EVM82504-BH-03A

Split-Input, 200A Output, High-Efficiency, Step-Down Module Evaluation Board

DESCRIPTION

The EVM82504-BH-03A is an evaluation board designed to demonstrate the capabilities of the MPM82504, a fully integrated, high-efficiency, synchronous, quad 25A, step-down power module. The MPM82504 can be paralleled to provide 50A, 75A, or 100A of output current (I_{OUT}).

The MPM82504 offers dual input supplies as a simple solution for applications such as PCIe cards. It can be easily configured to select between one or two input rails, depending on the application's power requirements.

Compared to the existing methods using O-ring circuits, the MPM82504 achieves higher efficiency as well as lower size and cost. The MPM82504 supports active current balancing with ±10% input voltage (V_{IN}) tolerance and tolerates uncontrolled V_{IN} start-up sequences. Refer to the MPM82504 datasheet for more detailed information.

It is recommended to read the MPM82504 datasheet prior to making any changes to the EVM82504-BH-03A.

PERFORMANCE SUMMARY (1)

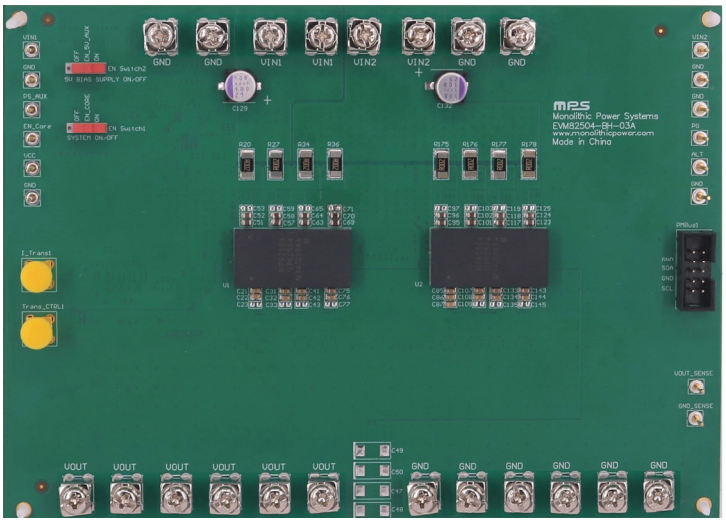
Specifications are at T_A = 25°C, unless otherwise noted.

Parameters	Conditions	Value
Input voltage (V_{IN1}) range (2)		10.8V to 13.2V
Input voltage (V_{IN2}) range (2)		10.8V to 13.2V
Output voltage (V_{OUT})	V_{IN1} = 10.8V to 13.2V, V_{IN2} = 10.8V to 13.2V	V_{OUT} = 0.85V (3)
Maximum output current (I_{OUT}) (both V_{IN1} and V_{IN2} are available)	V_{IN1} = 10.8V to 13.2V, V_{IN2} = 10.8V to 13.2V, V_{OUT} = 0.85V	200A
Maximum output current (I_{OUT}) (only V_{IN1} is available)	V_{IN1} = 10.8V to 13.2V, V_{IN2} open, V_{OUT} = 0.85V	50A
Default switching frequency (f_{SW})		600kHz (3)

Notes:

1) For different V_{IN} and V_{OUT} specifications with different output capacitors, the application circuit parameters may require changes.
2) Values are specified for dual-input applications. The MPM82504 supports 4V to 16V of V_{IN} for single-input applications.
3) V_{OUT} and f_{SW} are configurable. Refer to the MPM82504 datasheet for detailed information.

EVALUATION BOARD



LxWxH (18.6cmx13.3cmx1.5cm)

Board Number	MPS IC Number
EVM82504-BH-03A	MPM82504GBH

FUNCTIONAL BLOCK DIAGRAM

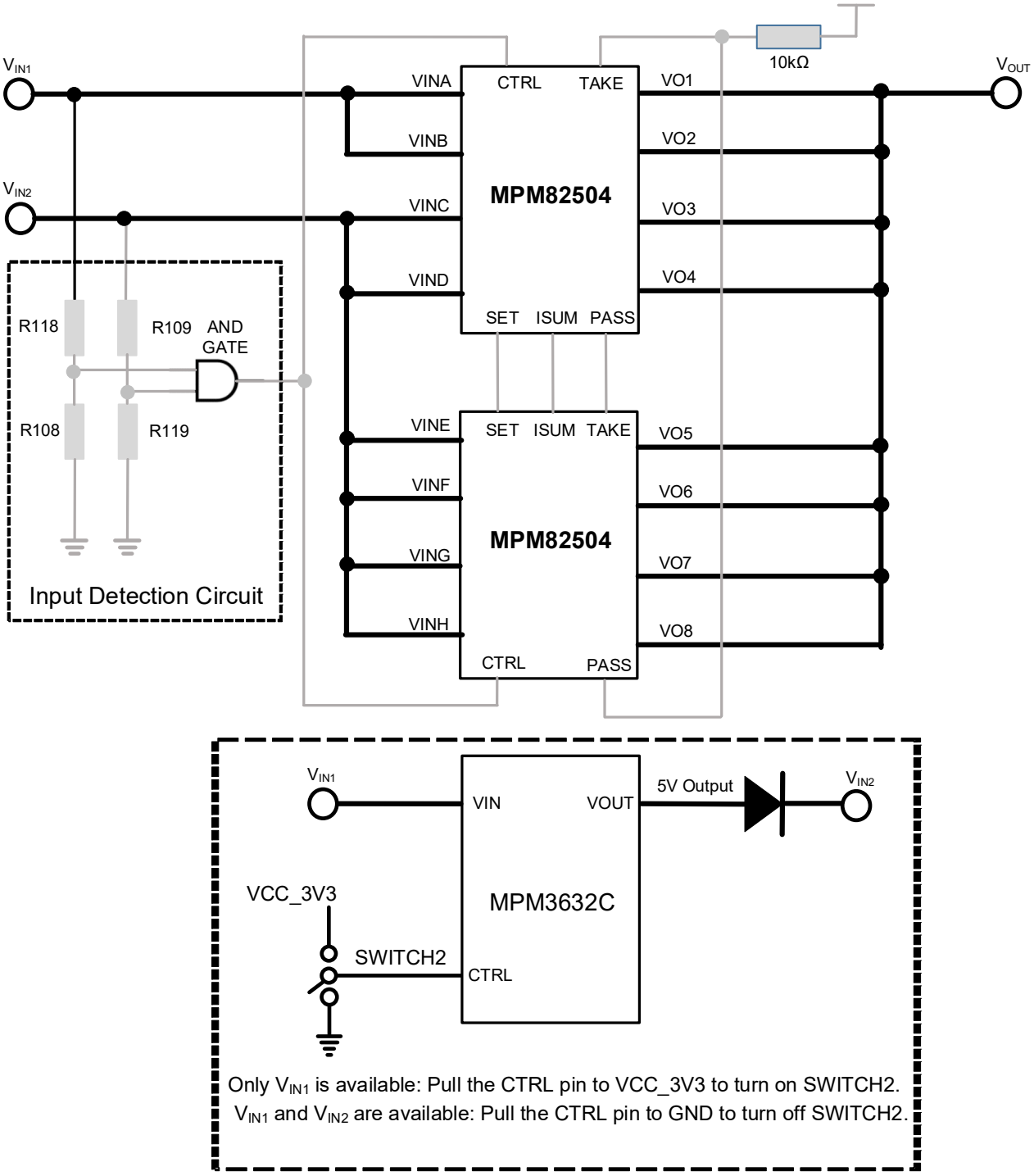


Figure 1: Functional Block Diagram

OPERATION MODES

Dual-input supplies are commonly used in PCIe applications where the PCIe edge connector can provide up to 75W of power, which limits the load current on a card. An auxiliary input power supply is used to increase the input power (P_{IN}) and allow a larger load to be installed on the card.

The EVM82504-BH-03A's dual-input architecture provides a single-stage solution that is easy to use in PCIe applications. The board supports two operation modes: dual-input mode and single-input mode.

Dual-input operation is the most commonly used mode. In this mode, supply power is taken from both inputs and the load on the PCIe card to operate at the full rated current.

Single-input operation is useful for an adaptive PCIe card design that must accommodate less common conditions where the auxiliary power supply is not available (unplugged) and only the PCIe edge connector is available. Under this condition, the PCIe card's load operates in a reduced current mode (up to 75W).

Dual-Input Mode (Power > 75W)

In dual-input mode, all phases of the paralleled MPM82504 are switching to provide full power and take power from both inputs. The system achieves an active current balance up to ±10% the input voltage (V_{IN}) tolerance of 12V, and it tolerates uncontrolled V_{IN} start-up sequences. The EVM82504-BH-03A can support a total of 200A (50A from V_{IN1} and 150A from V_{IN2}) in dual-input mode. Additional MPM82504s can be paralleled to provide higher current ratings.

Single-Input Mode (Power < 75W)

In single-input mode, only V_{IN1} is available, while V_{IN2} is unplugged. Phases powered by V_{IN1} are switching, while phases connected to V_{IN2} enter a low-power mode where switching is disabled. To keep the control circuit active, a 5V bias supply (the MPM3632C) is connected to V_{IN2} through a diode to power the logic and control circuit of the phases connected to V_{IN2}. The EVM82504-BH-03A can support a maximum output of 50A in single-input mode.

5V Bias Supply Control (MPM3632C)

SWITCH2 manually controls the 5V bias supply on the EVM82504-BH-03A. A standard 6-pin/8-pin PCIe AUX power connector has the SENSE pin, which indicates whether the AUX power cable is plugged in (see Table 1). The SENSE signal is pulled up to 3.3V through a 10kΩ resistor, and can be used to drive the MPM3632C's CTRL pin (see Figure 4). When no AUX power cable is detected, the 5V bias supply is required. When an AUX power cable is detected, the 5V bias supply is not required.

Table 1 shows the 6-pin connections.

Table 1: 6-Pin Connector (75W)

Pin	Description
1	12V
2	NC (typically 12V)
3	12V
4	GND
5	SENSE
6	GND

Figure 2 shows the 6-pin power connector.

Figure 2: 6-Pin Power Connector

Table 2 shows the 8-pin connections.

Table 2: 8-Pin Connector (150W)

Pin	Description
1	12V
2	12V
3	12V
4	SENSE1 (8-pin connected)
5	GND
6	SENSE0 (6-pin or 8-pin connected)
7	GND
8	GND

Figure 3 shows the 8-pin power connector.

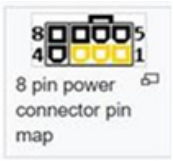
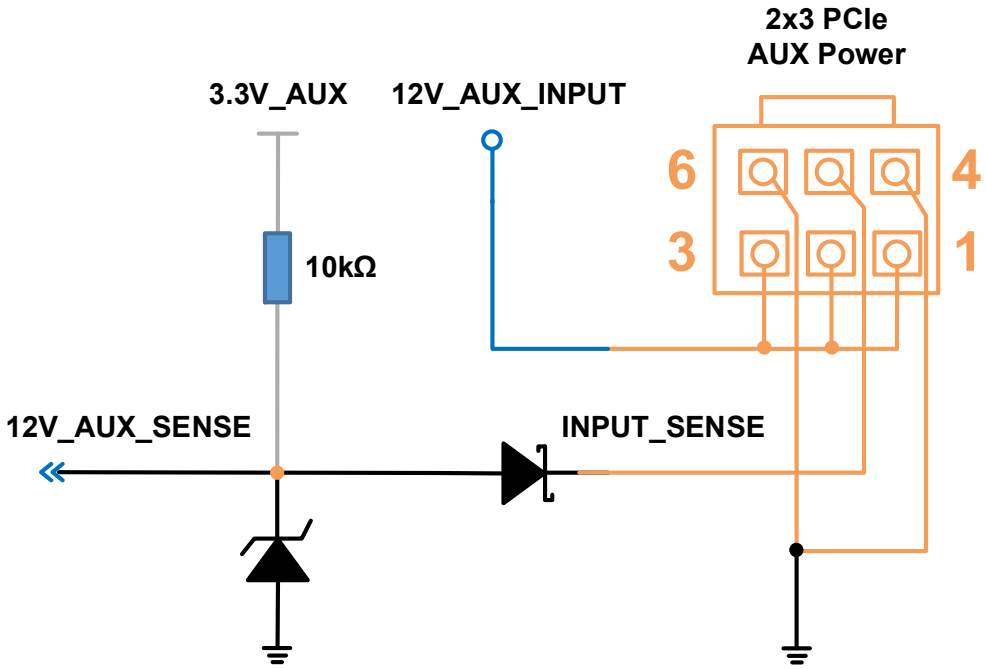


Figure 3: 8-Pin Power Connector

Figure 4 shows the function of the SENSE pin.



The standard 6-pin/8-pin PCIe AUX power connector has a SENSE pin, which indicates whether the AUX power cable is plugged in. SENSE helps control SWITCH2.

Figure 4: Function of SENSE Pin

QUICK START GUIDE FOR DUAL-INPUT MODE

The EVM82504-BH-03A evaluation board is easy to set up and use to evaluate the performance of the MPM82504. For proper measurement equipment set-up, refer to Figure 5 on page 7 and follow the steps below:

1. Preset the power supply (V_{IN1}, V_{IN2}) between 10.8V and 13.2V, then turn off the power supply. (4)
2. Connect the power supply (V_{IN1}) terminals to:
   a. Positive (+): VIN1
   b. Negative (-): GND
3. Connect the power supply (V_{IN2}) terminals to:
   a. Positive (+): VIN2
   b. Negative (-): GND
4. Connect the load terminals to: (5)
   a. Positive (+): VOUT
   b. Negative (-): GND
5. Turn off EN on the 5V bias supply (EN SWITCH2). This is the default setting.
6. After making the connections, turn on the power supply.
7. Turn on SWITCH1. The board should automatically start up.
8. Check for the proper output voltage (V_{OUT}) between the VOSENSE and VOGNDSEN terminals.
9. Once the proper V_{OUT} is established, adjust the load within the operating range and measure the efficiency, output ripple voltage, and other parameters. (6)
10. After completing all tests, adjust the load to 0A, then turn off the input power supply.

Notes:

4) Ensure that V_{IN} does not exceed 13.2V.
5) There is no initial load by default.
6) When measuring the output voltage ripple or input voltage ripple, do not use the oscilloscope probe's long ground lead.

EQUIPMENT SET-UP FOR DUAL-INPUT MODE

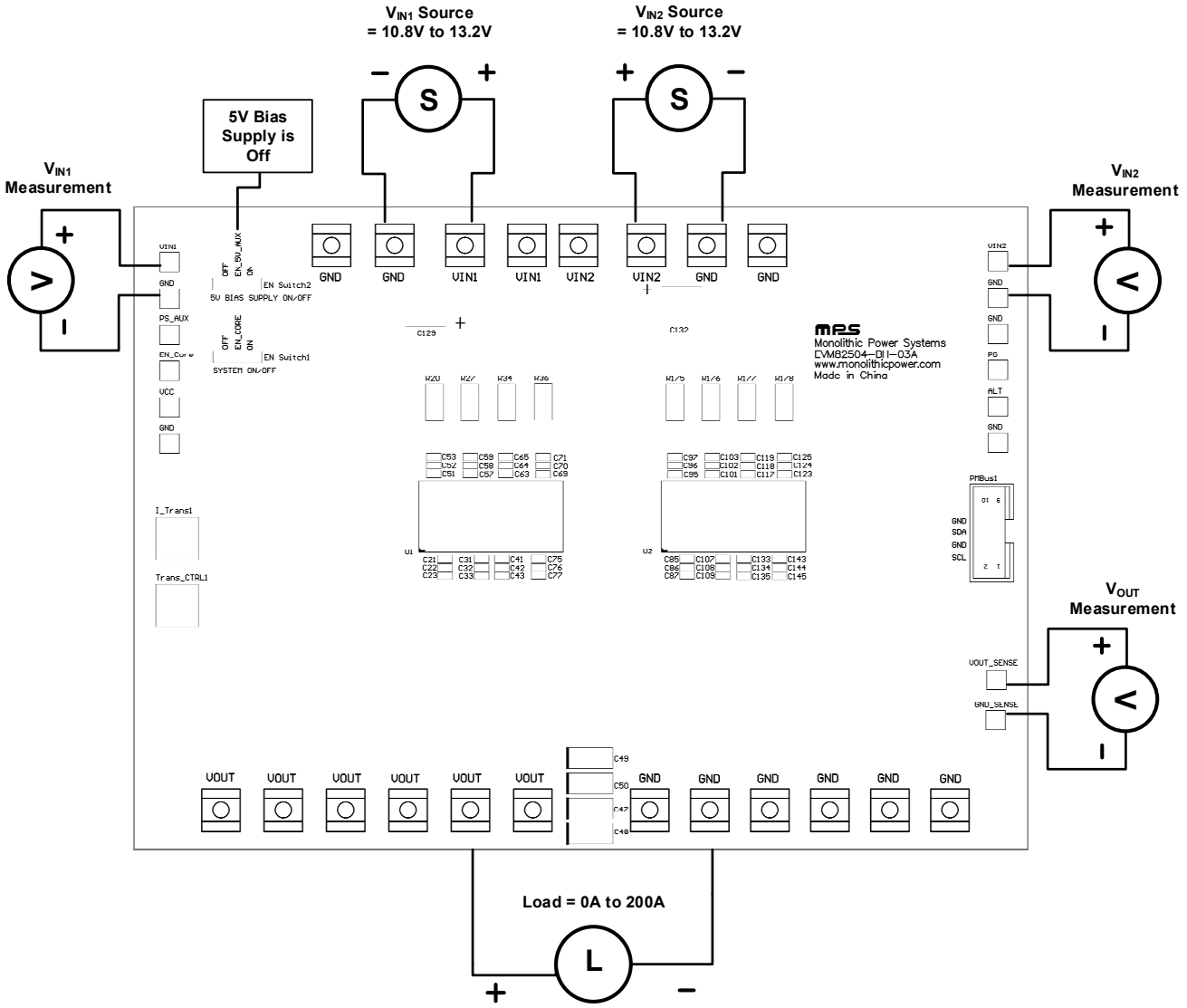


Figure 5: Measurement Equipment Set-Up for Dual-Input Mode

QUICK START GUIDE FOR SINGLE-INPUT MODE

The EVM82504-BH-03A evaluation board is easy to set up and use to evaluate the performance of the MPM82504. For proper measurement equipment set-up, refer to Figure 6 on page 9 and follow the steps below:

1. Preset the power supply (V_{IN1}) between 10.8V and 13.2V, then turn off the power supply. (7)
2. Connect the power supply (V_{IN1}) terminals to:
   a. Positive (+): VIN1
   b. Negative (-): GND
3. Connect the load terminals to: (8)
   a. Positive (+): VOUT
   b. Negative (-): GND
4. Turn on EN on the 5V bias supply (EN_SWITCH2). The MPM3632C generates a 5V bias voltage through a diode to power V_{IN2}.
5. After making the connections, turn on the power supply and SWITCH1. The board should automatically start up.
6. Check for the proper output voltage (V_{OUT}) between the VOSENSE and VOGNDSEN terminals.
7. Once the proper V_{OUT} is established, adjust the load within the operating range and measure the efficiency, output ripple voltage, and other parameters. (9)
8. After completing all tests, adjust the load to 0A, then turn off the input power supply.

Notes:

7) Ensure that V_{IN} does not exceed 13.2V.
8) There is no initial load by default.
9) When measuring the output voltage ripple or input voltage ripple, do not use the oscilloscope probe's long ground lead.

EQUIPMENT SET-UP FOR SINGLE-INPUT MODE

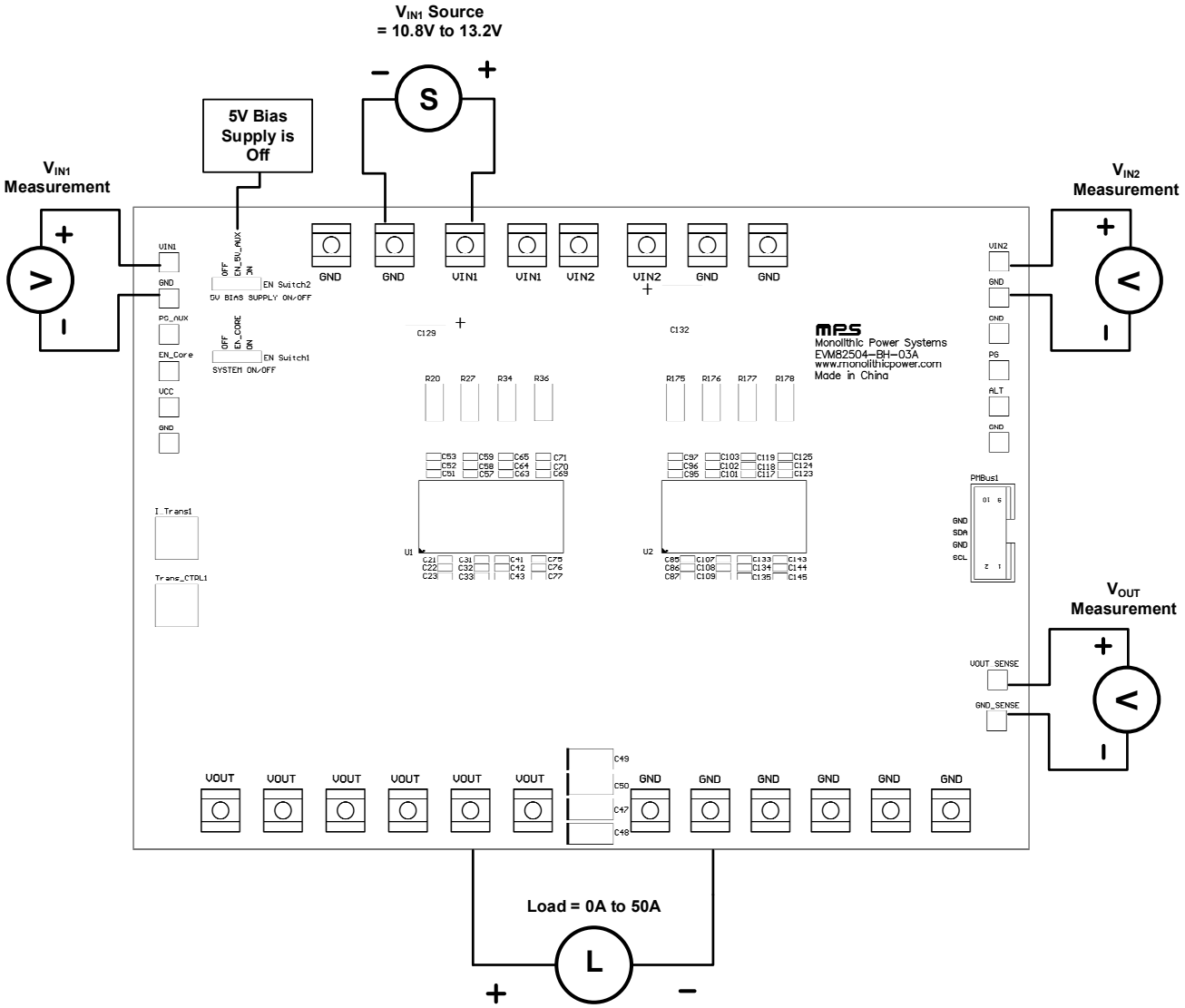


Figure 6: Measurement Equipment Set-Up for Single-Input Mode

EVALUATION BOARD SCHEMATIC

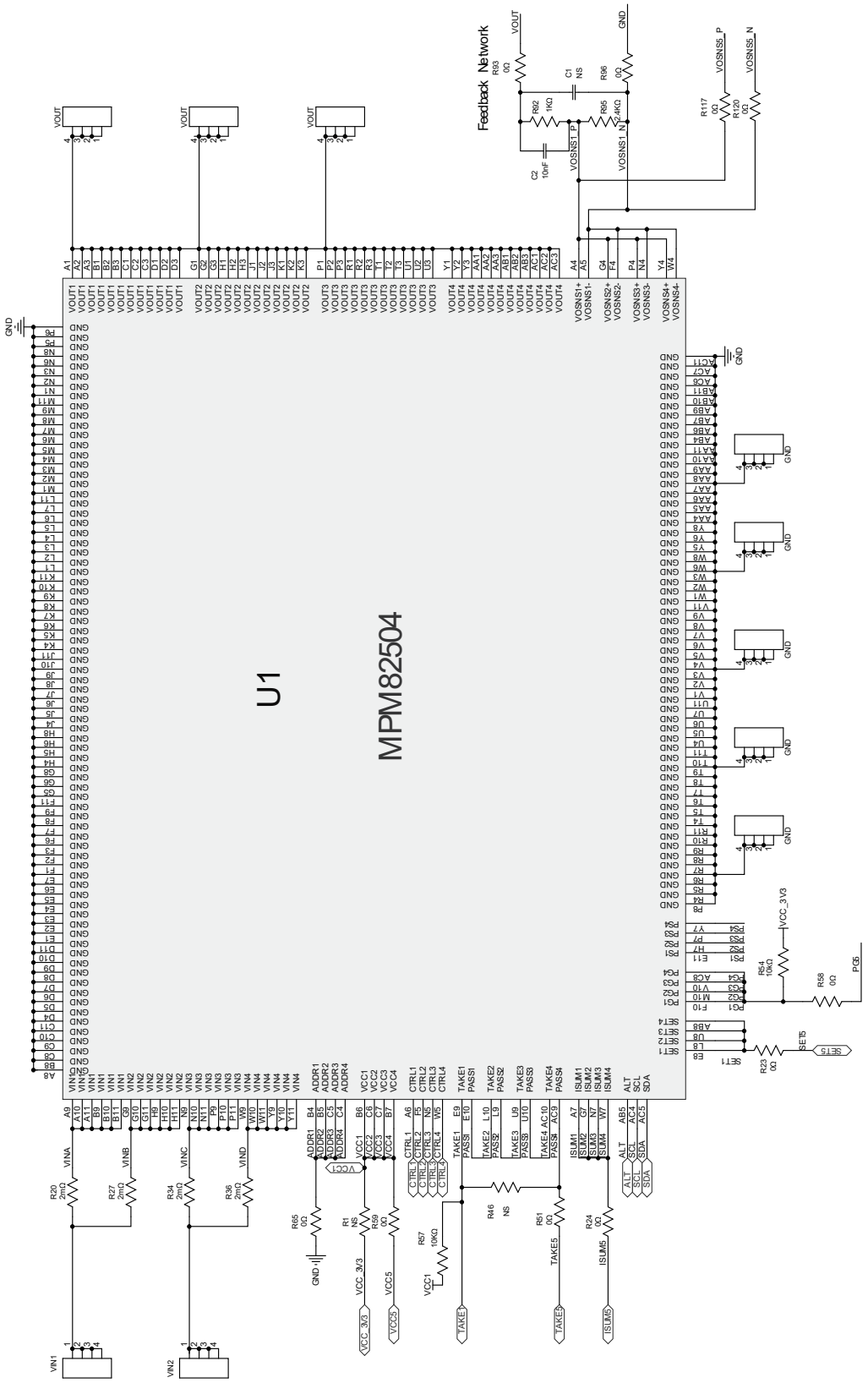


Figure 7: Evaluation Board Schematic Part 1

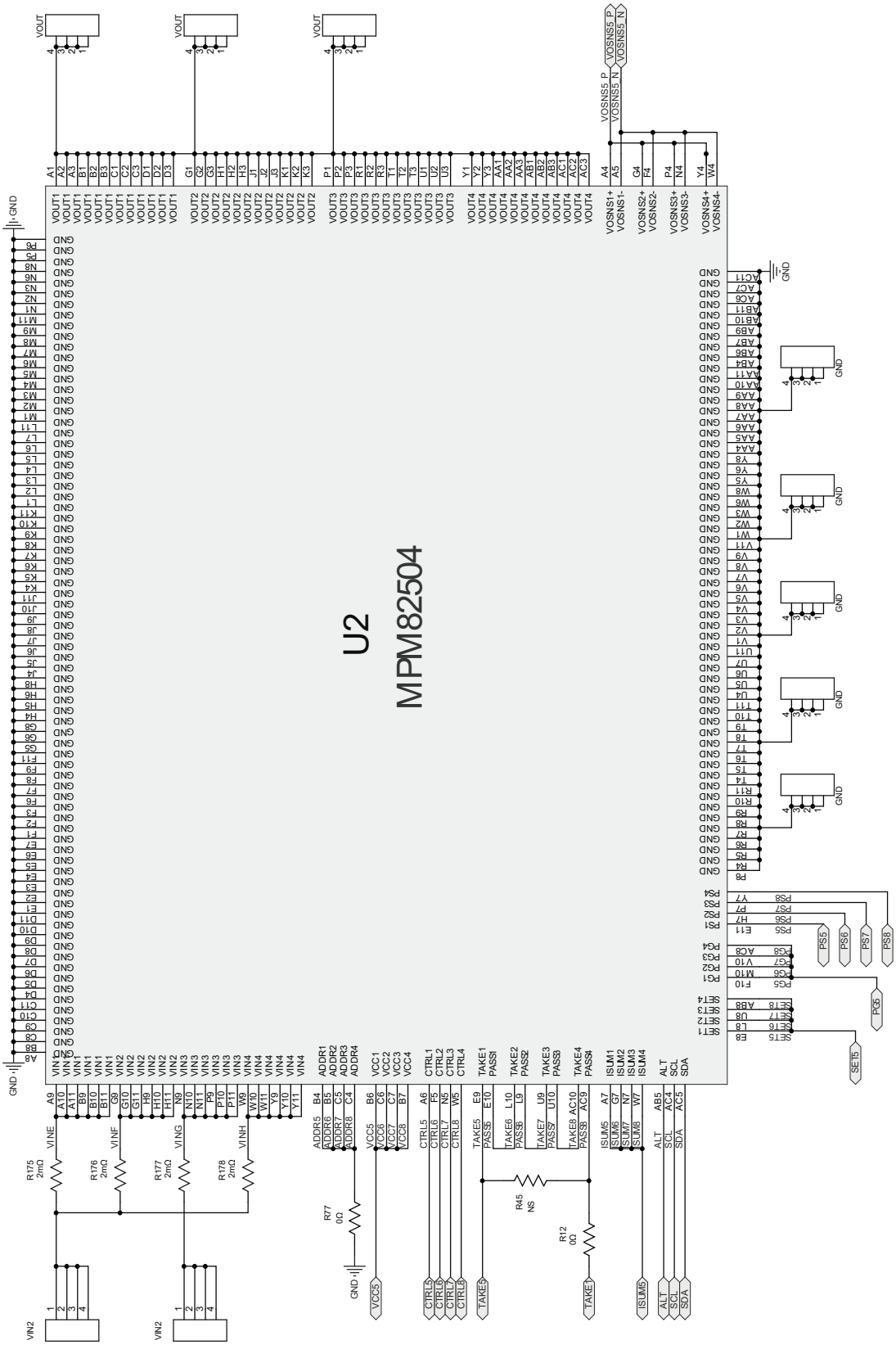


Figure 8: Evaluation Board Schematic Part 2

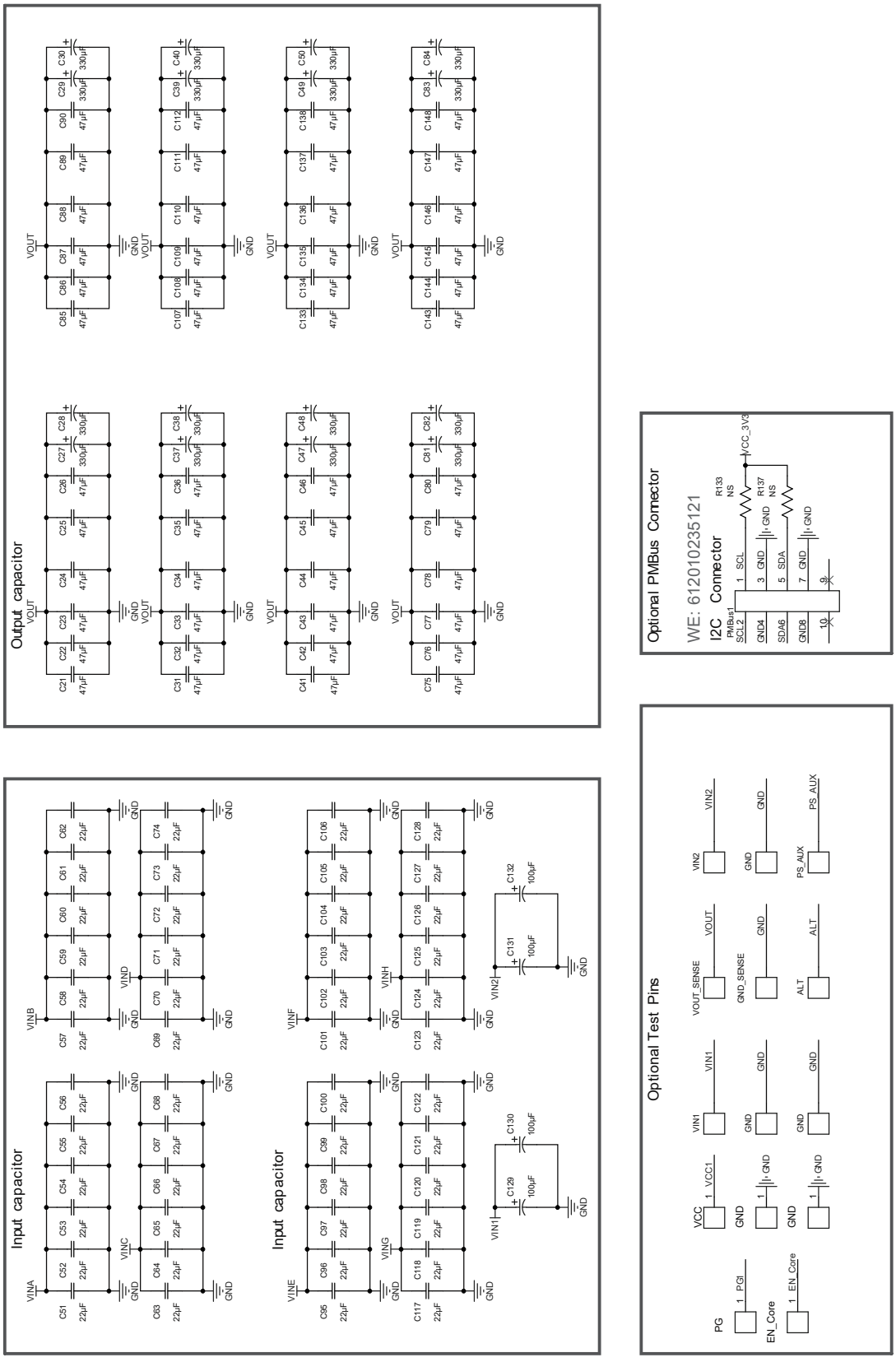


Figure 9: Evaluation Board Schematic Part 3

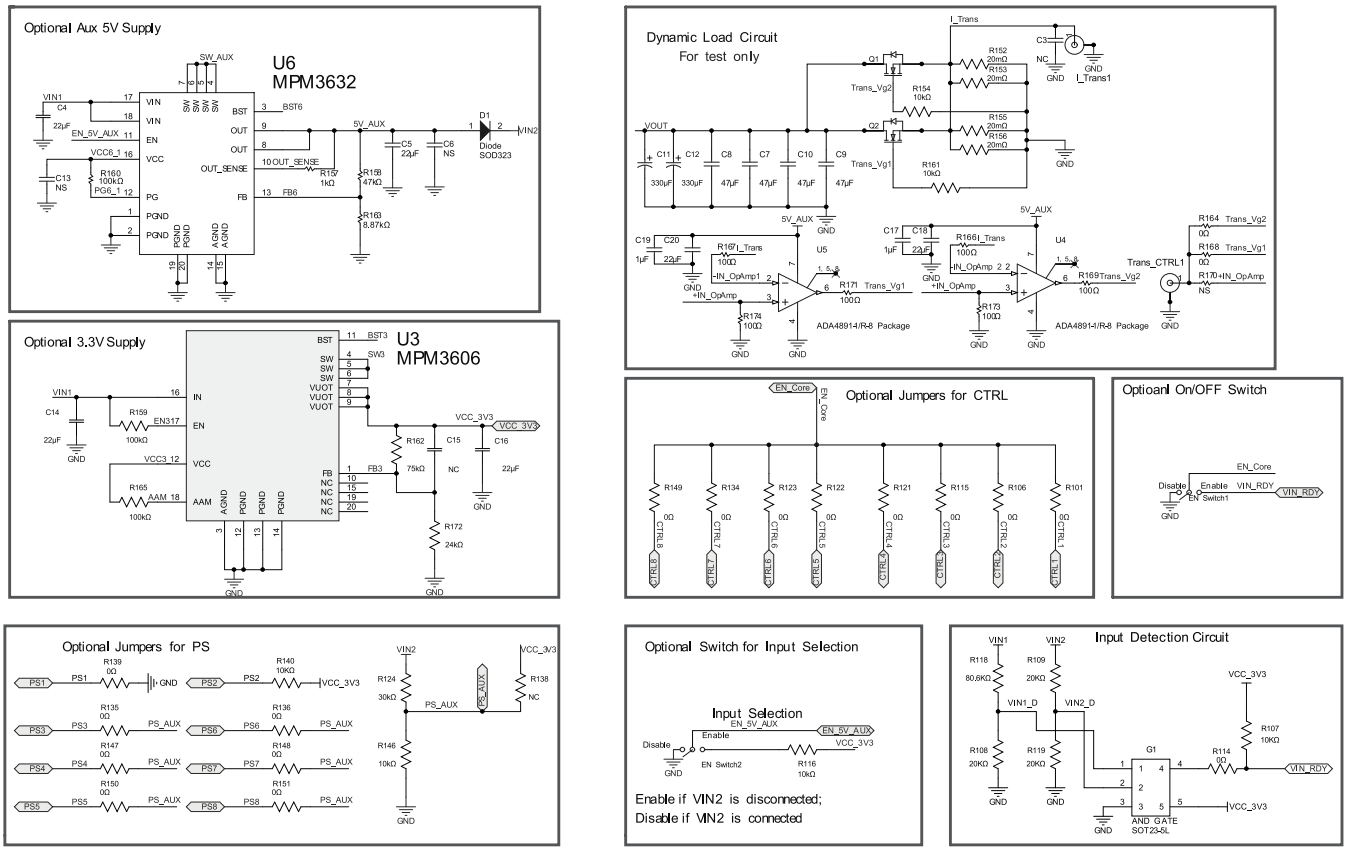


Figure 10: Evaluation Board Schematic Part 4

EVM82504-BH-03A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
4	C129, C130, C131, C132	100µF	Surface-mount polymer aluminum capacitor, 25V	OSCON E7	Panasonic	25SVPF100M
37	C7, C8, C9, C10, C16, C21, C22, C24, C25, C31, C32, C34, C35, C41, C42, C44, C45, C75, C76, C78, C79, C85, C86, C88, C89, C107, C108, C110, C112, C133, C134, C136, C137, C143, C144, C146, C147	47µF	Ceramic capacitor, 6.3V	0805	Murata	GRM21BR60J476 ME15L
37	C4, C5, C14, C18, C20, C51, C52, C55, C56, C57, C58, C60, C61, C63, C64, C66, C67, C69, C70, C72, C73, C95, C96, C98, C99, C101, C102, C104, C105, C117, C118, C120, C121, C123, C124, C126, C127	22µF	Ceramic capacitor, 25V	0805	Murata	GRM21BR61E226 ME44L
2	C17, C19	1µF	Ceramic capacitor, 25V	0805	Murata	GRM219R71E105 KA88D
1	C2	33nF	Ceramic capacitor, 50V, X7R	0603	Wurth	885012206092
25	R12, R51, R58, R59, R65, R77, R93, R96, R101, R106, R115, R121, R122, R123, R134, R135, R136, R139, R147, R148, R149, R150, R151, R164, R168	0Ω	Resistor, 1%	0603	Yageo	RC0603FR-070RL
7	R54, R57, R116, R140, R146, R154, R161	10kΩ	Resistor, 1%	0603	Yageo	RC0603FR-0710KL
2	EN SWITCH1, EN SWITCH2	500mA	SPDT slide switch, 500mA	10mmx 2.5mm	Wurth	450301014042
7	C12, C28, C30, C37, C39, C82, C84	220µF	Tantalum capacitor, 6.3V, 15mΩ	SMD	Panasonic	EEFCX0J221R

EVM82504-BH-03A BILL OF MATERIALS *(continued)*

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
4	R152, R153, R155, R156	20mΩ	Resistor, 1%	2512	Yageo	RL2512FK-070R02
2	U4, U5	NC				
1	D1	150mA	Fast switching diode, 75V	SOD-323	Diodes, Inc.	IN4148WS
1	G1	8mA	Single channel, dual-input gate, 4.5mV to 5.5mV	SOT-23-5	STMicroelectronics	74V1T08STR
1	PMBUS	2.54mm	Header, 10-pin	DIP	Wurth	612010235121
2	Q1, Q2	4.9mΩ	N-channel MOSFET, V_{DS} = 30V, I_{DS} = 24A	SOT23-8	Analog Power	AM7432N-T1-PF
5	C1, C3, C6, C13, C15	NC				
8	R20, R27, R34, R36, R175, R176, R177, R178	2mΩ	Film resistor, 1%	2512	Yageo	PA2512FKF070R002E
6	R1, R45, R46, R133, R137, R170	NC				
5	R23, R24, R114, R117, R120	0Ω	Resistor, 1%	0402	Yageo	RC0402FR-070RL
6	R166, R167, R169, R171, R173, R174	100Ω	Resistor, 1%	0603	Yageo	RC0603FR-07100RL
2	R92, R157	1kΩ	Resistor, 1%	0603	Yageo	RC0603FR-071KL
1	R95	2.4kΩ	Resistor, 1%	0603	Yageo	RC0603FR-072K4L
3	R159, R160, R165	100kΩ	Resistor, 1%	0603	Yageo	RC0603FR-07100KL
1	R158	47kΩ	Resistor, 1%	0603	Yageo	RC0603FR-0747KL
1	R163	8.87kΩ	Resistor, 1%	0603	Yageo	RC0603FR-078K87L
1	R162	75kΩ	Resistor, 1%	0603	Yageo	RC0603FR-0775KL
1	R172	24kΩ	Resistor, 1%	0603	Yageo	RC0603FR-0724KL
1	R107	10kΩ	Resistor, 1%	0402	Yageo	RC0402FR-0710KL
3	R108, R109, R119	20kΩ	Resistor, 1%	0603	Yageo	RC0603FR-0720KL
1	R118	80.6kΩ	Resistor, 1%	0603	Yageo	RC0603FR-0780K6L
1	R124	30kΩ	Resistor, 1%	0603	Yageo	RC0603FR-0730KL

EVM82504-BH-03A BILL OF MATERIALS *(continued)*

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	U6	MPM3632C	18V input, 3A, synchronous, step-down module with integrated inductor	QFN-20 (3mmx 5mm)	MPS	MPM3632CGQV
1	U3	MPM3606	21V input, 0.6A synchronous step-down power module with integrated inductor	QFN-20 (3mmx 5mm)	MPS	MPM3606GQV
2	U1, U2	MPM82504	16V, quad 25A, scalable DC/DC power module	BGA-253L (15mmx 30mm)	MPS	MPM82504GBH

PCB LAYOUT

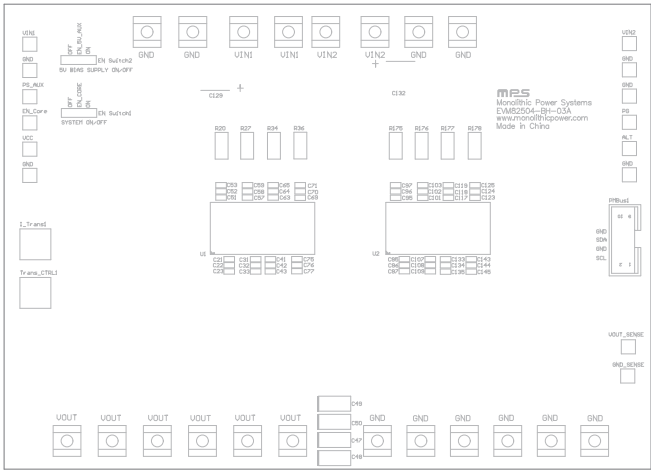


Figure 11: Top Silk

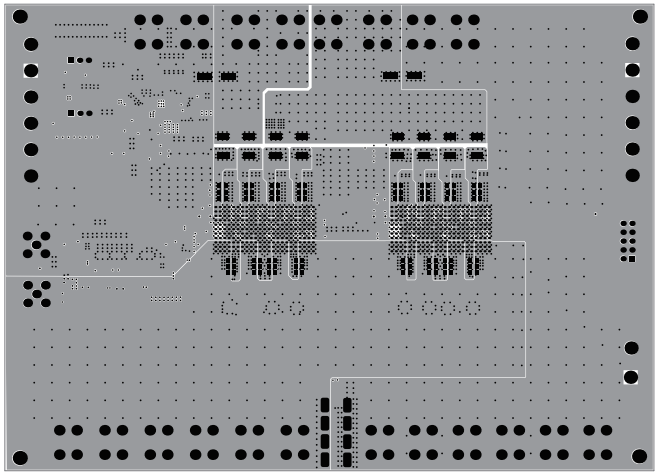


Figure 12: Top Layer

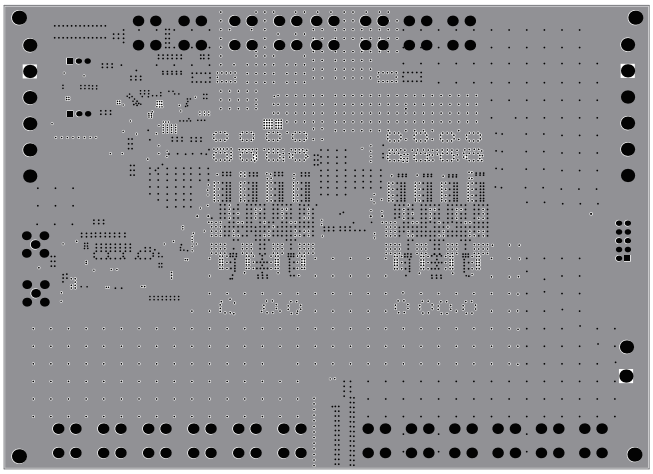


Figure 13: Mid-Layer 1

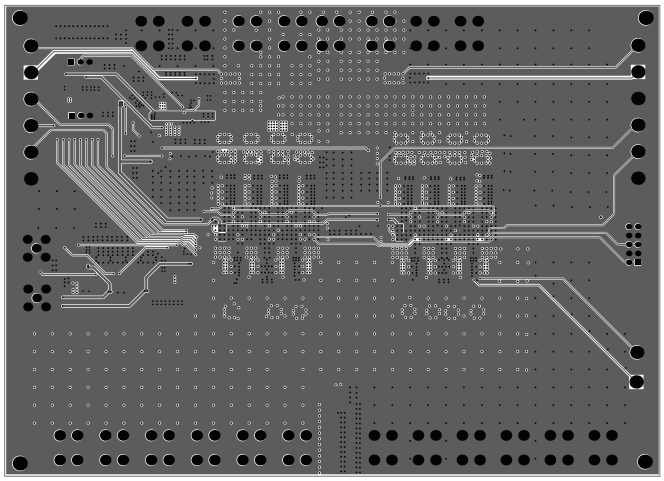


Figure 14: Mid-Layer 2

PCB LAYOUT *(continued)*

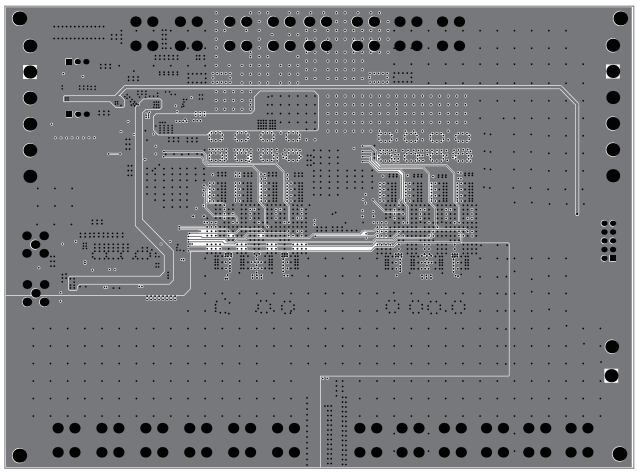


Figure 15: Mid-Layer 3

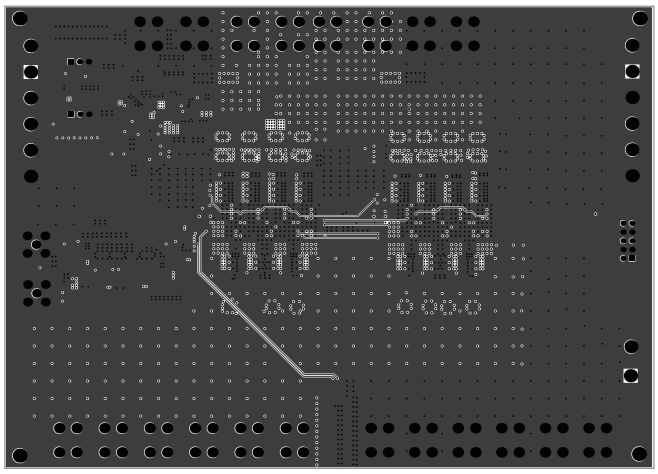


Figure 16: Mid-Layer 4

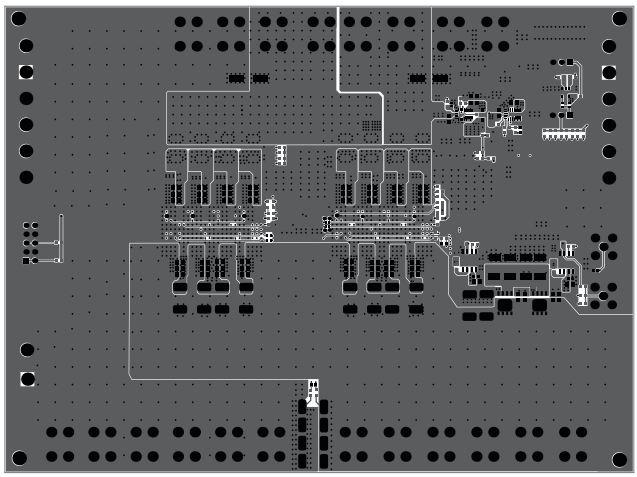


Figure 17: Bottom Layer

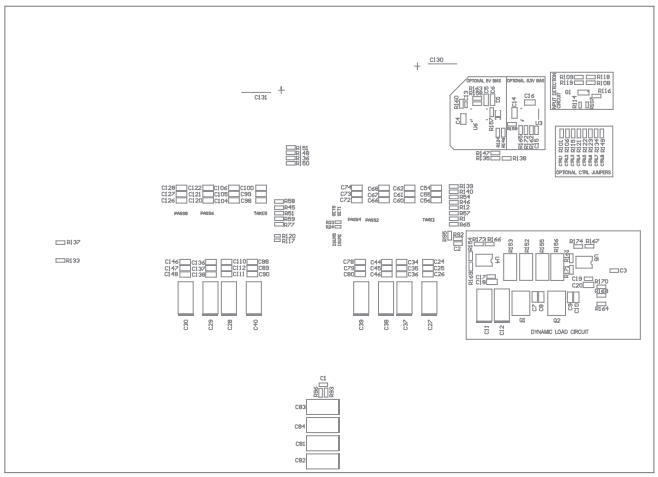


Figure 18: Bottom Silk

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	11/10/2021	Initial Release	-