EVQ4232-VE-00A

6A Buck-Boost Converter with Four Integrated MOSFETs and I²C Interface Evaluation Board, AEC-Q100 Qualified

DESCRIPTION

The EVQ4232-VE-00A is an evaluation board designed to demonstrate the capabilities of the MPQ4232, a synchronous, four-switch, buck-boost converter with integrated MOSFETs. The device can deliver up to 6A of output current (I_{OUT}) and achieve excellent efficiency across a certain input supply range.

The MPQ4232 is designed for USB power delivery (PD) and wireless charging applications. It can work well with an external PD controller or wireless charging controller through the I²C interface.

The MPQ4232 is available in a small QFN-19 (4mmx5mm) package with wettable flanks. It is recommended to read the MPQ4232 datasheet prior to making any changes to the EVQ4232-VE-00A.

PERFORMANCE SUMMARY

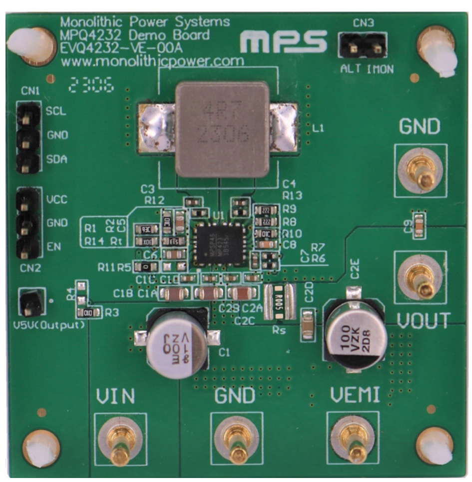
Specifications are at T_A = 25°C, unless otherwise noted.

Parameters	Conditions	Value
Input voltage (V_{IN}) range		4.3V to 22V, 36V tolerant
Output voltage (V_{OUT}) [1]	V_{IN} = 4.3V to 22V, I_{OUT} = 0A to 5A	V_{OUT} = 5V
Maximum output current (I_{OUT})	V_{IN} = 4.3V to 22V	6A
Typical efficiency	V_{IN} = 12V, V_{OUT} = 5V, I_{OUT} = 3A	95.58%
Peak efficiency	V_{IN} = 12V, V_{OUT} = 15V, I_{OUT} = 1.5A	98.28%
Switching frequency (f_{SW})		420kHz

Note:

1) V_{OUT} can be adjusted via the I²C or feedback resistance.

EVQ4232-VE-00A EVALUATION BOARD



LxWxH (50mmx50mmx16mm)
4 Layers (2oz, 1oz, 1oz, and 2oz)

Board Number	MPS IC Number
EVQ4232-VE-00A	MPQ4232GVE-0000-AEC1

QUICK START GUIDE

1. Preset the power supply (V_{IN}) to 12V, then turn the power supply off.
2. Connect the power supply terminals to:
    a. Positive (+): VIN
    b. Negative (-): GND
3. Connect the electronic load to:
    a. Positive (+): VOUT
    b. Negative (-): GND
4. After making the connections, turn the power supply on.
5. Once the power supply is on, the output voltage (V_{OUT}) should start up automatically.
6. To modify the MPQ4232's register setting, connect the EVQ4232-VE-00A to the USB-to-I²C communication kit (EVKT-USBI2C-02). Use Virtual Bench Pro 4.0 to read and write the I²C registers.
7. If the MPQ4232's silicon die temperature exceeds 165°C, over-temperature protection (OTP) is triggered and the entire chip shuts down. Once the temperature drops to below 145°C, the chip is enabled again and resumes normal operation.
8. Figure 1 shows the measurement equipment set-up.

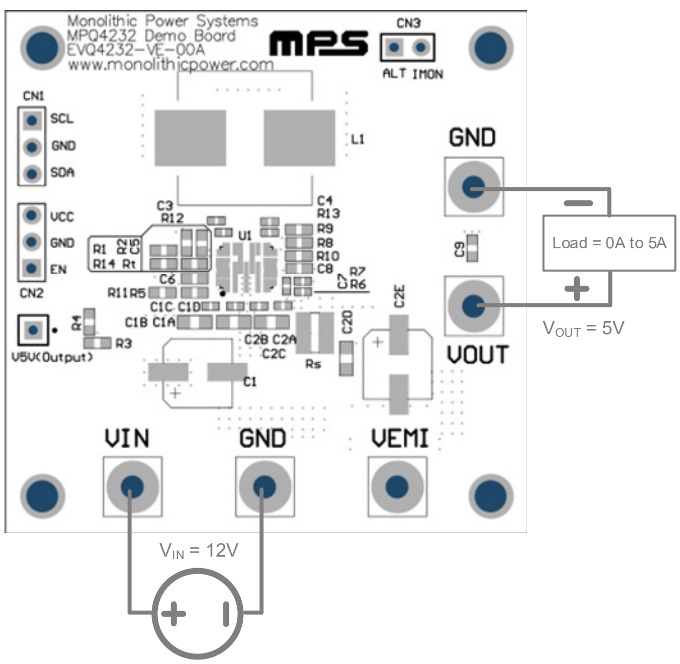


Figure 1: Measurement Equipment Set-Up

MPQ4232GVE-0000-AEC1 CONFIGURATIONS

OTP Items	Description	Value
OPERATION	The MPQ4232 is on or off by default	0: Off [(2)] (default)
VOUT_COMMAND	V_{OUT}, voltage reference (V_{REF}) = 0.5V	5V (default)
DITHER_ENABLE	Enables frequency spread spectrum (FSS)	1: Enabled
FREQ	Sets the switching frequency (f_{SW})	01: 420kHz (default)
PFM/PWM_MODE	Selects automatic pulse-frequency modulation (PFM) or pulse-width modulation (PWM) mode or forced PWM mode	01: Forced PWM mode (default)
OUTPUT_OVP_EN	Output OVP enable or disable	1: Enabled (default)
OUTPUT_DISCHARGE_EN	Enables output discharge function during the V_{IN}, I^2C, or EN disabled period	1: Enabled (default)
RSENS	Selects R_{SENS}	0: 5mΩ (default)
LDC_DISABLE	Enables line drop compensation	0: Enables line drop compensation (default)
CONSTANT_CURRENT_ LIMIT	Sets the output current (I_{OUT}) limit	5.4 (default)
LINE_DROP_ COMPENSATION	Sets V_{OUT} compensation vs. I_{OUT}	00: No compensation (default)
SWITCHING_CURRENT_ LIMIT	Sets the switch B (SWB) valley current limit and switch C (SWC) peak current limit	01: SWC peak 13.2A, SWB valley 9A
CC_ADJ	Adjusts the CC limit vs. V_{OUT} gain	0: Does not add 50mA to the CC limit (default)
SLEW_RATE_RISE	Sets the V_{REF} adjusted rising slew rate. The V_{OUT} slew rate can be calculated with the following equation: V_{OUT} Slew Rate = V_{REF} Slew Rate x Feedback Ratio Where the feedback ratio is 10.	01: 0.16mV/μs (default)
SLEW_RATE_FALL	Sets the V_{REF} adjusted falling slew rate. The V_{OUT} slew rate can be calculated with the following equation: V_{OUT} Slew Rate = V_{REF} Slew Rate x Feedback Ratio Where the feedback ratio is 10.	10: 0.1mV/μs (default)
FREQ_MODE	Sets the frequency mode under buck-boost conditions	1: Maintains the same frequency as buck and boost mode
CC_BLANK_TIMER	Sets the blank time before the MPQ4232 enters CC mode	01: 2ms (default)
HICCUP_EN	Enables hiccup mode during the current limit	1: Enabled
OT_WARNING	Enables the over-temperature (OT) warning	135°C (default)
I2C_ADDRESS	Sets the I^2C slave address	00111: 07h
VOUT_MSK	Masks ALT pin indication	1: Masked
IOUT/POUT_MSK		0: Not masked
VIN_MSK		1: Masked
TEMP_MSK		1: Masked
PG_MSK		11: The ALT pin does not indicate any PG edge changes
RESERVED		0: Not masked
UNKNOWN_MSK		1: Masked

Note:

2) Pull the ADDR pin to exceed V_{CC} by 57% to enable V_{OUT}.

EVALUATION BOARD SCHEMATIC

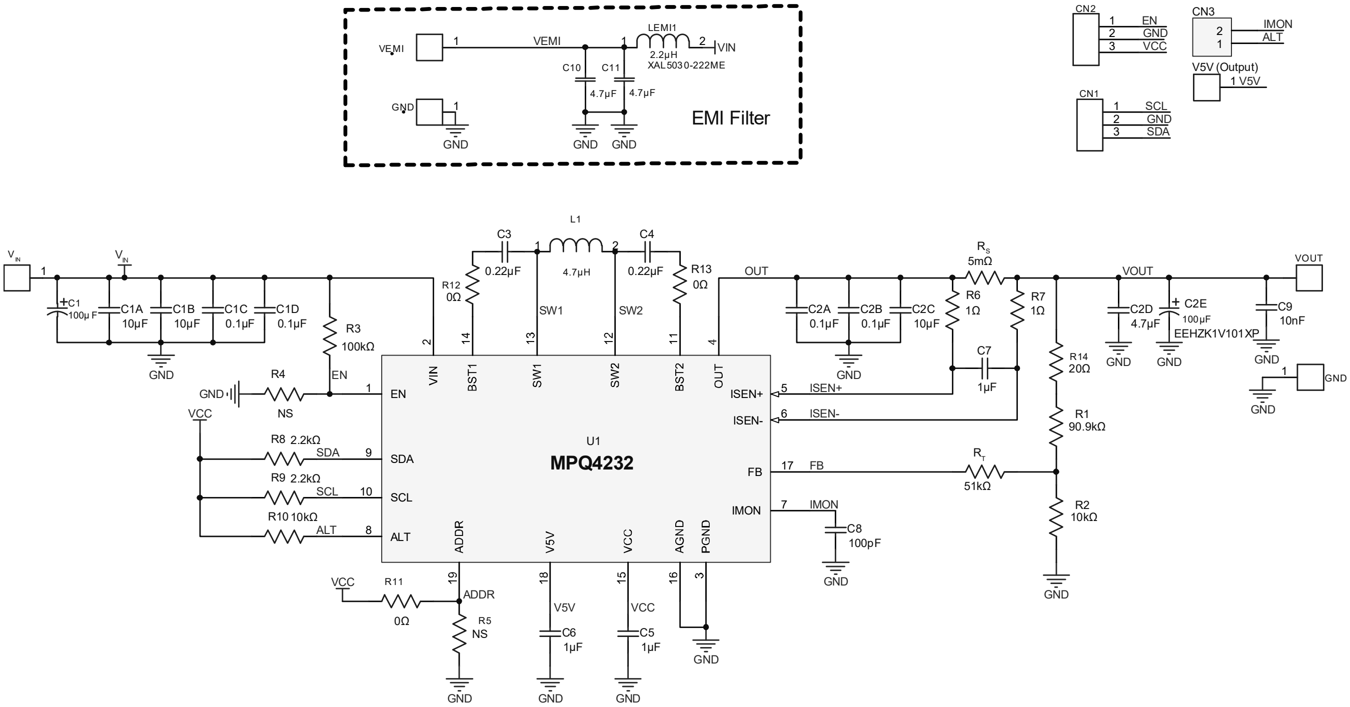


Figure 2: Evaluation Board Schematic (V_{IN} = 5V to 20V, default f_{SW} = 420kHz, V_{OUT} = 5V default) (3) (4)

Notes:

3) ADDR sets the I²C address and I2C_EN status. I2C_EN is the logic or result of the OPERATION bit and ADDR status. When ADDR is connected to V_{CC}, I2C_EN is on. V_{OUT} automatically starts up when V_{IN} and V_{EN} exceed their respective UVLO thresholds. When ADDR is connected to GND, I2C_EN is off. Once V_{IN} and V_{EN} exceed their respective UVLO thresholds, V_{OUT} does not start up until 1 is written to the OPERATION bit.

4) The V5V pin outputs 5V and can supply the external MCU with a 60mA capability.

EVQ4232-VE-00A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	C1	100µF	Aluminum electrolytic capacitor, 35V	SMD	Nippon Chemic-Con	EMZJ350ADA101MF80G
2	C1A, C1B	10µF	Ceramic capacitor, 50V, X5R	0805	Murata	GRM21BR61H106KE43L
4	C1C, C1D, C2A, C2B	0.1µF	Ceramic capacitor, 50V, X7R	0402	Murata	GRM155R71H104ME14D
1	C2C	10µF	Ceramic capacitor, 25V, X7S	0805	Murata	GRM21BC71E106KE11L
1	C2D	4.7µF	Ceramic capacitor, 25V, X7R	0805	Murata	GRM21BC71E475KE11L
1	C2E	100µF	Aluminum capacitor, 35V, ±20%, ESR = 35mΩ	SMD	Panasonic	EEHZK1V101XP
2	C3, C4	220nF	Ceramic capacitor, 16V, X7R	0402	Murata	GRM155R71C224KA12D
2	C5, C6	1µF	Ceramic capacitor, 16V, X5R	0603	Murata	GRM185R61C105KE44D
1	C7	1µF	Ceramic capacitor, 10V, X5R	0402	Wurth	885012105012
1	C8	100pF	Ceramic capacitor, 50V, X7R	0603	Wurth	885012206077
1	C9	10nF	Ceramic capacitor, 50V, X7R	0603	Wurth	885012206089
2	C10, C11	4.7µF	Ceramic capacitor, 50V, X7R	0805	TDK	CGA4J1X7R1H475K
1	R1	90.9kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0790K9L
2	R2, R10	10kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0710KL
1	RT	51kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0751KL
1	R3	100kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07100KL
0	R4, R5	NS				
2	R6, R7	1Ω	Film resistor, 1%	0402	Yageo	RC0402FR-071RL
2	R8, R9	2.2kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-072K2L
1	R11	0Ω	Film resistor, 1%	0603	Yageo	RC0603FR-070RL
2	R12, R13	0Ω	Film resistor, 1%	0402	Yageo	RC0402FR-070RL
1	R14	20Ω	Film resistor, 1%	0603	Yageo	RC0603FR-0720RL
1	Rs	5mΩ	Current-sensing resistor, long side, 1%, 1W	L1508	Susumu	RL3720WT-R005-F
1	L1	4.7µH	Inductor, R_{DC} = 8mΩ, I_{SAT} = 13A	SMD	Superworld	PIAQ1005S4R7MN
1	LEMI1	2.2µH	Inductor, R_{DC} = 14.5mΩ, I_{SAT} = 9.2A	5030	Coilcraft	XAL5030-222ME
2	CN1, CN2	2.54mm	Through-hole connector header, 1 x 3-pin, straight	DIP	Wurth	61300311121

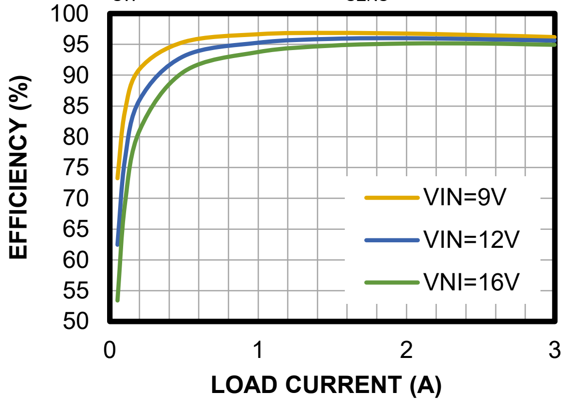
EVQ4232-VE-00A BILL OF MATERIALS *(continued)*

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	CN3	2.54mm	Through-hole connector header, 1 x 2-pin, straight	DIP	Wurth	61300211121
1	V5V	2.54mm	Through-hole connector header, 1 x 1-pin, straight	DIP	Wurth	61300111121
5	GND x 2, VIN, VEMI, VOUT	2mm	Copper pin, 1-pin	DIP	Any	
1	U1	MPQ4232	6A buck-boost converter with four integrated MOSFETs and I²C interface, AEC-Q100 qualified	QFN-19 (4mmx 5mm)	MPS	MPQ4232GVE-0000-AEC1

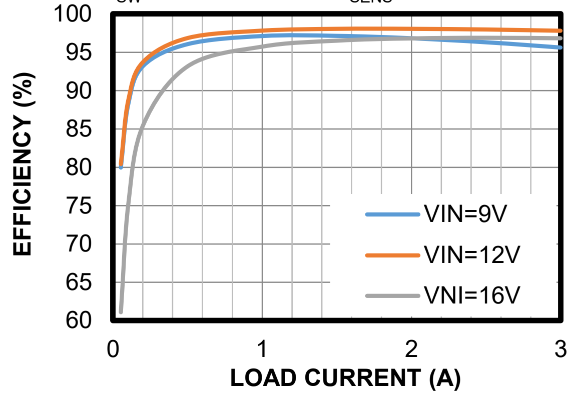
EVB TEST RESULTS

V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, T_A = 25°C, unless otherwise noted.

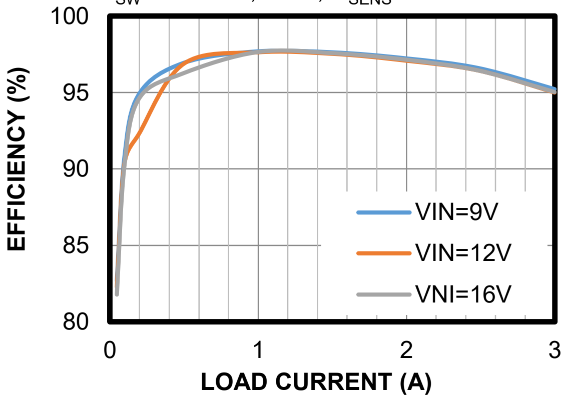
Efficiency vs. Load Current
V_{OUT} = 5V, L = 4.7µH, R_{DC} = 8mΩ,
f_{SW} = 420kHz, CCM, R_{SENS} = 5mΩ



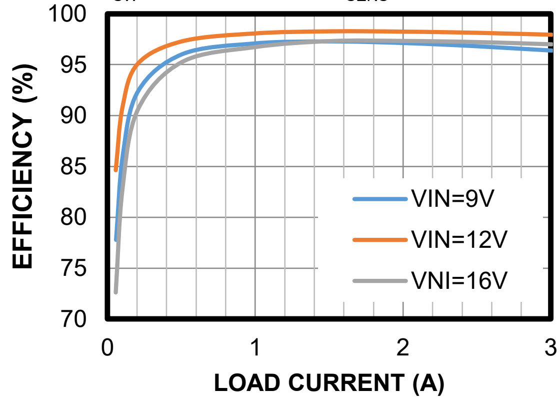
Efficiency vs. Load Current
V_{OUT} = 9V, L = 4.7µH, R_{DC} = 8mΩ,
f_{SW} = 420kHz, CCM, R_{SENS} = 5mΩ



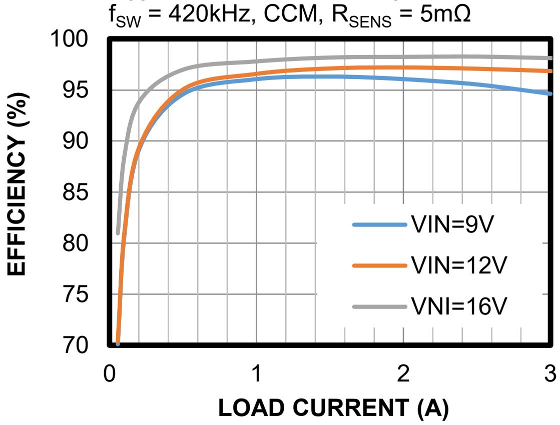
Efficiency vs. Load Current
V_{OUT} = 12V, L = 4.7µH, R_{DC} = 8mΩ,
f_{SW} = 420kHz, CCM, R_{SENS} = 5mΩ



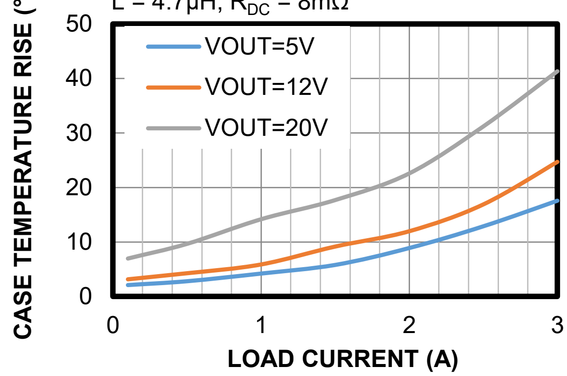
Efficiency vs. Load Current
V_{OUT} = 15V, L = 4.7µH, R_{DC} = 8mΩ,
f_{SW} = 420kHz, CCM, R_{SENS} = 5mΩ



Efficiency vs. Load Current
V_{OUT} = 20V, L = 4.7µH, R_{DC} = 8mΩ,
f_{SW} = 420kHz, CCM, R_{SENS} = 5mΩ



Case Temperature Rise vs. Load Current
V_{IN} = 12V, V_{OUT} = 5V/12V/20V,
f_{SW} = 420kHz, based on 5cmx5cm board,
L = 4.7µH, R_{DC} = 8mΩ



PCB LAYOUT

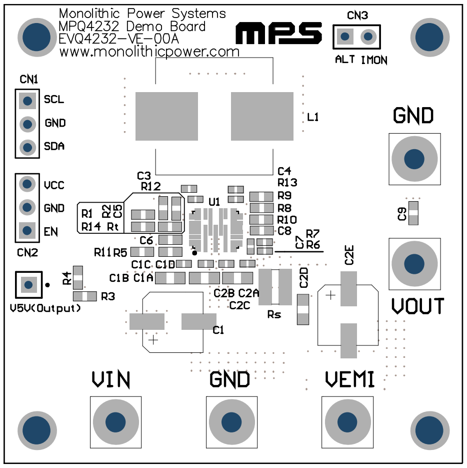


Figure 3: Top Silk

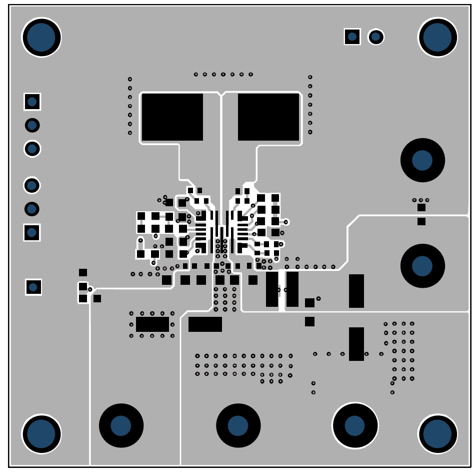


Figure 4: Top Layer

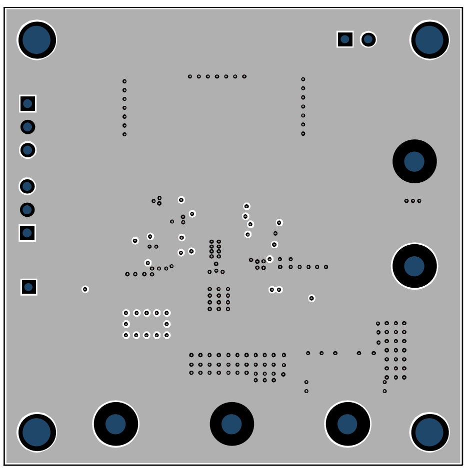


Figure 5: Mid-Layer 1

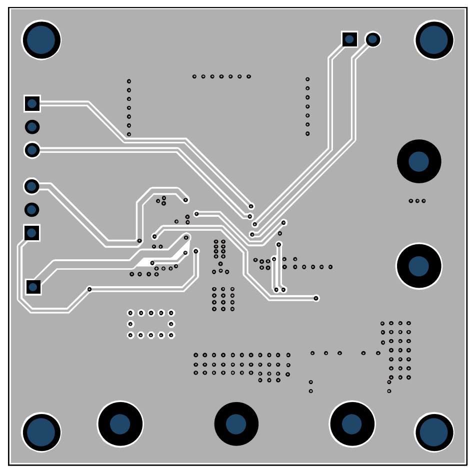


Figure 6: Mid-Layer 2

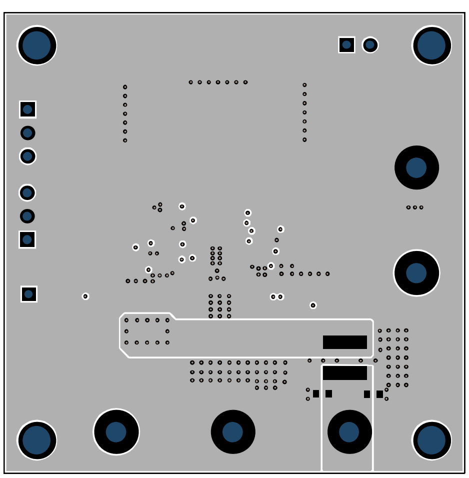


Figure 7: Bottom Layer

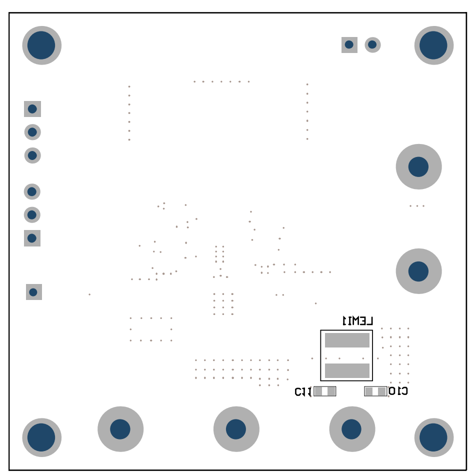


Figure 8: Bottom Silk

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	7/5/2024	Initial Release	-