EV4255-VE-00A

3A, 36V, Dual-Channel Buck Converter with I²C Interface for Power Delivery Evaluation Board

DESCRIPTION

The EV4255-VE-00A is an evaluation board designed to demonstrate the capabilities of the MP4255, a dual-channel, monolithic, step-down converter with an I²C interface. Each channel can deliver up to 3A (or a shared 6A) of output current, with excellent load and line regulation across a wide 4V to 36V input voltage supply range.

The MP4255 is suitable for USB dedicated charging ports (DCP) and USB power delivery (PD) applications. Both channels are compatible with external USB PD controllers.

The I²C interface and one-time programmable (OTP) memory provide flexible configuration options.

The MP4255's fault protections include constant current (CC) limiting, output over-voltage protection (OVP), short-circuit protection (SCP), and thermal shutdown (TSD).

The MP4255 requires a minimal number of readily available, standard external components, and is available in a QFN-21 (4mmx5mm) package.

ELECTRICAL SPECIFICATIONS

Parameter	Symbol	Value	Units
Input voltage (1)	V_{IN}	6 to 36	V
Output voltage (2)	V_{OUT1}, V_{OUT2}	3.3 to 36	V
Output current	I_{OUT1}, I_{OUT2}	3	A
Default operation mode (3)	Off		

Notes:

1) The resistor dividers set the EN rising threshold, which limits the V_{IN} start-up voltage to 6V.
2) To support an output voltage exceeding 20V, the BOM selection must be changed accordingly, such as the electrolytic capacitor voltage rating and the feedback resistors. In addition, connect the BIAS pin to an external 5V power supply to improve efficiency and avoid over-voltage (OV) conditions on BIAS.
3) The I²C GUI sets the on and off operations of the MP4255.

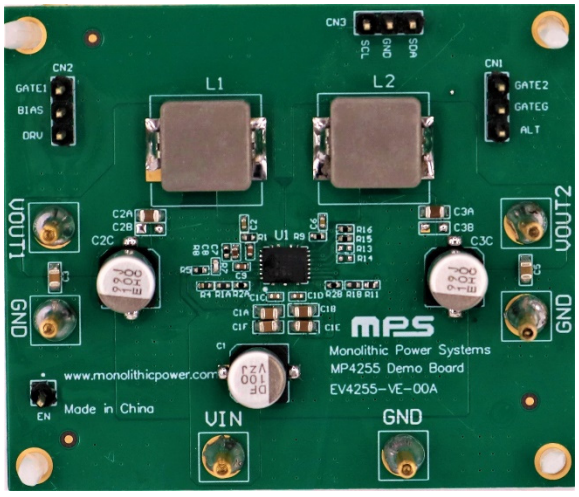
FEATURES

- Dual-Channel 3A or Shared 6A Output Current
- Wide 4V to 36V Input Voltage Range
- 1V to 36V Output Voltage Range with 12.6mV Resolution, V_{OUT} Scale Loop = 0.0635
- 250kHz, 420kHz, 1.1MHz, or 2.1MHz Configurable Switching Frequency
- Frequency Spread Spectrum
- Low-Dropout Mode
- Line Drop Compensation
- Configurable Constant Current (CC) Output Current Limiting, 50mA/Step via the I²C
- Short-Circuit Protection (SCP)
- Internal, Low $R_{DS(ON)}$ 22mΩ High-Side MOSFET (HS-FET) and 26mΩ Low-Side MOSFET (LS-FET)
- I²C Interface and One-Time Programmable (OTP) Memory (PMBus Compatible):
  - Pulse-Frequency Modulation (PFM) and Pulse-Width Modulation (PWM) Modes, Current Limiting, Output Voltage (V_{OUT}), Frequency Spread Spectrum, Phase Delay, Line Drop Compensation, etc.
- Bus Voltage (V_{BUS}) Isolated N-Channel MOSFET Gate Driver
- Load-Shedding Alert
- EN Shutdown Active Discharge
- Available in a QFN-21 (4mmx5mm) Package

APPLICATIONS

- USB Power Delivery (PD)
- USB Dedicated Charging Ports (DCP)

EV4255-VE-00A EVALUATION BOARD

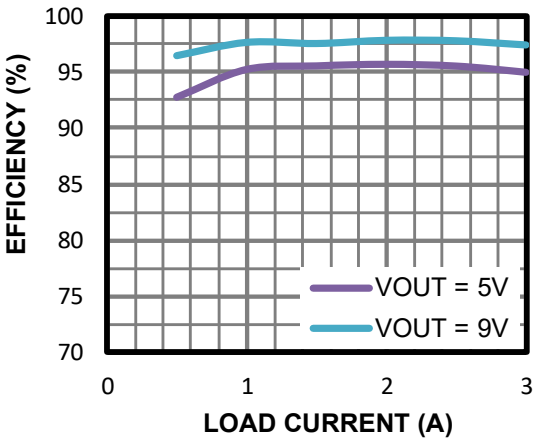


LxWxH (9.14cmx6.6cmx1.3cm)

Board Number	MPS IC Number
EV4255-VE-00A	MP4255GVE-0002

Efficiency vs. Load Current

V_{IN} = 12V, f_{SW} = 420kHz, PWM mode, buck 1 = buck 2, I_{OUT1} = I_{OUT2}



QUICK START GUIDE (3)

1. Connect the load terminals to:
   a. Positive (+): VOUT1 or VOUT2
   b. Negative (-): GND2
2. Preset the power supply output to 24V.
3. Turn off the power supply.
4. Connect the power supply terminals to:
   a. Positive (+): VIN
   b. Negative (-): GND
5. After making the connections, turn on the power supply. V_{OUT} is 5V at start-up.
6. Click the button with the search icon to obtain the address, then right-click “MP4255(0x01)” to input the I^2C slave address (see Figure 1).
7. Double-click CH0 or CH1 for the pages that control V_{OUT1} and V_{OUT2} (see Figure 1). V_{OUT1} and V_{OUT2} are controlled separately via the I^2C GUI. (4) CH0 controls V_{OUT1}, and CH1 controls V_{OUT2}.

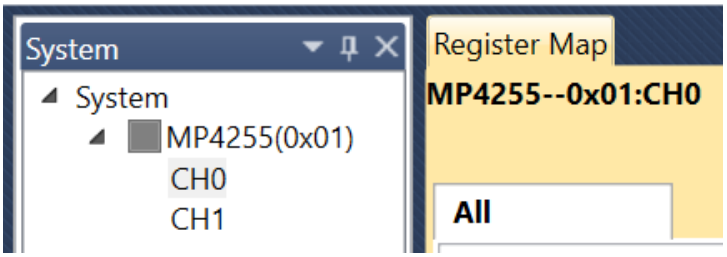


Figure 1: Setting the Controls for V_{OUT1} and V_{OUT2}

Notes:

4) Only the MP4255-0000 supports one-time programmable (OTP) memory.
5) The Virtual Bench Pro GUI can be downloaded from the MPS website.

OTP REGISTER VALUE SELECTED TABLE BY DEFAULT (MP4255-0002)

One-Time Programmable (OTP) Items	Description	Default Value
GATE1_2_EN	Enables/disables GATE1_2_EN	Enabled
I^2C address	Sets the I^2C slave address, bits[A5~A1]	61h
Frequency	Sets the buck switching frequency	420kHz
Slew rate	Sets the V_{REF} slew rate	0.4mv/μs V_{REF} rising slew rate, 0.1mv/μs V_{REF} falling slew rate
Dither enable	Enables/disables frequency spread spectrum	Disabled
DRV voltage	Driver pin V_{OUT} (LDO output)	6V
Phase delay	Select the buck's switching clock phase delay (from buck 1 to buck 2)	0° phase delay
Over-temperature protection threshold	Thermal shutdown (TSD) protection threshold	170°C
Over-temperature protection warning threshold	Thermal warning threshold	150°C
OTP configuration code	OTP configuration code (defined by MPS)	0x02

OTP Items	Description	CH1 Default Value	CH2 Default Value
OPERATION	MP4255 default is on or off	Off	Off
V_{OUT}	Output voltage	5V	5V
V_{OUT} scale loop	1 / (V_{OUT} feedback ratio)	0.0635	0.0635
EN OVP	Enables/disables output over-voltage protection (OVP)	Enabled	Enabled
Hiccup timer	Over-current protection (OCP) off timer	500ms	500ms
EN output discharge	Enables/disables EN output discharge	Enabled	Enabled
Pulse-frequency modulation (PFM) and pulse-width modulation (PWM) modes	Auto-PFM/PWM or forced PWM mode	Forced PWM mode	Forced PWM mode
Current limit	Output current limit	5.2A	5.2A
Line drop compensation gain	μA/A	0μA/A	0μA/A
V_{OUT} mask	Mask or no mask for the ALT pin indication	Masked	Masked
I_{OUT}/P_{OUT} mask		Not masked	Not masked
Input mask		Masked	Masked
Temperature mask		Not masked	Not masked
PG_STATUS mask		Masked	Masked
PG_ALT_EDGE mask		Masked	Masked
Other mask		Masked	Masked

EVALUATION BOARD SCHEMATIC

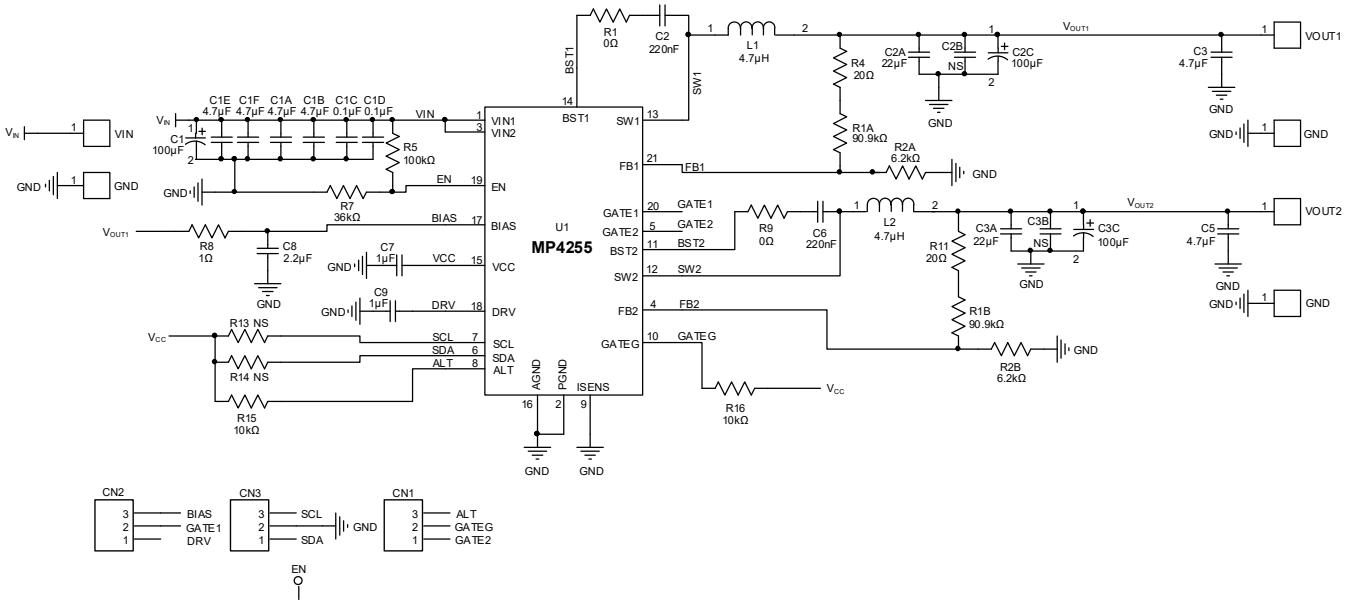


Figure 2: Evaluation Board Schematic

EV4255-VE-00A BILL OF MATERIALS

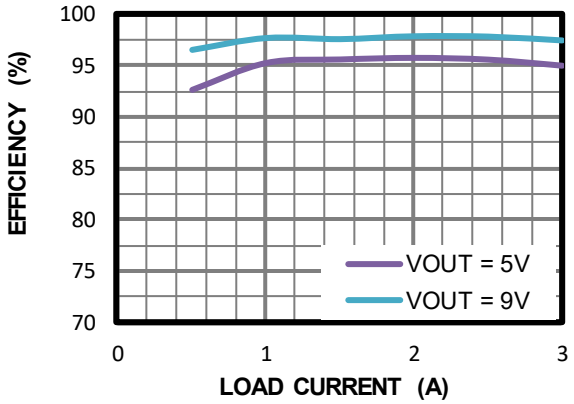
Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	U1	MP4255	Dual-channel buck converter	QFN-21 (4mmx5mm)	MPS	MP4255GVE-0002
1	C1	100µF	100µF, 35V	SMD	Nippon Chemicon	EMZJ350ADA101MF80G
4	C1A, C1B, C1E, C1F	4.7µF	Ceramic capacitor, 50V, X7S	0805	Murata	GRM21BC71H475KE11L
2	C1C, C1D	0.1µF	Ceramic capacitor, 50V, X7R	0402	Murata	GRM155R71H104ME14D
2	C2, C6	220nF	Ceramic capacitor, 25V, X5R	0402	Murata	GRM155R61E224KE01D
2	C2A, C3A	22µF	Ceramic capacitor, 25V, X5R	0805	Murata	GRM21BR61E226ME44L
0	C2B, C3B	NS		0402		
2	C2C, C3C	100µF	25V, hybrid, 20mΩ	SMD	Nippon Chemicon	HHXC250ARA101MF80G
2	C3, C5	4.7µF	Ceramic capacitor, 25V, X7S	0805	Murata	GRM21BC71E475KE11L
0	C4, C10	NS		0402		
2	C7, C9	1µF	Ceramic capacitor, 16V, X6S	0402	Murata	GRM155C81C105KE11D
1	C8	2.2µF	Ceramic capacitor, 25V, X5R	0402	Murata	GRM155R61E225KE11D
3	CN1, CN2, CN3	2.54mm	Header, 3 pins	DIP	Wurth	61300311121
6	GND, GND2, VIN, VOUT1, VOUT2	2mm	Copper pin	DIP	Custom	
2	L1, L2	4.7µH	Inductor, RDC = 8mΩ, I_{SAT} = 13A	SMD	Superworld	PIAQ1005S4R7MN
	L1, L2	4.7µH	Inductor, RDC = 9.5mΩ, I_{SAT} = 15A	SMD	MPS	MPL-AY1050-4R7
2	R1, R9	0Ω	Film resistor, 1%	0402	Yageo	RC0402FR-070RL
2	R1A, R1B	90.9kΩ	Film resistor, 1%	0402	Yageo	RC0402FR-0790K9L
2	R2A, R2B	6.2kΩ	Film resistor, 1%	0402	Yageo	RC0402FR-076K2L
1	R16	10kΩ	Film resistor, 1%	0402	Yageo	RC0402FR-0710KL
2	R4, R11	20Ω	Film resistor, 1%	0402	Yageo	RC0402FR-0720RL
1	R5	100kΩ	Film resistor, 1%	0402	Yageo	RC0402FR-07100KL
1	R7	36kΩ	Film resistor, 1%	0402	Yageo	RC0402FR-0736KL
0	R13, R14	NS	Film resistor, 1%	0402		
1	R8	1Ω	Film resistor, 1%	0402	Yageo	RC0402FR-071RL
1	R15	10kΩ	Film resistor, 1%	0402	Yageo	RC0402FR-0710KL

TYPICAL PERFORMANCE CHARACTERISTICS

V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, f_{SW} = 420kHz, forced PWM mode, T_A = 25°C, unless otherwise noted.

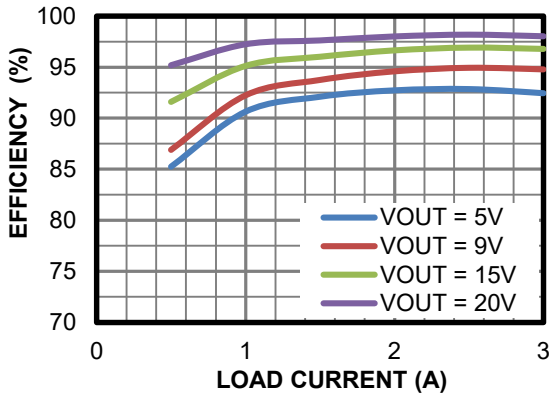
Efficiency vs. Load Current

V_{IN} = 12V, f_{SW} = 420kHz, PWM mode, buck 1 = buck 2, I_{OUT1} = I_{OUT2}



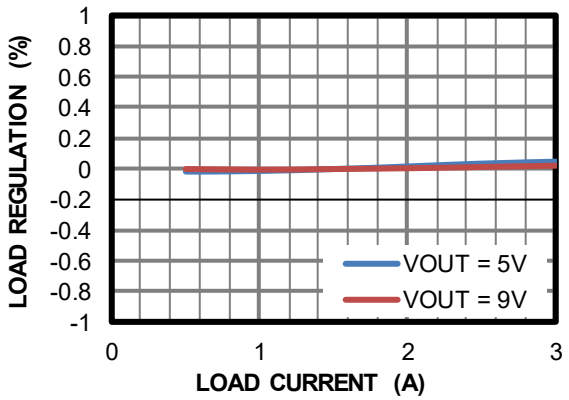
Efficiency vs. Load Current

V_{IN} = 24V, f_{SW} = 420kHz, PWM mode, buck 1 = buck 2, I_{OUT1} = I_{OUT2}



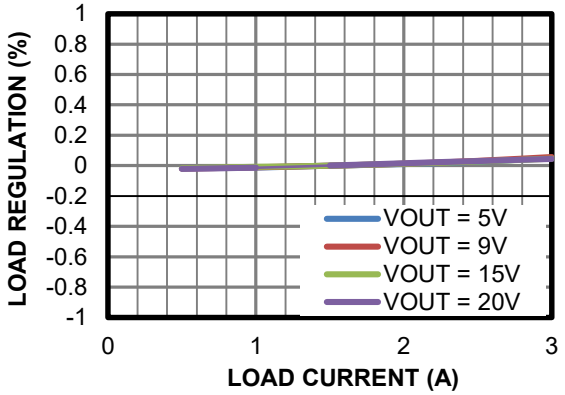
Load Regulation

V_{IN} = 12V, f_{SW} = 420kHz, PWM mode



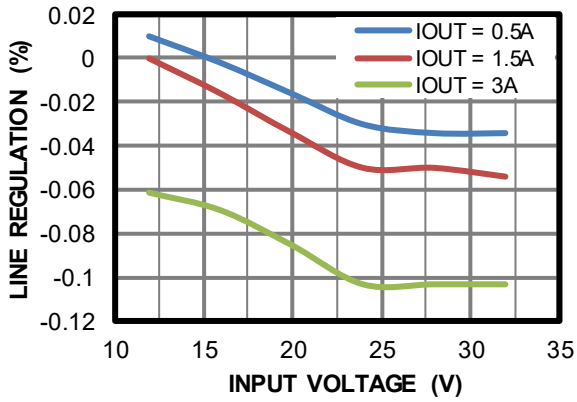
Load Regulation

V_{IN} = 24V, f_{SW} = 420kHz, PWM mode



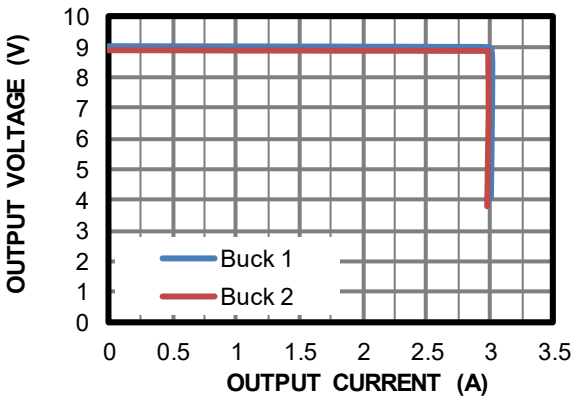
Line Regulation

V_{OUT} = 5V, f_{SW} = 420kHz, PWM mode



CC Curve

V_{IN} = 12V, V_{OUT} = 9V, CC = 3A, PWM mode

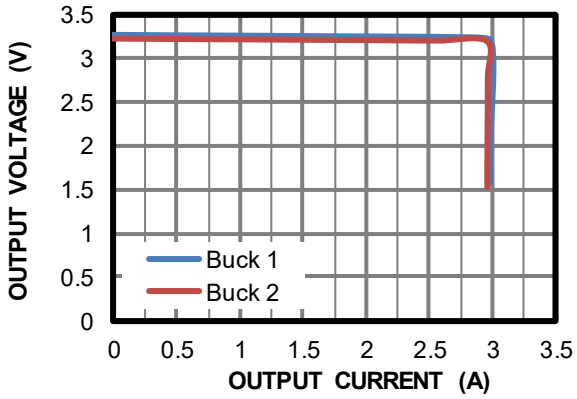


TYPICAL PERFORMANCE CHARACTERISTICS *(continued)*

V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, f_{SW} = 420kHz, forced PWM mode, T_A = 25°C, unless otherwise noted.

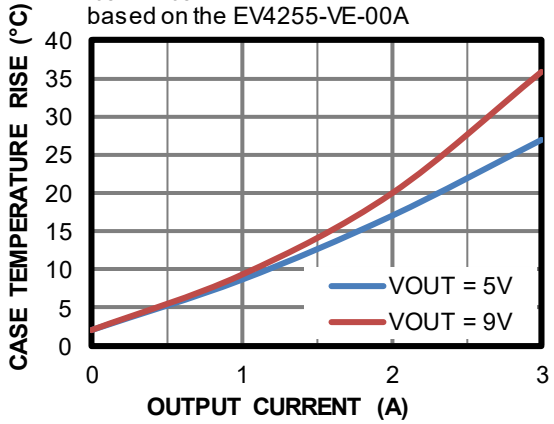
CC Curve

V_{IN} = 12V, V_{OUT} = 3.3V, CC = 3A, PWM mode



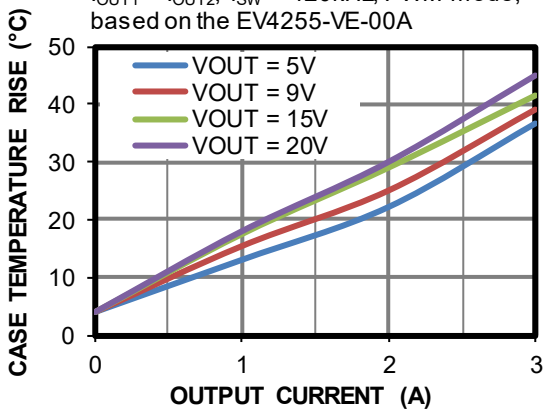
Case Temperature Rise

V_{IN} = 12V, buck 1 = buck 2, I_{OUT1} = I_{OUT2}, f_{SW} = 420kHz, PWM mode, based on the EV4255-VE-00A



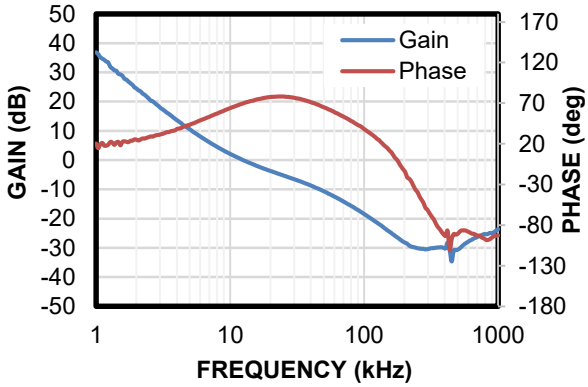
Case Temperature Rise

V_{IN} = 24V, buck 1 = buck 2, I_{OUT1} = I_{OUT2}, f_{SW} = 420kHz, PWM mode, based on the EV4255-VE-00A



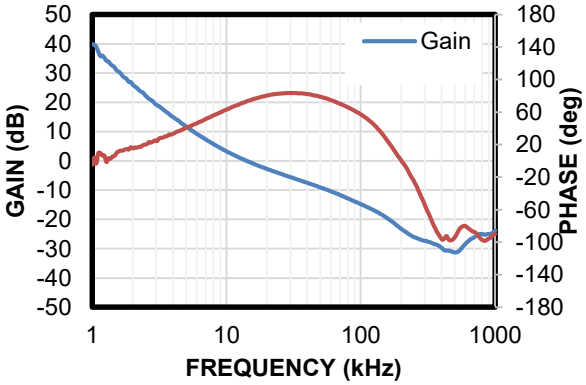
Bode Plot

V_{IN} = 12V, V_{OUT} = 5V, I_{OUT} = 3A, C_{OUT} = 100µF + 22µF, BW = 12.6kHz, PM = 70.04deg



Bode Plot

V_{IN} = 12V, V_{OUT} = 9V, I_{OUT} = 3A, C_{OUT} = 100µF + 22µF, BW = 14kHz, PM = 72.82deg

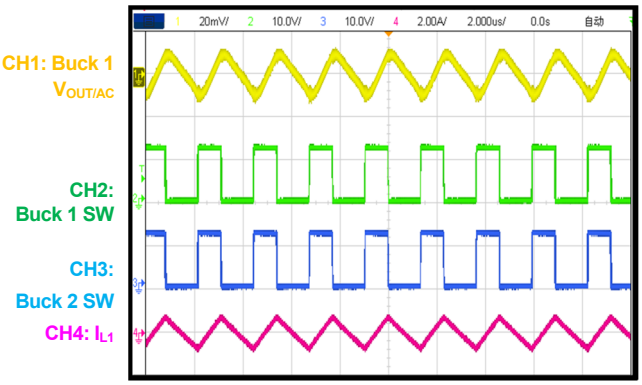


TYPICAL PERFORMANCE CHARACTERISTICS *(continued)*

V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, f_{SW} = 420kHz, forced PWM mode, T_A = 25°C, unless otherwise noted.

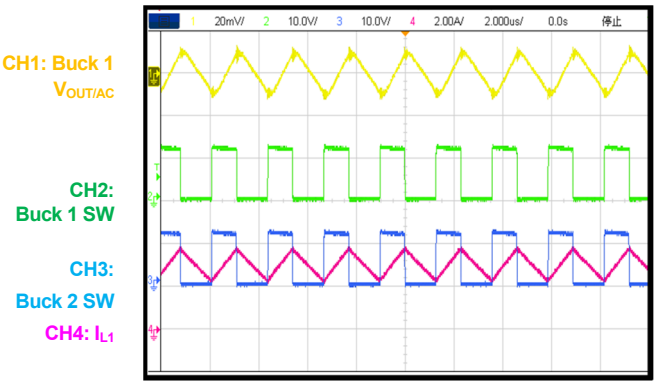
Output Ripple

V_{IN} = 12V, buck 1 V_{OUT} = buck 2 V_{OUT} = 5V,
I_{OUT1} = I_{OUT2} = 0A, PWM mode



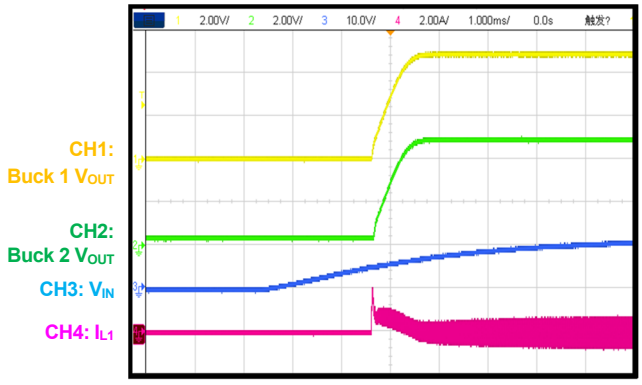
Output Ripple

V_{IN} = 12V, buck 1 V_{OUT} = buck 2 V_{OUT} = 5V,
I_{OUT1} = I_{OUT2} = 3A, PWM mode



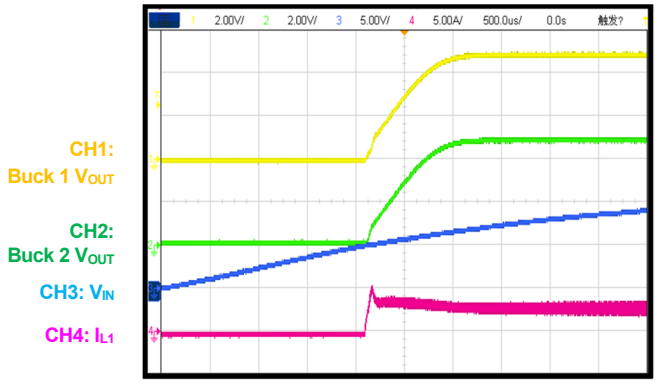
Start-Up

V_{IN} = 12V, buck 1 V_{OUT} = buck 2 V_{OUT} = 5V,
I_{OUT1} = I_{OUT2} = 0A, PWM mode



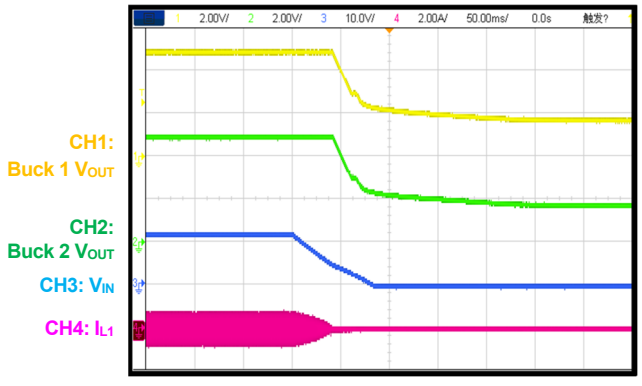
Start-Up

V_{IN} = 12V, buck 1 V_{OUT} = buck 2 V_{OUT} = 5V,
I_{OUT1} = I_{OUT2} = 3A, PWM mode



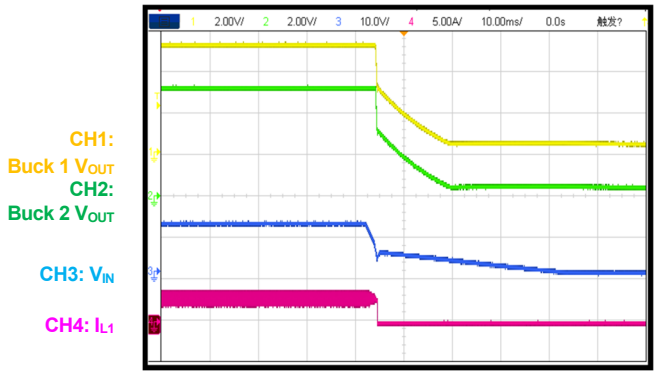
Shutdown

V_{IN} = 12V, buck 1 V_{OUT} = buck 2 V_{OUT} = 5V,
I_{OUT1} = I_{OUT2} = 0A, PWM mode



Shutdown

V_{IN} = 12V, buck 1 V_{OUT} = buck 2 V_{OUT} = 5V,
I_{OUT1} = I_{OUT2} = 3A, PWM mode

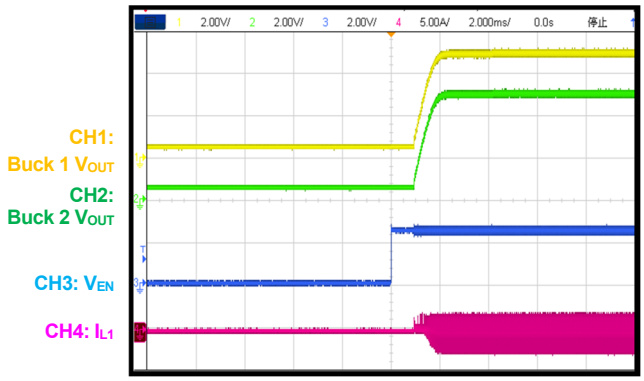


TYPICAL PERFORMANCE CHARACTERISTICS *(continued)*

V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, f_{SW} = 420kHz, forced PWM mode, T_A = 25°C, unless otherwise noted.

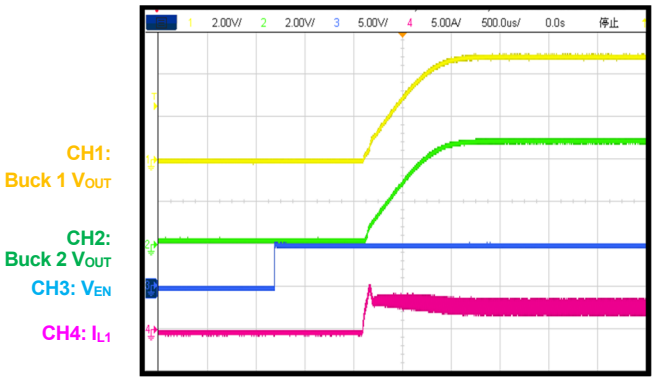
Start-Up through EN

V_{IN} = 12V, buck 1 V_{OUT} = buck 2 V_{OUT} = 5V,
I_{OUT1} = I_{OUT2} = 0A, PWM mode



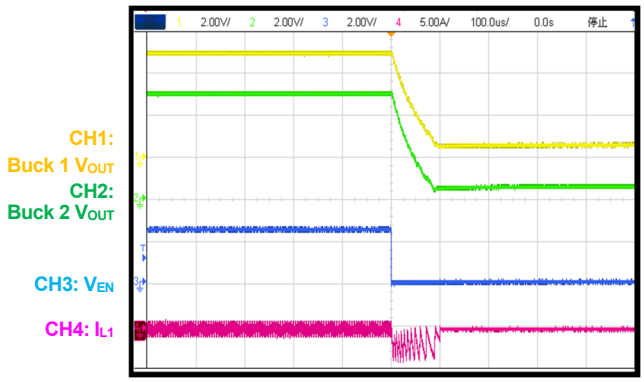
Start-Up through EN

V_{IN} = 12V, buck 1 V_{OUT} = buck 2 V_{OUT} = 5V,
I_{OUT1} = I_{OUT2} = 3A, PWM mode



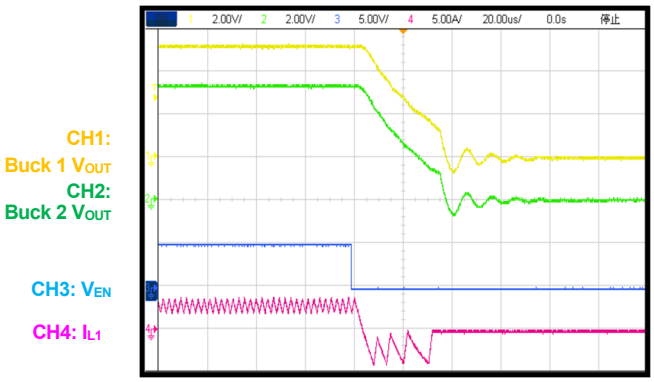
Shutdown through EN

V_{IN} = 12V, buck 1 V_{OUT} = buck 2 V_{OUT} = 5V,
I_{OUT1} = I_{OUT2} = 0A, PWM mode



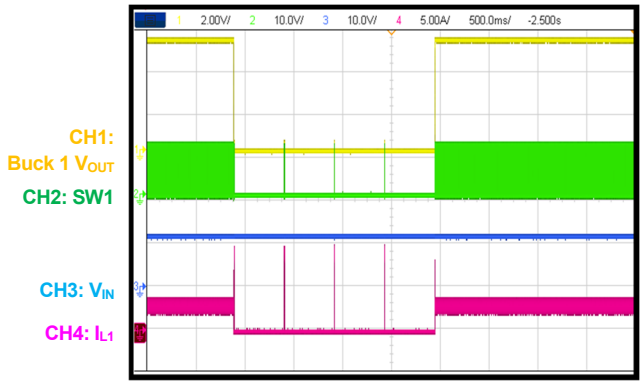
Shutdown through EN

V_{IN} = 12V, buck 1 V_{OUT} = buck 2 V_{OUT} = 5V,
I_{OUT1} = I_{OUT2} = 3A, PWM mode



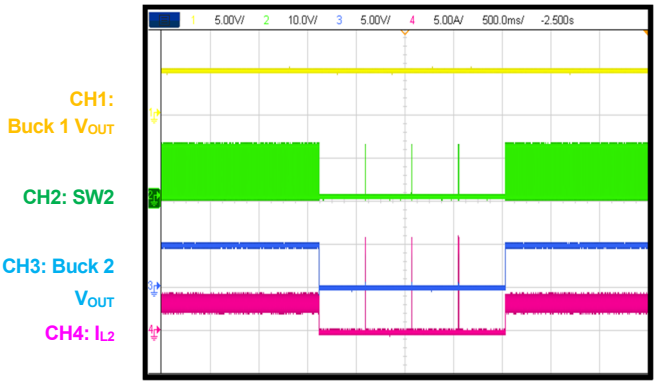
Buck 1 V_{OUT} SCP Entry and Recovery

V_{IN} = 12V, buck 1 V_{OUT} = buck 2 V_{OUT} = 5V,
I_{OUT1} = I_{OUT2} = 3A, PWM mode



Buck 2 V_{OUT} SCP and Recovery

V_{IN} = 12V, buck 1 V_{OUT} = buck 2 V_{OUT} = 5V,
I_{OUT1} = I_{OUT2} = 3A, PWM mode

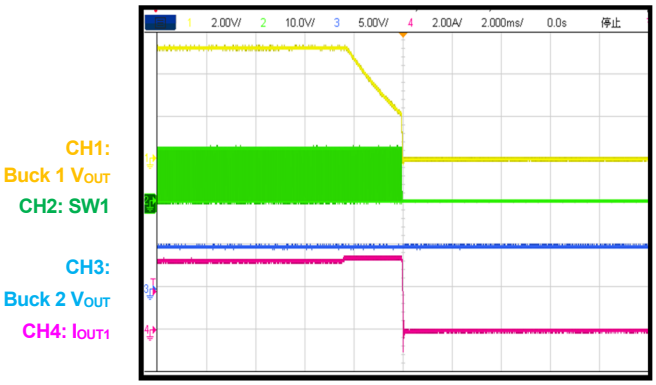


TYPICAL PERFORMANCE CHARACTERISTICS *(continued)*

V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, f_{SW} = 420kHz, forced PWM mode, T_A = 25°C, unless otherwise noted.

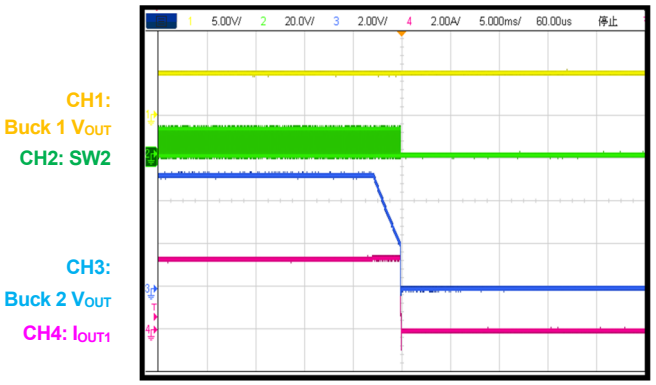
Buck 1 V_{OUT} OCP Test

V_{IN} = 12V, buck 1 V_{OUT} = buck 2 V_{OUT} = 5V, I_{OUT2} = 0A, CL = 3.6A, slowly ramp up I_{OUT1}



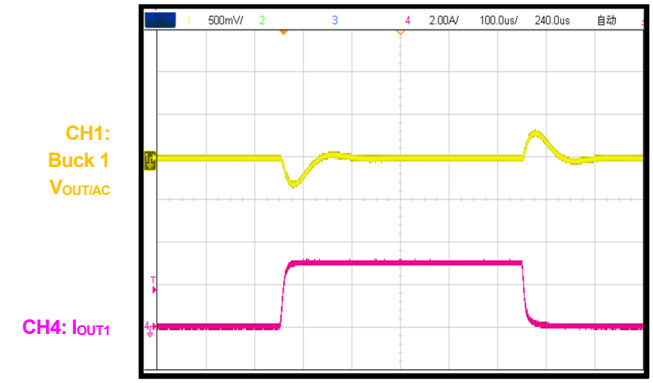
Buck 2 V_{OUT} OCP Test

V_{IN} = 12V, buck 1 V_{OUT} = buck 2 V_{OUT} = 5V, I_{OUT1} = 0A, CL = 3.6A, slowly ramp up I_{OUT2}



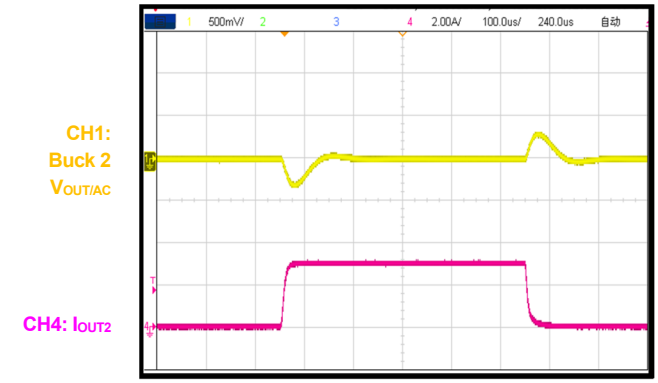
Load Transient for Buck 1 V_{OUT}

V_{IN} = 12V, buck 1 V_{OUT} = buck 2 V_{OUT} = 5V, I_{OUT1} = 0A to 3A, slew rate = 2.5A/µs



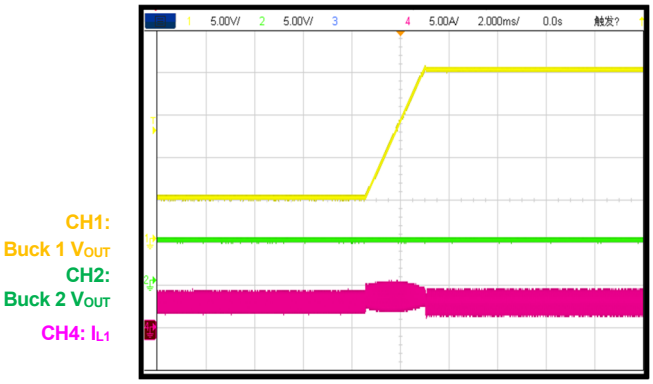
Load Transient for Buck 2 V_{OUT}

V_{IN} = 12V, buck 1 V_{OUT} = buck 2 V_{OUT} = 5V, I_{OUT2} = 0A to 3A, slew rate = 2.5A/µs



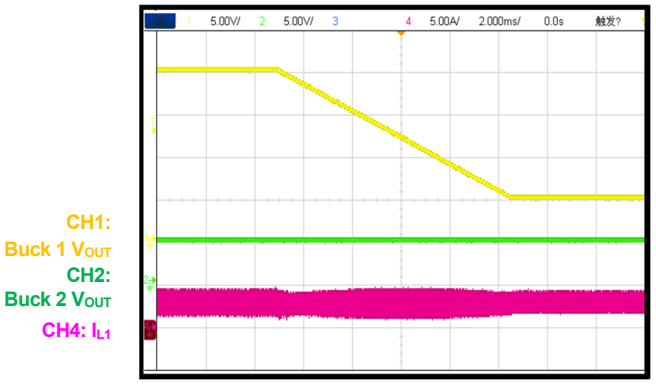
Buck 1 V_{OUT} Transition via the I^2C

V_{IN} = 24V, buck 2 V_{OUT} = 5V, I_{OUT1} = I_{OUT2} = 3A, buck 1 V_{OUT} = 5V to 20V



Buck 1 V_{OUT} Transition via the I^2C

V_{IN} = 24V, buck 2 V_{OUT} = 5V, I_{OUT1} = I_{OUT2} = 3A, buck 1 V_{OUT} = 5V to 20V

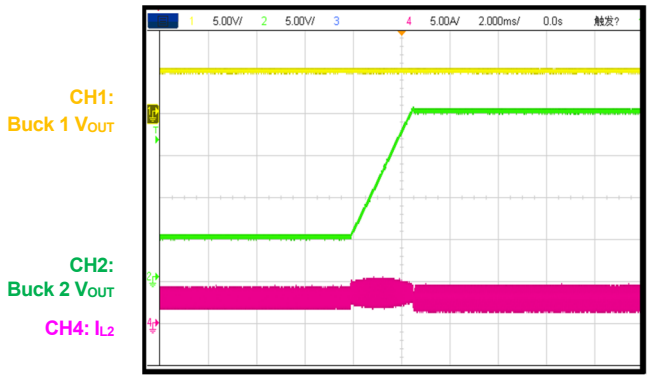


TYPICAL PERFORMANCE CHARACTERISTICS *(continued)*

V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, f_{SW} = 420kHz, forced PWM mode, T_A = 25°C, unless otherwise noted.

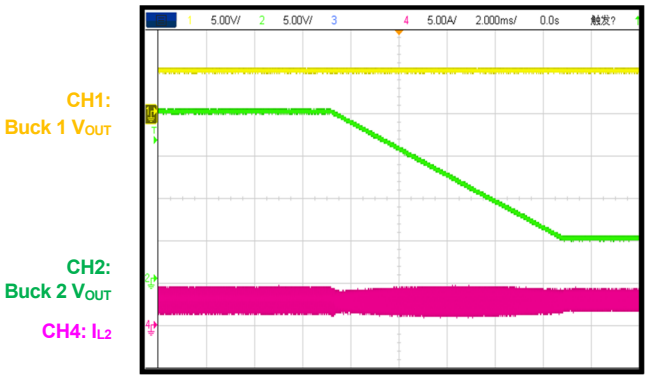
Buck 2 V_{OUT} Transition via the I^2C

V_{IN} = 24V, buck 1 V_{OUT} = 5V, I_{OUT1} = I_{OUT2} = 3A, buck 2 V_{OUT} = 5V to 20V



Buck 2 V_{OUT} Transition via the I^2C

V_{IN} = 24V, buck 1 V_{OUT} = 5V, I_{OUT1} = I_{OUT2} = 3A, buck 2 V_{OUT} = 5V to 20V



PCB LAYOUT

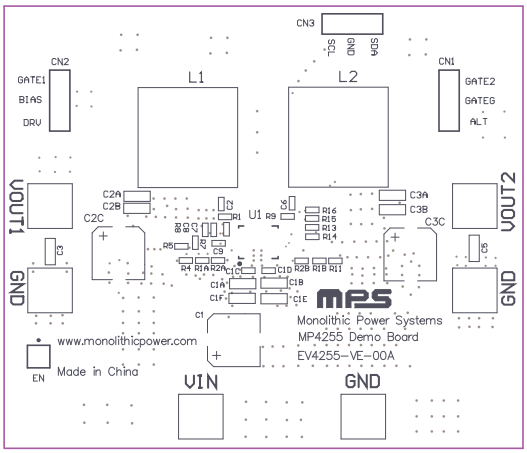


Figure 3: Top Silk Layer

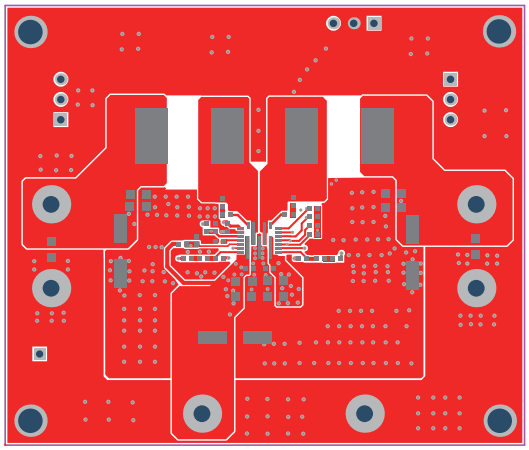


Figure 4: Top Layer

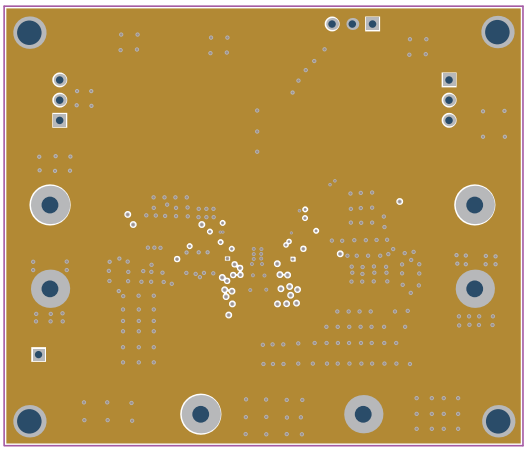


Figure 5: Mid-Layer 1

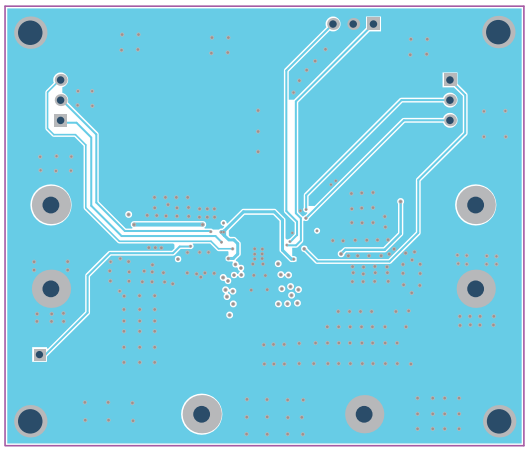


Figure 6: Mid-Layer 2

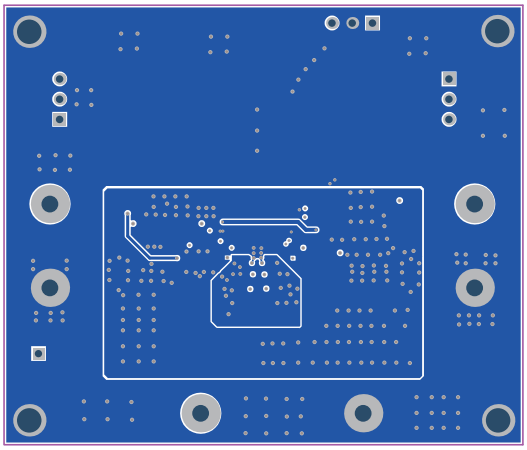


Figure 7: Bottom Layer

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	3/22/2021	Initial Release	-
1.1	3/8/2024	Updated the maximum output voltage from 21 to 36 in both the Electrical Specifications and Features sections; added a note for the output voltage as note 2, updated the previous note 2 to note 3, and made minor formatting edits to the overall notes in the Electrical Specifications section	1