EV5024-V-00A

16V, 20A, Hot-Swap Intelli-Fuse Solution Evaluation Board

DESCRIPTION

The EV5024-V-00A is an evaluation board designed to demonstrate the capabilities of the MP5024, a fully integrated, PMBus-compliant, compact, hot-swap protection device. The device allows a reference circuit evaluation of the MP5024. It is designed to protect circuitry on its output from transients on its input. It also protects its input from undesired shorts and transients coming from its output. The device can achieve up to 20A of continuous output current (I_{OUT}) per device at room temperature.

The device limits the power supply's voltage drop by limiting the inrush current to the load while a circuit card is inserted into a live backplane power source. It limits the internal MOSFET current (I_{FET}) by controlling the gate voltage (V_{GATE}) via a low-power resistor from ISET to ground and soft-start ramp.

The MP5024 provides rich fault protections, such as input voltage (V_{IN}) over-voltage protection (OVP), I_{OUT} over-current protection (OCP), short-circuit protection (SCP), and over-temperature protection (OTP). The MP5024 detects power MOSFET gate, source, and drain short conditions. The fault status can be indicated with the fault report output (FLT#/ALT#). The MP5024 also provides power good (PG) indication.

The PMBus interface provides V_{IN}, input current (I_{IN}), input energy (E_{IN}), output voltage (V_{OUT}), I_{OUT}, input power (P_{IN}), and output power (P_{OUT}) telemetry. The MP5024 monitors and reports fault statuses through the PMBus interface.

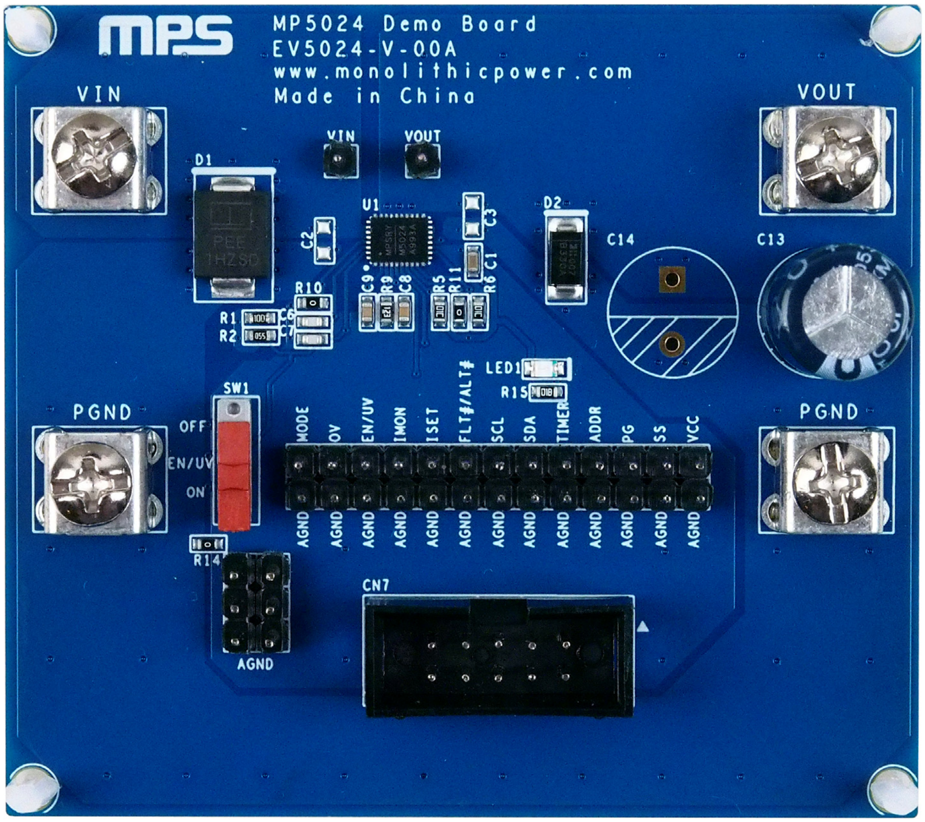
The MP5024 is available in a QFN-32 (3.5mmx4.5mm) package. The EV5024-V-00A has 4 layers, which are each 2oz, and the total size is 7.15cmx6.35cm.

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C, unless otherwise noted.

Parameters	Conditions	Value
Input voltage (V_{IN}) range		2.7V to 16V
Soft-start time (t_{SS})	C_{SS} = 100nF	9.9ms
Over-current protection (OCP) limit (steady state)	R_{ISET} = 12kΩ	25A
OCP limit (soft start)		20A
SCP limit		50A
Insertion delay time (t_{IDT})	C_{TIMER} = 10nF	3.03ms
OCP delay time (t_{OC})		303µs
Over-voltage protection (OVP) limit	R_{OV_UP} = 124kΩ, R_{OV_BOT} = 10kΩ	16.2V
Under-voltage protection (UVP) rising threshold	R_{EN_UP} = 365kΩ, R_{EN_BOT} = 100kΩ	5.6V
UVP falling threshold		4.8V
Operation mode		Latch-off mode
PMBus address		40h

EVALUATION BOARD



LxWxH (7.15cmx6.35cmx1.6cm)

Board Number	MPS IC Number
EV5024-V-00A	MP5024GRM

QUICK START GUIDE

To start up the EV5024-V-00A, follow the steps below.

VIN Start-Up

1. Preset the power supply between 2.7V and 12V, then turn the power supply off.
2. Connect the power supply terminals and load terminals to the evaluation board's corresponding terminals.
3. Turn the EN/UV switch (SW1) on and ensure that it remains on.
4. After making the connections, turn the power supply on. The output voltage (V_{OUT}) should automatically start up.

Enable (EN/UV) Start-Up

1. Connect the power supply terminals and load terminals to the evaluation board's corresponding terminals.
2. Turn SW1 off, then turn the power supply on. V_{OUT} remains low during this time.
3. Turn SW1 on. V_{OUT} should automatically start up.

Notes:

1) If testing with a continuous input voltage (V_{IN}) exceeding 12V, remove the TVS diode (D1) and replace with the appropriate TVS diode according to V_{IN}.
2) SW1 changes the EN/UV pin connection. If SW1 is switched to the on status, the EN/UV pin is connected to VIN via the resistor divider. In this scenario, the EN/UV voltage must exceed its rising threshold.

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MP5024 GUI GUIDLINES

The MPS GUI provides an interface to monitor the evaluation board's operation status, including operating parameters and fault statuses. To use the MP5024 GUI properly, follow the steps below:

1. Use the PMBus interface kit (EVKT-USBI2C-02) to connect the EV5024-V-00A to a PC (see Figure 1).

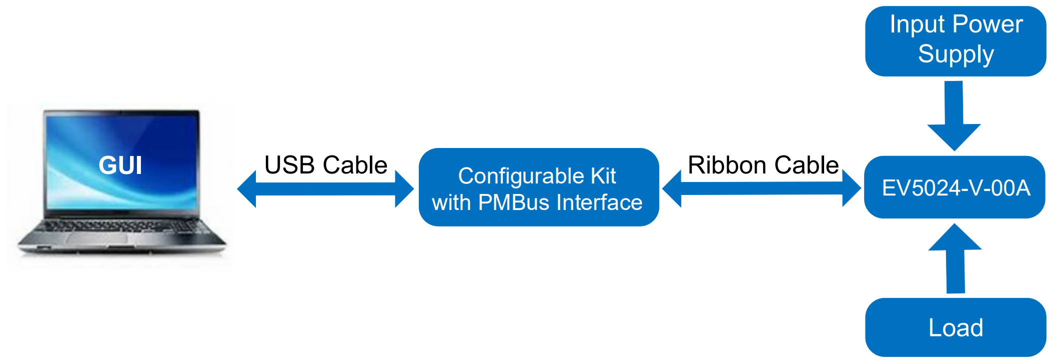


Figure 1: PMBus Connection Diagram

2. Turn on the power supply.
3. Open the GUI. It should scan the online devices automatically (see Figure 2).

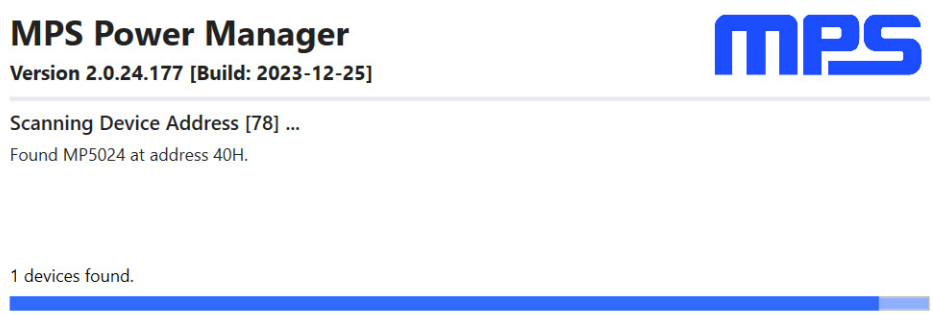


Figure 2: GUI Automatic Scanning Interface

4. Select "MP5024 [40H]" in the device list, then click the "Details" button to enter the GUI homepage, or double click "MP5024 [40H]" to enter the GUI homepage directly (see Figure 3 on page 5).

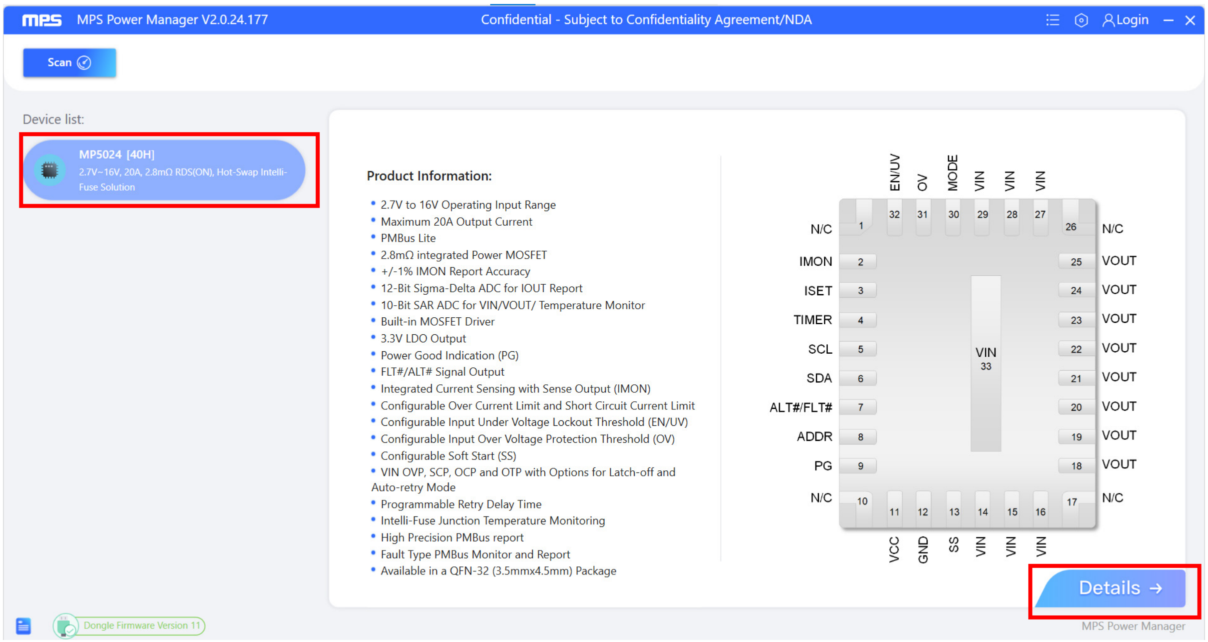


Figure 3: MP5920 Scan Operation

5. The system's operation status can be monitored directly on the "Monitor" page (see Figure 4). The MP5024 can also be controlled to turn on or off via the "On/Off" button.

   Note that the "Write Enable" button must be enabled; otherwise, the "On/Off" button does not work.

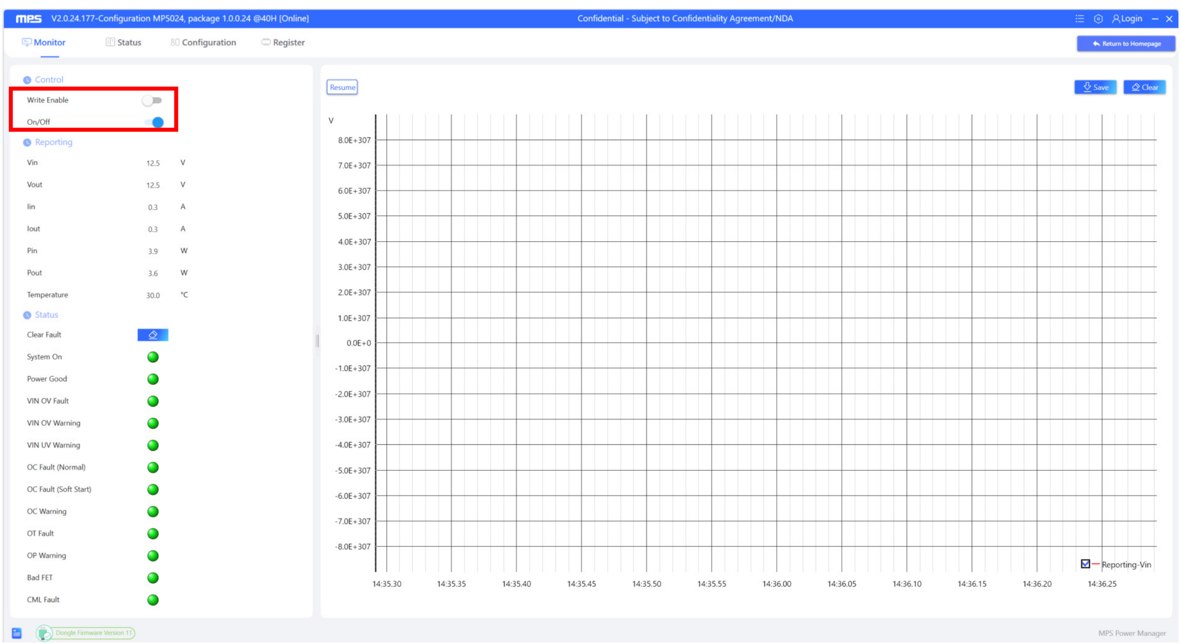


Figure 4: GUI Monitor Page

6. The “Status” page provides detailed system fault and warning status indication. The corresponding item should be highlighted with red if a fault or warning event occurs (see Figure 5).

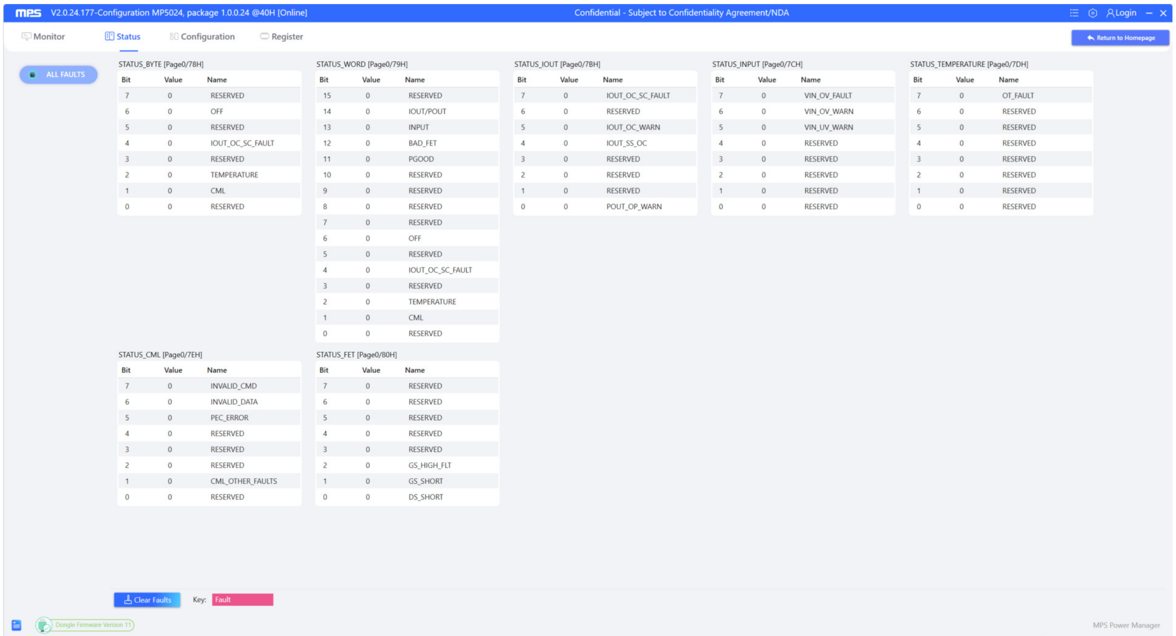


Figure 5: GUI Protection Page

7. The “Configuration” page configures the MP5024’s basic operation setting and protection levels. When the configuration is updated, click “Write RAM” for the configurations to take effect (see Figure 6).

   Note that the “Write Enable” button in “Monitor page” must be turned on; otherwise the “Write RAM” button does not work.

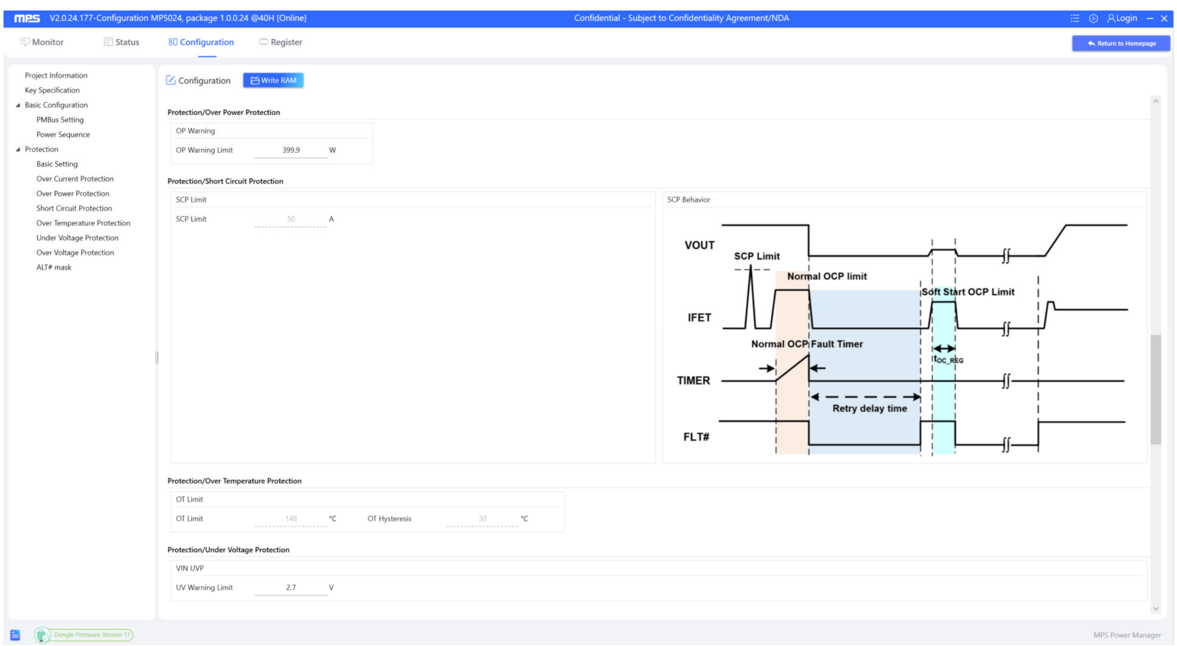


Figure 6: GUI Configuration Page

8. The “Register” page allows the user to import, export, and diagnose the RAM settings. The user can enter the register’s R/W interface by pressing the “ALT” and “W” keys simultaneously (see Figure 7).

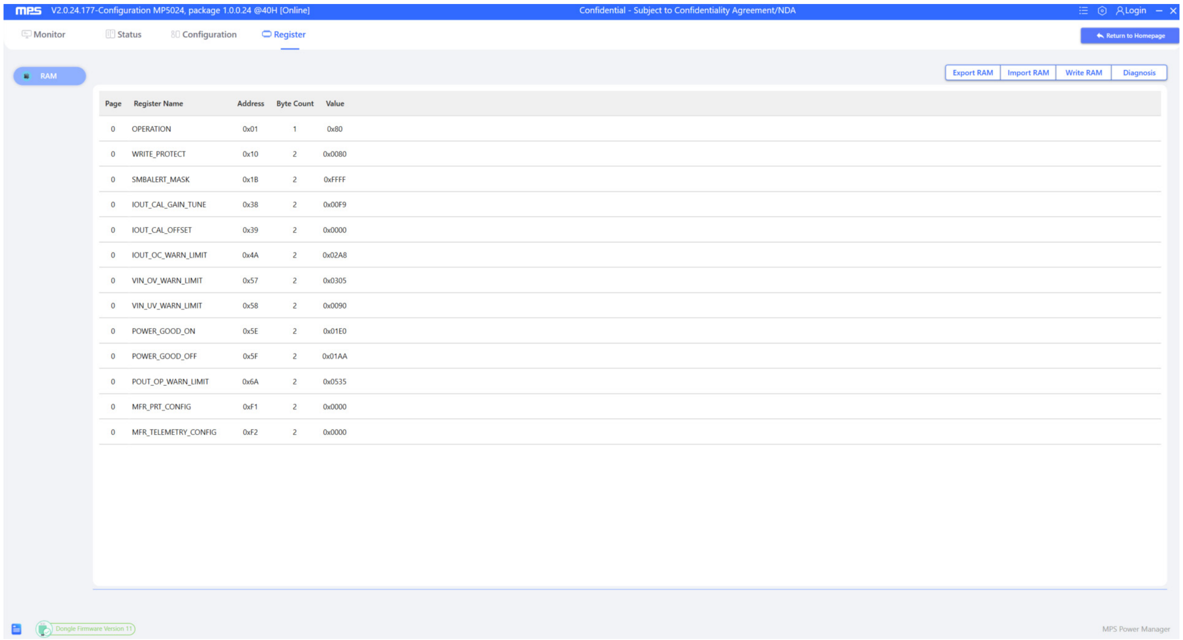


Figure 7: GUI Register Page

MP5024 DEFAULT CODE

Name	Code	Type	Bytes	Default Value
OPERATION	01h	R/W with PEC	1	80h
CLEAR_FAULT	03h	Send byte with PEC	0	-
WRITE_PROTECT	10h	R/W with PEC	2	0080h
CAPABILITY	19h	Read with PEC	1	D0h
SMBALERT_MASK	1Bh	Read with PEC	2	FFFFh
IOUT_CAL_GAIN	38h	R/W with PEC	2	00F9h
IOUT_CAL_OFFSET	39h	R/W with PEC	2	0000h
IOUT_OC_WARN_LIMIT	4Ah	R/W with PEC	2	02A8h
VIN_OV_WARN_LIMIT	57h	R/W with PEC	2	0305h
VIN_UV_WARN_LIMIT	58h	R/W with PEC	2	0090h
POWER_GOOD_ON	5Eh	R/W with PEC	2	01E0h
POWER_GOOD_OFF	5Fh	R/W with PEC	2	01AAh
POUT_OP_WARN_LIMIT	6Ah	R/W with PEC	2	0535h
STATUS_BYTE	78h	Read with PEC	1	00h
STATUS_WORD	79h	Read with PEC	2	0000h
STATUS_IOUT	7Bh	Read with PEC	1	00h
STATUS_INPUT	7Ch	Read with PEC	1	00h
STATUS_TEMPERATURE	7Dh	Read with PEC	1	00h
STATUS_CML	7Eh	Read with PEC	1	00h
STATUS_FET	80h	Read with PEC	1	00h
READ_EIN	86h	Block read with PEC	1 (byte) + 6 (data)	06h, 0000h, 00h, 000000h
READ_VIN	88h	Read with PEC	2	0000h
READ_VOUT	8Bh	Read with PEC	2	0000h
READ_IOUT	8Ch	Read with PEC	2	0000h
READ_TEMPERATURE	8Dh	Read with PEC	2	0000h
READ_IIN	8Eh	Read with PEC	2	0000h
READ_POUT	96h	Read with PEC	2	0000h
READ_PIN	97h	Read with PEC	2	0000h
PMBUS_REVISION	98h	Read with PEC	1	33h
MFR_ID	99h	Block read with PEC	3	ASCII “MPS”
MFR_MODEL	9Ah	Block read with PEC	6	ASCII “MP5024”
MFR_REVISION	9Bh	Read with PEC	1	00h
MFR_DATE	9Dh	Block read with PEC	6	ASCII “YYMMDD”
MFR_PMBUS_ADDR	F0h	Read with PEC	1	40h
MFR_PRT_CONFIG	F1h	R/W with PEC	2	0000h
MFR_TELEMETRY_CONFIG	F2h	R/W with PEC	2	0001h

EVALUATION BOARD SCHEMATIC

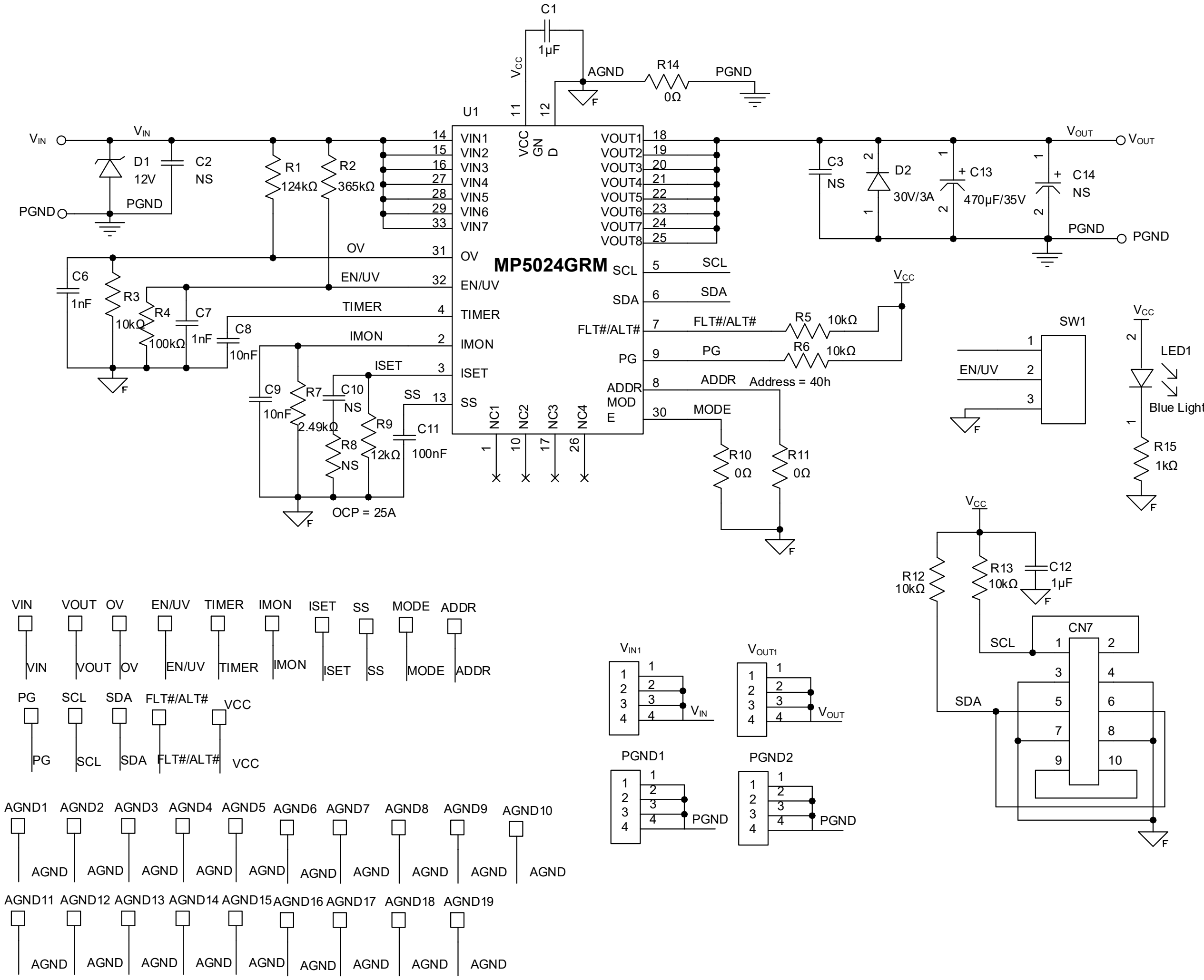


Figure 8: Evaluation Board Schematic

EV5024-V-00A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
34	AGND1, AGND2, AGND3, AGND4, AGND5, AGND6, AGND7, AGND8, AGND9, AGND10, AGND11, AGND12, AGND13, AGND14, AGND15, AGND16, AGND17, AGND18, AGND19, VOUT, VIN, VCC, TIMER, SS, SDA, SCL, PG, OV, MODE, ISET, IMON, FLT#/ALT#, EN/UV, ADDR	3A	Test point	Through-hole	Any	
1	CN7	3A	Header, 5-pin, dual-row	Through-hole	Any	
2	C1, C12	1µF	Capacitor, 25V, X7R	0603	Murata	GCM188R71E105KA64D
2	C6, C7	1nF	Capacitor, 50V, X7R	0603	Murata	GRM188R71H102KA01D
2	C8, C9	10nF	Capacitor, 25V, X7R	0603	Murata	GRM188R71E103KA01D
3	C2, C3, C10	NS				
1	C11	100nF	Capacitor, 25V, X7R	0603	Murata	GRM188R71E104KA01D
1	C13	470µF	Capacitor, 35V, DIP	Radial	Jianghai	CD263-35V470
1	C14	NS				
1	LED1	20mA	LED, blue light	0805	Honglitronic	HL-PSC-2012H203BC
1	D1	12V	TVS diode	DO-214AB	Littelfuse	SMDJ12A
1	D2	30V, 3A	Schottky diode	SMA	Diodes	B330A
4	VOUT1, VIN1, PGND1, PGND2	30A	Connector	Through-hole	Any	
1	R1	124kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07124KL
1	R2	365kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07365KL
5	R3, R5, R6, R12, R13	10kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0710KL
1	R4	100kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07100KL
1	R7	2.49kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-072K49L
1	R8	NS				

EV5024-V-00A BILL OF MATERIALS *(continued)*

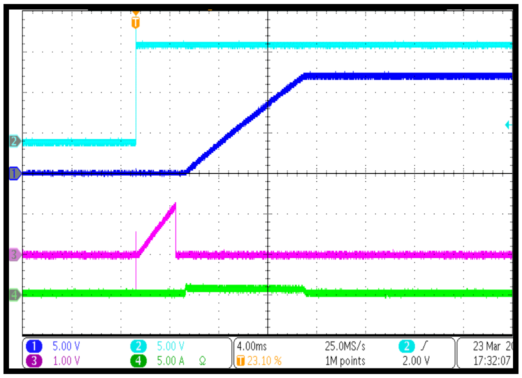
Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	R9	12kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0712KL
3	R10, R11, R14	0Ω	Film resistor, 1%	0603	Yageo	RC0603FR-070RL
1	R15	1kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-071KL
1	SW1	12V, 0.5A	Switch	Through-hole	Wurth	450301014042
1	U1	MP5024	16V, 20A, 2.8mΩ $R_{DS(ON)}$, hot-swap Intelli-Fuse with PMBus	QFN-32 (3.5mmx 4.5mm)	MPS	MP5024GRM

EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 12V, R_{IMON} = 2.49kΩ, R_{ISET} = 12kΩ, T_A = 25°C, unless otherwise noted.

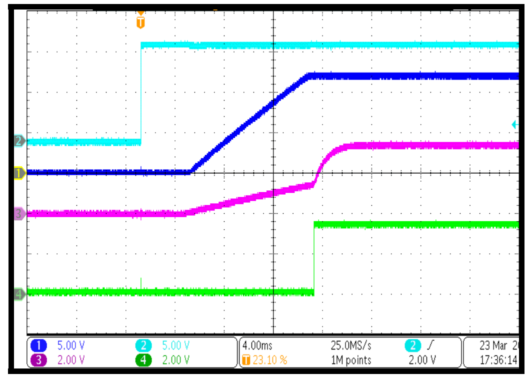
VIN Hot Plug
I_{OUT} = 0A

CH2: V_{IN}
CH1: V_{OUT}
CH3: TIMER
CH4: I_{IN}



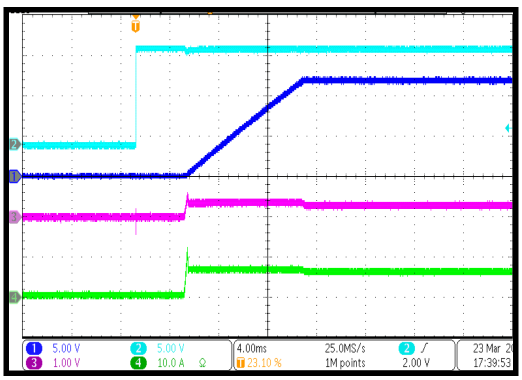
VIN Hot Plug
I_{OUT} = 0A

CH2: V_{IN}
CH1: V_{OUT}
CH3: SS
CH4: PG



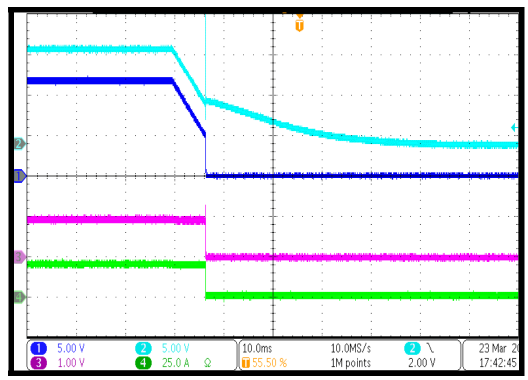
VIN Hot Plug
I_{OUT} = 6A

CH2: V_{IN}
CH1: V_{OUT}
CH3: IMON
CH4: I_{IN}



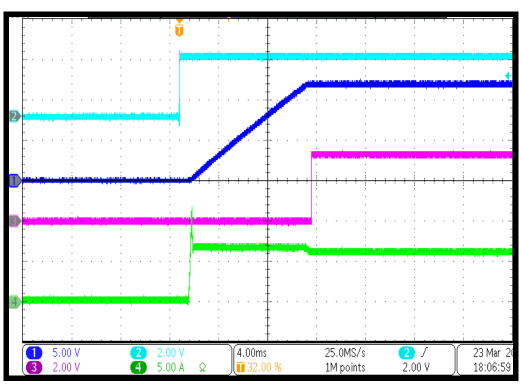
Shutdown through VIN
I_{OUT} = 20A

CH2: V_{IN}
CH1: V_{OUT}
CH3: IMON
CH4: I_{IN}



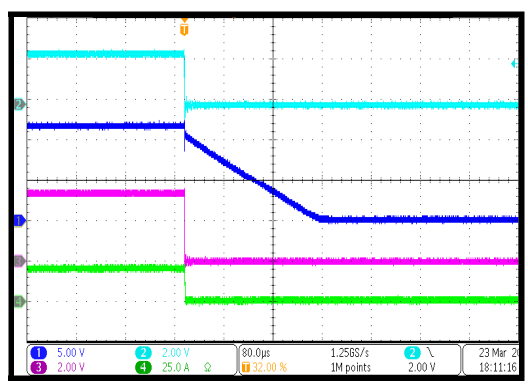
Start-Up through EN
I_{OUT} = 6A

CH2: EN
CH1: V_{OUT}
CH3: PG
CH4: I_{IN}



Shutdown through EN
I_{OUT} = 20A

CH2: EN
CH1: V_{OUT}
CH3: PG
CH4: I_{IN}

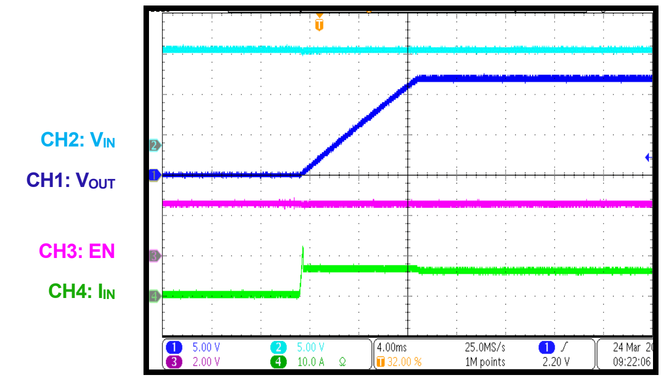


EVB TEST RESULTS *(continued)*

V_{IN} = 12V, R_{IMON} = 2.49kΩ, R_{ISET} = 12kΩ, T_A = 25°C, unless otherwise noted.

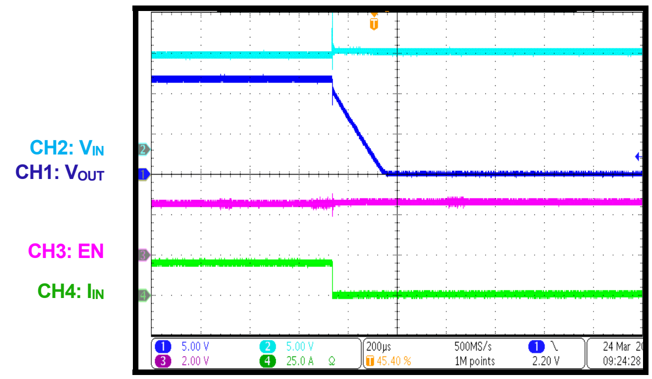
Start-Up via OPERATION Command

I_{OUT} = 6A



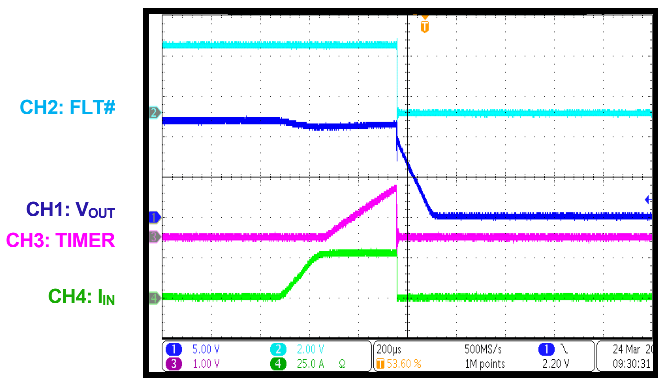
Shutdown via OPERATION Command

I_{OUT} = 20A



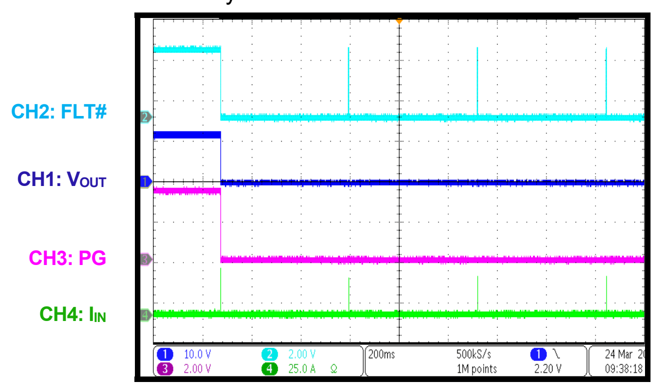
OCP

I_{LIMIT} = 25A, latch-off mode



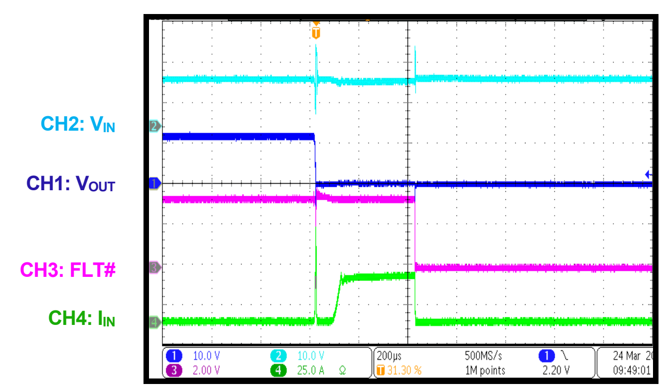
OCP

I_{LIMIT} = 25A, hiccup mode,
auto-retry time = 500ms



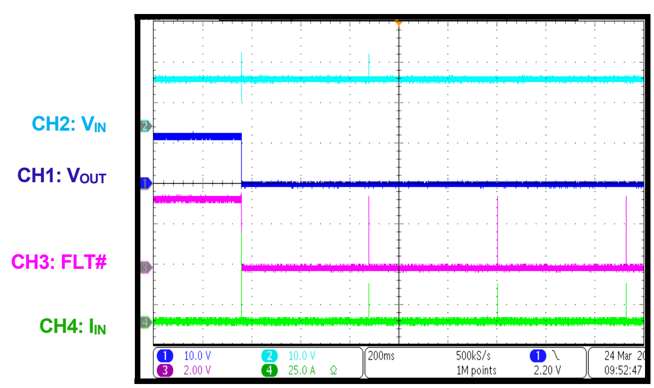
SCP

Latch-off mode



SCP

Hiccup mode

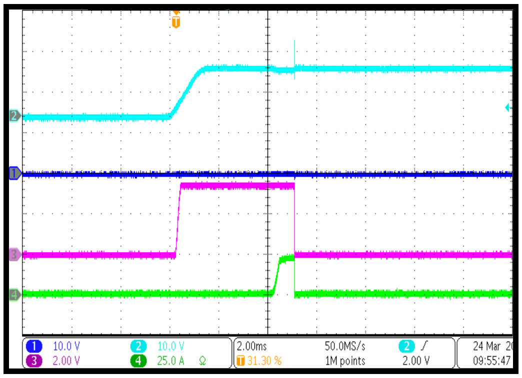


EVB TEST RESULTS *(continued)*

V_{IN} = 12V, R_{IMON} = 2.49kΩ, R_{ISET} = 12kΩ, T_A = 25°C, unless otherwise noted.

Short Circuit Start-Up

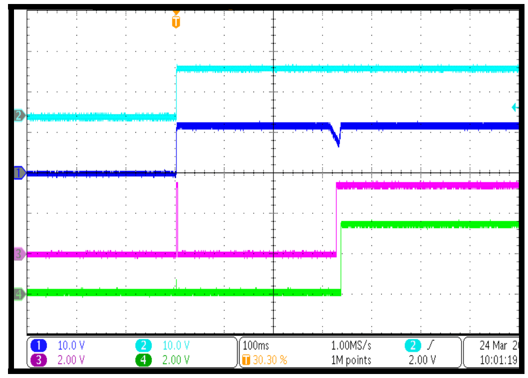
CH2: V_{IN}
CH1: V_{OUT}
CH3: FLT#
CH4: I_{IN}



DS Short

I_{OUT} = 0.1A, connect VOUT to VIN before start-up, then disconnect it after start-up

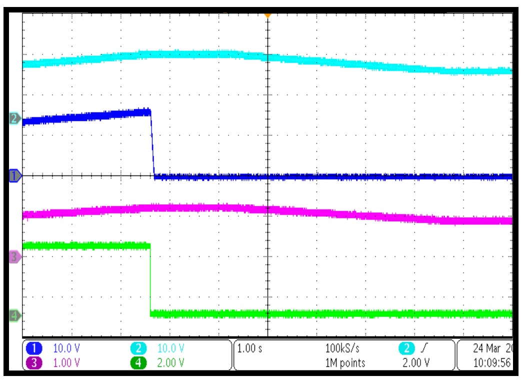
CH2: V_{IN}
CH1: V_{OUT}
CH3: FLT#
CH4: I_{IN}



V_{IN} OVP in Latch-Off Mode

I_{OUT} = 0.1A, apply V_{IN} to trip OVP, then reduce V_{IN}

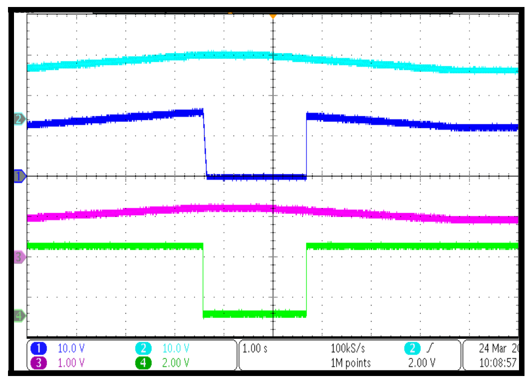
CH2: V_{IN}
CH1: V_{OUT}
CH3: OV
CH4: FLT#



V_{IN} OVP in Hiccup Mode

I_{OUT} = 1A, apply 18.5V on VIN, then reduce V_{IN}

CH2: V_{IN}
CH1: V_{OUT}
CH3: OV
CH4: FLT#



PCB LAYOUT

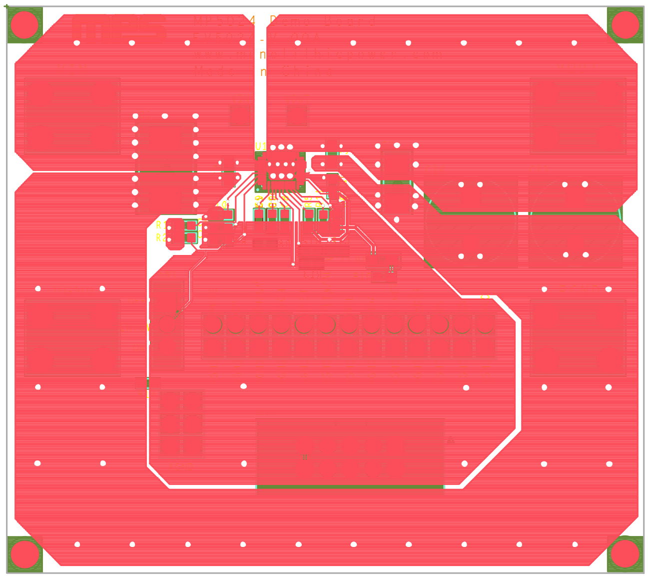


Figure 9: Top Layer

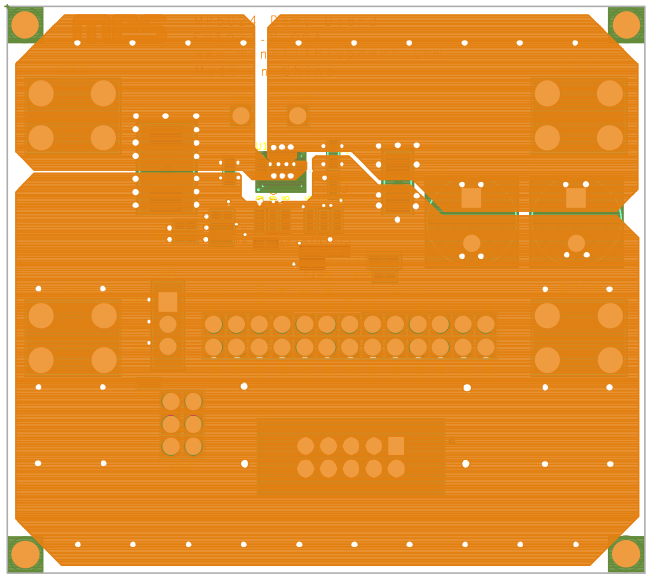


Figure 10: Mid-Layer 1

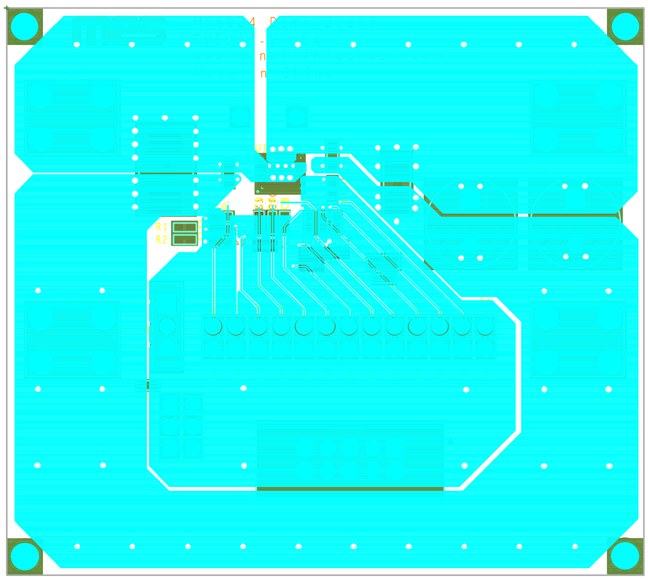


Figure 11: Mid-Layer 2

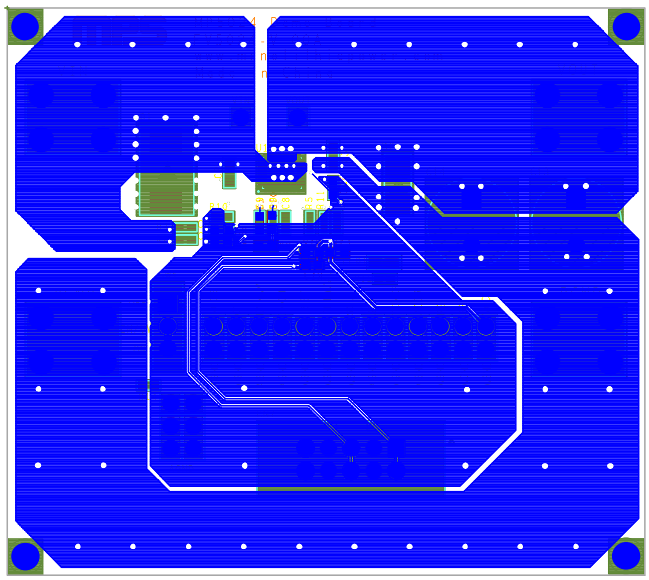


Figure 12: Bottom Layer

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	1/26/2024	Initial Release	-