



# EV2624-L-01A

## I<sup>2</sup>C Controlled 4.5A Single Cell USB / Adaptor Charger with Narrow VDC Power Path Management and USB OTG

### DESCRIPTION

The MP2624 is a 4.5A, highly integrated, switching-mode battery charger IC for single-cell Li-ion or Li-polymer batteries. This device supports NVDC architecture with power path management suitable for different portable applications, such as tablets, MID, and smart phones. Its low impedance power path optimizes efficiency, reduces battery charging time, and extends battery life. The I<sup>2</sup>C serial interface with charging and system settings allows the device to be controlled flexibly.

The MP2624 supports a wide range of input sources, including standard USB host ports and higher power wall adapters. The MP2624 detects the input source type according to the USB Battery Charging Spec 1.2 (BC1.2) and then informs the host to set the proper input current limit. Also, this device is compliant with USB2.0 and USB3.0 power specifications by adopting a proper input current and voltage regulation scheme. In addition, the MP2624 supports USB On-The-Go operation by supplying 5V with current up to 2.0A.

The power path management regulates the system voltage slightly above the set maximum voltage between the battery voltage and the I<sup>2</sup>C programmable lowest voltage level (e.g. 3.6V). With this feature, the system is able to operate even when the battery is depleted completely or removed. When the input source current or voltage limit is reached, the power path management reduces automatically the charge current to meet the priority of the system power requirement. If the system current continues increasing, even when the charge current is reduced to zero, the supplement mode allows the battery to power both the system together with the input power supply at the same time.

### FEATURES

- High Efficiency 4.5A 1.7MHz Buck Charger and 1.7MHz 2.0A Boost Mode to Support OTG
  - 94% Efficiency @ 2A, 92% @ 4A
  - Fast Charge Time by Battery Path Impedance Compensation
  - USB OTG
  - 94% Efficiency @ 5V, 1.2A OTG
  - Selectable OTG Current Outputs
- 3.9V to 7.0V Operating Input Voltage Range
- Highest Battery Discharge Efficiency with 10mΩ Battery Discharge MOSFET up to 9A
- Single Input USB Compliant Charge
- Narrow System Bus Voltage Power Path Management
  - Instant On Works with No Battery or Deeply Discharged Battery
  - Ideal Diode Operation in Battery Supplemental Mode
- Constant-Off-Time Control to Reduce Charging Time under Low Input Voltages
- High Accuracy of Charging Parameter
- I<sup>2</sup>C Port for Flexible System Parameter Setting and Status Reporting
- Full DISC Control to Support Shipping Mode
- High Integration
  - Fully Integrated Power Switches and No External Blocking Diode and Sense Resistor Required
  - Built-In Robust Charging Protection including Battery Temperature Monitor and Programmable Timer
  - Built-In Battery Disconnection Function
- High Accuracy
  - ±0.5% Charge Voltage Regulation
  - ±5% Charge Current Regulation
  - ±5% Input Current Regulation
  - ±2% Output Regulation in Boost Mode
- Safety
  - Battery Temperature Sensing for Charge Mode
  - Battery Charging Safety Timer

## ELECTRICAL SPECIFICATION

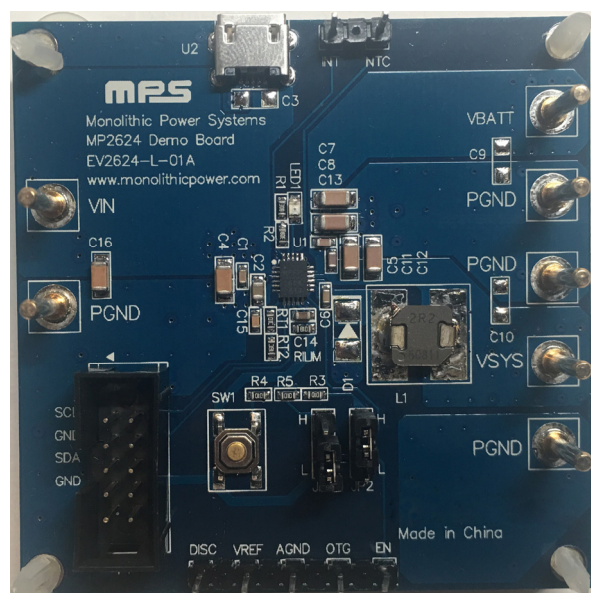
| Parameter                | Symbol           | Value                    | Units |
|--------------------------|------------------|--------------------------|-------|
| Input Voltage            | $V_{IN}$         | 3.9 – 7.0                | V     |
| Charge Full Voltage      | $V_{BATT\_FULL}$ | 4.2 / I <sup>2</sup> C   | V     |
| Charge Current           | $I_{CHG}$        | 1.024 / I <sup>2</sup> C | A     |
| Input Voltage Regulation | $V_{IN\_REG}$    | 4.36 / I <sup>2</sup> C  | V     |
| Input Current Limit      | $I_{IN\_LMT}$    | 1.8 / I <sup>2</sup> C   | A     |
| OTG Voltage Regulation   | $V_{IN\_OTG}$    | 5.1 / I <sup>2</sup> C   | V     |
| OTG Current Limit        | $I_{OLIM}$       | 1.3 / I <sup>2</sup> C   | A     |

## APPLICATIONS

- Tablet PCs
- Smart Phones
- Mobile Internet Devices

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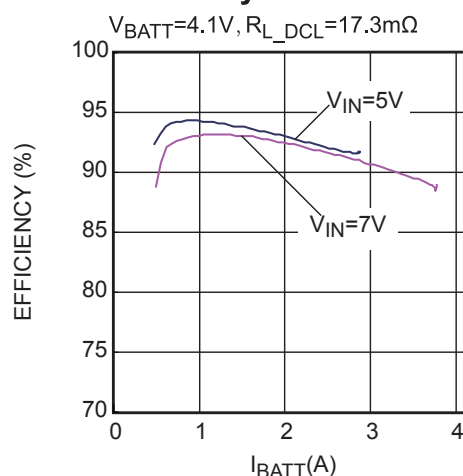
## EV2624-L-01A EVALUATION BOARD



(L x W x H) 6.3cm x 6.3cm x 1.3cm

| Board Number | MPS IC Number |
|--------------|---------------|
| EV2624-L-01A | MP2624GL      |

### Efficiency



## QUICK START GUIDE

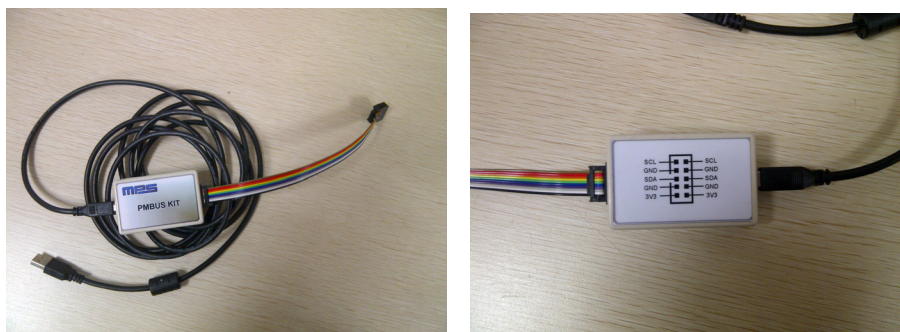
Table 1. Jumper Connections

| Jack | Description                                   | Factory Setting |
|------|-----------------------------------------------|-----------------|
| JP2  | OTG pin setting: pull low to enable the OTG   | Pull high       |
| JP1  | EN pin setting: pull low to enable the charge | Pull Low        |
| P1   | I <sup>2</sup> C connector                    |                 |

This board is designed for MP2624 used as a standalone switching charger with integrated USB detection and USB-OTG function, and layout accommodates most commonly used capacitors. The default function of this board is preset for charger mode and the charge full voltage is preset to 4.2V for 1 cell Li-Ion battery.

Evaluation Platform Preparation:

### 1) USB-to-GPIO Communication Kit

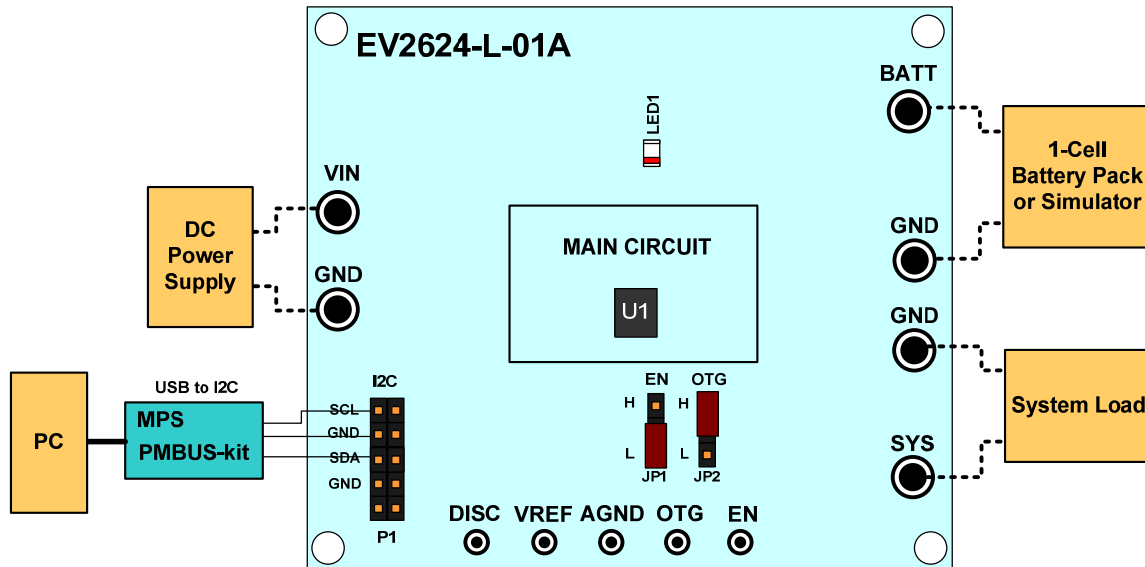


2) Software - double-click on the MP2624.EXE file and open the software. The software supports the Windows® XP operating systems.



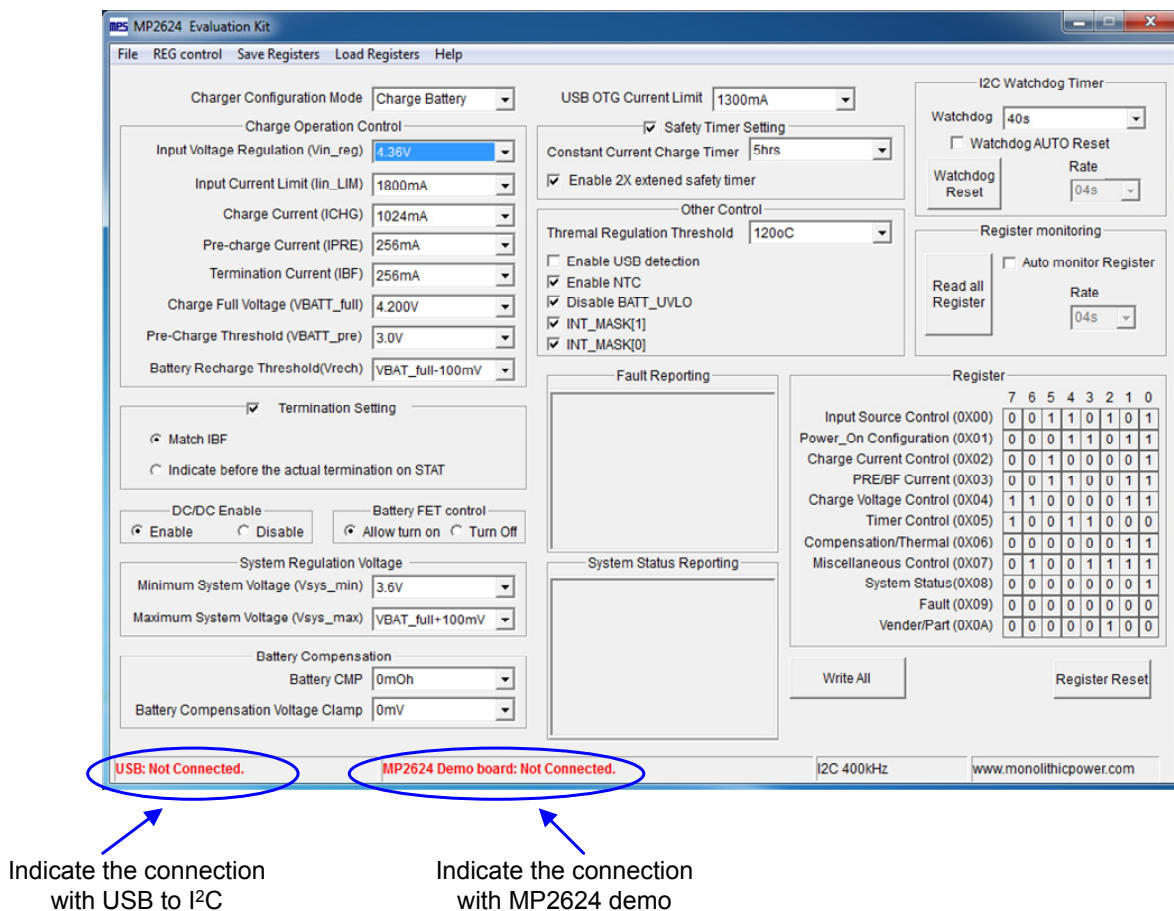
3) A computer with at least one USB port and a USB cable. The MP2624 evaluation software must be properly installed.

4) Original Test Setup for MP2624 in Figure1



**Figure 1: Test Setup for MP2624**

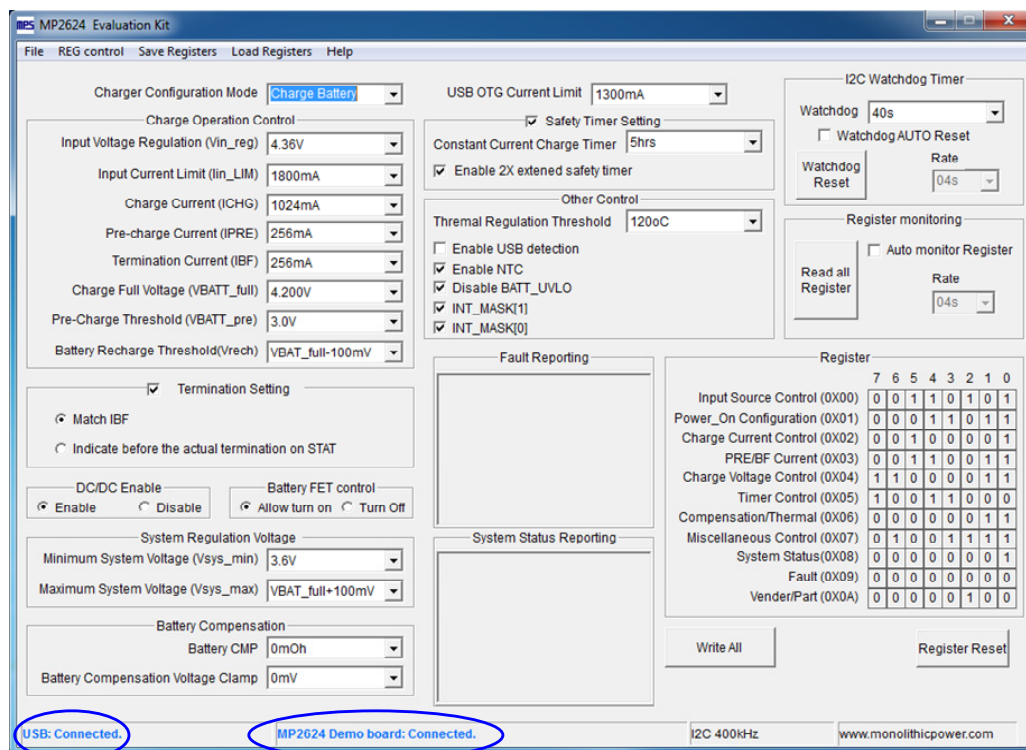
5) Turn on the computer. Launch the MP2624 evaluation software. The main window of the software is shown in Figure 2.



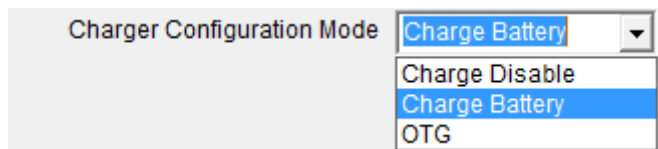
**Figure 2: MP2624 evaluation software**

## Procedure

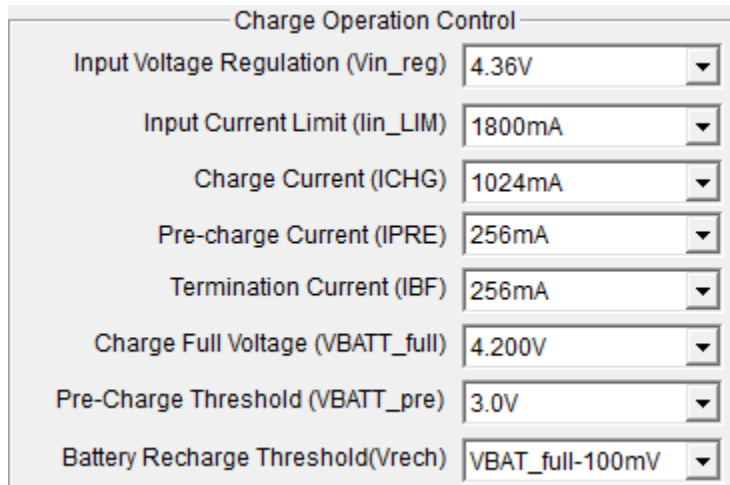
Make sure all the connections are normal -- the EVPMBUS connected and MP2624 DEMO board connected. It is ready to run the program!



### 1) Select the operation mode of MP2624:



### 2) Charger Function



1. Set Input Voltage Regulation at 4.60 V (the range is 3.88 - 5.08V)

|                                    |       |
|------------------------------------|-------|
| Input Voltage Regulation (Vin_reg) | 4.60V |
|                                    | 4.44V |
|                                    | 4.52V |
|                                    | 4.60V |
|                                    | 4.68V |
|                                    | 4.76V |
|                                    | 4.84V |
|                                    | 4.92V |

2. Set Input Current Limit to 1800 mA (the range is 100 – 3000mA)

|                               |        |
|-------------------------------|--------|
| Input Current Limit (lin_LIM) | 1800mA |
|                               | 150mA  |
|                               | 500mA  |
|                               | 900mA  |
|                               | 1200mA |
|                               | 1800mA |
|                               | 2000mA |
|                               | 3000mA |

The input current limit can be set to be a little bit lower than the max current rating of the input source. When input current hits the limit the charge current will be decreased to keep the input current constant at this limit, in order to power the system firstly.

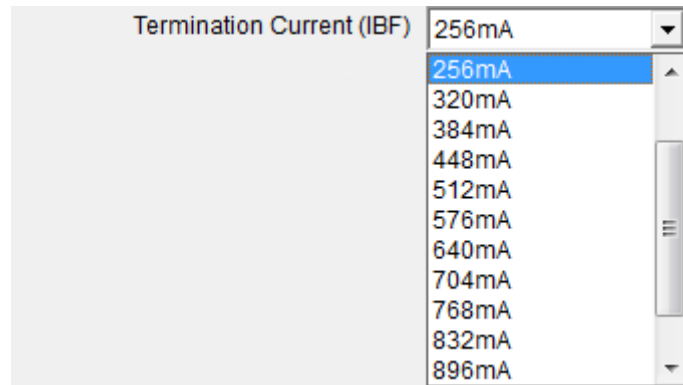
3. Set Constant Charge Current, ICHG to 3008mA (the range is 512 – 4544mA)

|                       |        |
|-----------------------|--------|
| Charge Current (ICHG) | 3008mA |
|                       | 2816mA |
|                       | 2880mA |
|                       | 2944mA |
|                       | 3008mA |
|                       | 3072mA |
|                       | 3136mA |
|                       | 3200mA |
|                       | 3264mA |
|                       | 3328mA |
|                       | 3392mA |
|                       | 3456mA |

4. Set Pre -Charge Current to 256 mA (the range is 64 – 1024mA)

|                           |       |
|---------------------------|-------|
| Pre-charge Current (IPRE) | 256mA |
|                           | 256mA |
|                           | 320mA |
|                           | 384mA |
|                           | 448mA |
|                           | 512mA |
|                           | 576mA |
|                           | 640mA |
|                           | 704mA |
|                           | 768mA |
|                           | 832mA |
|                           | 896mA |

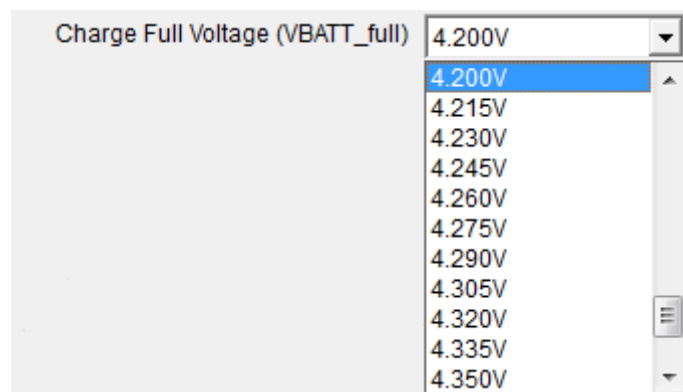
5. Set Terminal Charge Current to 256 mA (the range is 64 – 1024mA)



Termination Current (IBF) 256mA

- 256mA
- 320mA
- 384mA
- 448mA
- 512mA
- 576mA
- 640mA
- 704mA
- 768mA
- 832mA
- 896mA

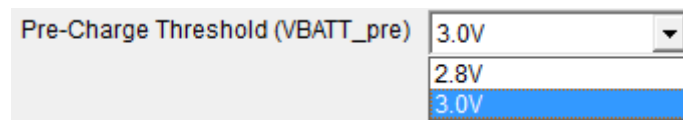
6. Set Charge Full Voltage to 4.200 V (the range is 3.480 - 4.425V)



Charge Full Voltage (VBATT\_full) 4.200V

- 4.200V
- 4.215V
- 4.230V
- 4.245V
- 4.260V
- 4.275V
- 4.290V
- 4.305V
- 4.320V
- 4.335V
- 4.350V

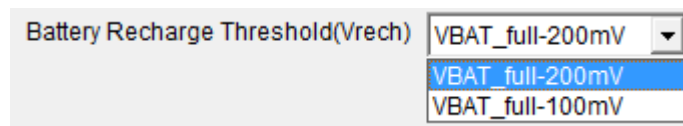
7. Set Pre- Charge to CC Charge Threshold Voltage to 3.0 V (the range is 2.8 – 3.0V)



Pre-Charge Threshold (VBATT\_pre) 3.0V

- 2.8V
- 3.0V

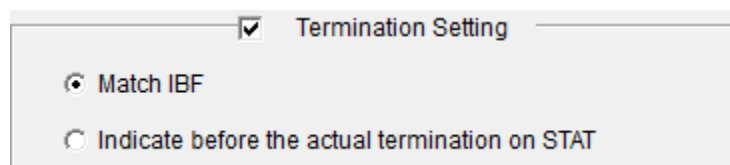
8. Set Battery auto recharge Voltage to VBATT\_Full – 200mV (the range is 100mV or 200mV)



Battery Recharge Threshold(Vrech) VBAT\_full-200mV

- VBAT\_full-200mV
- VBAT\_full-100mV

9. Deselect Enable Termination

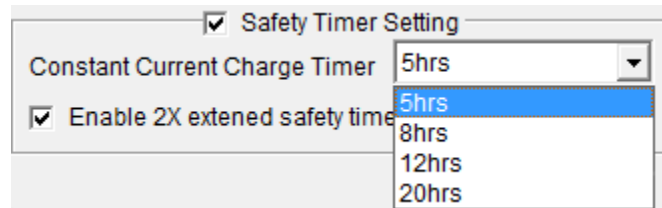


☒ Termination Setting

☒ Match IBF

☐ Indicate before the actual termination on STAT

10. Set Charge Timer to 5hrs (the range is 5 – 20hrs)

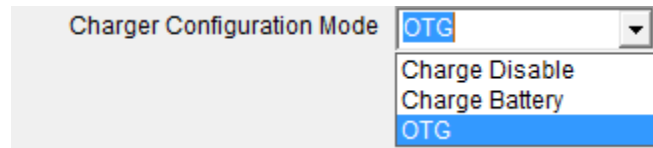


The integrated charge timer provides a back-up protection to prevent a damaged battery from being charged after a certain time. The MP2624 can disable the timer function by deselecting.

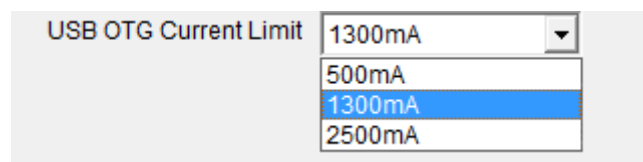
### 3) Boost Function

When the MP2624 is programmed to OTG mode, the output current limit can be controlled via I<sup>2</sup>C.

1. Turn off and disconnect power at VIN to PGND
2. If the constant voltage load connected from BATT+ to GND is not a four-quadrant supply (sources current) remove the load and use the power source disconnected in step one, set to 3.7 V and 2 A current limit and connect between BATT+ and PGND
3. Apply Resistor (5 W or greater, R=3 to 10ohm) across VIN(+) to PGND(–)
4. Select OTG in the Configuration drop-down window

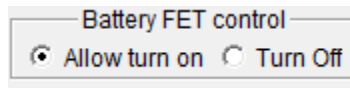


5. Verify the voltage on VIN to GND is between 4.9 V and 5.3 V
6. The OTG current setting is unlocked after choosing the OTG mode. The default OTG current is 1300mA.



## Others

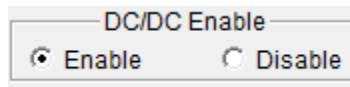
1. Charge Battery Control:



Battery FET control

☒ Allow turn on ☐ Turn Off

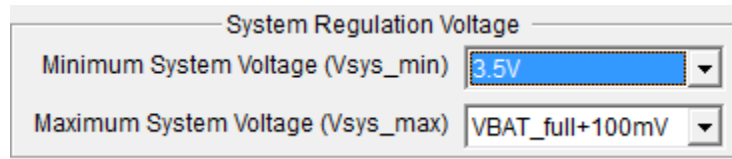
2. DC/DC Enable Control:



DC/DC Enable

☒ Enable ☐ Disable

3. Adjust System Voltage in the charge mode

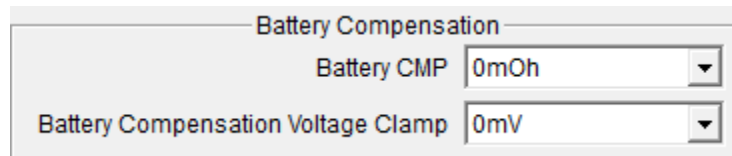


System Regulation Voltage

Minimum System Voltage (Vsys\_min) 3.5V

Maximum System Voltage (Vsys\_max) VBAT\_full+100mV

4. Battery Voltage Compensation in charge mode:

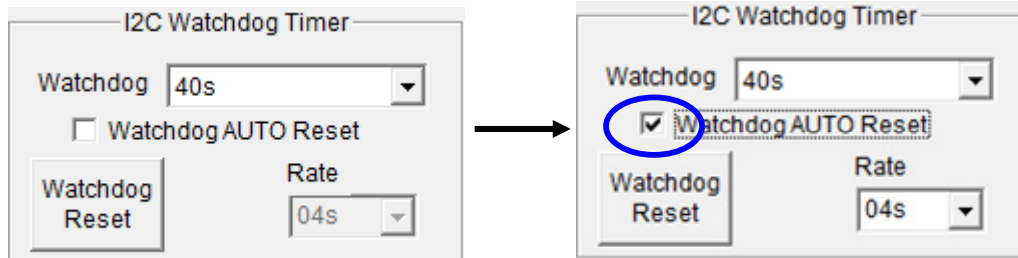


Battery Compensation

Battery CMP 0mOh

Battery Compensation Voltage Clamp 0mV

5. Select I<sup>2</sup>C Watchdog Timer Limit: click “Watchdog AUTO Reset” to run the program automatically.



I2C Watchdog Timer

Watchdog 40s

☐ Watchdog AUTO Reset

Watchdog Reset Rate 04s

→

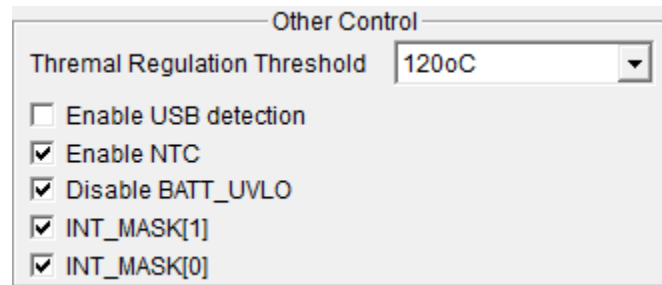
I2C Watchdog Timer

Watchdog 40s

☒ Watchdog AUTO Reset

Watchdog Reset Rate 04s

6. Other Control: include the thermal regulation threshold, USB detection, NTC monitor, UVLO control, indication setting.



Other Control

Thermal Regulation Threshold 120oC

☐ Enable USB detection

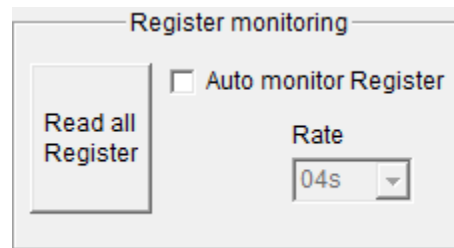
☒ Enable NTC

☒ Disable BATT\_UVLO

☒ INT\_MASK[1]

☒ INT\_MASK[0]

## 7. Resistor Auto Monitor



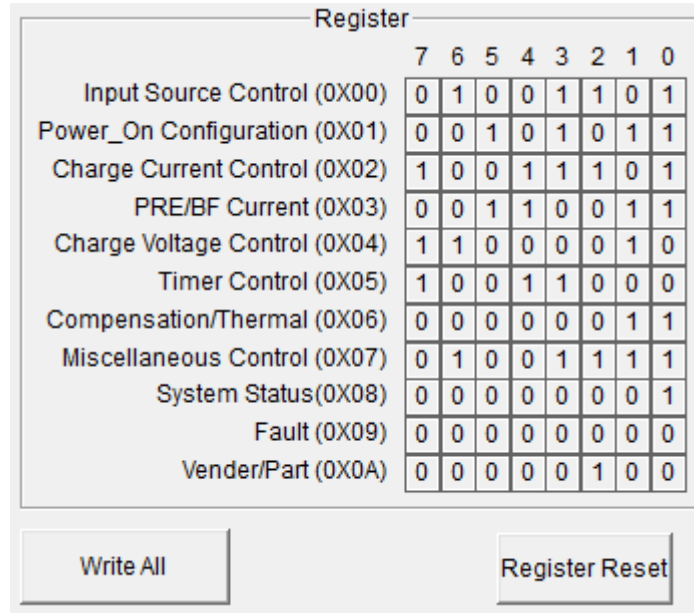
Register monitoring

☐ Auto monitor Register

Read all Register

Rate  
04s

## 8. Content of the Registers:



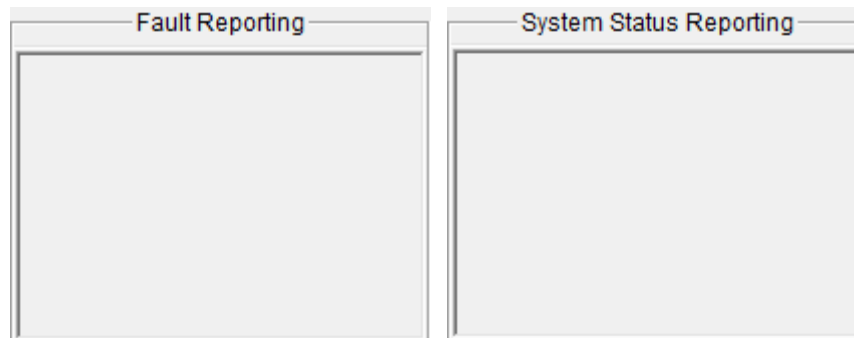
Register

|                               | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------------------------|---|---|---|---|---|---|---|---|
| Input Source Control (0X00)   | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 |
| Power_On Configuration (0X01) | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| Charge Current Control (0X02) | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |
| PRE/BF Current (0X03)         | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| Charge Voltage Control (0X04) | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| Timer Control (0X05)          | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| Compensation/Thermal (0X06)   | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Miscellaneous Control (0X07)  | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| System Status(0X08)           | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Fault (0X09)                  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Vender/Part (0X0A)            | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

Write All

Register Reset

## 9. Monitor the MP2624 operation status and Fault report



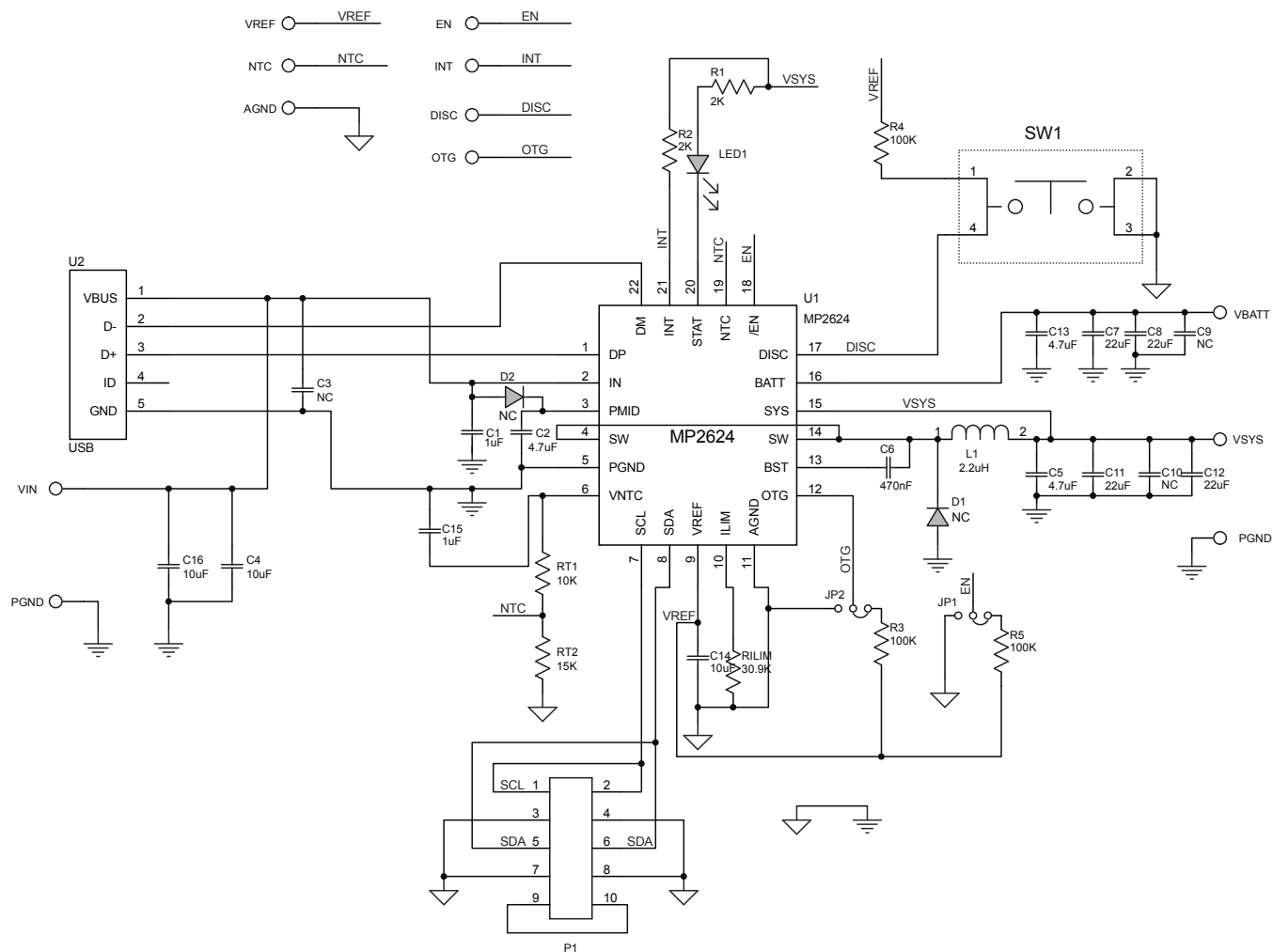
Fault Reporting

System Status Reporting

### ❖Notes❖

- For the other detailed description on the operation of this part, please contact local FAE to apply the latest datasheet.

# EVALUATION BOARD SCHEMATIC



## EV2624-L-01A BILL OF MATERIALS

| Qty | Ref                               | Value         | Description                     | Package | Manufacture | Manufacture_PN     |
|-----|-----------------------------------|---------------|---------------------------------|---------|-------------|--------------------|
| 1   | C1                                | 1 $\mu$ F     | Ceramic Capacitor;25V;X7R;0603; | 0603    | muRata      | GRM188R71E105KA12D |
| 1   | C2                                | 4.7 $\mu$ F   | Ceramic Capacitor;25V;X5R;0805; | 0805    | muRata      | GRM21BR61E475KA12L |
| 1   | C3                                | NC            | Ceramic Capacitor;25V;X5R;1206; | 1206    | muRata      | GRM31CR61E106KA12L |
| 2   | C4,C16                            | 10 $\mu$ F    | Ceramic Capacitor;25V;X5R;1206; | 1206    | muRata      | GRM31CR61E106KA12L |
| 2   | C5,C13                            | 4.7 $\mu$ F   | Ceramic Capacitor;16V;X7R;0805  | 0805    | muRata      | GRM21BR71C475KA73L |
| 1   | C6                                | 470nF         | Ceramic Capacitor;25V;X5R;0603; | 0603    | muRata      | GRM188R61E474KA12D |
| 4   | C7, C8, C11, C12                  | 22 $\mu$ F    | Ceramic Capacitor;10V;X7R;1206  | 1206    | muRata      | GRM31CR71A226KE15L |
| 2   | C9, C10                           | NC            | Ceramic Capacitor;16V;X5R;0805; | 0805    | muRata      | GRM21BR61C475KA88  |
| 1   | C14                               | 10 $\mu$ F    | Ceramic Capacitor;16V;X5R;0603  | 0603    | muRata      | GRM188R61C106KAALD |
| 1   | C15                               | 1 $\mu$ F     | Ceramic Capacitor;16V;X7R;0603; | 0603    | muRata      | GRM188R71C105KA12D |
| 2   | D1,D2                             | NC            | Diode;50V;3A;                   | SMA     | HQ          | B350A-13-F         |
| 1   | L1                                | 2.2 $\mu$ H   | Inductor;2.2uH;17.3m;8.2A       | SMD     | TDK         | SPM6530T-2R2M      |
| 1   | LED1                              | BL-HUF35A-TRB | LED;Red                         | 0805    | BRIGHT LED  | BL-HUF35A-TRB      |
| 2   | R1, R2                            | 2k $\Omega$   | Film Resistor;1%;               | 0603    | Yageo       | RC0603FR-072KL     |
| 3   | R3, R4, R5                        | 100k $\Omega$ | Film Resistor;5%;               | 0603    | Yageo       | RC0603JR-07100KL   |
| 1   | RILIM                             | 1k $\Omega$   | Film Resistor;1%                | 0603    | Yageo       | RC0603FR-071KL     |
| 1   | RT1                               | 10k $\Omega$  | Film Resistor;1%                | 0603    | Yageo       | RC0603FR-0710KL    |
| 1   | RT2                               | 15k $\Omega$  | Film Resistor;1%;               | 0603    | Yageo       | RC0603FR-0715KL    |
| 1   | SW1                               |               | Button;SM 4x10mm;1.5mm Height   |         |             |                    |
| 2   | JP1, JP2,                         |               | 2.54mm Connector;               |         |             |                    |
| 2   | JP1, JP2,                         |               | 2.54mm Connector;shorter        |         |             |                    |
| 1   | P1                                |               | Header, 5-Pin, Dual row         |         |             |                    |
| 7   | DISC,V REF,AG ND,OT G,EN,IN T,NTC |               | 2.54mm Connector;               |         |             |                    |

# EV2624-L-01A BILL OF MATERIALS (continued)

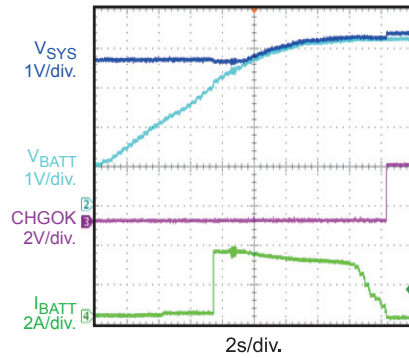
| Qty | Ref                                               | Value | Description               | Package  | Manufacture | Manufacture_PN |
|-----|---------------------------------------------------|-------|---------------------------|----------|-------------|----------------|
| 6   | VIN,<br>PGND,V<br>BATT,P<br>GND,P<br>GND,VS<br>YS |       | 2mm                       |          |             |                |
| 1   | U1                                                |       | IC;                       | FCQFN3*4 | MPS         | MP2624GL       |
| 1   | U2                                                |       | Micro-B USB<br>connector; |          |             |                |

# EVB TEST RESULTS

$V_{IN} = 5.0V$ ,  $V_{BATT} = \text{full range}$ ,  $I^2C$  controlled,  $I_{CHG} = 4.5A$ ,  $I_{IN\_LMT} = 3.0A$ ,  $V_{IN\_REG} = 4.36V$ ,  $L1 = 2.2\mu H$ ,  $T_A = 25^\circ C$ , unless otherwise noted.

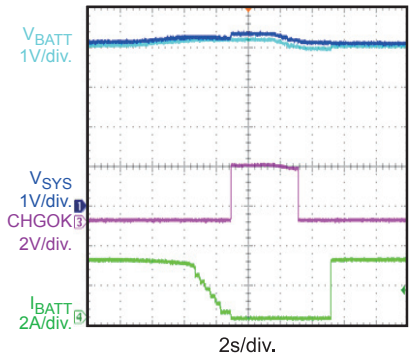
## Battery Charge Curve

$V_{IN}=5V$ ,  $I_{SYS}=0A$



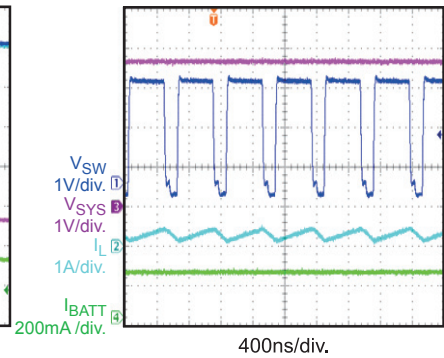
## Auto Recharge

$V_{IN}=5V$ ,  $I_{SYS}=0A$



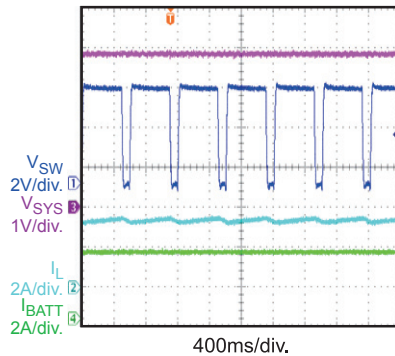
## Trickle Charge Steady State

$V_{IN}=5V$ ,  $V_{BATT}=2.8V$



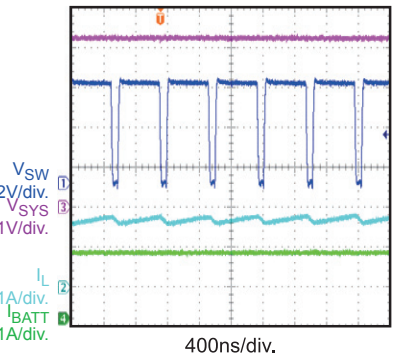
## Constant Current Charge Steady State

$V_{IN}=5V$ ,  $V_{BATT}=3.6V$



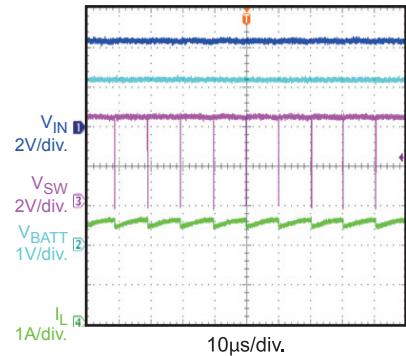
## Constant Voltage Charge Steady State

$V_{IN}=5V$ ,  $V_{BATT}=4.2V$



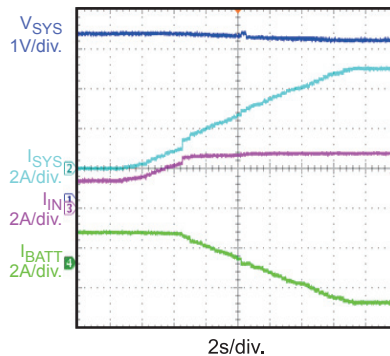
## COT Operation

$V_{IN}=4.5V$



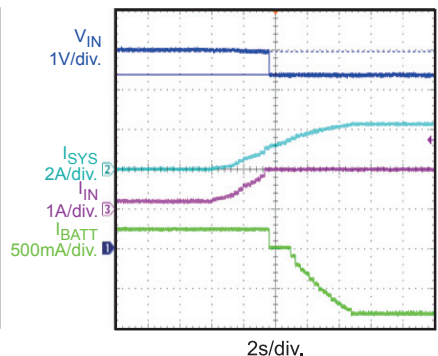
## Input Current Limit

$V_{IN}=5V$ ,  $V_{BATT}=4.2V$ ,  $I_{CHG}=3.5A$



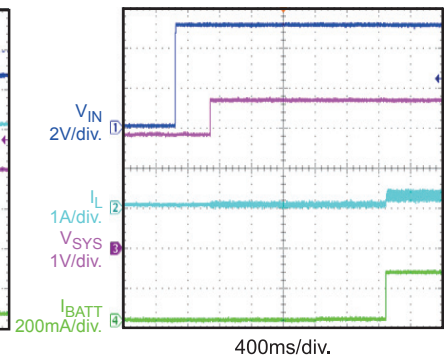
## Input Voltage Limit

$V_{IN}=5V/1.0A$ ,  $V_{BATT}=2.8V$ ,  $I_{CHG}=2A$



## Power On

$V_{IN}=5V$ ,  $V_{BATT}=3.7V$

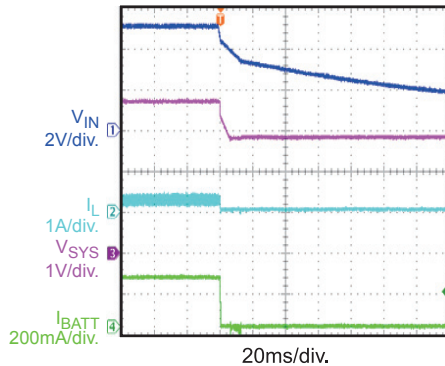


## EVB TEST RESULTS (continued)

$V_{IN} = 5.0V$ ,  $V_{BATT} = \text{full range}$ , I<sup>2</sup>C controlled,  $I_{CHG} = 4.5A$ ,  $I_{IN\_LMT} = 3.0A$ ,  $V_{IN\_REG} = 4.36V$ ,  $L1 = 2.2\mu H$ ,  $T_A = 25^\circ C$ , unless otherwise noted.

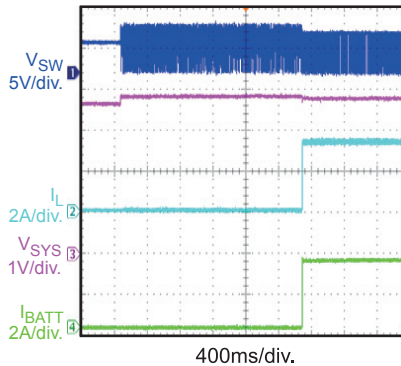
### Power Off

$V_{IN}=5V$ ,  $V_{BATT}=3.7V$



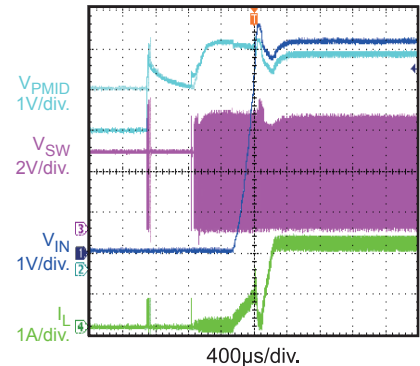
### EN On

$V_{IN}=5V$ ,  $V_{BATT}=3.7V$



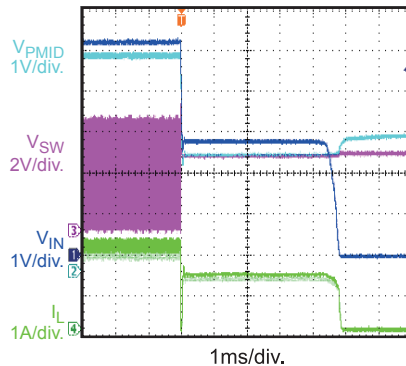
### OTG Mode Start-Up

$V_{IN\_OTG}=5V$ ,  $V_{BATT\_OTG}=3.6V$ ,  $I_{OTG}=1.3A$



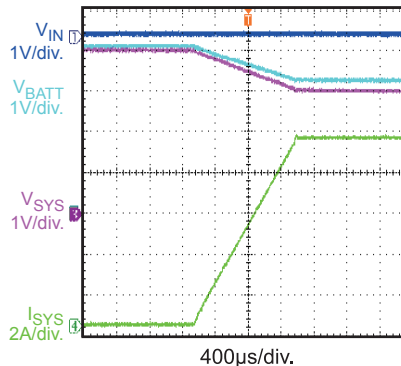
### OTG Mode Shutdown

$V_{IN\_OTG}=5V$ ,  $V_{BATT\_OTG}=3.6V$ ,  $I_{OTG}=1.3A$



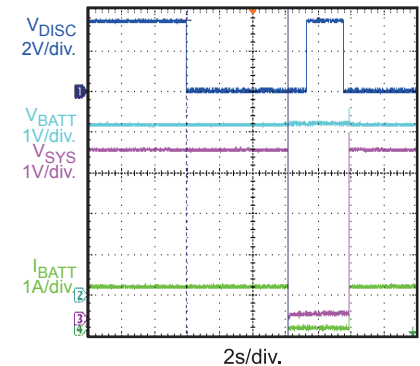
### Battery Discharge Current

$V_{IN}=\text{Float}$ ,  $I_{SYS}=9A$ ,  $V_{BATT}=4.0V$



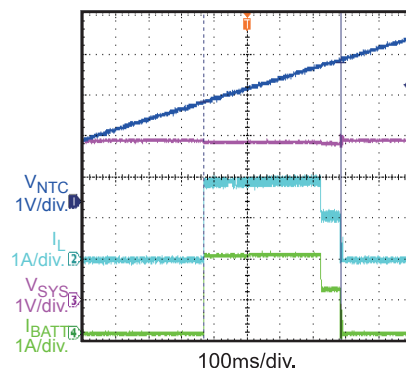
### DISC Function

$V_{IN}=\text{Float}$ ,  $I_{SYS}=1A$ ,  $V_{BATT}=4.2V$



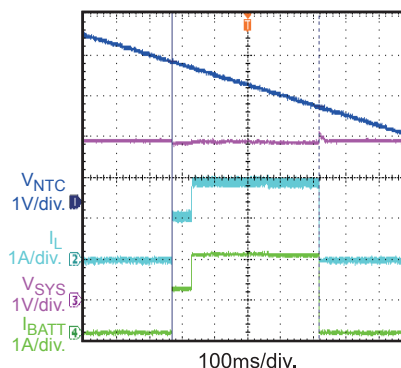
### NTC Function

$V_{IN}=5V$ ,  $V_{BATT}=3.8V$ ,  $I_{CHG}=2A$



### NTC Function

$V_{IN}=5V$ ,  $V_{BATT}=3.8V$ ,  $I_{CHG}=2A$



## PRINTED CIRCUIT BOARD LAYOUT

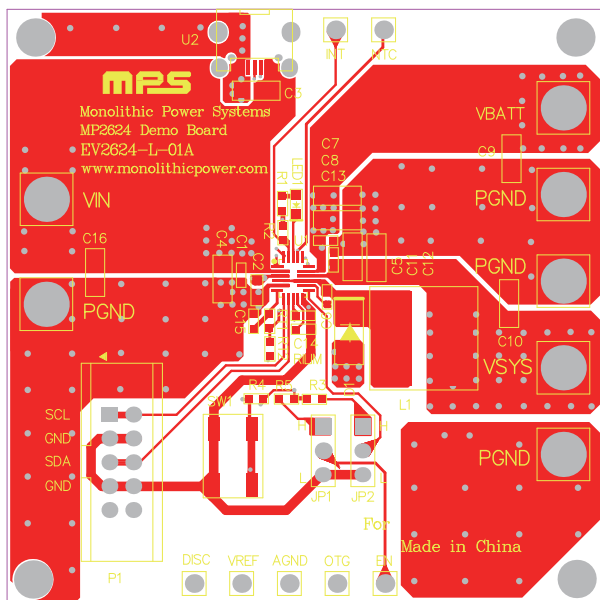


Figure 1: Top Layer

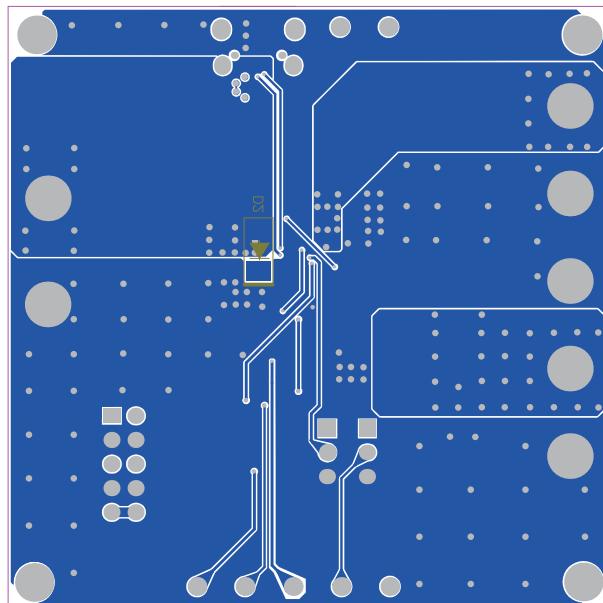


Figure 2: Bottom Layer

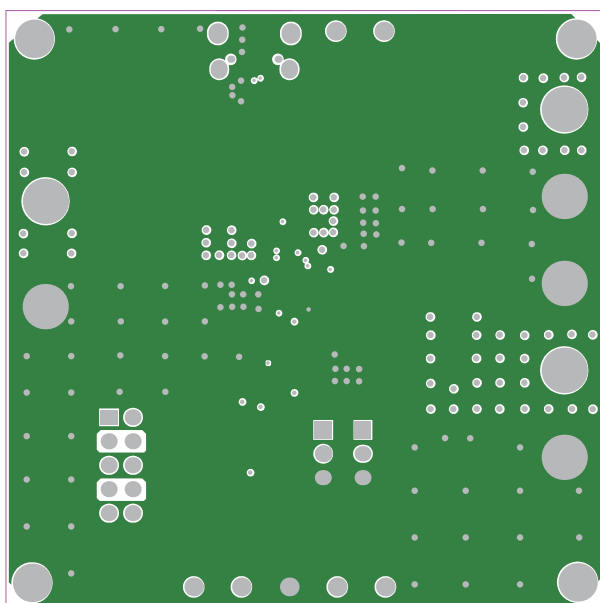


Figure 3: Middle Layer1

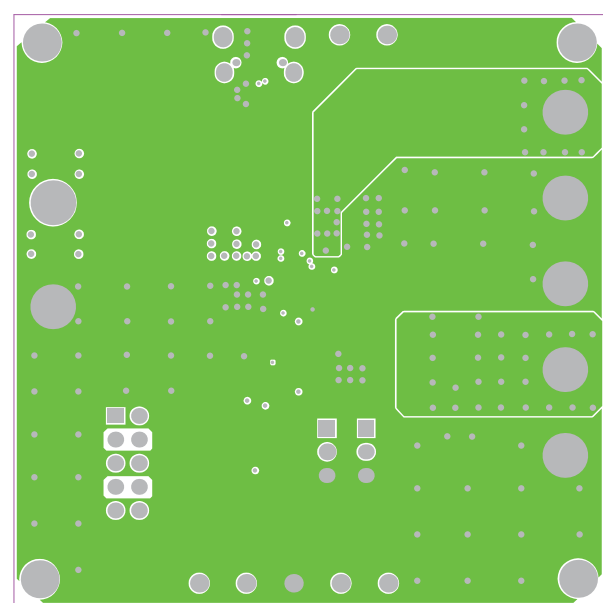


Figure 4: Middle Layer2

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