EVM82504-BH-02A

16V, Quad 25A, Scalable, DC/DC Power Module Evaluation Board

DESCRIPTION

The EVM82504-BH-02A evaluation board is designed to demonstrate the capabilities of the MPM82504, a 4V to 16V input voltage (V_{IN}), 0.5V to 3.3V adjustable output voltage (V_{OUTx}) power module. The board can output up to 25A per channel, and can provide 50A, 75A, or 100A output current (I_{OUTx}) with different parallel operation modes.

The MPM82504 adopts MPS's proprietary, multi-phase constant-on-time (MCOT) control, which provides ultra-fast transient response and simple loop compensation. The integrated PMBus interface provides flexible power management functions. Refer to the MPM82504 datasheet for more detailed information. The EVKT-USBI2C-02 and Virtual Bench Pro 4.0 GUI allow the user to fully explore the digital functions of the board. Contact MPS for more information.

It is recommended to read the datasheet for the MPM82504 prior to making any changes to the EVM82504-BH-02A.

PERFORMANCE SUMMARY (1)

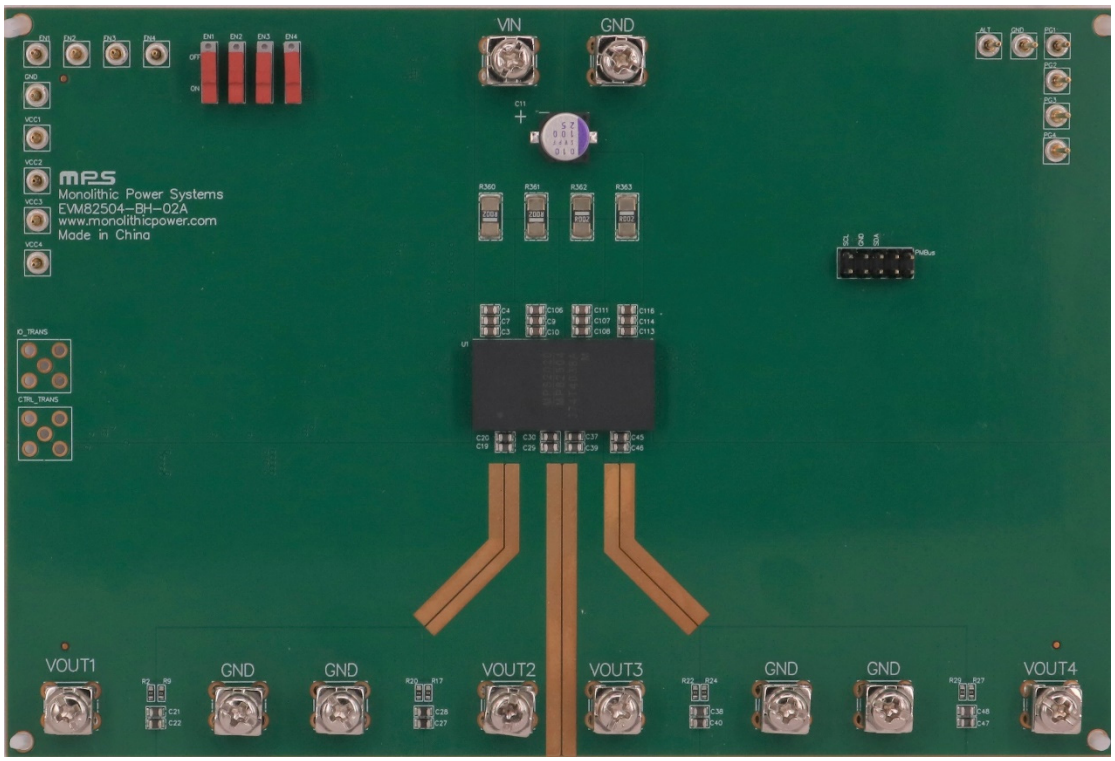
Specifications are at T_A = 25°C, unless otherwise noted.

Parameter	Condition	Value
Input voltage (V_{IN}) range (2)		4V to 16V (2)
Output voltage (V_{OUT1}) range (3)	V_{IN} = 4V to 16V, I_{OUT1} = 0A to 25A	0.5V to 3.3V, default: 0.85V
Maximum output current (I_{OUT1})	V_{IN} = 4V to 16V, V_{OUT1} = 0.5V to 3.3V	25A
Output voltage (V_{OUT2}) range (3)	V_{IN} = 4V to 16V, I_{OUT2} = 0A to 25A	0.5V to 3.3V, default: 0.9V
Maximum output current (I_{OUT2})	V_{IN} = 4V to 16V, V_{OUT2} = 0.5V to 3.3V	25A
Output voltage (V_{OUT3}) range (3)	V_{IN} = 4V to 16V, I_{OUT3} = 0A to 25A	0.5V to 3.3V, default: 1.2V
Maximum output current (I_{OUT3})	V_{IN} = 4V to 16V, V_{OUT3} = 0.5V to 3.3V	25A
Output voltage (V_{OUT4}) range (3)	V_{IN} = 4V to 16V, I_{OUT4} = 0A to 25A	0.5V to 3.3V, default: 1.8V
Maximum output current (I_{OUT4})	V_{IN} = 4V to 16V, V_{OUT4} = 0.5V to 3.3V	25A
Default frequency (f_{REQ1}) (3)		1000kHz
Default frequency (f_{REQ2}) (3)		1000kHz
Default frequency (f_{REQ3}) (3)		1000kHz
Default frequency (f_{REQ4}) (3)		1000kHz

Notes:

1) For different V_{IN} and V_{OUTx} specifications with different output capacitors/inductors, the application circuit parameters may require changes.
2) The MPM82504 supports a 4V to 16V V_{IN} for single input applications with an internal VCC supply.
3) V_{OUTx} and the switching frequency are configurable. Refer to the MPM82504 datasheet for more detailed information.

EVALUATION BOARD



(LxWxH) 18.6cmx12.6cmx1.3cm

Board Number	MPS Module Number
EVM82504-BH-02A	MPM82504GBH-0000

QUICK START GUIDE

1. Connect the load terminals (<25A) to:
   a. Positive (+): VOUT
   b. Negative (-): GND
2. Preset the power supply output voltage 12V, then turn off the power supply.
3. Connect the power supply output terminals to:
   a. Positive (+): VIN
   b. Negative (-): GND
4. After making the connections, turn on the power supply. If the EN switch is turned on, the MPM82504 channel(s) should output automatically. The output voltage (V_{OUTx}) for each channel is set to: V_{OUT1} = 0.85V, V_{OUT2} = 0.9V, V_{OUT3} = 1.2V, and V_{OUT4} = 1.8V for channels 1 through 4, respectively (see Figure 1).
5. When setting V_{OUTx}, a feedback resistor divider is required to set the proper feedback gain. The values of the feedback resistors can be estimated with Equation (1):

$$R_{LOWER}=\frac{V_{REF}}{V_{OUTx}-V_{REF}}\times R_{UPPER} \quad (1)$$

   Where V_{OUTx} is the output voltage.

   The output voltage feedback gain (G_{FB}) is calculated with Equation (2):

$$G_{FB}=\frac{R_{LOWER}}{R_{LOWER}+R_{UPPER}} \quad (2)$$

   The reference voltage (V_{REF}), which has a default value of 0.6V, can be adjusted to be between 0.5V and 0.672V. V_{REF} is the product of V_{OUTx} and G_{FB}.

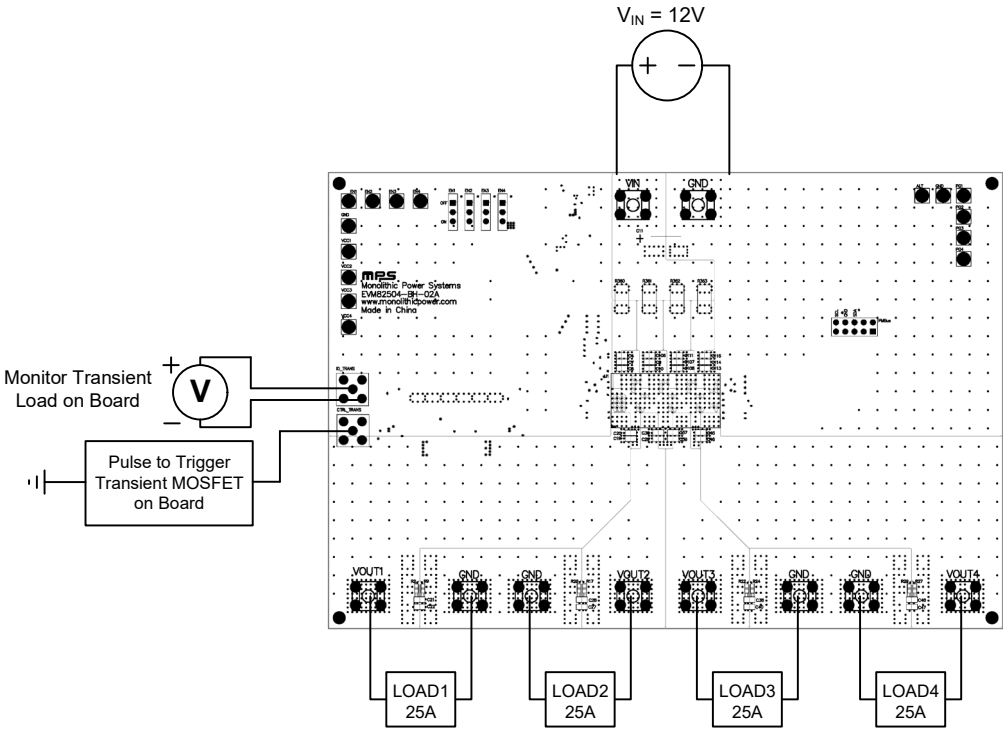


Figure 1: Measurement Equipment Set-Up

6. To set V_{OUTx} through the PMBus interface:

a. Before changing any register values, disable the evaluation board. Write the G_{FB} value calculated with Equation (2) to the VOUT_SCALE_LOOP register.

b. Write the V_{OUTx} value to the VOUT_COMMAND register.

c. V_{REF} is automatically updated based on V_{OUT} and G_{FB}.

7. To change the parallel mode:

a. Remove all optional materials of the current parallel mode (see the Bill of Materials section on page 11).

b. Solder all optional materials of the desired parallel mode (see the Bill of Materials section on page 11).

c. Solder the tin jumper on the front and back of board between the exposed output copper of different channels for parallel operation (see Figure 2). (4)

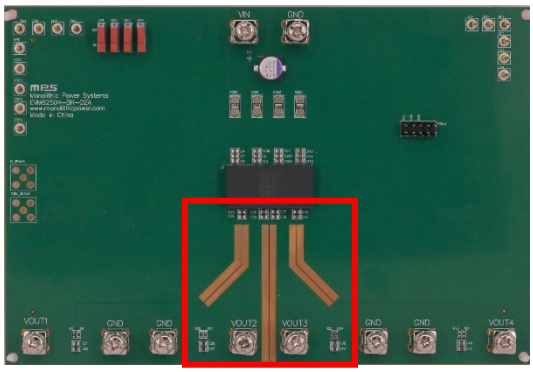


Figure 2: Tin Jumper Solder Points

d. Pull the EN pin down before powering up the board (see Figure 3).

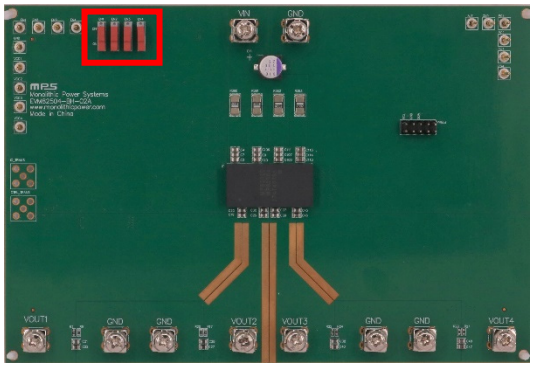


Figure 3: EN Pin Pulled Down

8. Change the configuration code to parallel operation mode.

9. Pull EN high to enable the board.

Note:

4) Be careful of static electricity when soldering any component.

Table 2: Operation Mode Description

Operation Mode	Number of Outputs	Maximum Output Current	Description
A	4	CH1: 25A CH2: 25A CH3: 25A CH4: 25A	The four EVB channels are independent, and each channel can output up to 25A.
B	3	CH1//CH2: 50A CH3: 25A CH4: 25A	Channels 1 and 2 are connected in parallel, and can output up to 50A. Channels 3 and 4 are independent.
C	2	CH1//CH2: 50A CH3//CH4: 50A	Channels 1 and 2 are connected in parallel, and channels 3 and 4 are also connected in parallel.
D	2	CH1//CH2//CH3: 75A CH4: 25A	Channels 1, 2, and 3 are connected in parallel, and can output up to 75A. Channel 4 is independent.
E	1	CH1//CH2//CH3//CH4:100A	All four channels are connected in parallel, and can output up to 100A.

Table 3: Recommended Resistor Divider Values for Different Output Voltages

Output Voltage (V)	R_{UPPER} (kΩ)	R_{LOWER} (kΩ)
0.8	1	3
0.85	1	2.4
0.9	1	2
1	1	1.5
1.2	1	1
1.8	2	1
3.3	9.09	2

MPM82504 GUI QUICK START GUIDE

1. Ensure that all of the components listed in Table 1 are present.

Table 1: Required Components to Use the MPM82504 GUI

Item	Part Number	Quantity
EVB	EVM82504-BH-02A	1
PMBus kit	EVKT-USBI2C-02	1
USB cable	-	1
PMBus wire	-	1

2. Connect the PMBus wires to the EVB.
3. Click “Virtual Bench Pro.exe”, then add the device (see Figure 4).

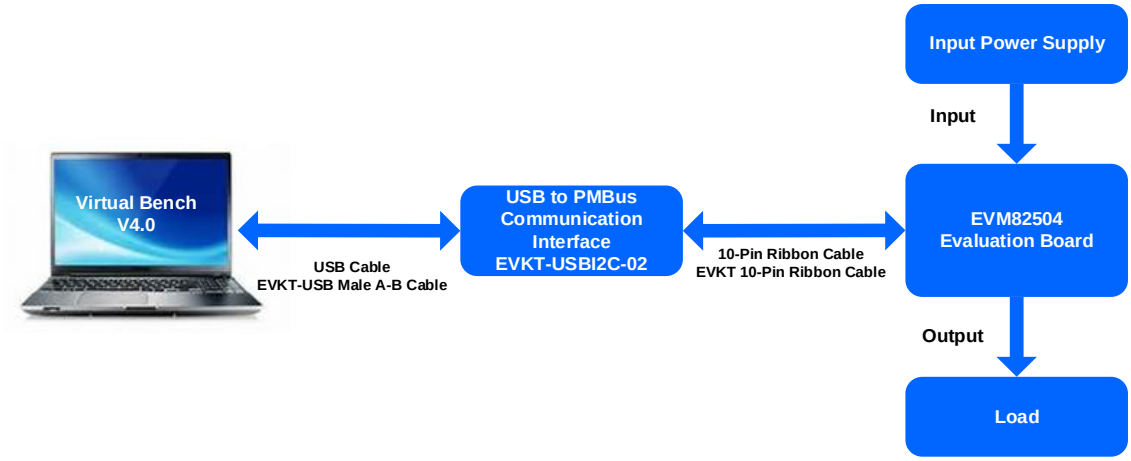


Figure 4: Configuration to Use the MPM82504 GUI

4. When the part is found, the part number will be shown on the screen. The GUI allows users to modify the module’s internal parameters. For more register details, refer to the MPM82504 datasheet.
5. The operating conditions, including the output voltage (V_{OUTx}), input voltage (V_{IN}), output current (I_{OUT}), and temperature, can be monitored on the right-side panel of the GUI (see Figure 5).

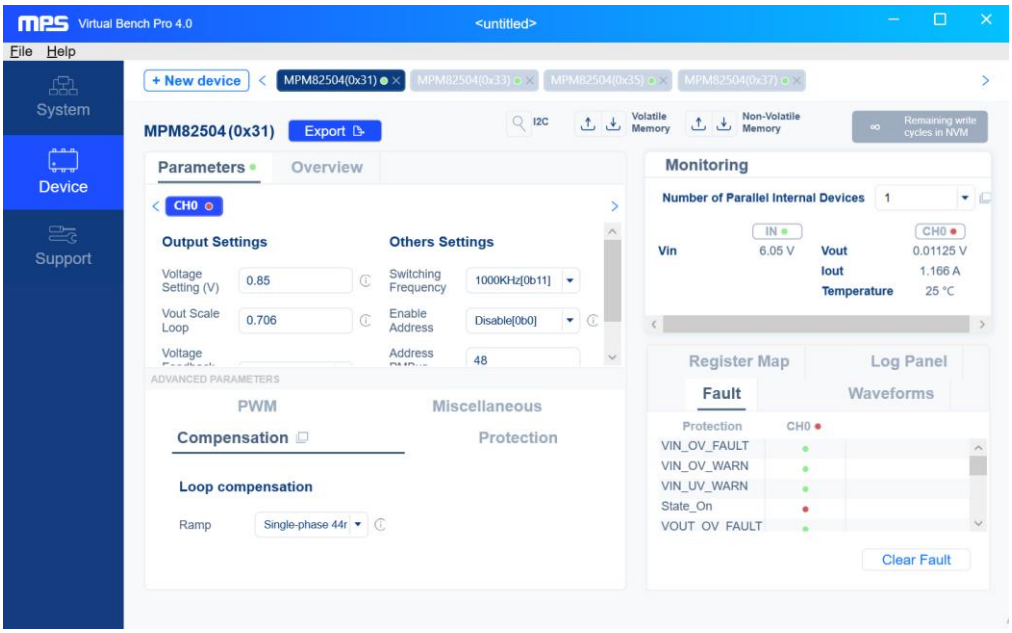


Figure 5: MPM82504 GUI Screen

EVALUATION BOARD SCHEMATIC

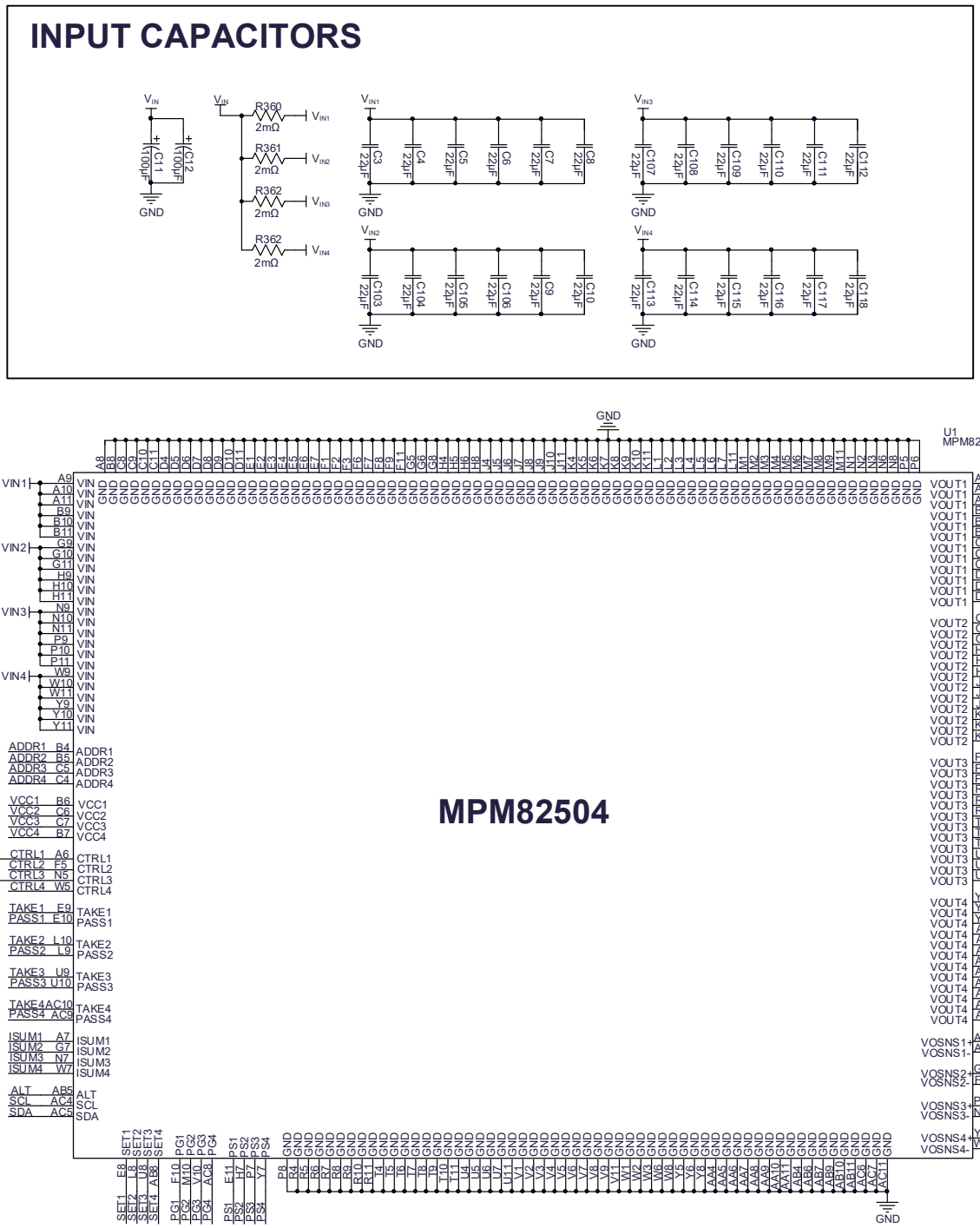


Figure 6: Evaluation Board Schematic for Operation Mode A (Part 1)

EVALUATION BOARD SCHEMATIC *(continued)*

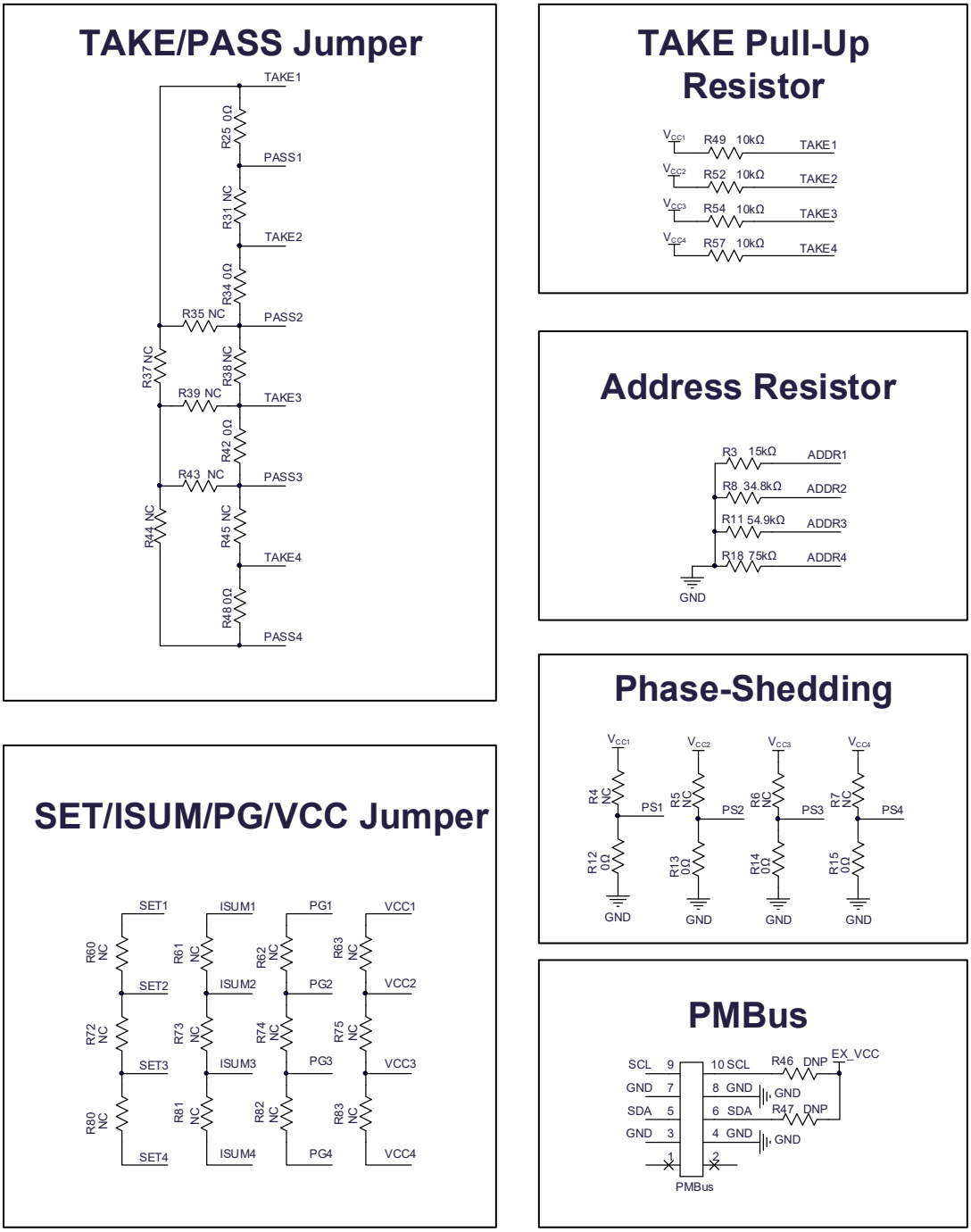


Figure 7: Evaluation Board Schematic for Operation Mode A (Part 2)

EVALUATION BOARD SCHEMATIC *(continued)*

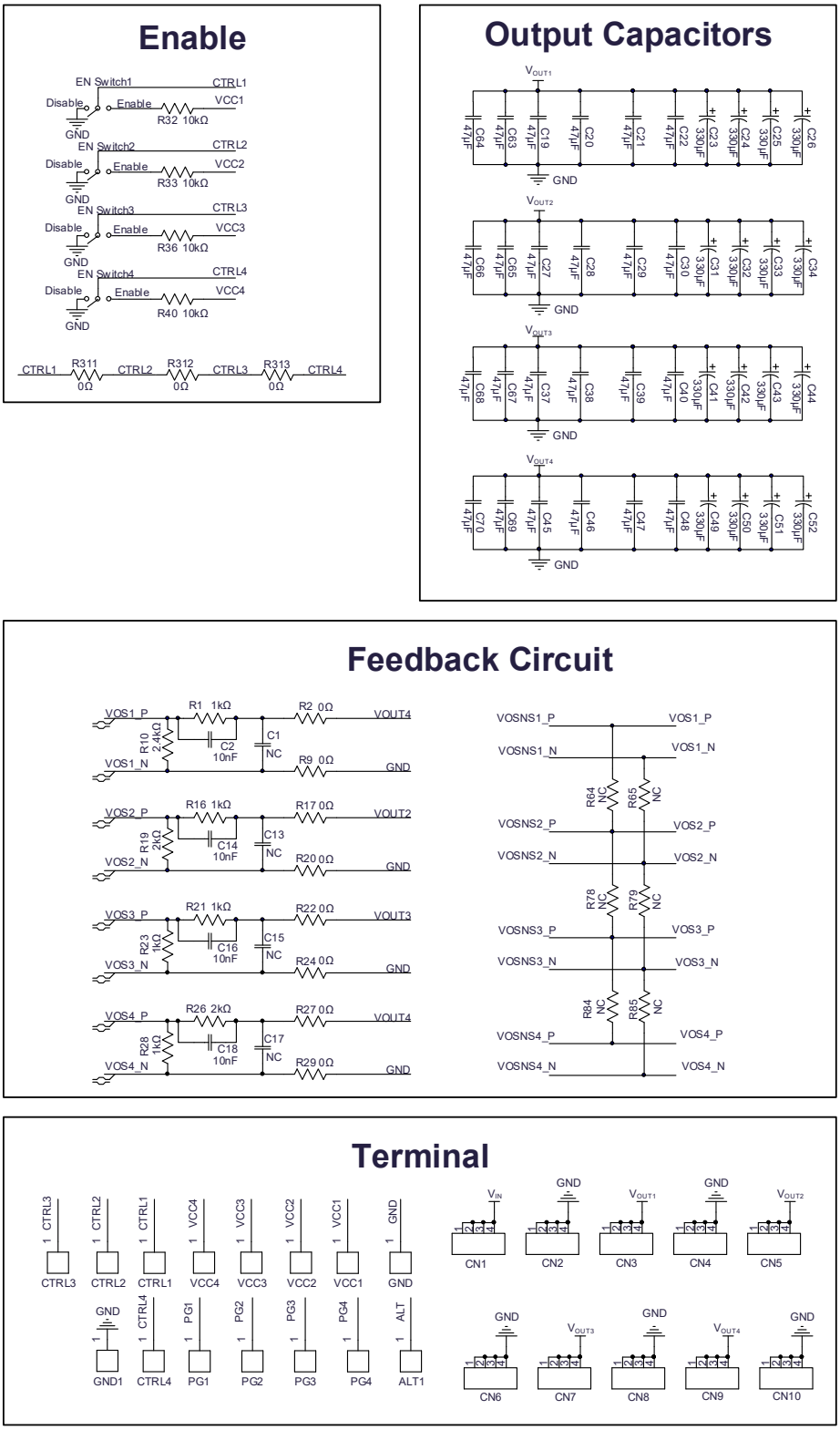


Figure 8: Evaluation Board Schematic for Operation Mode A (Part 3)

EVALUATION BOARD SCHEMATIC *(continued)*

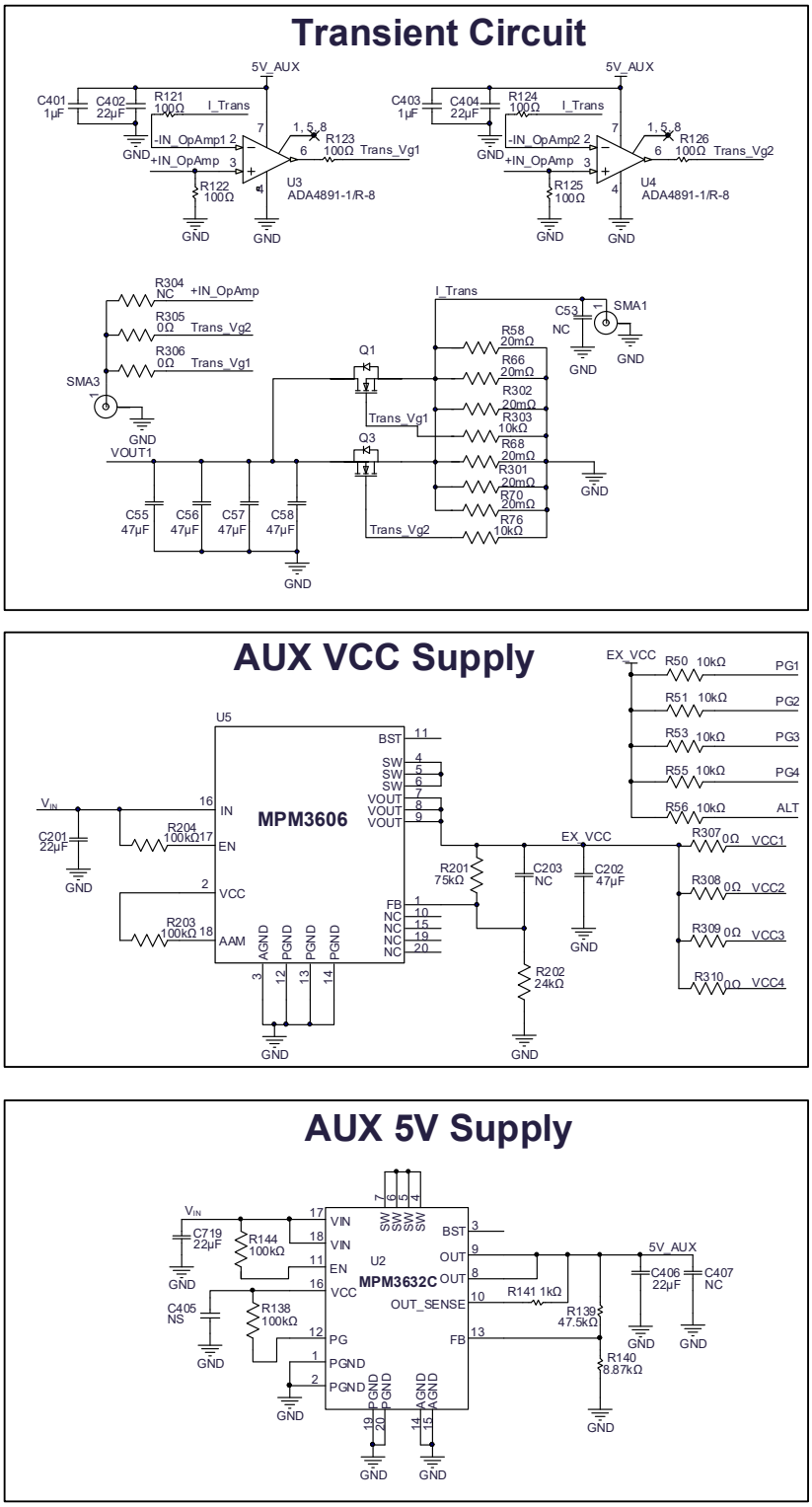


Figure 9: Evaluation Board Schematic for Operation Mode A (Part 4)

EVM82504-BH-02A BILL OF MATERIALS

Required Components

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
15	ALT1, CTRL1, CTRL2, CTRL3, CTRL4, GND, GND1, PG1, PG2, PG3, PG4, VCC1, VCC2, VCC3, VCC4	φ1.0	φ1.0 copper pin	DIP	Custom	
2	C35, C36	1μF	Ceramic capacitor, 25V, X7R	0603	Wurth	885012206076
1	C2	10nF	Ceramic capacitor, 50V, X7R	0603	Wurth	885012206089
28	C3, C4, C5, C6, C7, C8, C9, C10, C103, C104, C105, C106, C107, C108, C109, C110, C111, C112, C113, C114, C115, C116, C117, C118, C201, C406, C407, C719	22μF	Ceramic capacitor, 25V, X5R	0805	TDK	C2012X5R1E226 MT000E
1	C11	100μF	Capacitor, 100μF, 25V	OSCON E7	Panasonic	25SVPF100M
25	C19, C20, C21, C22, C27, C28, C29, C30, C37, C38, C39, C40, C45, C46, C47, C48, C63, C64, C65, C66, C67, C68, C69, C70, C202	47μF	Ceramic capacitor, 6.3V, X5R	0805	Murata	GRM21BR60J476 ME15L
8	C25, C26, C31, C32, C42, C44, C49, C50	330μF	POSCAP capacitor, 330μF, 6.3V, D2	OSCON D7	Panasonic	6TPE330ML
10	CN1, CN2, CN3, CN4, CN5, CN6, CN7, CN8, CN9, CN10	7.87mmx 7.87mmx 5.33mm	Power connector	DIP	Keystone	KEYSTONE7697-75
4	EN switch 1, EN switch 2, EN switch 3, EN switch 4	10mmx 2.5mmx 6.4mm	Switch	DIP	Wurth	450301014042
1	PMBus	12.7mmx 5.08mm	Header, 5x2	DIP	Custom	
7	R32, R33, R36, R40, R49, R50, R56	10kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0710KL
2	R2, R9	0Ω	Film resistor, 1%	0603	Yageo	RC0603FR-070RL
1	R202	24kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0724KL
1	R201	75kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0775KL
4	R138, R144, R203, R204	100kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07100KL

EVM82504-BH-02A BILL OF MATERIALS *(continued)*

Required Components

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	R3	15kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0715KL
1	R10	2.4kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-072K4L
1	R139	47.5kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0747K5L
1	R140	8.87kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-078K87L
2	R1, R141	1kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-071KL
4	R360, R361, R362, R363	2mΩ	Film resistor, 1%	2512	Yageo	PA2512FKF070R002E
1	U1	MPM82504	16V, quad 25A, scalable, DC/DC power module with a PMBus interface	BGA	MPS	MPM82504GBH
1	U2	MPM3632C	18V input, 3A, synchronous step-down converter power module with an integrated inductor	QFN-20 (3mmx 5mm)	MPS	MPM3632GQV
1	U5	MPM3606	21V input, 0.6A, synchronous step-down converter power module with an integrated inductor	QFN-20 (3mmx 5mm)	MPS	MPM3606GVQ

Optional Materials in Mode A

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
3	C14, C16, C18	10nF	Ceramic capacitor, 50V, X7R	0603	Wurth	885012206089
6	R51, R52, R53, R54, R55, R57	10kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0710KL
10	R17, R20, R22, R24, R25, R27, R29, R34, R42, R48	0Ω	Film resistor, 1%	0603	Yageo	RC0603FR-070RL
1	R8	34.8kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0734K8L
1	R11	54.9kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0754K9L
1	R18	75kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0775KL
2	R19, R26	2kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-072KL
4	R16, R21, R23, R28	1kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-071KL

EVM82504-BH-02A BILL OF MATERIALS *(continued)*

Optional Materials in Mode B

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
2	C16, C18	10nF	Ceramic capacitor, 10nF, 50V, X7R	0603	Wurth	885012206089
4	R53, R54, R55, R57	10kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0710KL
11	R22, R24, R27, R29, R31, R35, R42, R48, R62, R63, R311	0Ω	Film resistor, 1%	0603	Yageo	RC0603FR-070RL
4	R60, R61, R64, R65	0Ω	Film resistor, 1%	0402	Yageo	RC0402FR-070RL
1	R8	15kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0715KL
1	R10	2.4kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-072K4L
1	R11	54.9kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0754K9L
1	R18	75kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0775KL
1	R26	2kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-072KL
3	R21, R23, R28	1kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-071KL

Optional Materials in Mode C

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	C16	10nF	Ceramic capacitor, 10nF, 50V, X7R	0603	Wurth	885012206089
2	R53, R54	10kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0710KL
13	R22, R24, R31, R35, R39, R44, R45, R62, R63, R82, R83, R311, R313	0Ω	Film resistor, 1%	0603	Yageo	RC0603FR-070RL
8	R60, R61, R64, R65, R80, R81, R84, R85	0Ω	Film resistor, 1%	0402	Yageo	RC0402FR-070RL
1	R8	15kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0715KL
2	R11, R18	54.9kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0754K9L
2	R21, R23	1kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-071KL

Optional Materials in Mode D

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	C18	10nF	Ceramic capacitor, 10nF, 50V, X7R	0603	Wurth	885012206089
2	R55, R57	10kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0710KL
13	R27, R29, R31, R37, R38, R43, R48, R62, R63, R74, R75, R311, R312	0Ω	Film resistor, 1%	0603	Yageo	RC0603FR-070RL
8	R60, R61, R64, R65, R72, R73, R78, R79	0Ω	Film resistor, 1%	0402	Yageo	RC0402FR-070RL
2	R8, R11	15kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0715KL
1	R18	75kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0775KL
1	R26	2kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-072KL
1	R28	1kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-071KL

EVM82504-BH-02A BILL OF MATERIALS *(continued)*

Optional Materials in Mode E

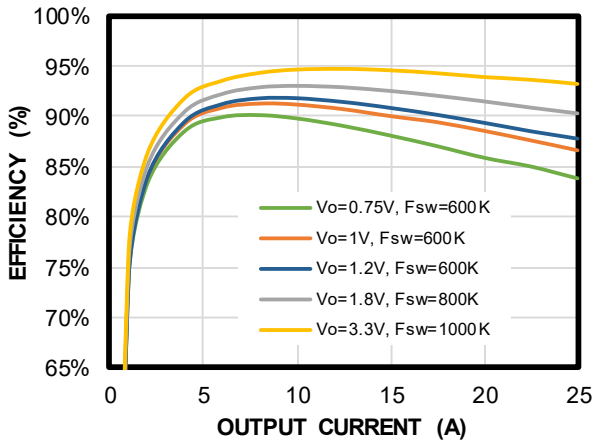
Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
13	R31, R37, R38, R44, R45, R62, R63, R74, R75, R82, R83, R311, R312, R313	0Ω	Film resistor, 1%	0603	Yageo	RC0603FR-070RL
12	R60, R61, R64, R65, R72, R73, R78, R79, R80, R81, R84, R85	0Ω	Film resistor, 1%	0402	Yageo	RC0402FR-070RL
3	R8, R11, R18	15kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0715KL

EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board, operation mode A, V_{IN} = 12V, T_A = 25°C, unless otherwise noted.

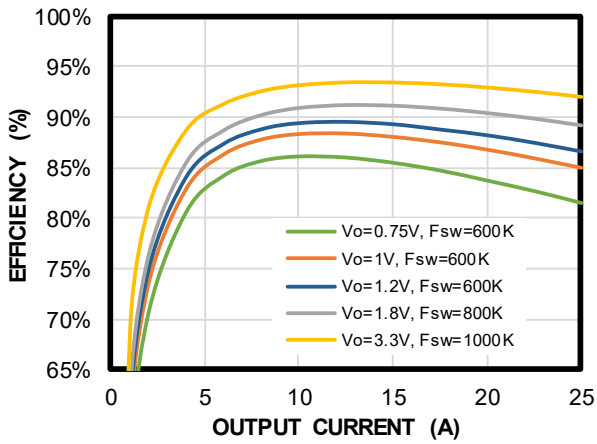
12V Efficiency vs. Output Current

Single channel with external 3.3V VCC and cooling fan



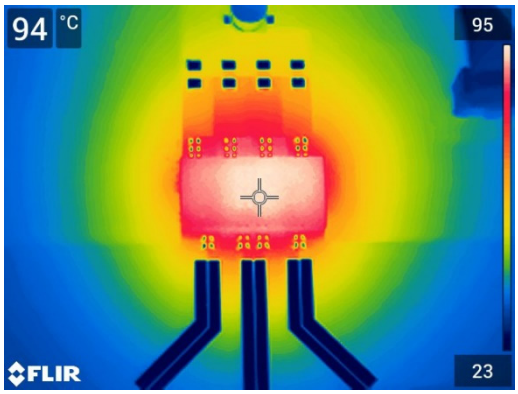
5V Input Efficiency vs. Output Current

Single channel with external 3.3V VCC and 2m/s air flow



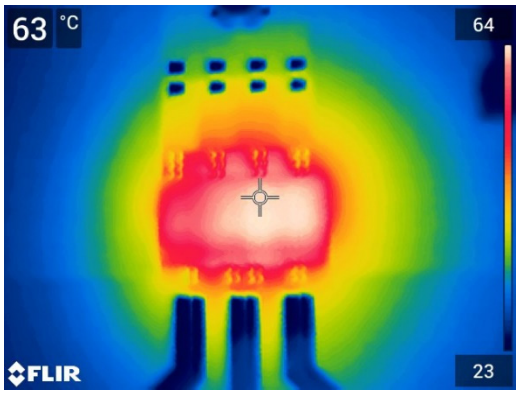
Thermal Performance

V_{OUT1} = 0.85V, V_{OUT2} = 0.9V, V_{OUT3} = 1.2V, V_{OUT4} = 1.8V, I_{OUT1}/I_{OUT2}/I_{OUT3}/I_{OUT4} = 20A, without air flow



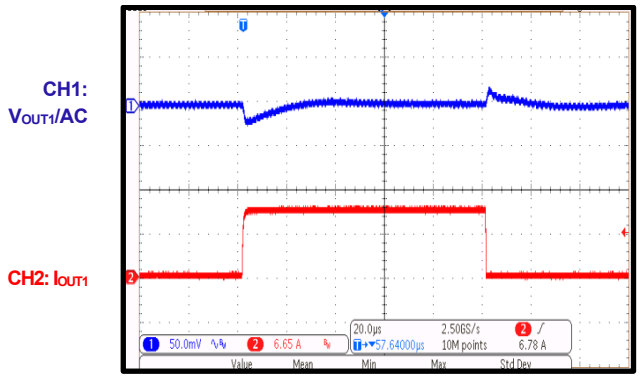
Thermal Performance

V_{OUT1} = 0.85V, V_{OUT2} = 0.9V, V_{OUT3} = 1.2V, V_{OUT4} = 1.8V, I_{OUT1}/I_{OUT2}/I_{OUT3}/I_{OUT4} = 20A, with 2m/s air flow



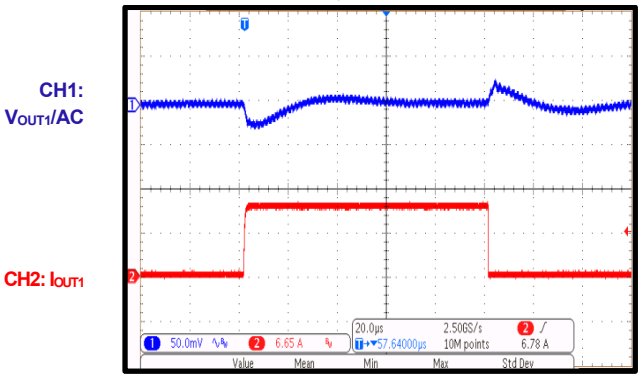
Transient

V_{OUT1} = 0.85V, step = 0A to 10A, slew rate = 10A/µs, f_{SW} = 600kHz, RAMP = 15.1mV, C_{OUT} = 10 x 47µF MLCC + 2 x 330µF POSCAP, undershoot = -23mV, overshoot = 21mV



Transient

V_{OUT1} = 1.2V, step = 0A to 10A, slew rate = 10A/µs, f_{SW} = 600kHz, RAMP = 15.1mV, C_{OUT} = 10 x 47µF MLCC + 2 x 330µF POSCAP, undershoot = -27mV, overshoot = 29mV

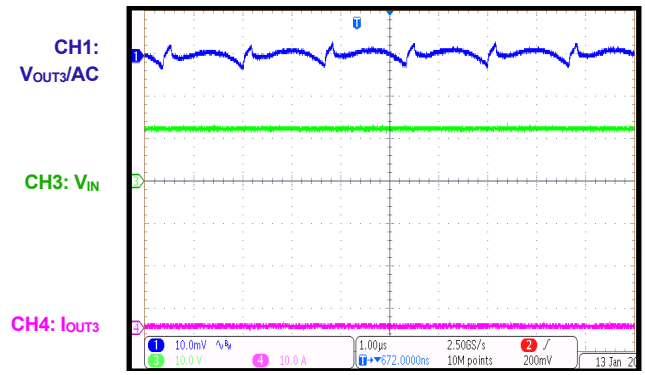


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, operation mode A, V_{IN} = 12V, T_A = 25°C, unless otherwise noted.

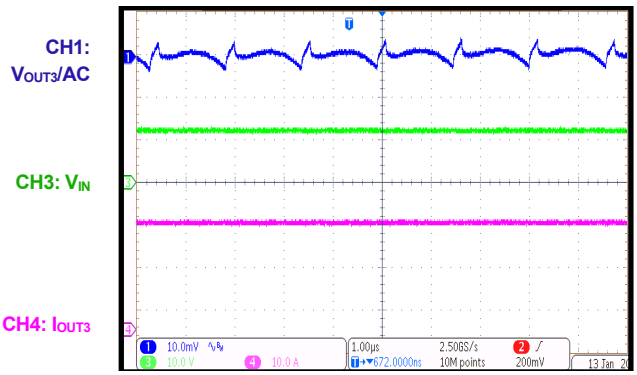
Steady Ripple

V_{OUT3} = 1.2V, I_{OUT3} = 0A,
capacitor = 6 x 47μF + 330μF



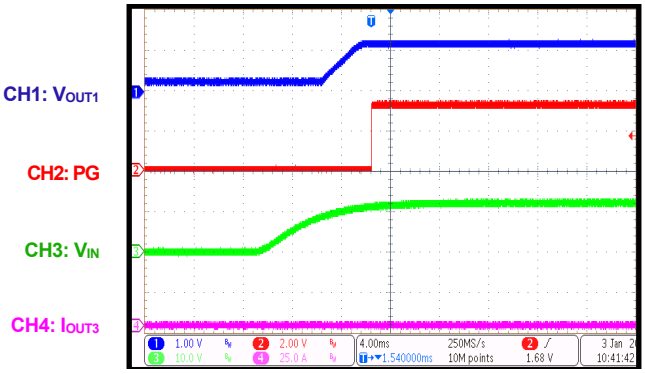
Steady Ripple

V_{OUT3} = 1.2V, I_{OUT3} = 25A,
capacitor = 6 x 47μF + 330μF



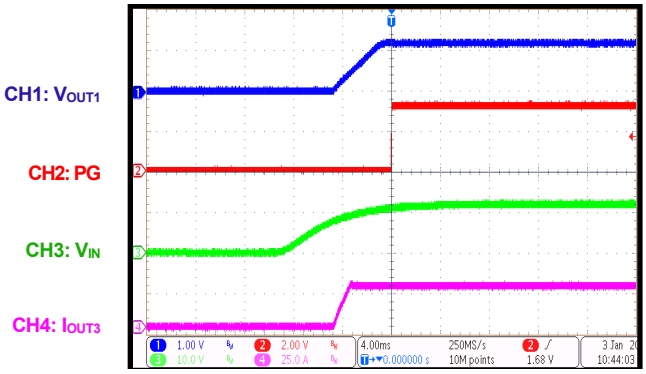
Start-Up through VIN

V_{OUT3} = 1.2V, I_{OUT3} = 0A



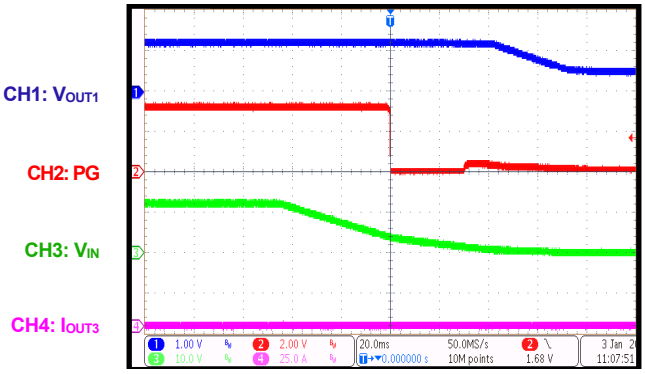
Start-Up through VIN

V_{OUT3} = 1.2V, I_{OUT3} = 25A



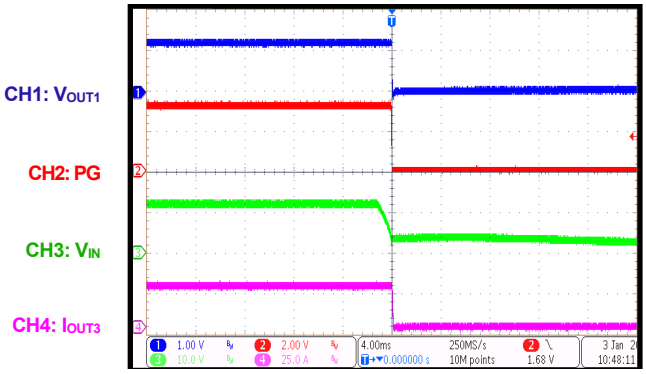
Shutdown through VIN

V_{OUT3} = 1.2V, I_{OUT3} = 0A



Shutdown through VIN

V_{OUT3} = 1.2V, I_{OUT3} = 0A



PCB LAYOUT

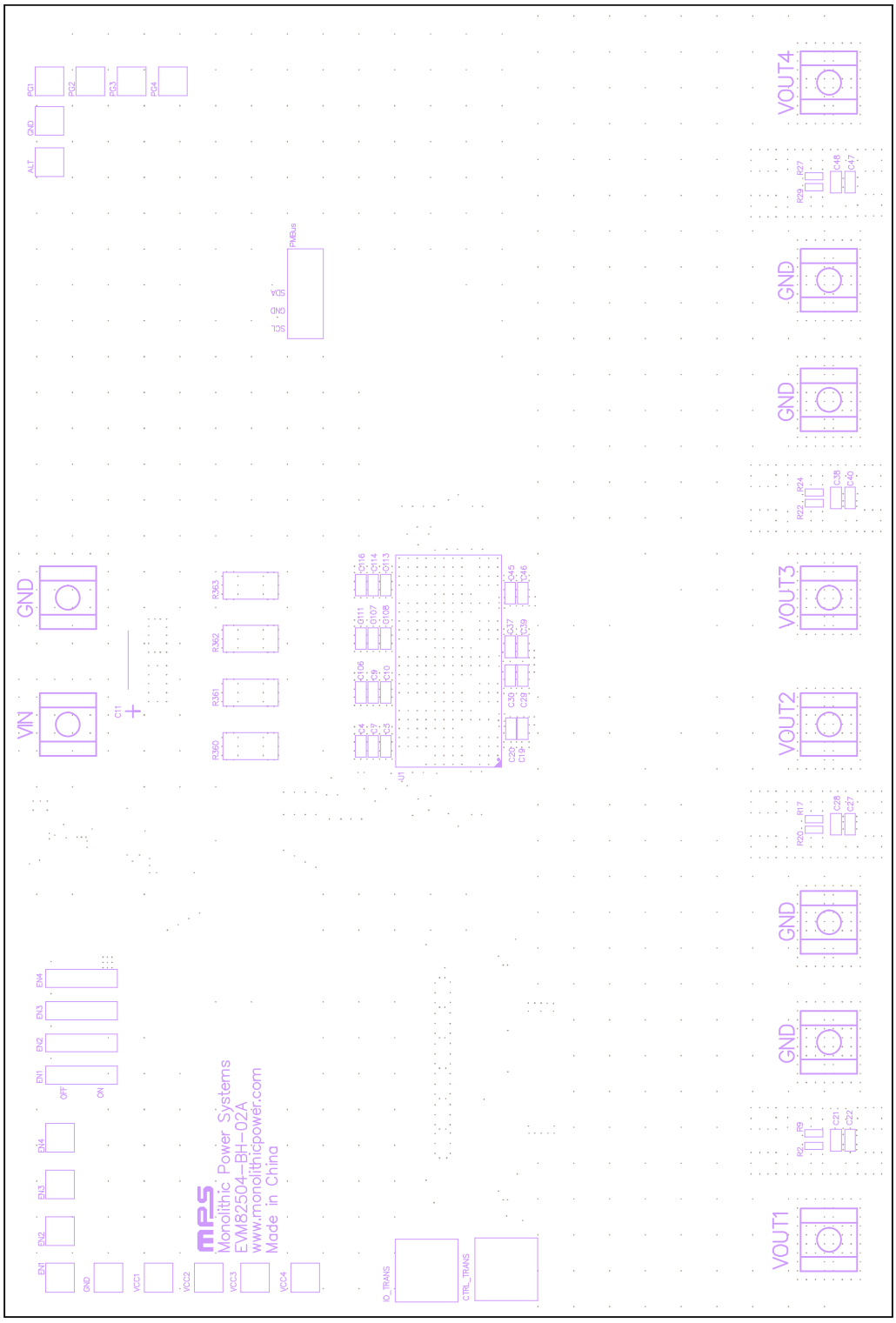


Figure 10: Top Silk

PCB LAYOUT *(continued)*

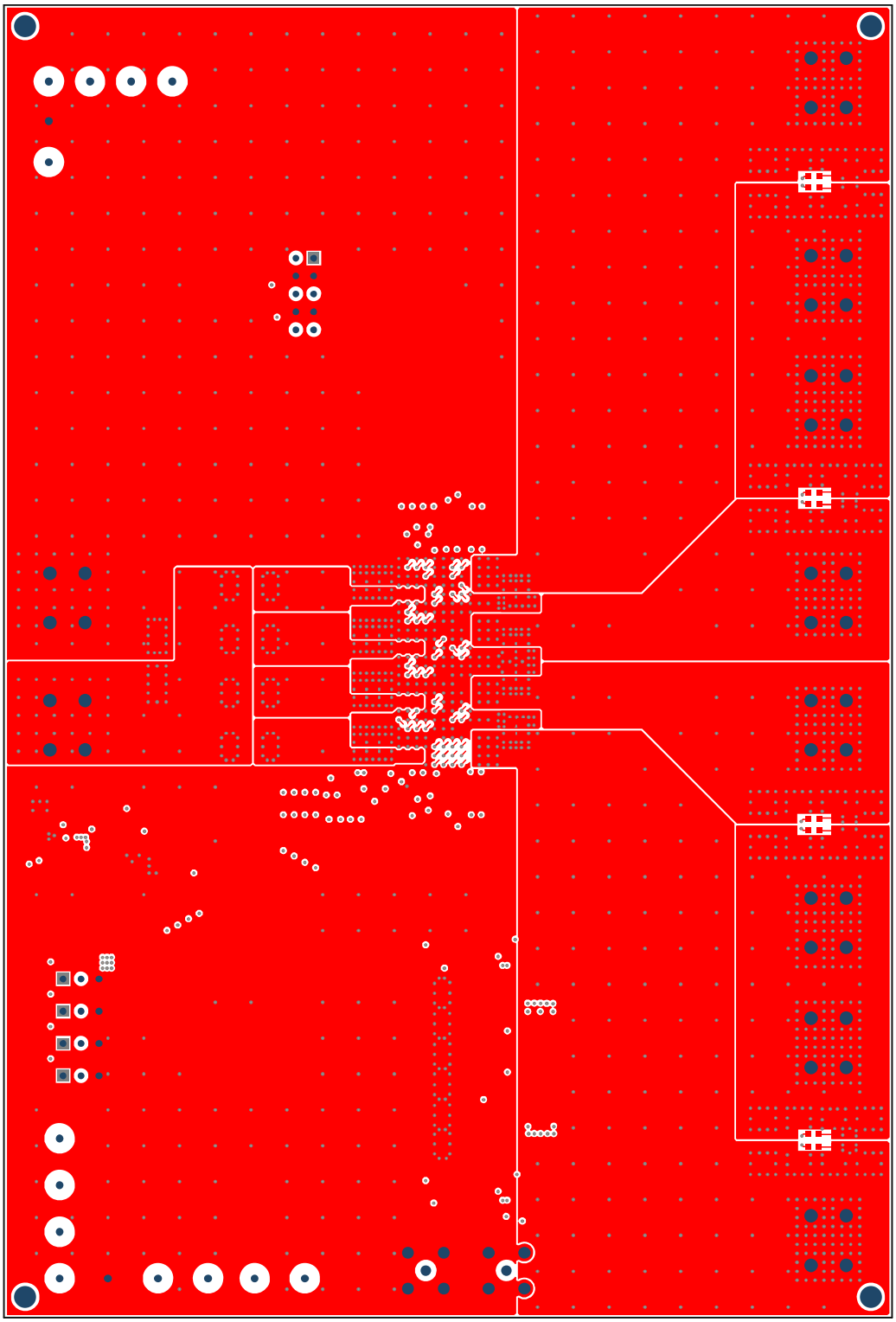


Figure 11: Top Layer

PCB LAYOUT *(continued)*

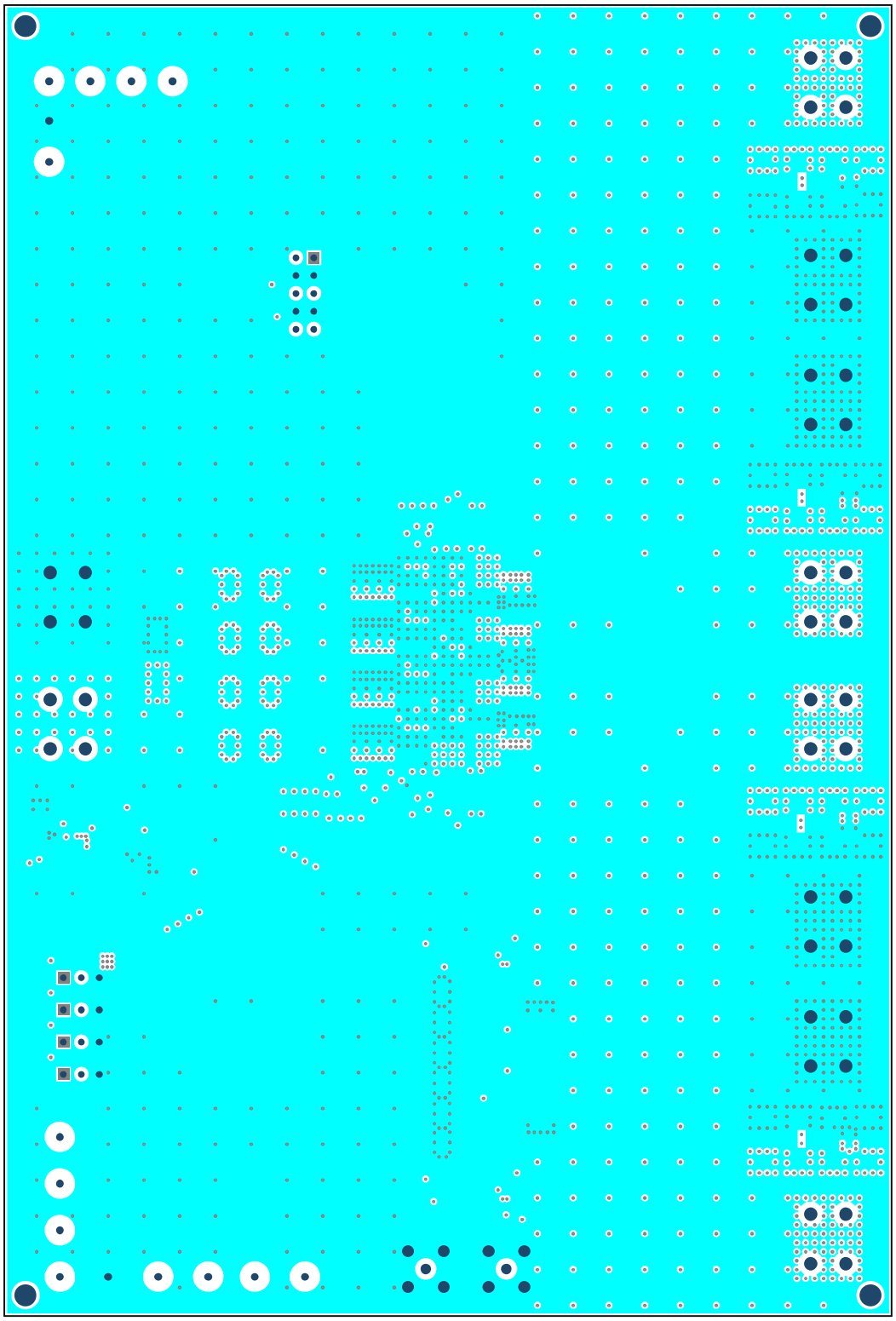


Figure 12: Mid-Layer 1

PCB LAYOUT *(continued)*

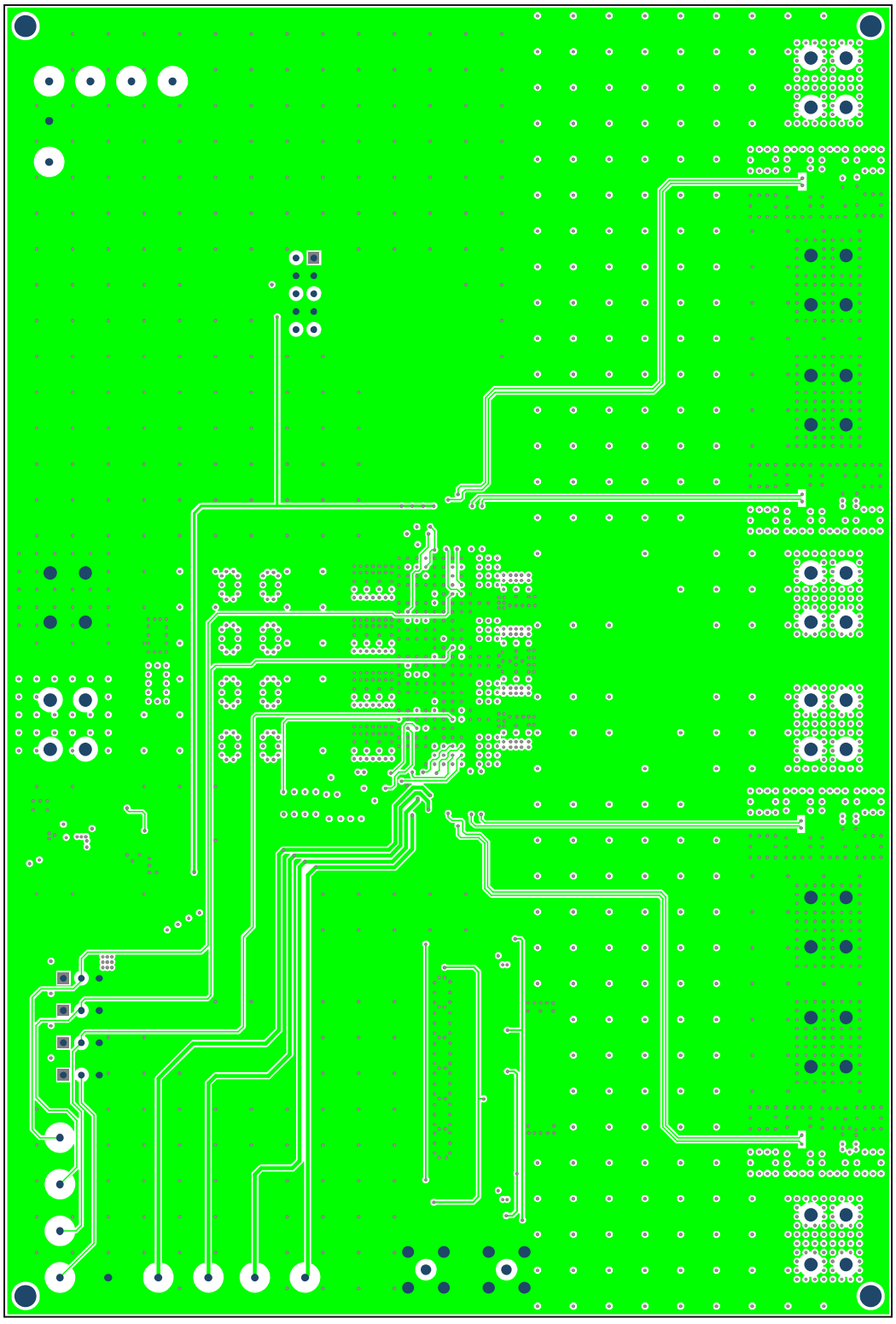


Figure 13: Mid-Layer 2

PCB LAYOUT *(continued)*

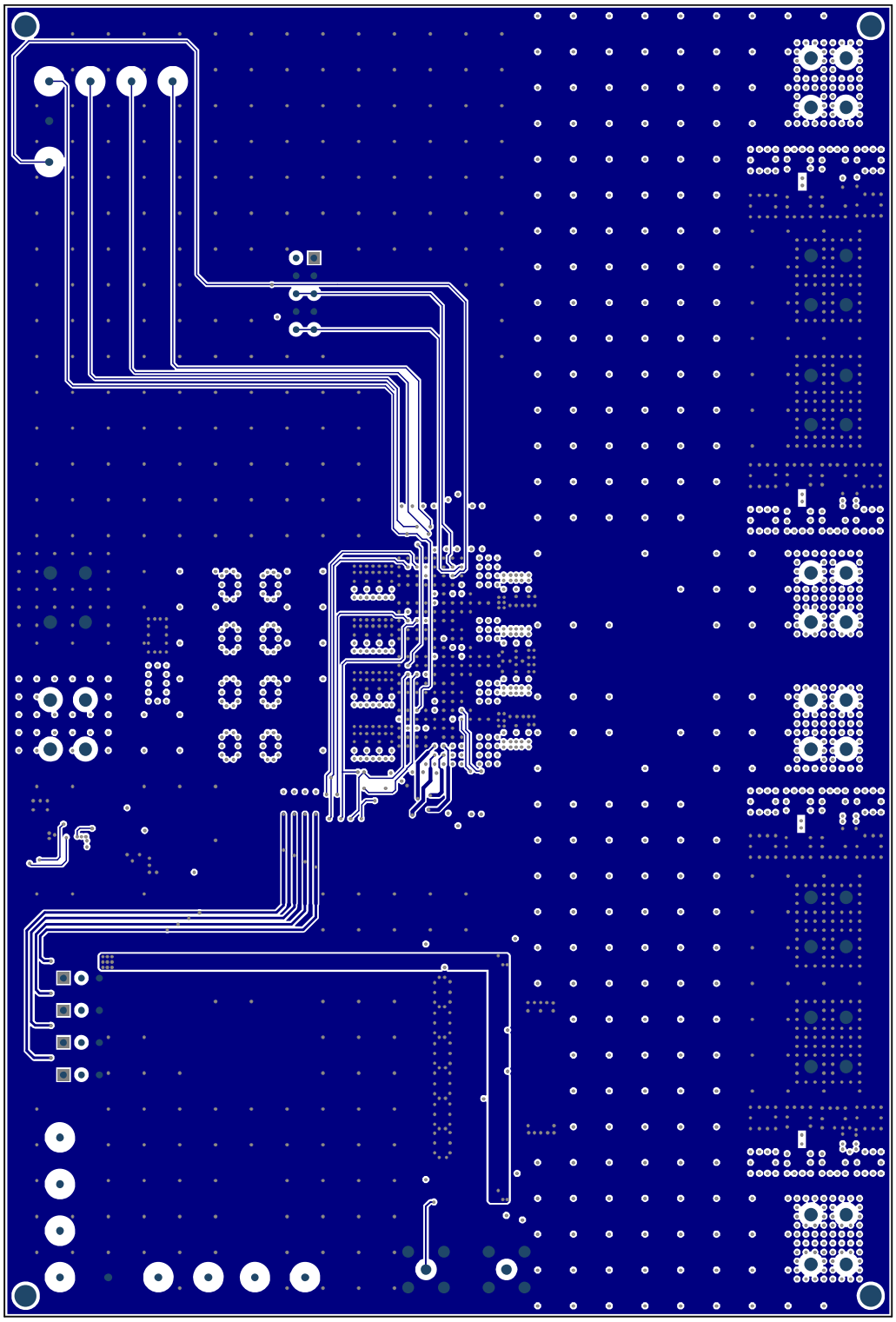


Figure 14: Mid-Layer 3

PCB LAYOUT *(continued)*

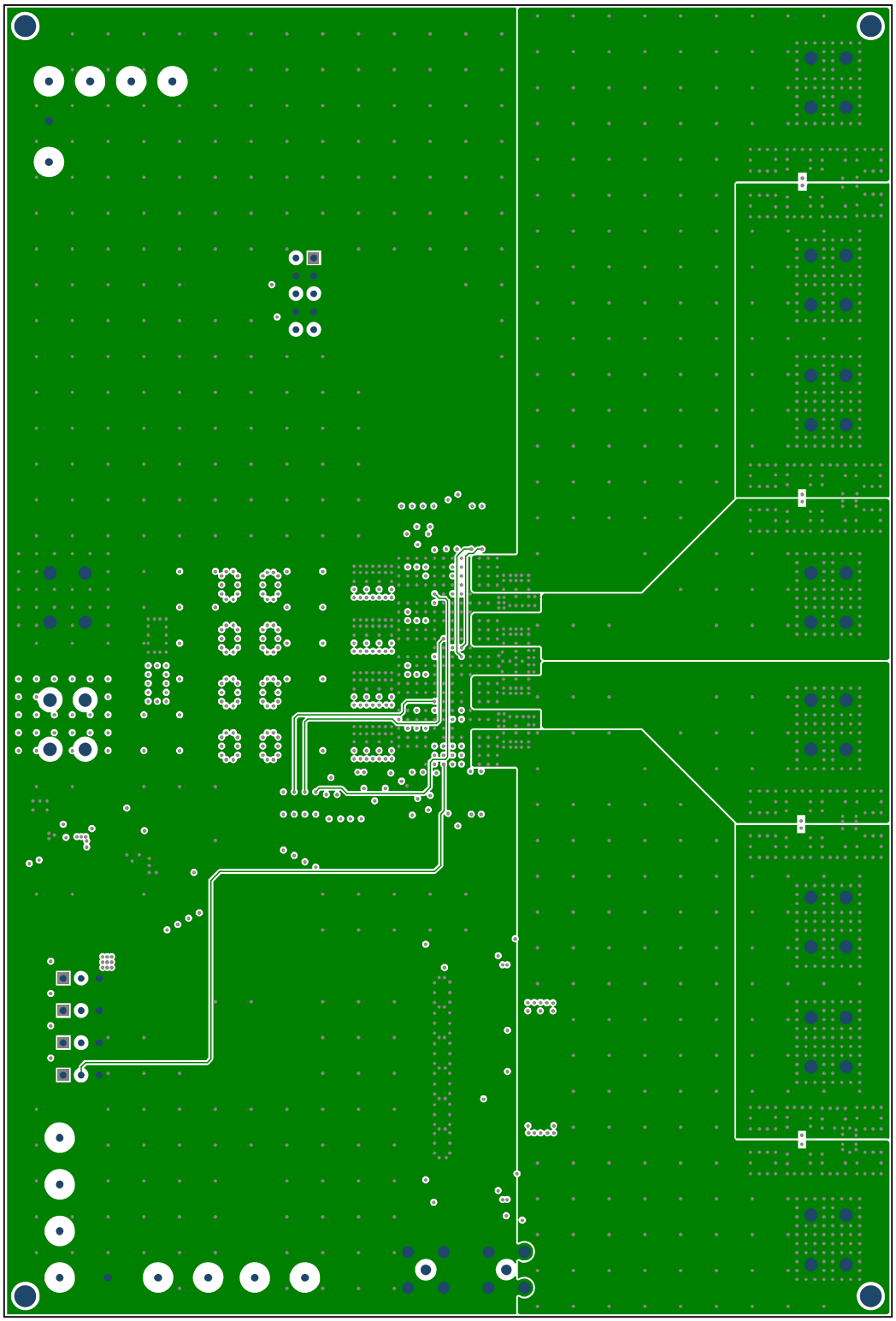


Figure 15: Mid-Layer 4

PCB LAYOUT *(continued)*

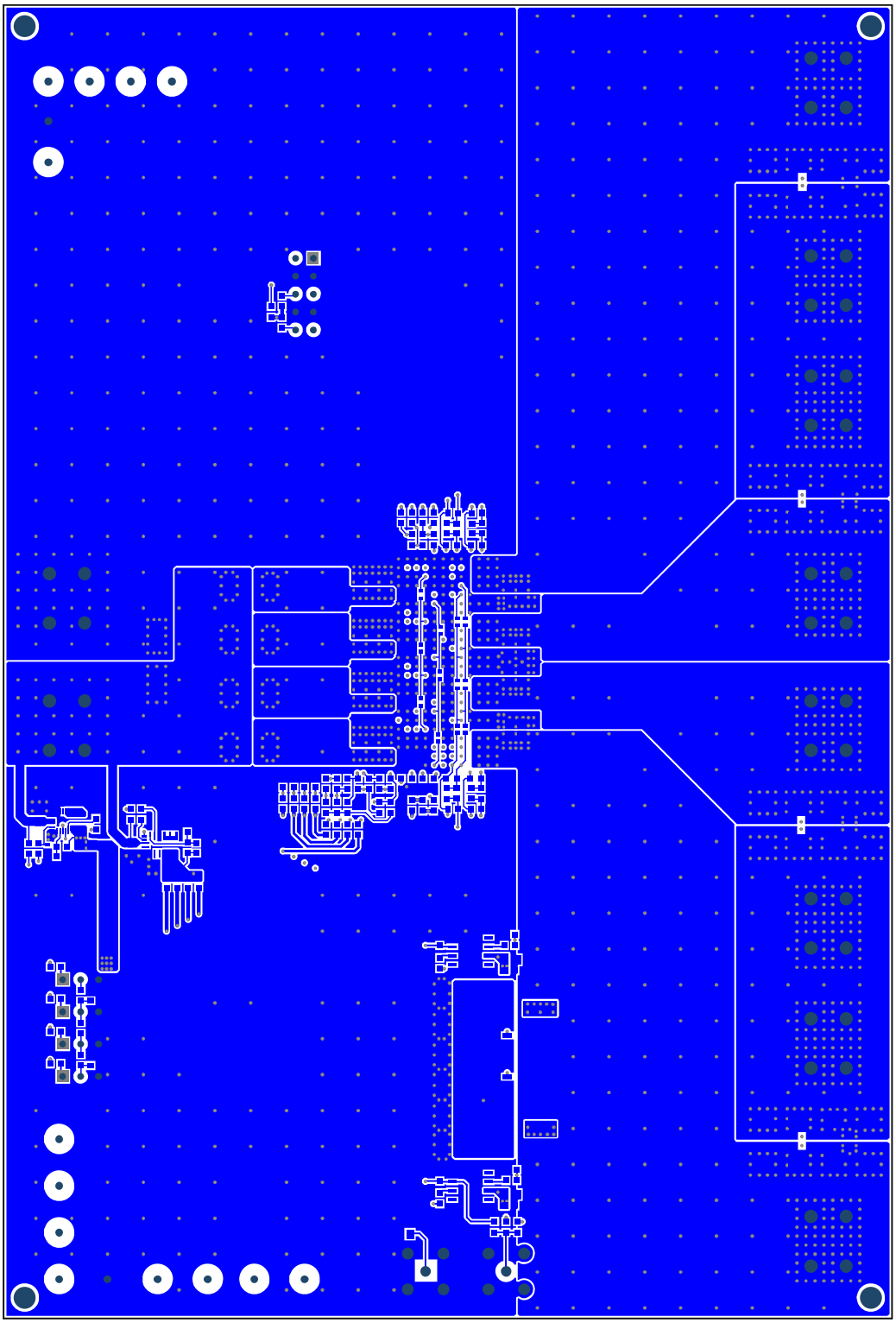


Figure 16: Bottom Layer

PCB LAYOUT *(continued)*

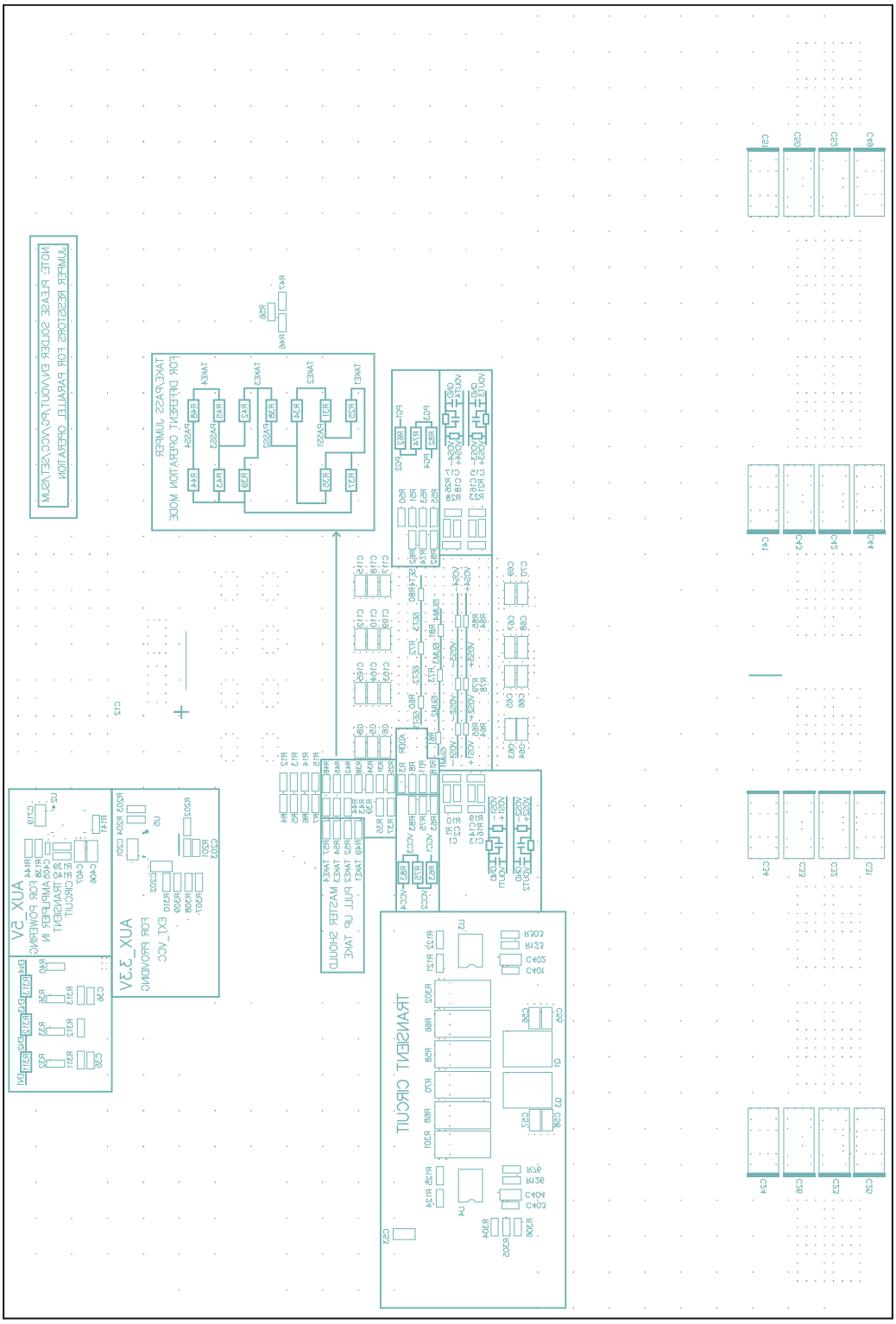


Figure 17: Bottom Silk

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	11/04/2021	Initial Release	-