



EV2624-L-01A

I²C 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 I²C 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 I²C 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
- I²C 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

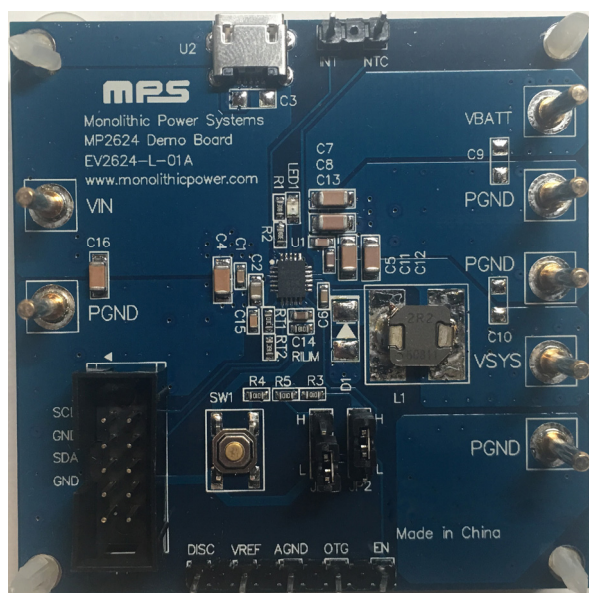
Parameter	Symbol	Value	Units
Input Voltage	V_{IN}	3.9 – 7.0	V
Charge Full Voltage	V_{BATT_FULL}	4.2 / I^2C	V
Charge Current	I_{CHG}	1.024 / I^2C	A
Input Voltage Regulation	V_{IN_REG}	4.36 / I^2C	V
Input Current Limit	I_{IN_LMT}	1.8 / I^2C	A
OTG Voltage Regulation	V_{IN_OTG}	5.1 / I^2C	V
OTG Current Limit	I_{OLIM}	1.3 / I^2C	A

APPLICATIONS

- Tablet PCs
- Smart Phones
- Mobile Internet Devices

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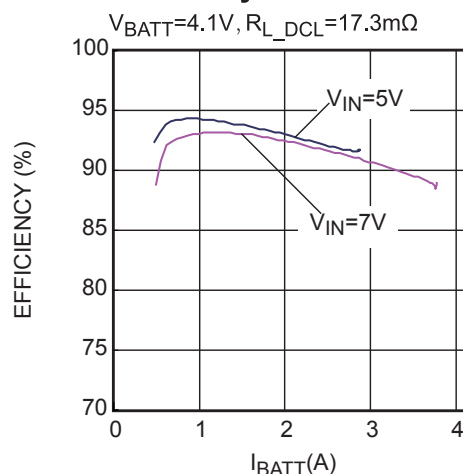
EV2624-L-01A EVALUATION BOARD



(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 ² 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

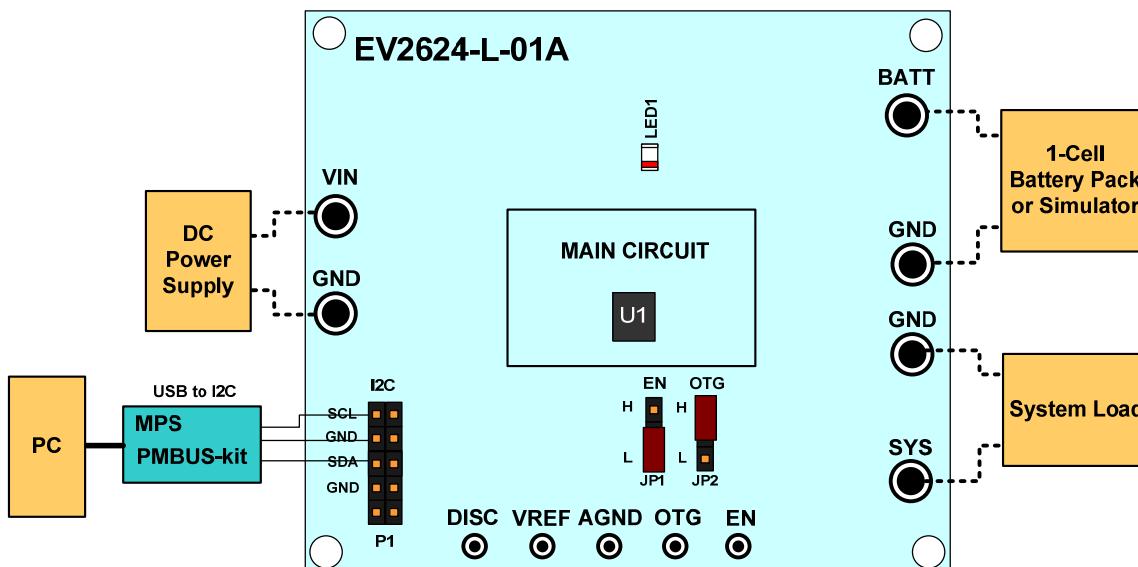


Figure 1: Test Setup for MP2624

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

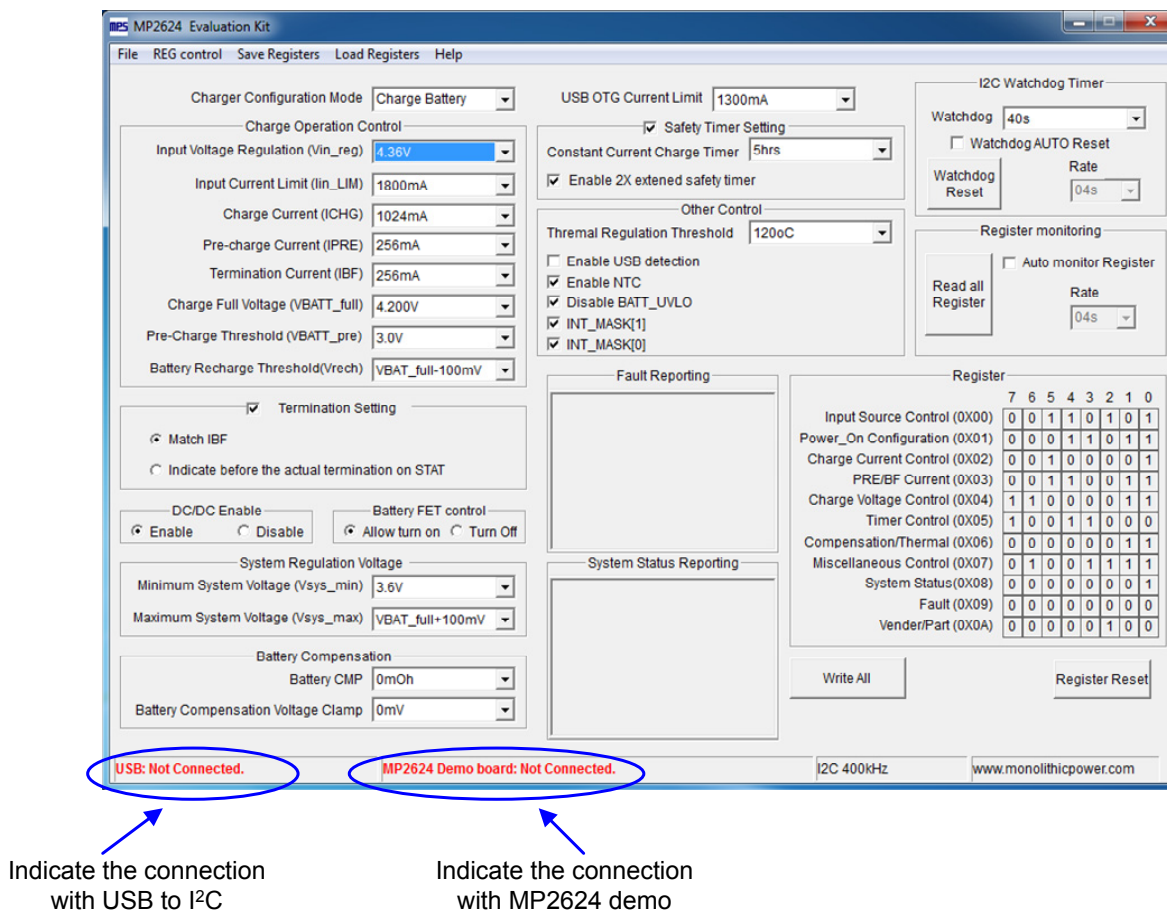
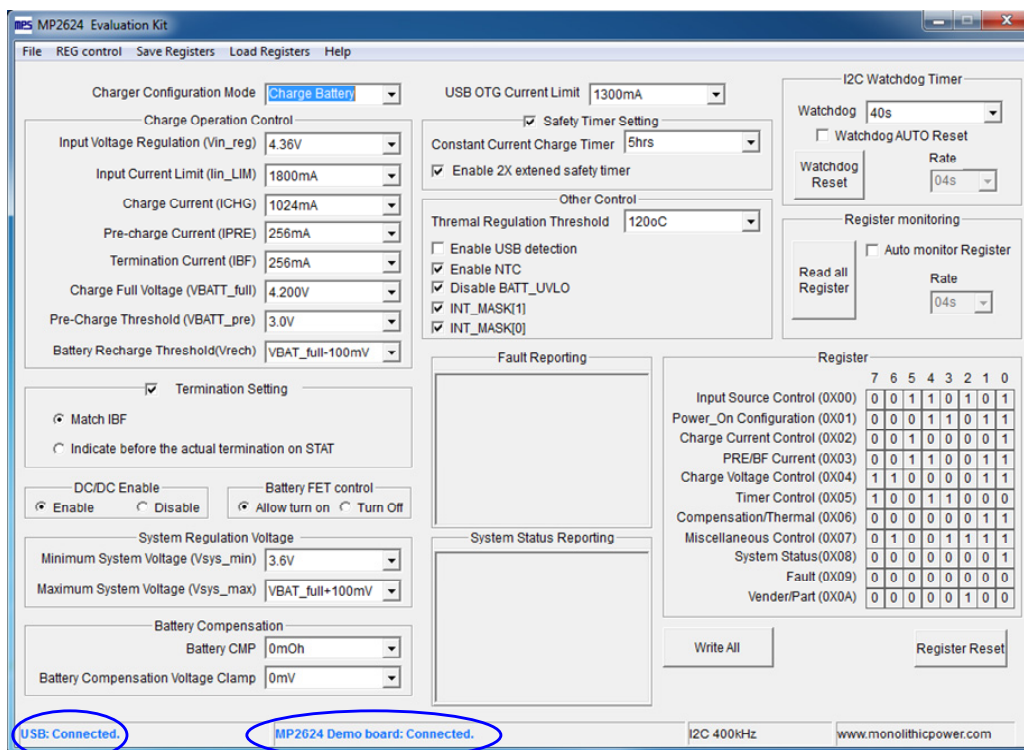


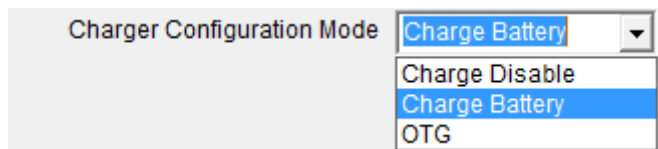
Figure 2: MP2624 evaluation software

Procedure

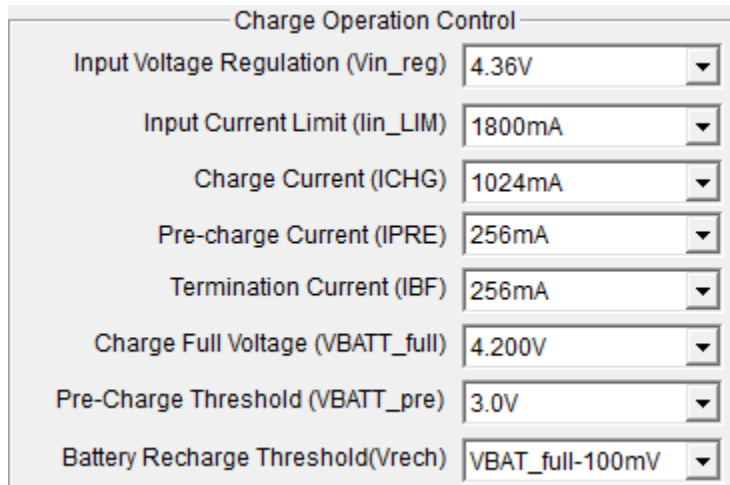
Make sure all the connections are normal -- the EVPMBUS connected and MP2624 DEMO board connected. It is ready to run the program!



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.

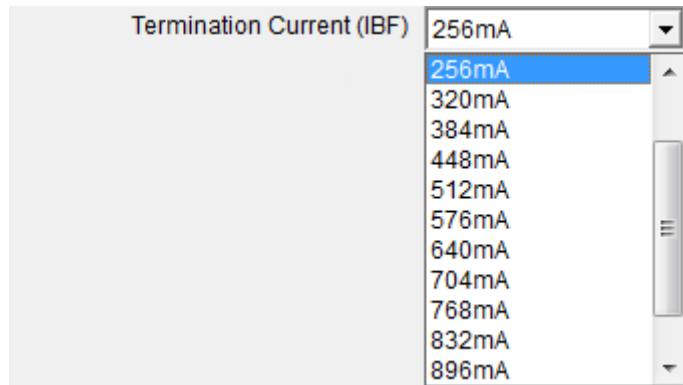
3. Set Constant Charge Current, ICHG to 3008mA (the range is 512 – 4544mA)

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

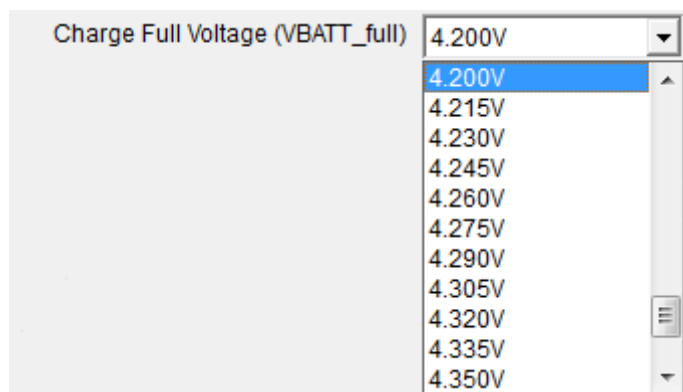
5. Set Terminal Charge Current to 256 mA (the range is 64 – 1024mA)



Termination Current (IBF)

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

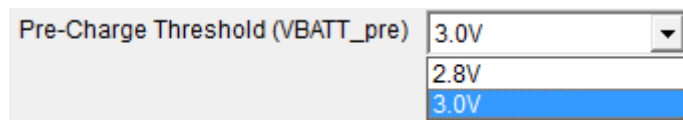
6. Set Charge Full Voltage to 4.200 V (the range is 3.480 - 4.425V)



Charge Full Voltage (VBATT_full)

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

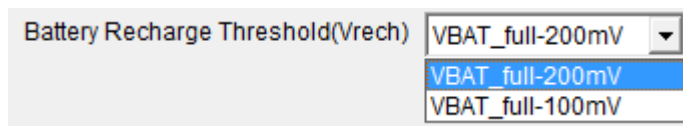
7. Set Pre- Charge to CC Charge Threshold Voltage to 3.0 V (the range is 2.8 – 3.0V)



Pre-Charge Threshold (VBATT_pre)

- 3.0V
- 2.8V
- 3.0V

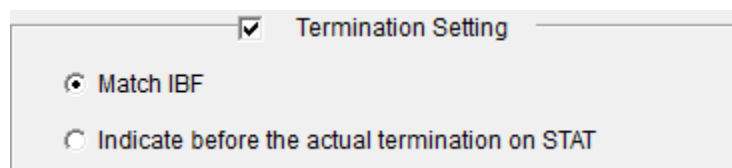
8. Set Battery auto recharge Voltage to VBATT_Full – 200mV (the range is 100mV or 200mV)



Battery Recharge Threshold (Vrech)

- VBAT_full-200mV
- VBAT_full-200mV
- VBAT_full-100mV

9. Deselect Enable Termination

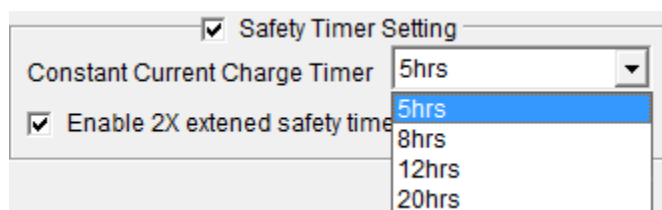


☒ Termination Setting

☒ Match IBF

☐ Indicate before the actual termination on STAT

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

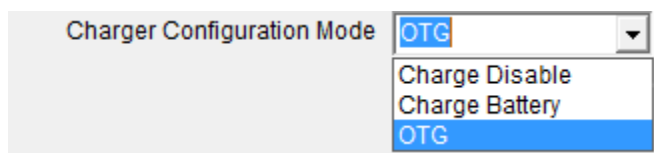


The integrated charge timer provides a back-up protection to prevent a damaged battery from being charged after a certain time. The MP2624 can disable the timer function by deselecting.

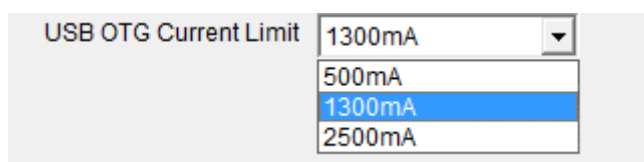
3) Boost Function

When the MP2624 is programmed to OTG mode, the output current limit can be controlled via I²C.

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 I²C Watchdog Timer Limit: click “Watchdog AUTO Reset” to run the program automatically.

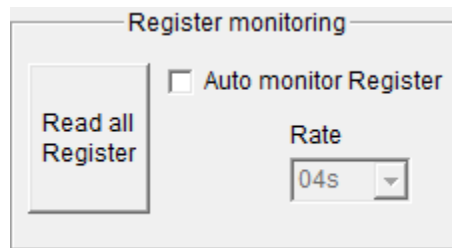
I2C Watchdog Timer
 Watchdog 40s
☐ Watchdog AUTO Reset
 Watchdog Reset Rate 04s

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



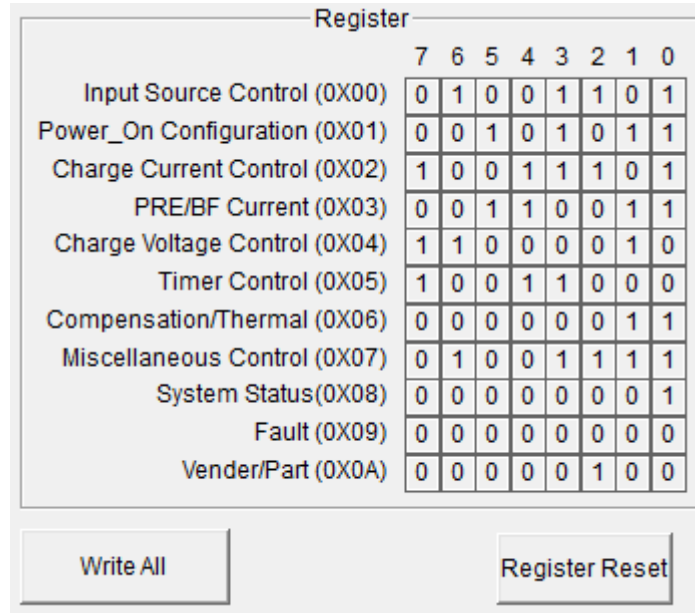
Register monitoring

☐ Auto monitor Register

Read all Register

Rate
04s

8. Content of the Registers:



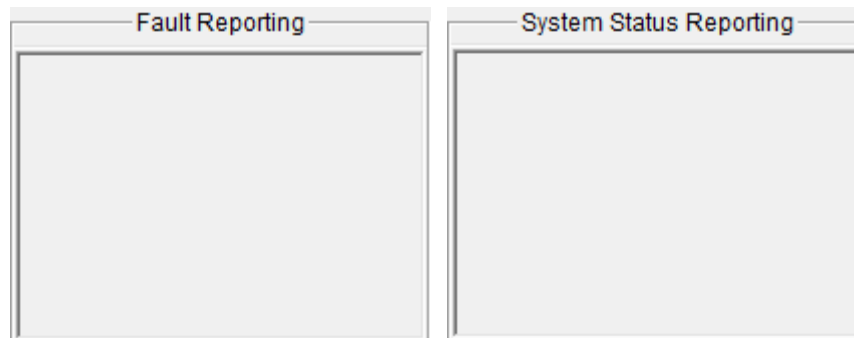
Register

	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.

The schematic diagram illustrates the internal circuitry of a USB-to-serial module. Key components and their connections include:

- MP2624 Converter (U1):** The central component responsible for voltage conversion. Its pins are connected to various parts of the circuit:
 - DM (22), INT (21), STAT (20), NTC (19), /EN (18):** Connected to the microcontroller (P1).
 - DISC (17):** Connected to the switch (SW1).
 - BATT (16):** Connected to the battery input (VBATT).
 - SYS (15):** Connected to the system voltage output (VSYS).
 - SW (14):** Connected to the switch (SW1).
 - BST (13):** Connected to the boost inductor (L1).
 - OTG (12):** Connected to the OTG pin of the microcontroller (P1).
 - SCL (7), SDA (8):** Connected to the I2C interface of the microcontroller (P1).
 - VREF (9):** Connected to the VREF pin of the microcontroller (P1).
 - ILIM (10):** Connected to the ILIM pin of the microcontroller (P1).
 - AGND (11):** Connected to the ground plane.
- USB Interface (U2):** Provides the USB connection. Its pins are connected to the USB bus (VBUS, D-, D+, ID, GND) and the microcontroller (P1).
- Power and Grounding:**
 - VIN:** The main power input, connected to the USB VBUS and the microcontroller's VIN pin.
 - PGND:** The main ground connection.
 - VREF:** A reference voltage pin, connected to the microcontroller's VREF pin and the MP2624's VREF pin.
 - VSYS:** The system voltage output, connected to the MP2624's SYS pin and the microcontroller's VSYS pin.
 - VBATT:** The battery input, connected to the MP2624's BATT pin.
- Control and Status:**
 - EN (Enable):** Connected to the microcontroller's EN pin and the MP2624's /EN pin.
 - INT (Interrupt):** Connected to the microcontroller's INT pin and the MP2624's INT pin.
 - STAT (Status):** Connected to the microcontroller's STAT pin and the MP2624's STAT pin.
 - NTC (Temperature Sensor):** Connected to the microcontroller's NTC pin and the MP2624's NTC pin.
 - OTG (On-The-Go):** Connected to the microcontroller's OTG pin and the MP2624's OTG pin.
- Passive Components:**
 - Resistors (R1-R5, R10-R12):** Used for current limiting, voltage division, and pull-up/pull-down.
 - Capacitors (C1-C16):** Used for decoupling, filtering, and timing.
 - Inductor (L1):** Used for the boost converter stage.
 - LED1:** A status indicator LED.
 - SW1:** A manual switch for power control.

EV2624-L-01A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacture	Manufacture_PN
1	C1	1 μ F	Ceramic Capacitor;25V;X7R;0603;	0603	muRata	GRM188R71E105KA12D
1	C2	4.7 μ F	Ceramic Capacitor;25V;X5R;0805;	0805	muRata	GRM21BR61E475KA12L
1	C3	NC	Ceramic Capacitor;25V;X5R;1206;	1206	muRata	GRM31CR61E106KA12L
2	C4,C16	10 μ F	Ceramic Capacitor;25V;X5R;1206;	1206	muRata	GRM31CR61E106KA12L
2	C5,C13	4.7 μ 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 μ F	Ceramic Capacitor;10V;X7R;1206	1206	muRata	GRM31CR71A226KE15L
2	C9, C10	NC	Ceramic Capacitor;16V;X5R;0805;	0805	muRata	GRM21BR61C475KA88
1	C14	10 μ F	Ceramic Capacitor;16V;X5R;0603	0603	muRata	GRM188R61C106KAALD
1	C15	1 μ 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 μ 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 Ω	Film Resistor;1%;	0603	Yageo	RC0603FR-072KL
3	R3, R4, R5	100k Ω	Film Resistor;5%;	0603	Yageo	RC0603JR-07100KL
1	RILIM	1k Ω	Film Resistor;1%	0603	Yageo	RC0603FR-071KL
1	RT1	10k Ω	Film Resistor;1%	0603	Yageo	RC0603FR-0710KL
1	RT2	15k Ω	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)

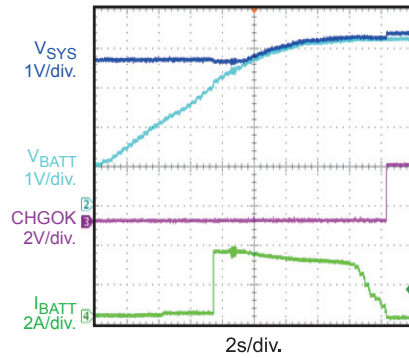
Qty	Ref	Value	Description	Package	Manufacture	Manufacture_PN
6	VIN, PGND,V BATT,P GND,P GND,VS YS		2mm			
1	U1		IC;	FCQFN3*4	MPS	MP2624GL
1	U2		Micro-B USB connector;			

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.

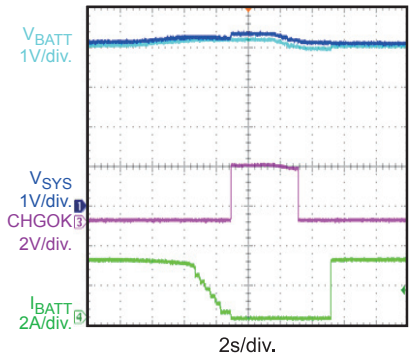
Battery Charge Curve

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



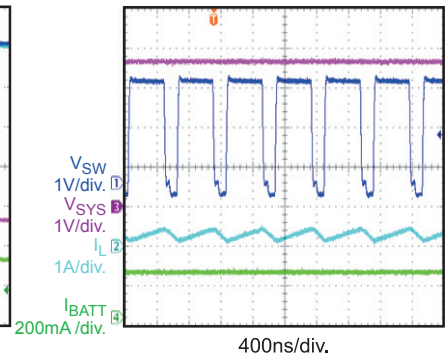
Auto Recharge

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



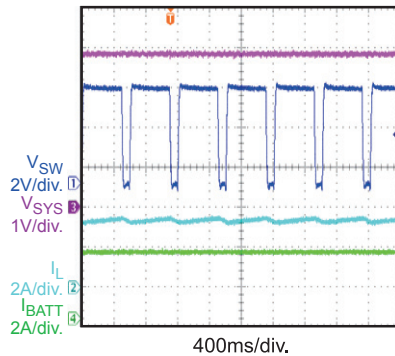
Trickle Charge Steady State

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



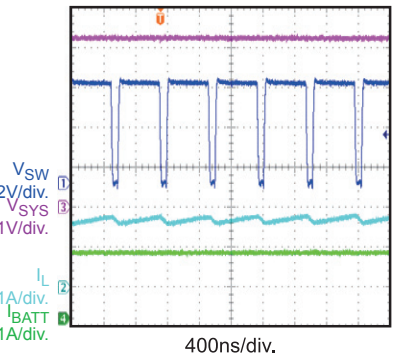
Constant Current Charge Steady State

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



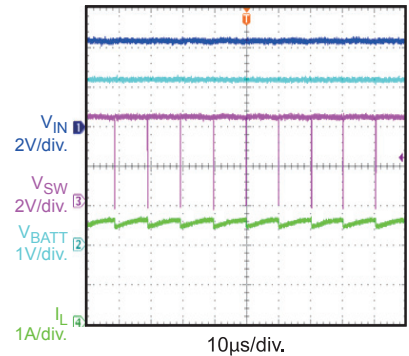
Constant Voltage Charge Steady State

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



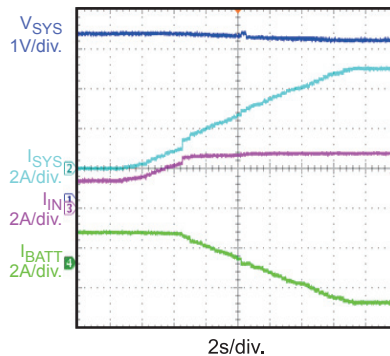
COT Operation

$V_{IN}=4.5V$



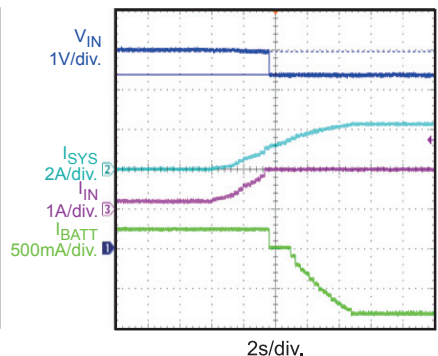
Input Current Limit

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



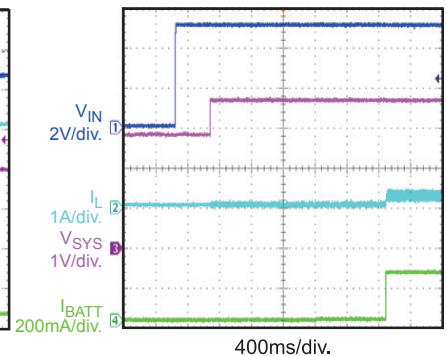
Input Voltage Limit

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



Power On

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

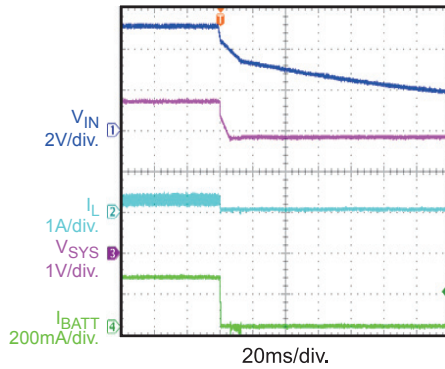


EVB TEST RESULTS (continued)

$V_{IN} = 5.0V$, $V_{BATT} = \text{full range}$, I²C 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.

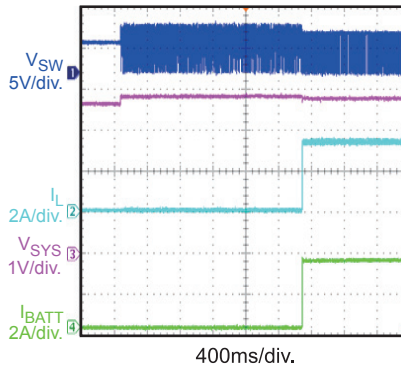
Power Off

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



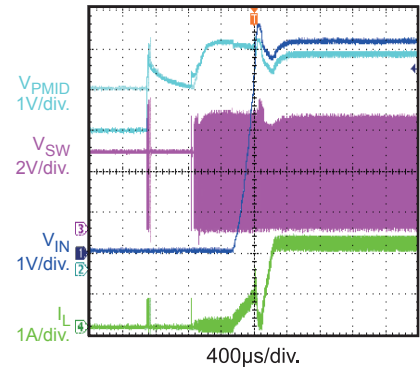
EN On

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



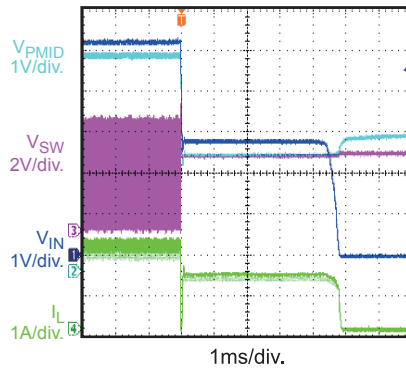
OTG Mode Start-Up

$V_{IN_OTG}=5V$, $V_{BATT_OTG}=3.6V$, $I_{OTG}=1.3A$



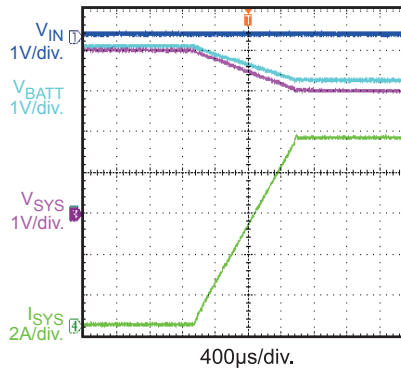
OTG Mode Shutdown

$V_{IN_OTG}=5V$, $V_{BATT_OTG}=3.6V$, $I_{OTG}=1.3A$



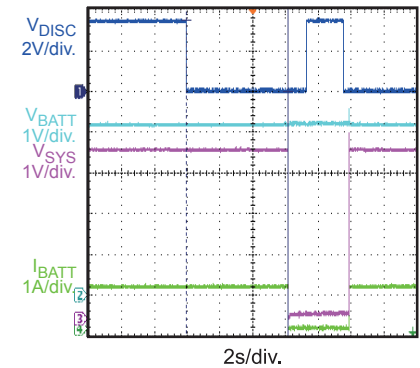
Battery Discharge Current

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



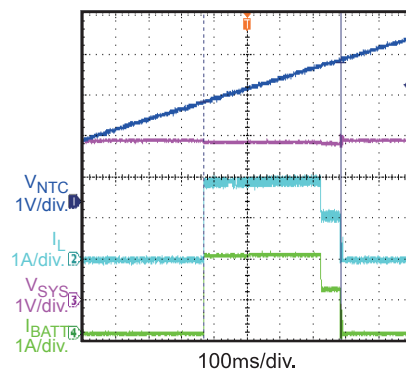
DISC Function

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



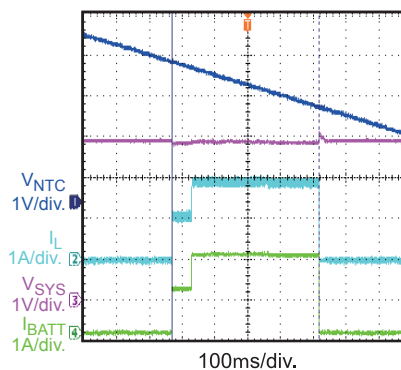
NTC Function

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



NTC Function

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



PRINTED CIRCUIT BOARD LAYOUT

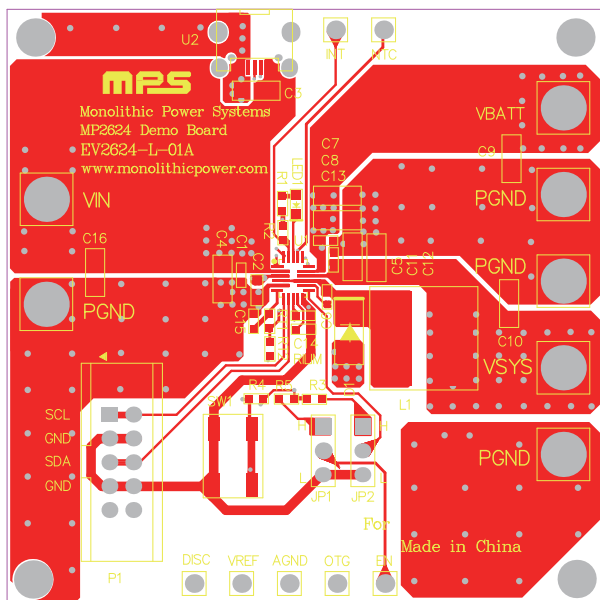


Figure 1: Top Layer

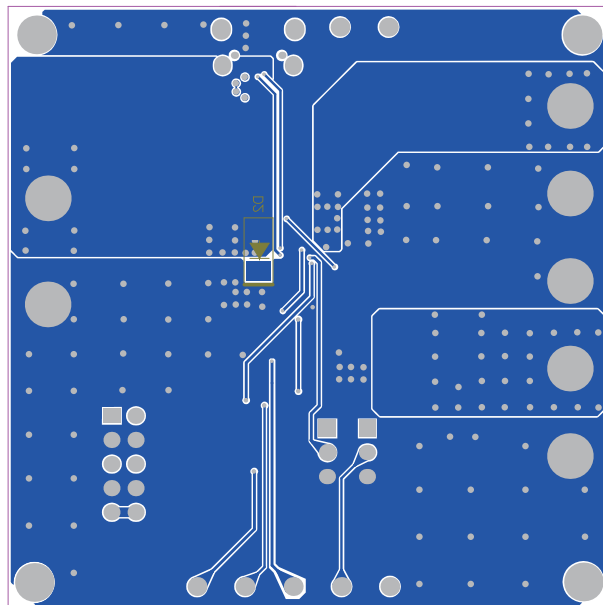


Figure 2: Bottom Layer

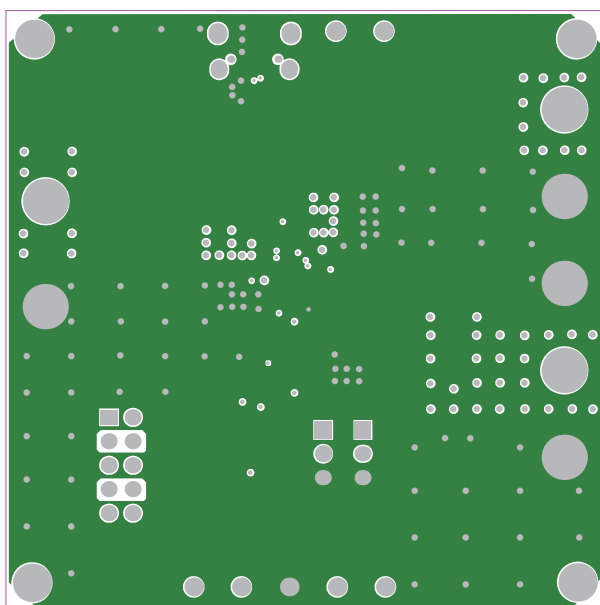


Figure 3: Middle Layer1

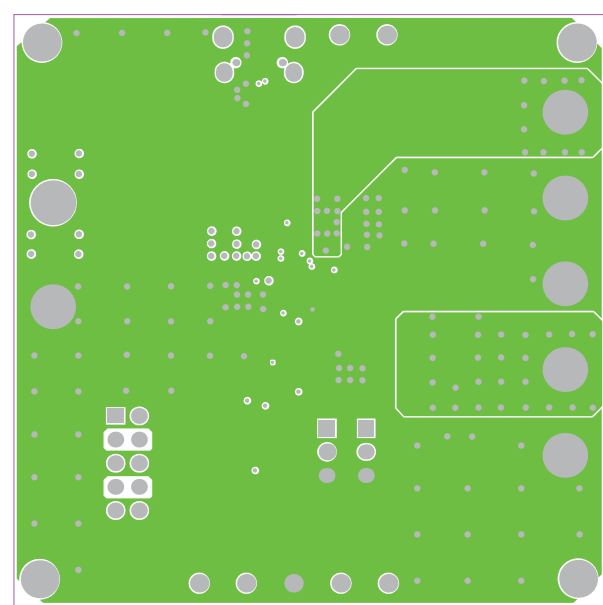


Figure 4: Middle Layer2

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