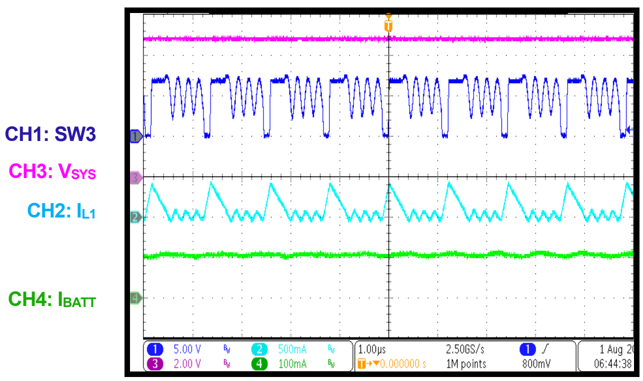
Auto-Recharge

V_{IN} = 5V, V_{BATT_PRE} = 6.8V, V_{BATT_REG} = 8.4V



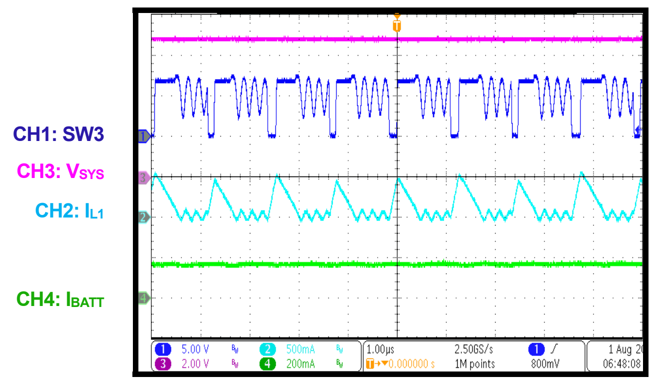
Trickle Charge Steady State

V_{IN} = 5V, V_{BATT} = 1V



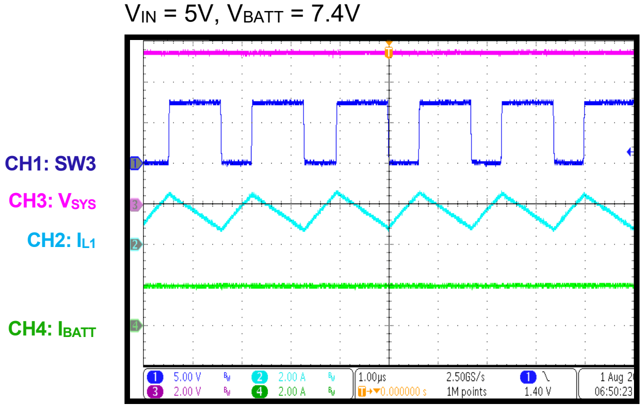
Pre-Charge Steady State

V_{IN} = 5V, V_{BATT} = 5.8V



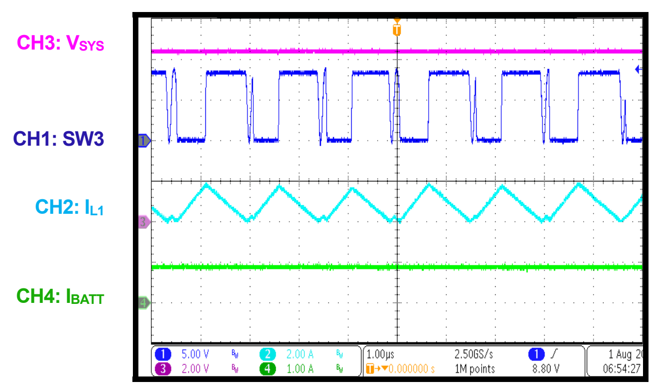
Constant Current Charge Steady State

V_{IN} = 5V, V_{BATT} = 7.4V



Constant Voltage Charge Steady State

V_{IN} = 5V, V_{BATT} = 8.4V

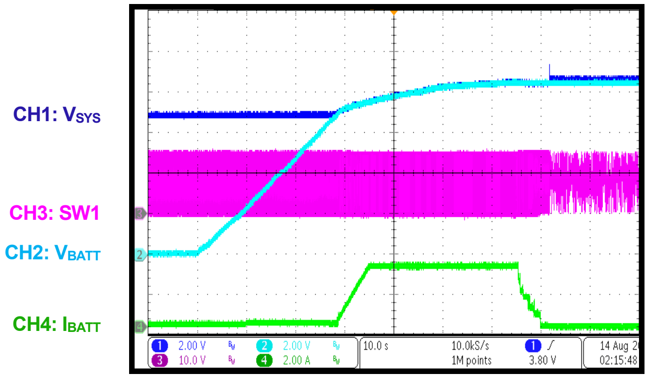


EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 15V, V_{BATT} = 0V to 8.4V, I_{CC} = 3A, I_{IN_LIM1} = I_{IN_LIM2} = 3A, V_{IN_MIN} = 4.5V, f_{SW} = 600kHz, L1 = L2 = 1.5µH, T_A = 25°C, unless otherwise noted.

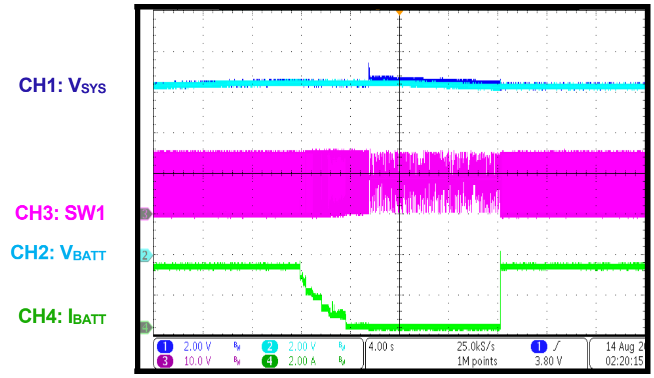
Battery Charge Curve

V_{IN} = 15V, V_{BATT_PRE} = 6.8V, V_{BATT_REG} = 8.4V



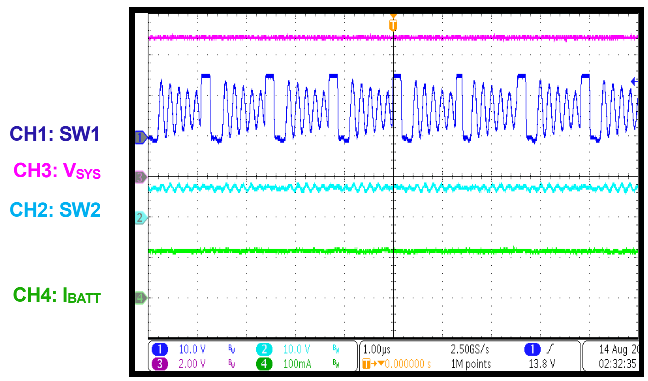
Auto-Recharge

V_{IN} = 15V, V_{BATT_PRE} = 6.8V, V_{BATT_REG} = 8.4V



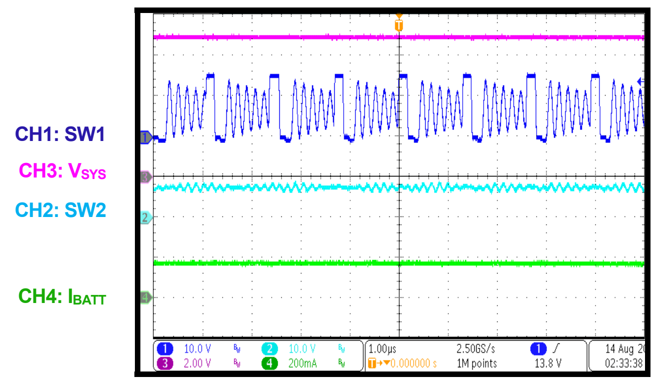
Trickle Charge Steady State

V_{IN} = 15V, V_{BATT} = 1V



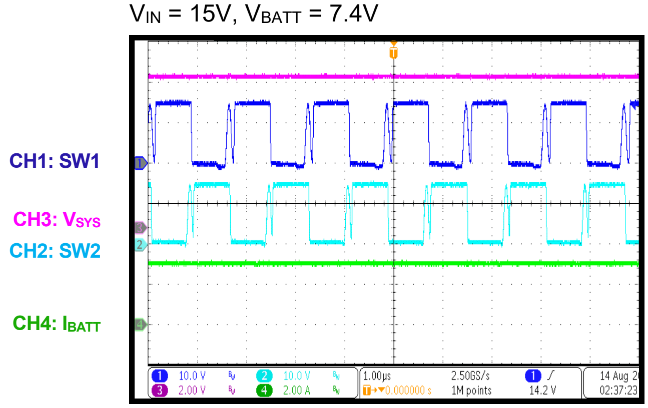
Pre-Charge Steady State

V_{IN} = 15V, V_{BATT} = 5.8V



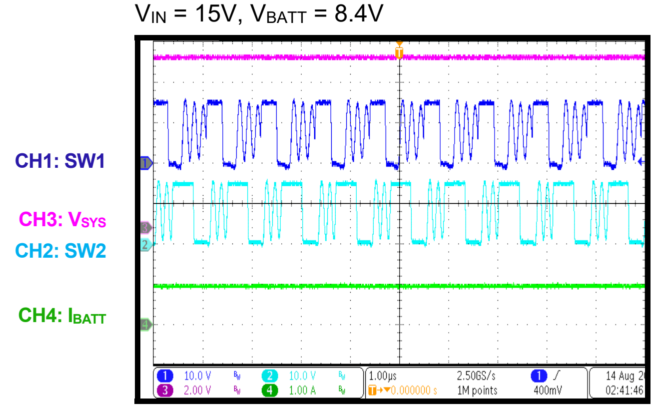
Constant Current Charge Steady State

V_{IN} = 15V, V_{BATT} = 7.4V



Constant Voltage Charge Steady State

V_{IN} = 15V, V_{BATT} = 8.4V

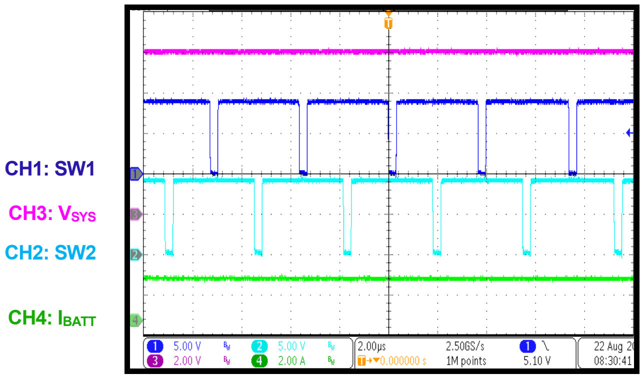


EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 5V to 15V, V_{BATT} = 0V to 8.4V, I_{CC} = 2A, I_{IN_LIM1} = I_{IN_LIM2} = 3A, V_{IN_MIN} = 4.5V, f_{SW} = 600kHz, L1 = L2 = 1.5μH, T_A = 25°C, unless otherwise noted.

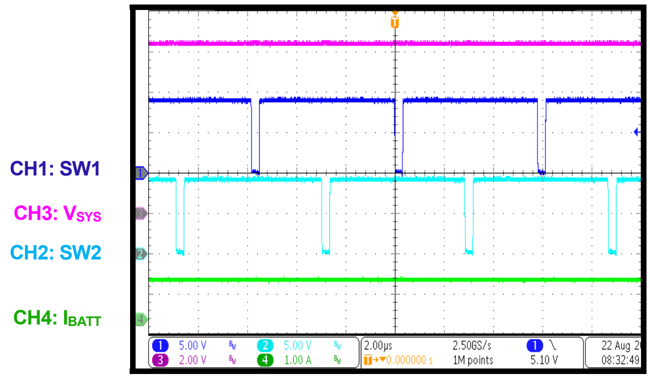
Constant Current Charge Steady State

V_{IN} = 9V, V_{BATT} = 8V, I_{IN_LIM1} = I_{IN_LIM2} = 5A, I_{SYS} = 2A



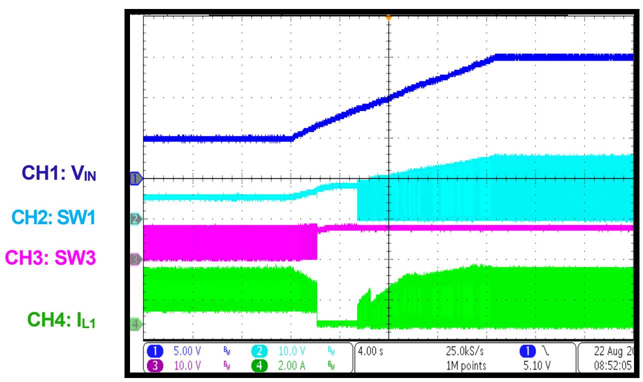
Constant Voltage Charge Steady State

V_{IN} = 9V, V_{BATT} = 8.4V, I_{IN_LIM1} = I_{IN_LIM2} = 5A, I_{SYS} = 2A



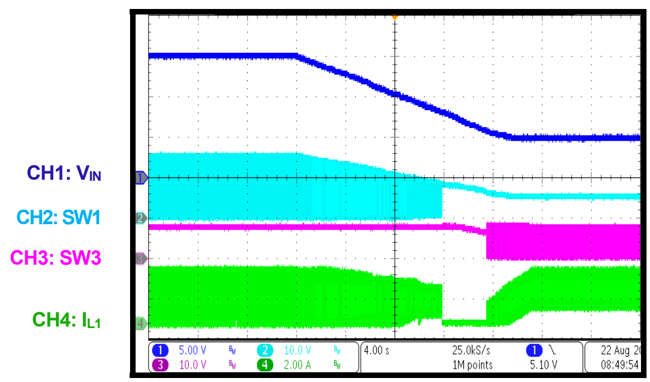
Boost to Buck Transition

V_{IN} = 5V to 15V, V_{BATT} = 7.4V



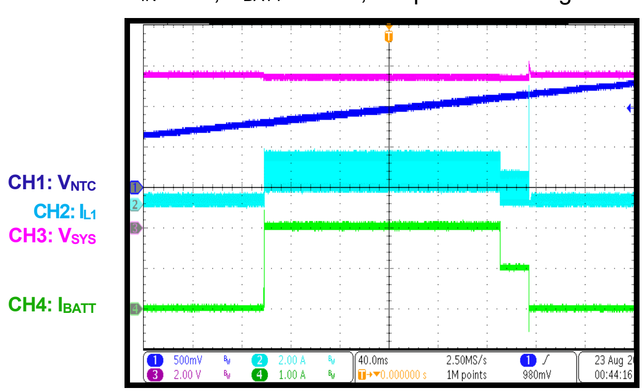
Buck to Boost Transition

V_{IN} = 15V to 5V, V_{BATT} = 7.4V



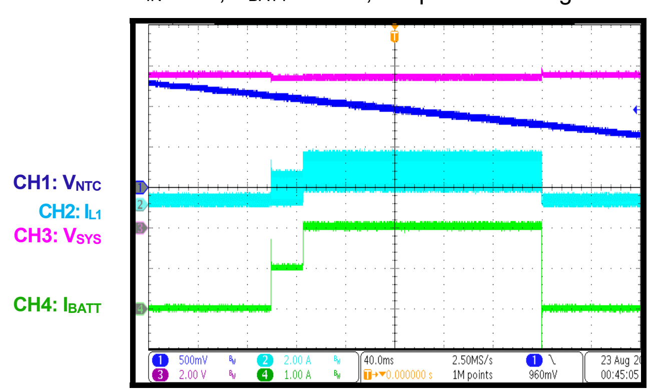
NTC

V_{IN} = 5V, V_{BATT} = 7.4V, temperature falling



NTC

V_{IN} = 5V, V_{BATT} = 7.4V, temperature rising

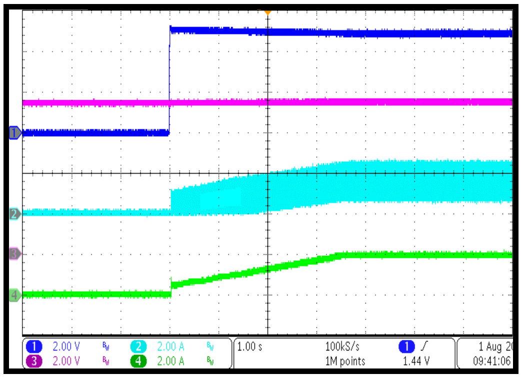


EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 5V, V_{BATT} = 0V to 8.4V, I_{CC} = 2A, I_{IN_LIM1} = I_{IN_LIM2} = 3A, V_{IN_MIN} = 4.5V, f_{SW} = 600kHz, L1 = L2 = 1.5µH, T_A = 25°C, unless otherwise noted.

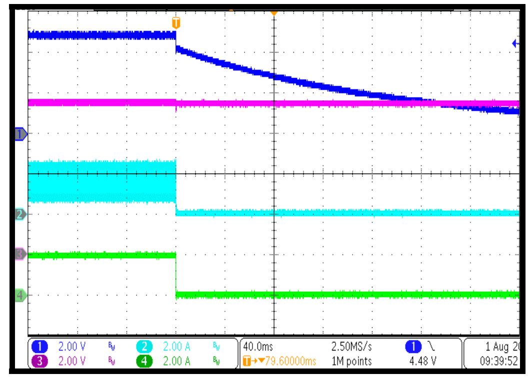
Start-Up through VIN

V_{IN} = 5V, V_{BATT} = 7.4V



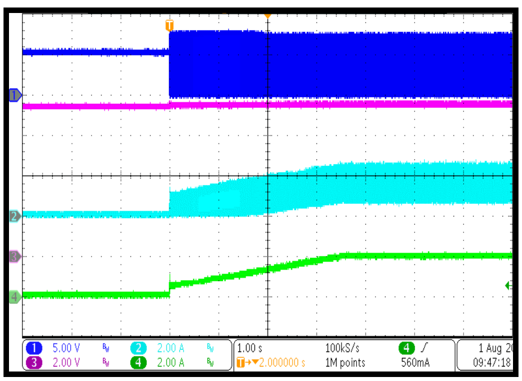
Shutdown through VIN

V_{IN} = 5V, V_{BATT} = 7.4V



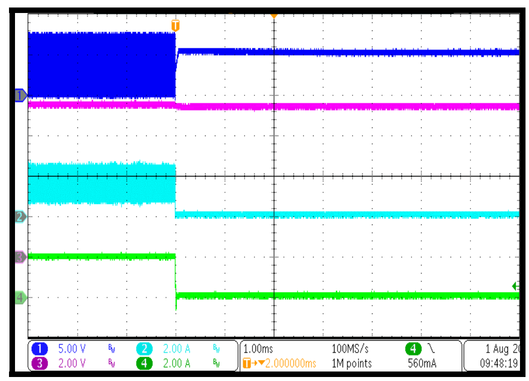
EN On

V_{IN} = 5V, V_{BATT} = 7.4V



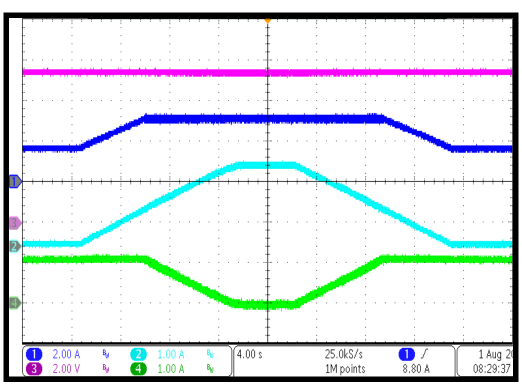
EN Off

V_{IN} = 5V, V_{BATT} = 7.4V



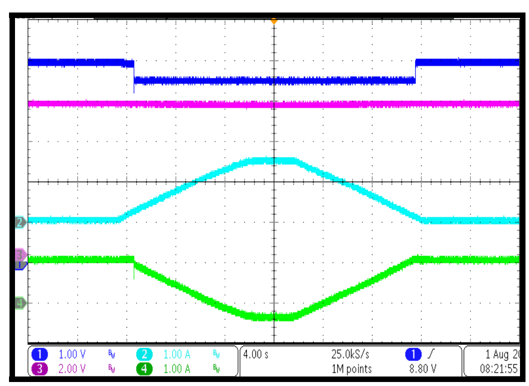
Input Current Limit

V_{IN} = 5V, V_{BATT} = 7.4V, I_{CC} = 1A



Input Voltage Limit

V_{IN} = 5V (2A), V_{BATT} = 7.4V, I_{CC} = 1A



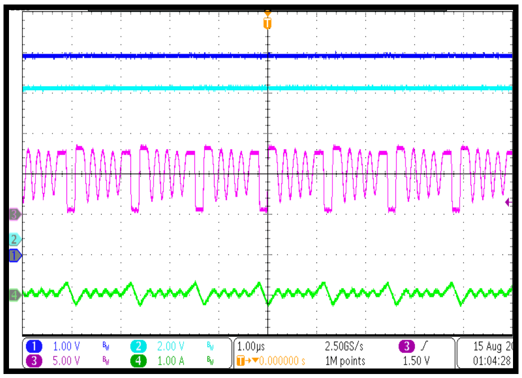
EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board. V_{IN_OTG} = 5V, V_{BATT} = 0V to 8.4V, I_{OLIM} = 3A, f_{SW} = 600kHz, L1 = L2 = 1.5µH, T_A = 25°C, unless otherwise noted.

OTG Steady State

V_{BATT} = 7.4V, I_{OTG} = 0A

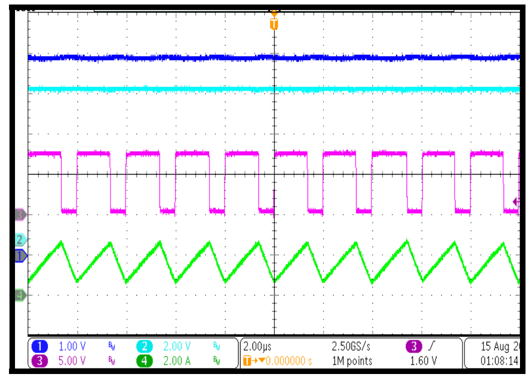
CH3: SW3
CH2: V_{BATT}
CH1: V_{IN}
CH4: I_{L1}



OTG Steady State

V_{BATT} = 7.4V, I_{OTG} = 3A

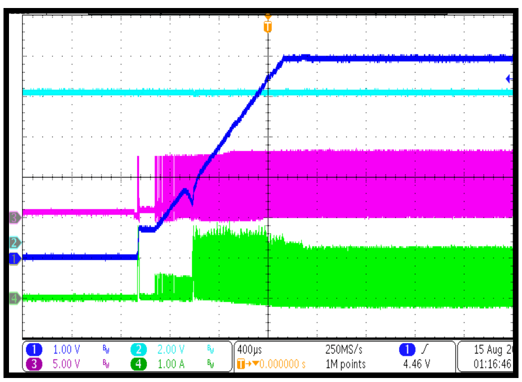
CH3: SW3
CH2: V_{BATT}
CH1: V_{IN}
CH4: I_{L1}



OTG EN On

V_{BATT} = 7.4V, I_{OTG} = 1A

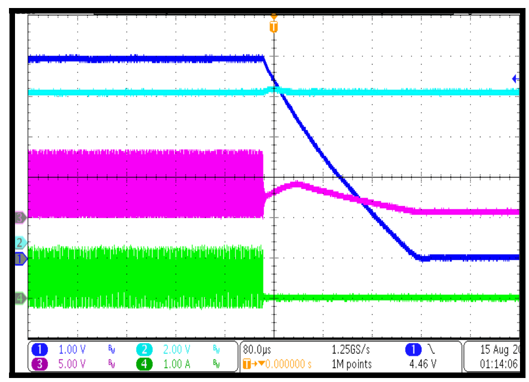
CH3: SW3
CH2: V_{BATT}
CH1: V_{IN}
CH4: I_{L1}



OTG EN Off

V_{BATT} = 7.4V, I_{OTG} = 1A

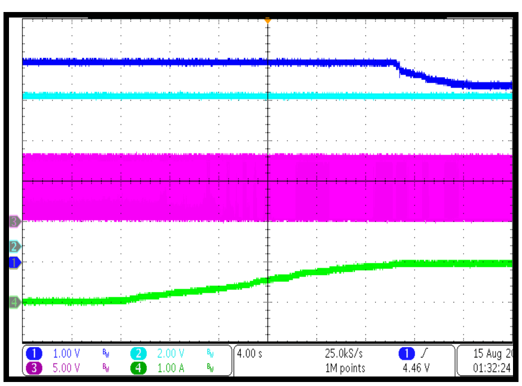
CH3: SW3
CH2: V_{BATT}
CH1: V_{IN}
CH4: I_{L1}



OTG Output Current Limit

V_{BATT} = 7.4V, I_{OLIM} = 1A

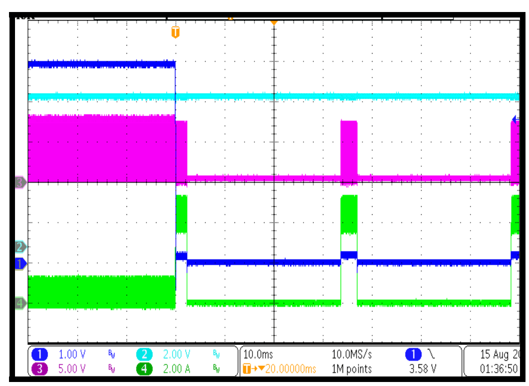
CH3: SW3
CH2: V_{BATT}
CH1: V_{IN}
CH4: I_{OTG}



OTG SCP

V_{BATT} = 7.4V, I_{OTG} = 1A

CH3: SW3
CH2: V_{BATT}
CH1: V_{IN}
CH4: I_{L1}



PCB LAYOUT

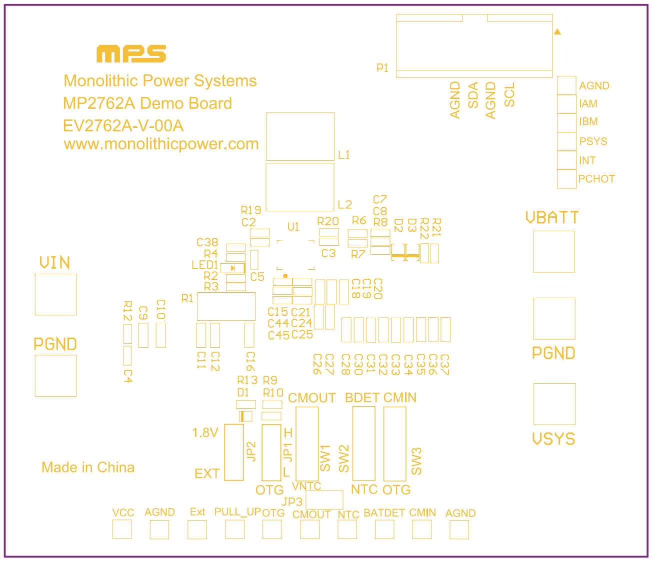


Figure 28: Top Silkscreen Layer

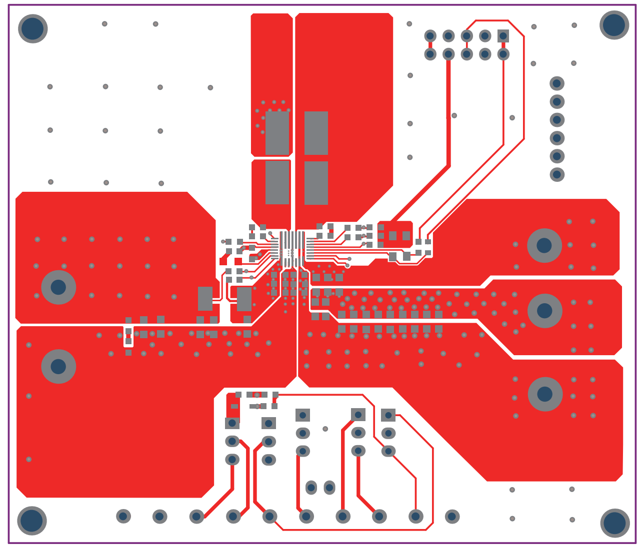


Figure 29: Top Layer

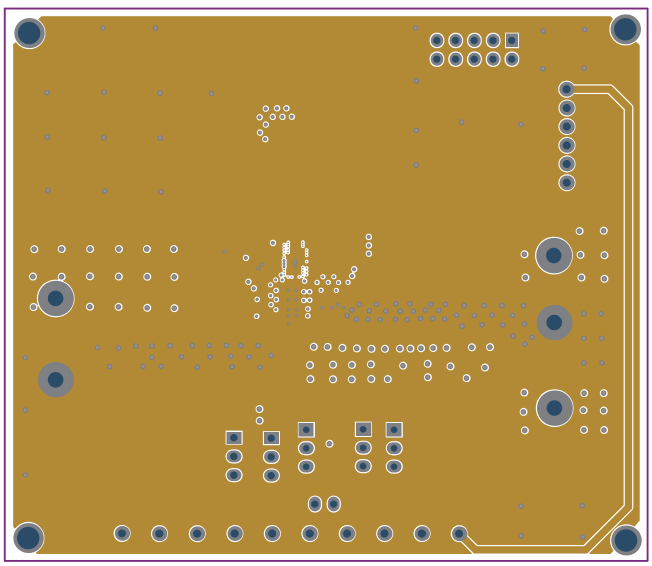


Figure 30: Middle Layer 1

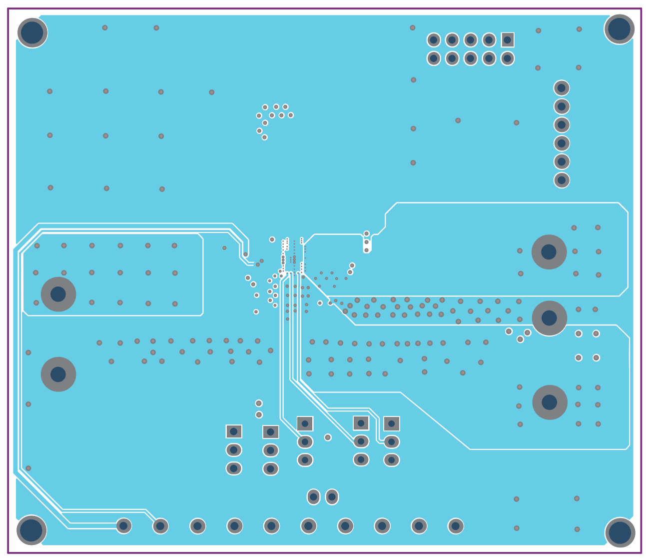


Figure 31: Middle Layer 2

PCB LAYOUT *(continued)*

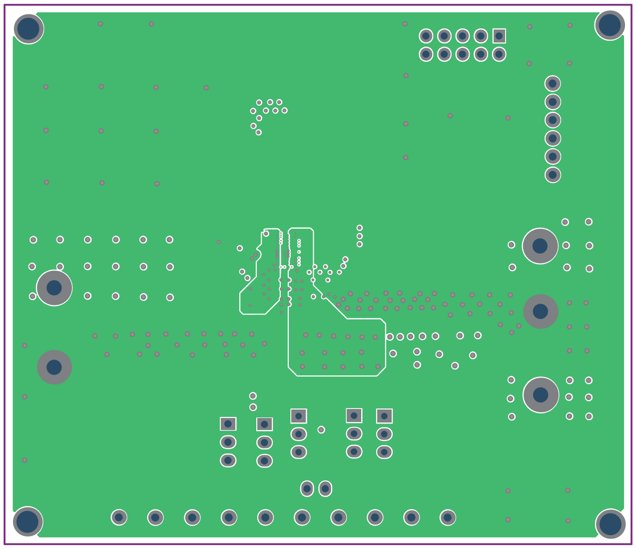


Figure 32: Middle Layer 3

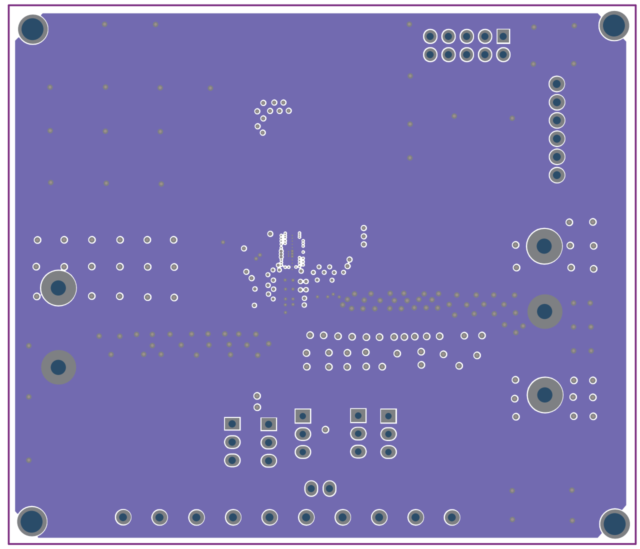


Figure 33: Middle Layer 4

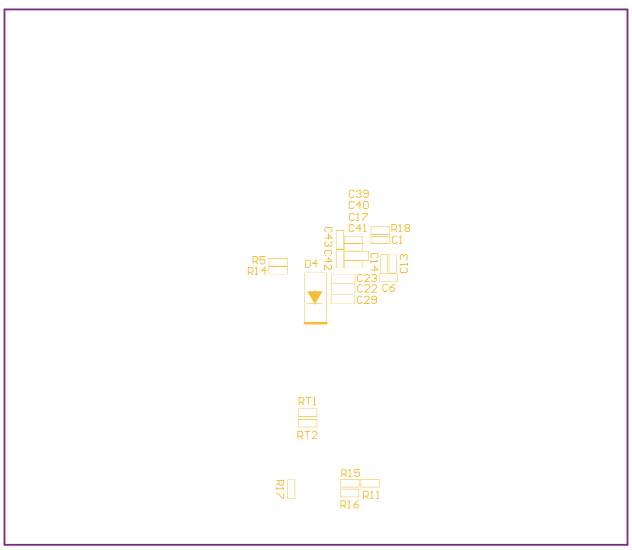


Figure 34: Bottom Silkscreen Layer

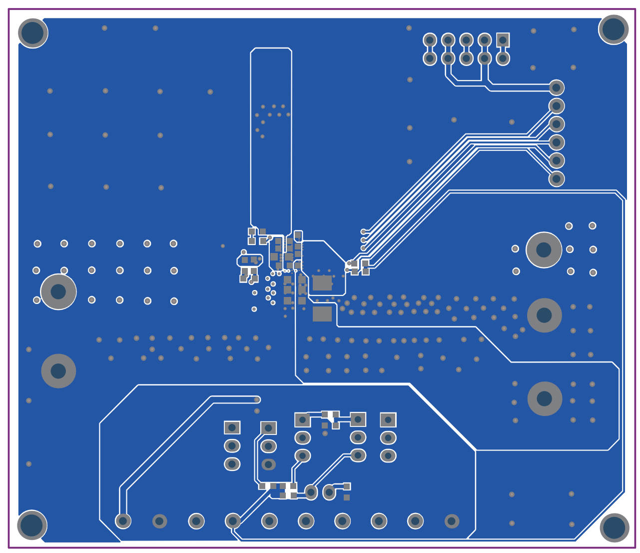


Figure 35: Bottom Layer

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	2/8/2021	Initial Release	-