EVL2652-VT-00A

I²C-Controlled, 2-Cell to 5-Cell, Buck-Boost Charger with Reverse Source Mode Evaluation Board

DESCRIPTION

The EVL2652-VT-00A is an evaluation board designed to demonstrate the capabilities of the MP2652, a buck-boost charger IC designed for 2-cell to 5-cell series battery packs. The device can accept a wide 4V to 22V input voltage (V_{IN}) range to charge the battery. It also supplies a wide 4V to 21V voltage range at the IN pin in source mode, which is compliant to the USB powered delivery (PD) specifications.

When input power is present, the EVL2652-VT-00A charges the battery with a maximum 6A charge current. When source mode is enabled, the IN pin's output current in source mode (I_{IN_SRC}) is limited to 6A.

With the I²C/SMBus interface, the MP2652 can flexibly configure the charge and discharge parameters. The I²C interface can also provide the device and fault statuses through the registers.

The MP2652 is available in a TQFN-30 (4mmx5mm) package.

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})	5 cells	21V (I²C-configurable)
Fast charge current (I_{CC})	V_{IN} = 9V to 22V	3A (I²C-configurable)
IN pin's output voltage in source mode (V_{IN_SRC}) range		4V to 21V
IN pin's output voltage in source mode (V_{IN_SRC})		4.98V (I²C-configurable)
IN pin's output current limit in source mode (I_{IN_SRC})		2A (I²C-configurable)
Charge typical efficiency	V_{IN} = 20V, V_{BATT} = 20V, I_{CC} = 3A	97.68%
Source mode typical efficiency	V_{BATT} = 18V, V_{IN_SRC} = 20V, I_{IN_SRC} = 3A	98.06%
Switching frequency (f_{SW})		425kHz (I²C-configurable)

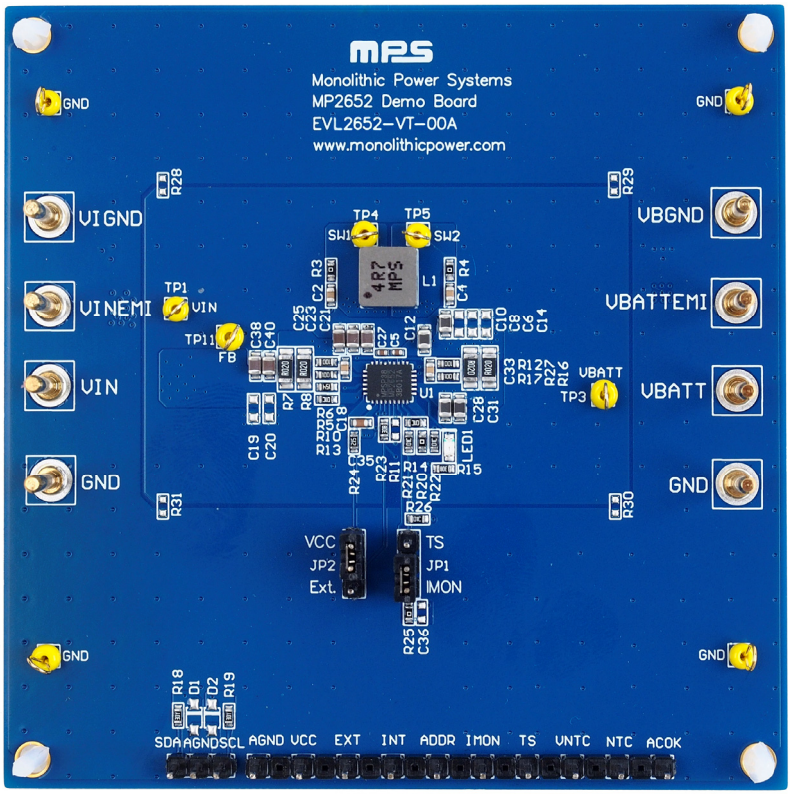
Note:

1) Refer to the MP2652 datasheet for more details.

MPL Optimized Performance with the MPS Inductor MPL-AL6050 Series

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EVL2652-VT-00A EVALUATION BOARD



LxWxH (8.9cmx8.9cmx0.8cm)

Board Number	MPS IC Number
EVL2652-VT-00A	MP2652GVT-0000

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QUICK START GUIDE

The EVL2652-VT-00A evaluation board is designed for the MP2652 when it is used as a buck-boost charger to charge a 5-cell battery pack. The board layout accommodates most commonly used resistors and capacitors. This board is preset for charge mode, and the full-charge voltage is preset to 21V. In charge mode, the MP2652 can work automatically in buck, buck-boost, or boost mode according to the input and battery voltages (V_{IN} and V_{BATT}, respectively).

Follow the steps below to prepare the evaluation board:

1. Ensure that the computer has at least one USB port and a USB cable. The MP2652 evaluation software must be properly installed.
2. Connect the USB-to-I²C communication kit (EVKT-USBI2C-02) (see Figure 1).



Figure 1: USB-to-I²C Communication Kit

3. To enable the software, double-click on the “MP2652 Evaluation Kit.exe” file to run the MP2652 evaluation software. The software supports Windows 7 and Windows 10 operating systems.

   The MP2652 evaluation kit.exe file can be downloaded from the MPS website.

Original Test Set-Up for the MP2652

1. Connect the battery terminals to:
   a. Positive (+): VBATT
   b. Negative (-): GND
2. If using a battery simulator, preset V_{BATT} between 0V and 21V, then turn off V_{BATT}.
3. Connect the battery simulator outputs to the VBATT and GND pins, respectively.
4. Ensure that V_{BATT} is present. If using a battery simulator, turn the simulator on after making the connections.
5. For charge mode testing, connect the input terminals to:
   a. Positive (+): VIN
   b. Negative (-): GND
6. For source mode testing, connect the load terminals to:
   a. Positive (+): VIN
   b. Negative (-): GND
7. For EMI testing, connect the input or load terminals to:
   a. Positive (+): VINEMI
   b. Negative (-): VIGND

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8. For EMI testing, connect the battery terminals to:
   a. Positive (+): VBATTEMI
   b. Negative (-): VBGND
9. Remove all other connectors (VIN, GND, VBATT, and GND) and pin headers.

   Figure 2 shows the charge mode testing set-up.

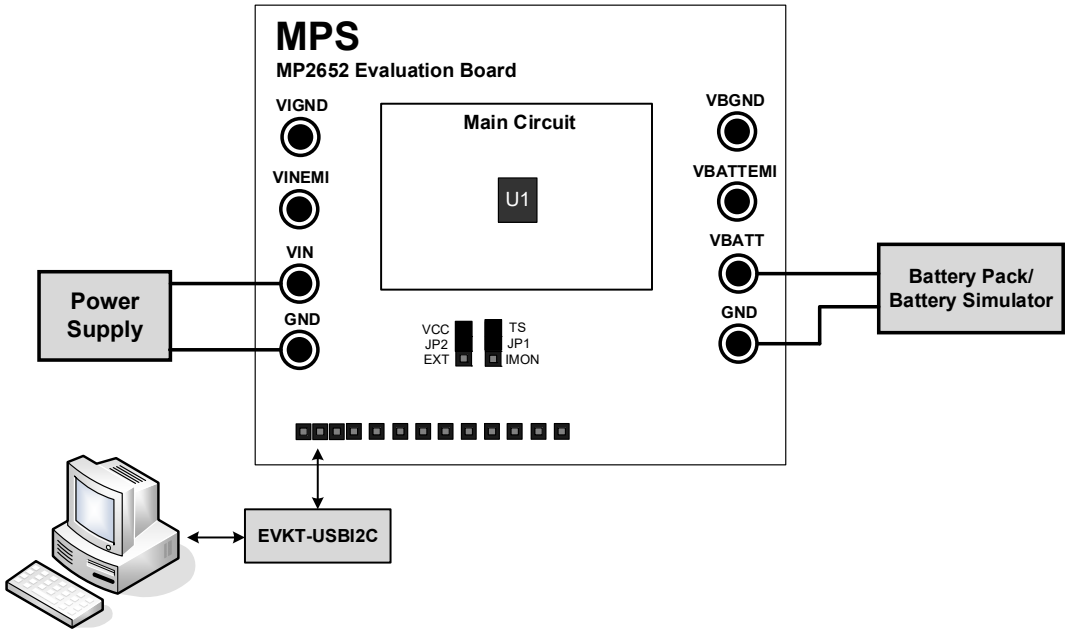


Figure 2: MP2652 Charge Mode Test Set-Up

Table 1 shows the jumper connection settings.

Table 1: Jumper Connections

Jack	Description	Default Setting
JP1 (2)	To select the pull-voltage, pull JP1 up to VCC or an external power source.	Pull JP1 up to VCC
JP2 (3)	For the TS/IMON connection, connect pin 7 to different external circuitry depending on the TS/IMON selection.	Pull JP2 up to TS

Notes:

2) If JP1 is pulled up to an external source, add an external power source (e.g. 3.3V) to AGND. Otherwise, no other actions are required.
3) If TS/IMON has different external circuity, connect the TS/IMON pin to the corresponding circuit via the I^2C.

10. Launch the MP2652 evaluation software. The main software window should show up on the screen (see Figure 3 on page 5).

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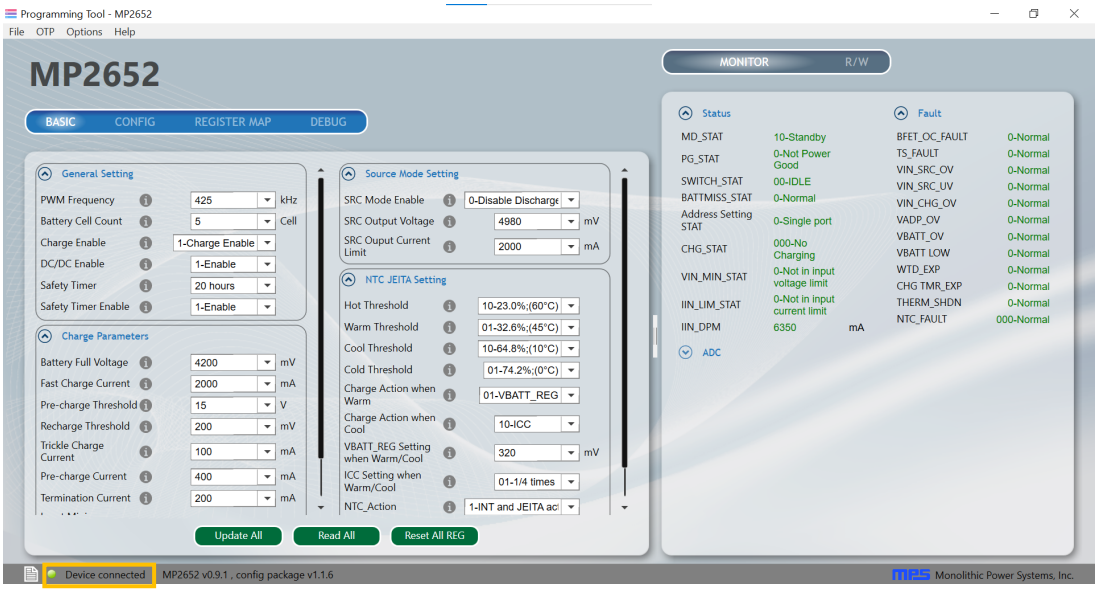


Figure 3: MP2652 Evaluation Software

11. Turn on V_{IN} to charge the battery with the default settings.

Modifying Parameters via the GUI

To use MPS's graphic user interface (GUI), ensure that all connections are successful, such as the connections between the computer, USB-to-I²C communication kit, and the evaluation board. All parameters can be input using the keyboard.

BASIC Page

Figure 4 shows the MP2652's basic settings.

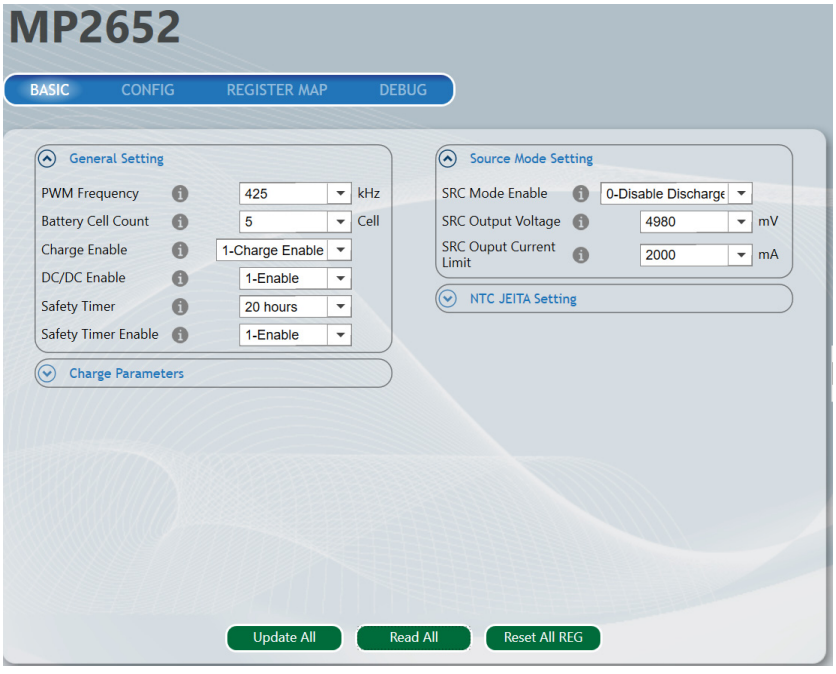


Figure 4: Basic Settings

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The general settings include the pulse-width modulation (PWM) switching frequency (f_{SW}), battery cell count, safety charge timer, and basic controls in charge mode such as enabling the charge and safety timer (see Figure 5).

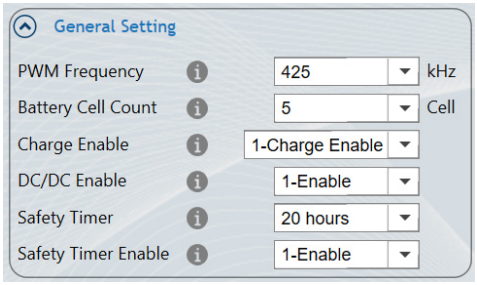


Figure 5: General Settings

Note that the recommended f_{SW} is between 375kHz and 770kHz.

Charge Mode Settings

The charge mode parameters include the battery-full voltage, fast charge current, pre-charge threshold, recharge threshold, trickle charge current, pre-charge current, and termination current. The parameters for power path management include the input minimum voltage limit and input current limit (see Figure 6).

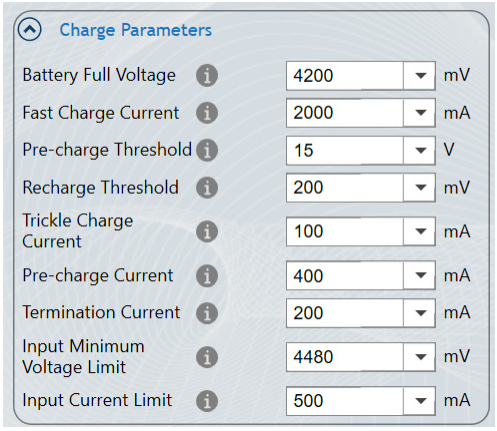


Figure 6: Charge Mode Settings

The battery-full voltage is set via register 15h. If BAT_NUM[1:0] = 01, 10, or 11 for 2-cell to 4-cell battery packs, then VBATT_REG[10:0] has a full charge voltage with a cell voltage range between 3.4V/cell and 4.67V/cell. For example, if there is a 4-cell battery pack with 4.2V/cell and the battery charge regulation voltage (V_{BATT_REG}) is set to 16.8V, then the full charge voltage is 16.8V.

However, if BAT_NUM [1:0] = 00 for 5-cell battery packs, VBATT_REG[10:0] has a cell voltage range between 3.4V/cell and 4.4V/cell. The full charge voltage is VBATT_REG x BAT_NUM. For example: if there is a 5-cell battery pack with 4.2V/cell and V_{BATT_REG} is set to 4.2V, then the full charge voltage is 21V.

Table 2 on page 7 compares the minimum and maximum battery charge regulation voltages ($V_{BATT_REG_MIN}$ and $V_{BATT_REG_MAX}$, respectively).

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Table 2: $V_{BATT_REG_MIN}$ vs. $V_{BATT_REG_MAX}$

Cell	V_{BATT} Range/Cell	$V_{BATT_REG_MIN}$			$V_{BATT_REG_MAX}$		
		V_{BATT_REG} (mV)	REG15h Decimal	REG15H Hexadecimal	V_{BATT_REG} (mV)	REG15h Decimal	REG15h Hexadecimal
2-cell	3.4V to 4.67V	6800	680	0x2A80	9340	934	0x3A60
3-cell	3.4V to 4.67V	10200	1020	0x3FC0	14010	1401	0x5790
4-cell	3.4V to 4.67V	13600	1360	0x5500	18680	1868	0x74C0
5-cell	3.4V to 4.4V	17000	340	0x1540	22000	440	0x1B80

Figure 7 shows the JEITA parameters for battery thermal protection.

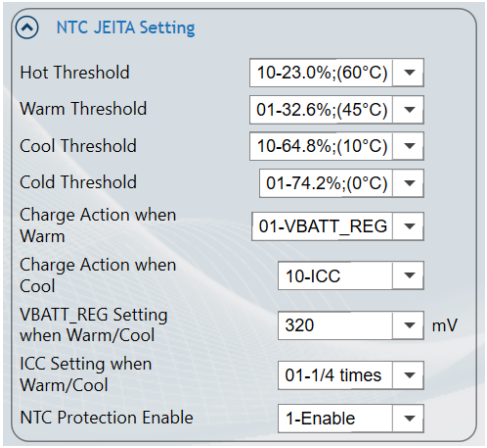


Figure 7: Battery Thermal Protection Parameters

Source Mode Settings

The MP2652 can work in source mode where the battery supplies power to the IN pin. The discharge parameters include the SRC mode (enabled or disabled), SRC output voltage, and SRC output current limit (see Figure 8).

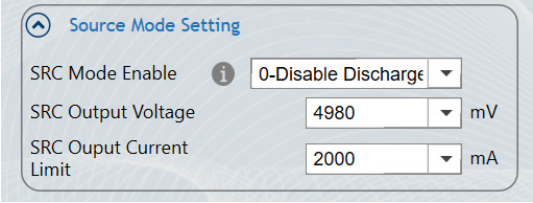


Figure 8: Discharge Parameters

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CONFIG Page

Figure 9 shows the MP2652's configuration settings.

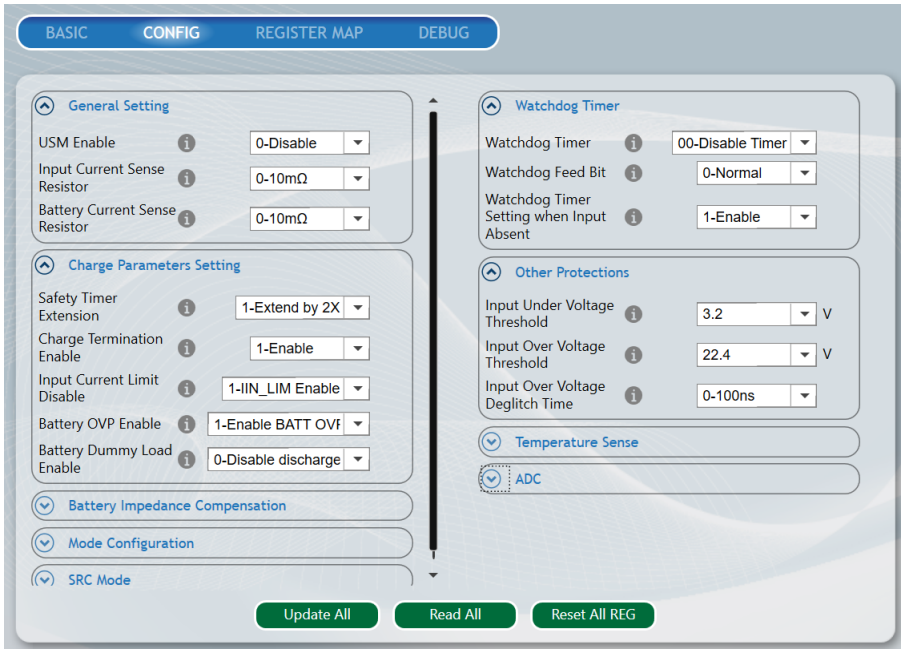


Figure 9: MP2652 Configuration Settings

General Settings

Figure 10 shows the ultrasound mode (USM) control and selection for the current-sense resistors.

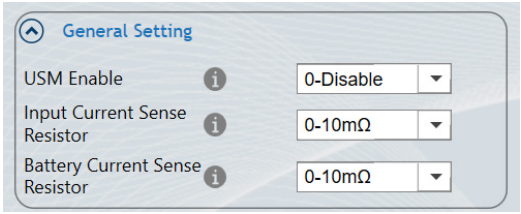


Figure 10: Setting the Current-Sense Resistors

Charge Protection Settings

Safety timer extension control enables the user to control parameters such as charge termination, the input current limit, battery over-voltage protection (OVP), and the battery dummy load (see Figure 11).

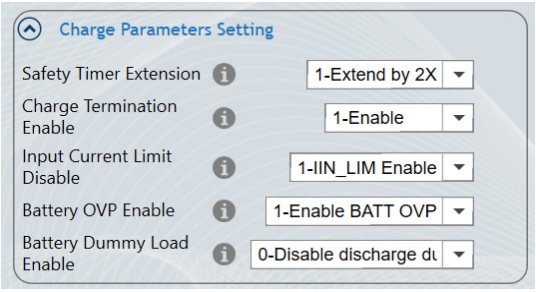


Figure 11: Charge Parameter Settings

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1. Select the battery impedance compensation and the voltage limit (see Figure 12).

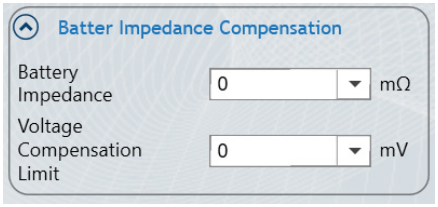


Figure 12: Battery Impedance Compensation

2. Select the external MOSFET mode configuration (input connection) (see Figure 13).

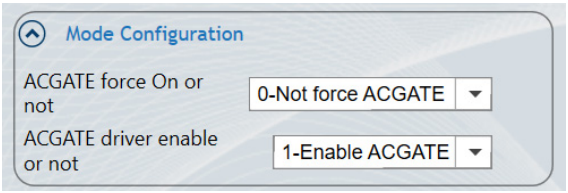


Figure 13: External MOSFET Mode Configuration

3. Select the parameters for SRC mode control, such as the SRC output voltage configuration and additional protections (see Figure 14).

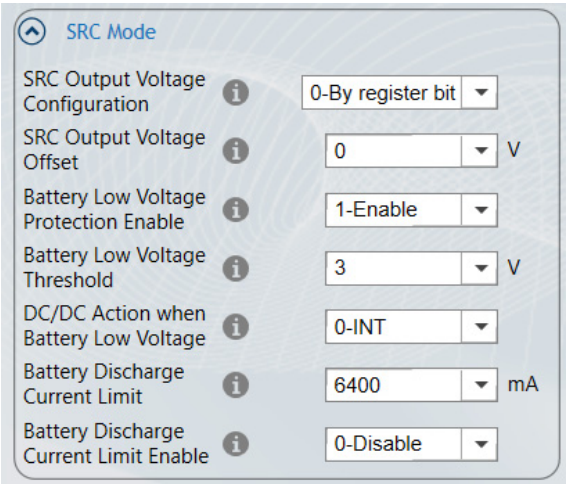


Figure 14: SRC Mode Configurations

Note: the battery low voltage threshold for 5cell is 15V = 3V / cell x 5cell.

4. Select the watchdog timer configurations (see Figure 15).

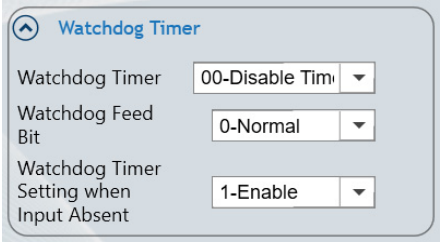


Figure 15: Watchdog Timer Configurations

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Additional Protections

Additional threshold settings, such as the input under-voltage (UV) threshold, input over-voltage (OV) threshold, and input OV deglitch time, can also be configured (see Figure 16).

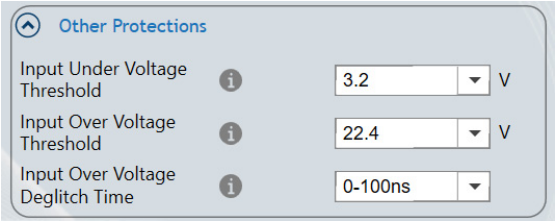


Figure 16: Additional Protections

1. Select the parameters for temperature-sense control. The TS/IMON pin can be set as either the temperature-sense pin (TS) or the battery monitor pin (IMON) (see Figure 17).

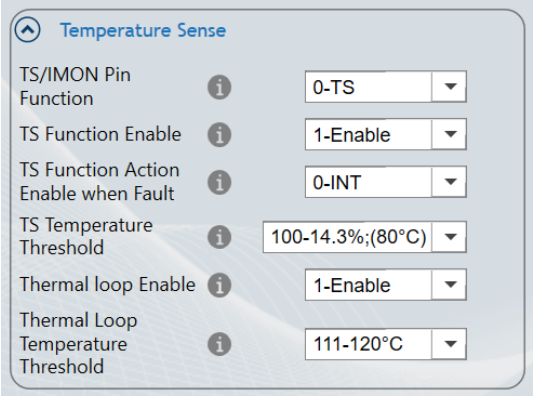


Figure 17: Temperature-Sense Settings

2. Select the analog-to-digital converter (ADC) operation mode configurations (Figure 18).

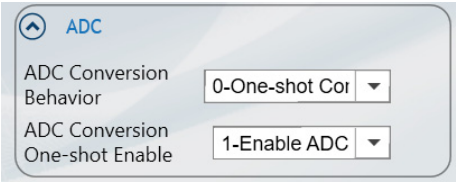


Figure 18: ADC Configurations

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REGISTER MAP Page

The REGISTER MAP page shows all the registers results that match the displays of the BASIC and CONFIG pages (see Figure 19).



Figure 19: MP2652 Register Map Sheet

MONITOR Page

The MONITOR page reports certain devices statuses (see Figure 20).

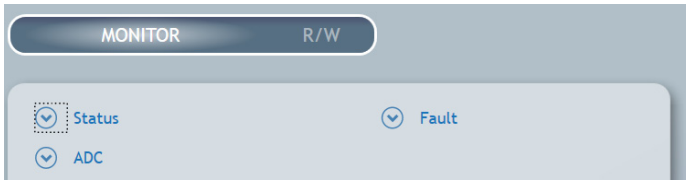


Figure 20: MP2652 Monitor Sheet

The MONITOR page indicates the general statuses (see Figure 21).

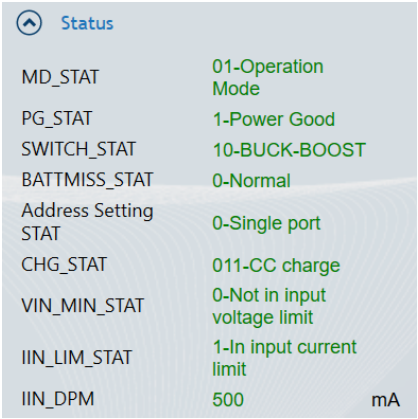


Figure 21: General Statuses

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The MONITOR page also reports the fault statuses (see Figure 22).

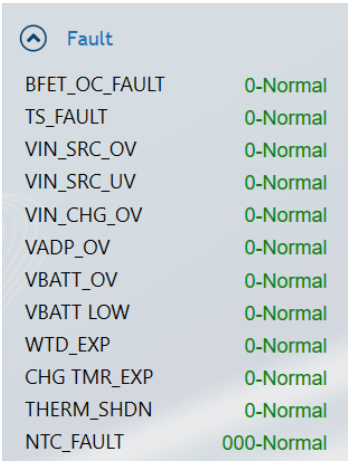


Figure 22: Fault Statuses

The MONITOR page indicates the ADC statuses (see Figure 23).



Figure 23: ADC Statuses

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EVALUATION BOARD SCHEMATIC

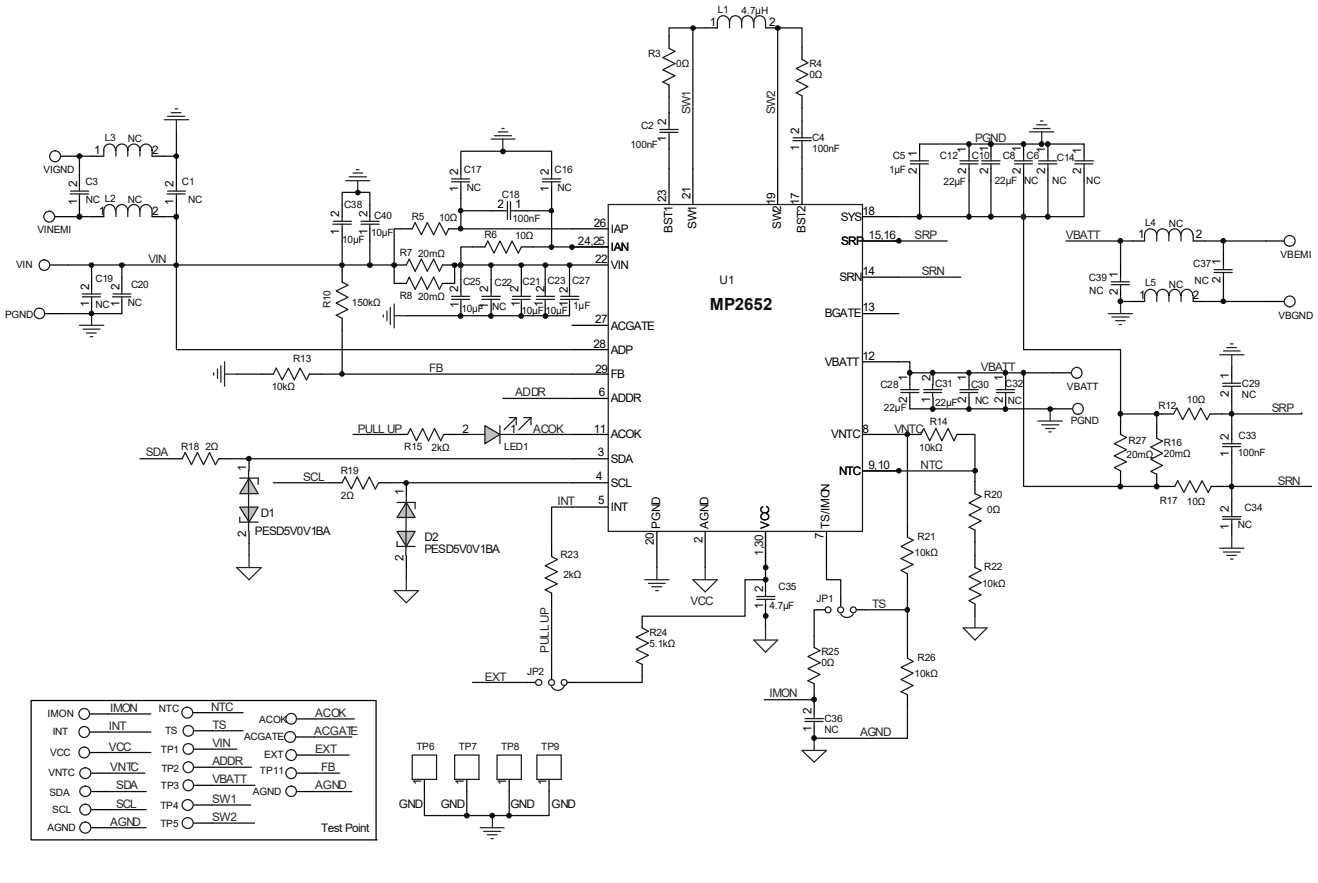


Figure 24: Evaluation Board Schematic

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EVL2652-VT-00A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
4	L2, L3, L4, L5	NC				
1	LED1	Red	LED	0805	Bright LED	BL-HUE35A-AV-TRB
4	R3, R4, R20, R25	0Ω	Film resistor, 5%	0603	Yageo	RC0603JR-070RL
4	R5, R6, R12, R17	10Ω	Film resistor, 5%	0603	Yageo	RC0603JR-0710RL
4	R7, R8, R16, R27	20mΩ	Film resistor, 1%, 1/4W	1206	Cyntec	RL1632H-R020-FN
1	R10	150kΩ	Film resistor, 5%, 1/10W	0603	Yageo	RC0603JR-07150KL
5	R13, R14, R21, R22, R26	10kΩ	Film resistor, 1%, 1/10W	0603	Yageo	RC0603FR-0710KL
2	R15, R23	2kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-072KL
2	R18, R19	2Ω	Film resistor, 5%	0603	Liz	CR0603JA02R0G
1	R24	5.1kΩ	Film resistor, 5%	0603	Yageo	RC0603JR-075K1L
5	R11, R28, R29, R30, R31	NC				
10	C1, C3, C16, C17, C22, C29, C34, C36, C37, C39	NC				
4	C2, C4, C18, C33	100nF	Ceramic capacitor, 50V, X7R	0603	Wurth	885012206095
2	C5, C27	1μF	Ceramic capacitor, 35V, X5R	0402	Murata	GRM155R6YA105ME11D
7	C6, C8, C14, C19, C20, C30, C32	NC				
4	C10, C12, C28, C31	22μF	Ceramic capacitor, 35V, X5R	0805	TDK	C2012X5R1V226M125AC
5	C21, C23, C25, C38, C40	10μF	Ceramic capacitor, 35V, X5R	0805	Murata	GRM21BR6YA106KE43L
1	C35	4.7μF	Capacitor, 25V, X5R	0603	Murata	GRM188R61E475KE11D
2	D1, D2	NC				
13	ACOK, ADDR, AGND, AGND, EXT, IMON, INT, NTC, TS, VCC, VNTC, SCL, SDA	2.54mm	Pin header	DIP	Any	

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EVL2652-VT-00A BILL OF MATERIALS *(continued)*

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
9	GND (4), TP1, TP11, TP4, TP5, TP3	2mm	Test point	DIP	Any	
4	VIN, VBATT, GND, GND	2mm	Connector	DIP	Any	
4	VINEMI, VBATTEMI, VIGND, VBGND	2mm	Connector	DIP	Any	
2	JP1, JP2	2.54mm	Pin header	DIP	Any	
2	JP1, JP2	2.54mm	Mini jumper	Shunt	Any	
1	L1	4.7μH	Inductor, 0.0165Ω, 7.5A	SMD	MPS	MPL-AL6050-4R7
1	U1	MP2652	2-cell to 5-cell buck-boost charger	TQFN-30 (4mmx 5mm)	MPS	MP2652GVT-0000

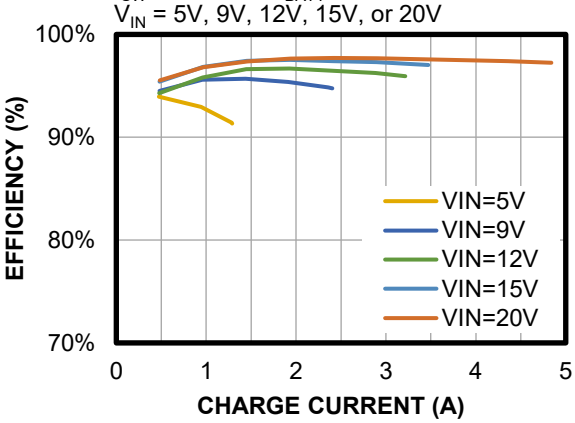
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EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board. The default setting is for a 5-cell battery pack, I_{IN_LIM} = 3A, V_{BATT} = 18V, I_{CC} = 3A, T_A = 25°C, unless otherwise noted.

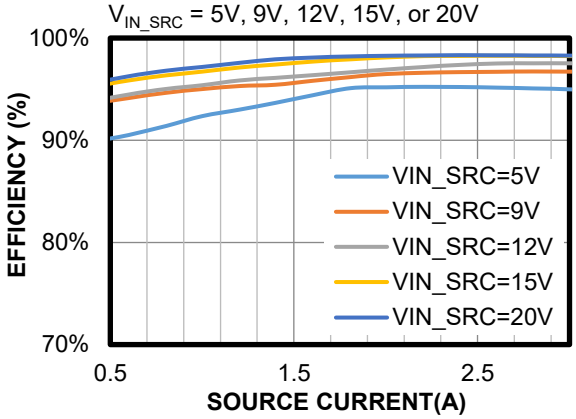
Efficiency vs. Charge Current

Charge mode, 5-cell battery pack,
f_{SW} = 425kHz, V_{BATT} = 20V,
V_{IN} = 5V, 9V, 12V, 15V, or 20V



Efficiency vs. Source Current

Source mode, 5-cell battery pack,
f_{SW} = 425kHz, V_{BATT} = 20V,
V_{IN_SRC} = 5V, 9V, 12V, 15V, or 20V



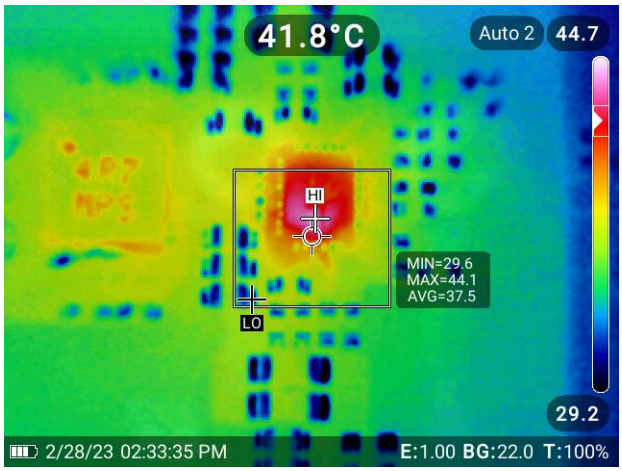
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EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. The default setting is for a 5-cell battery pack, I_{IN_LIM} = 3A, V_{BATT} = 18V, I_{CC} = 3A, T_A = 25°C, unless otherwise noted.

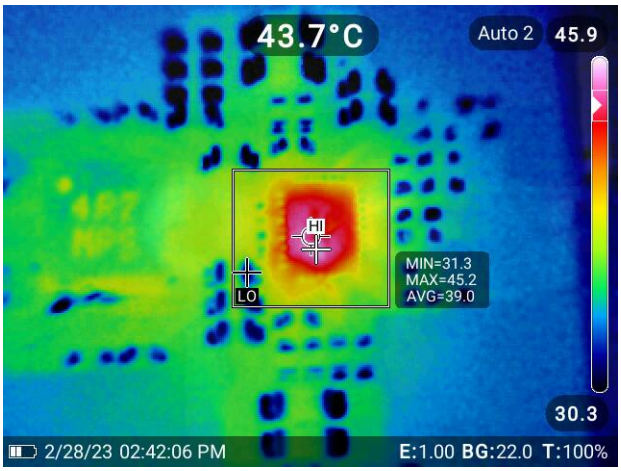
Thermal Performance

Charge mode, V_{IN} = 20V, V_{BATT} = 18V, I_{CC} = 3A, no forced airflow, T_{CASE} = 44.1°C



Thermal Performance

Source mode, V_{BATT} = 18V, V_{IN_SRC} = 20V, I_{IN_SRC} = 3A, no forced airflow, T_{CASE} = 45.2°C



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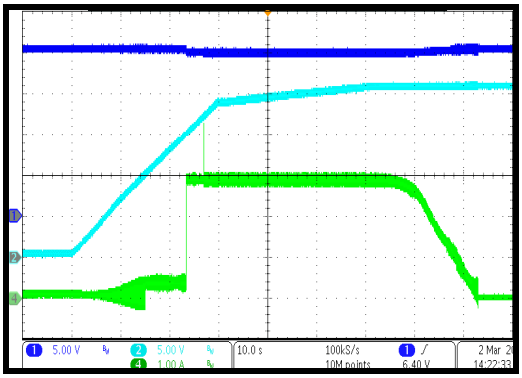
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. The default setting is for a 5-cell battery pack, I_{IN_LIM} = 3.5A, V_{BATT} = 18V, I_{CC} = 3A, T_A = 25°C, unless otherwise noted.

Charge Profile

V_{IN} = 20V, V_{BATT_REG} = 21V

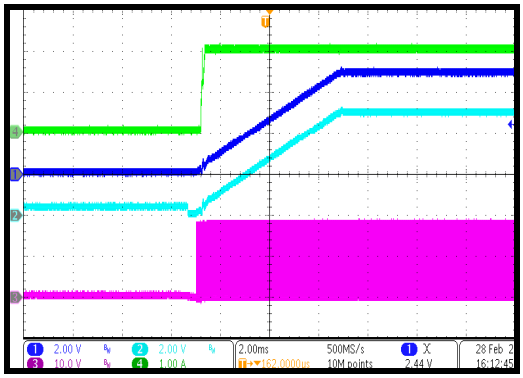
CH1: V_{IN} 5V/div.
CH2: V_{BATT} 5V/div.
CH4: I_{CHG} 1A/div.



Source Mode Enabled

V_{IN_SRC} = 5V, I_{IN_SRC} = 2A (CC load)

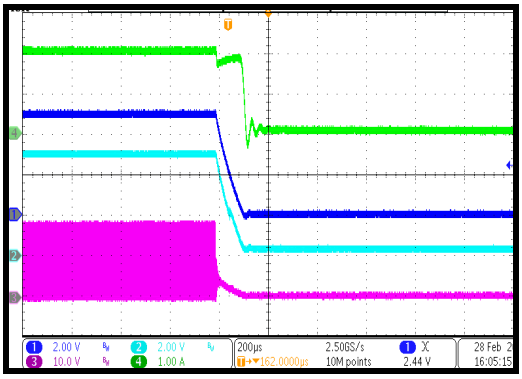
CH4: I_{OUT_SRC} 1A/div.
CH1: V_{OUT_SRC} 2V/div.
CH2: V_{SW1} 2V/div.
CH3: V_{SW2} 10V/div.



Source Mode Disabled

V_{IN_SRC} = 5V, I_{IN_SRC} = 2A (CC load)

CH4: I_{OUT_SRC} 1A/div.
CH1: V_{OUT_SRC} 2V/div.
CH2: V_{SW1} 2V/div.
CH3: V_{SW2} 10V/div.



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PCB LAYOUT

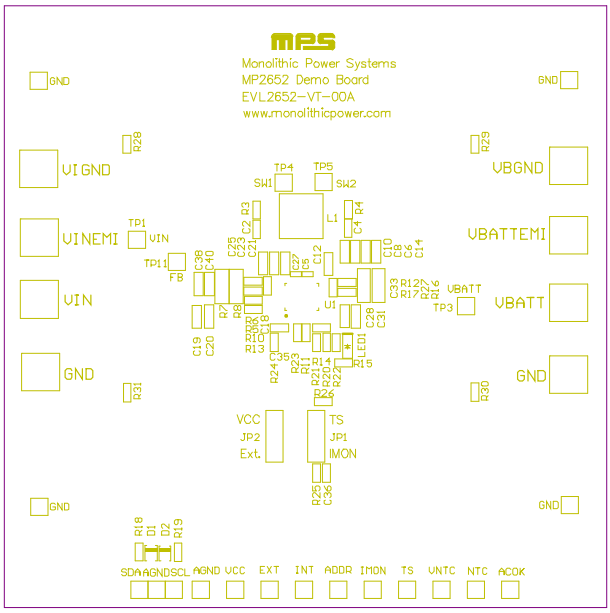


Figure 25: Top Silk

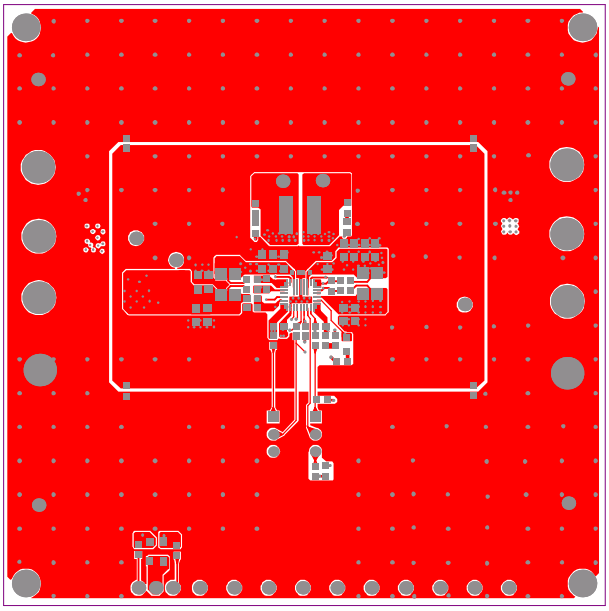


Figure 26: Top Layer

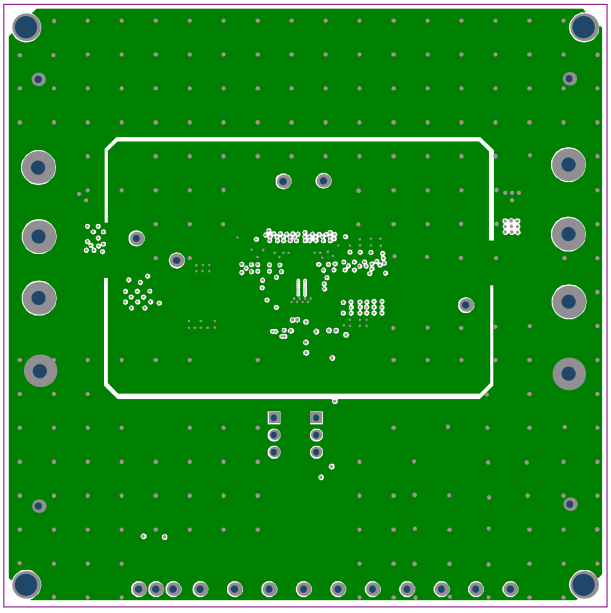


Figure 27: Mid-Layer 1

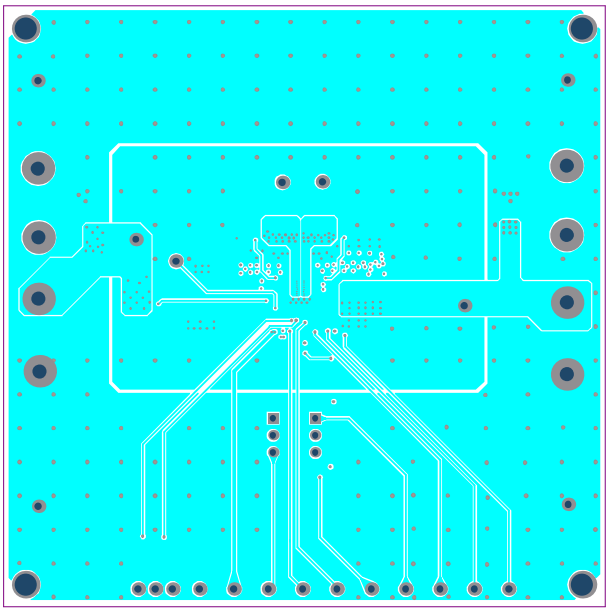


Figure 28: Mid-Layer 2

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PCB LAYOUT *(continued)*

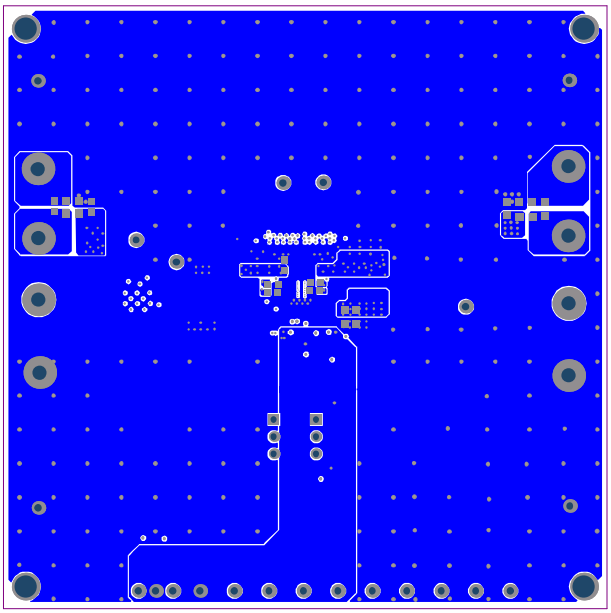


Figure 29: Bottom Layer

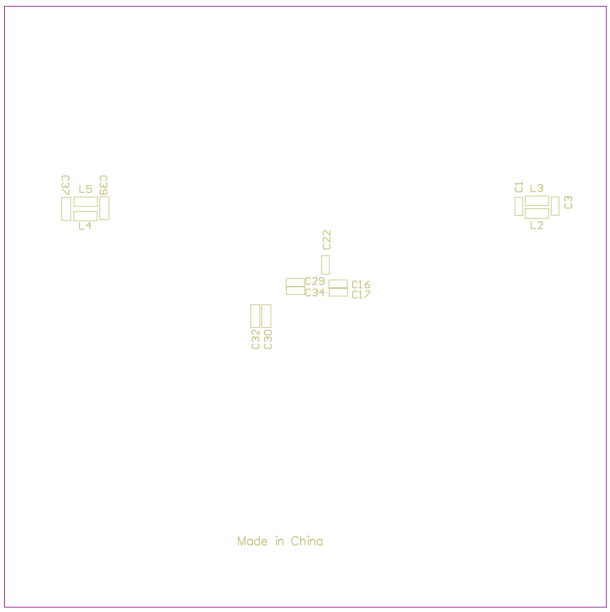


Figure 30: Bottom Silk

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REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	7/11/2025	Initial Release	-

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