EVQ4262-QVE-00A

36V, 100W Buck-Boost Converter with Two Integrated LS-FETs and I²C Interface Evaluation Board, AEC-Q100 Qualified

DESCRIPTION

The EVQ4262-QVE-00A is an evaluation board designed to demonstrate the capabilities of the MPQ4262, a buck-boost converter with two integrated low-side power MOSFETs (LS-FETs). It can deliver up to 100W of peak output power across its input supply range, with excellent efficiency.

The MPQ4262 is designed for USB power delivery (PD) applications. It works with external USB PD controllers via its I²C interface. The device's features can be flexibly configured via the I²C and one-time programmable (OTP) memory.

Full protection features include constant-current limiting, output over-voltage protection (OVP), and thermal shutdown.

The MPQ4262 requires a minimal number of readily available, standard external components, and is available in a QFN-20 (3mmx5mm) package.

ELECTRICAL SPECIFICATIONS

Parameter	Symbol	Value	Units
Input voltage	V_{IN}	12	V
Output voltage	V_{OUT}	5	V
Output current	I_{OUT}	3	A
Switching frequency	f_{SW}	420	kHz
Default operating status		On	

Note:

1) The default reference voltage (V_{REF}) is set at 0.5V. Change the output voltage (V_{OUT}) command register to achieve other voltage values. The target V_{OUT} can be set by adjusting the FB resistor divider.
2) The default absolute output OVP is 25.5V. If intending to test at V_{OUT} > 25V, disable OVP by setting the output OVP enable command to 0 (0xD0 register, D[2] = 0) and changing any BOM components that cannot withstand >25V, such as electrolytic capacitors.

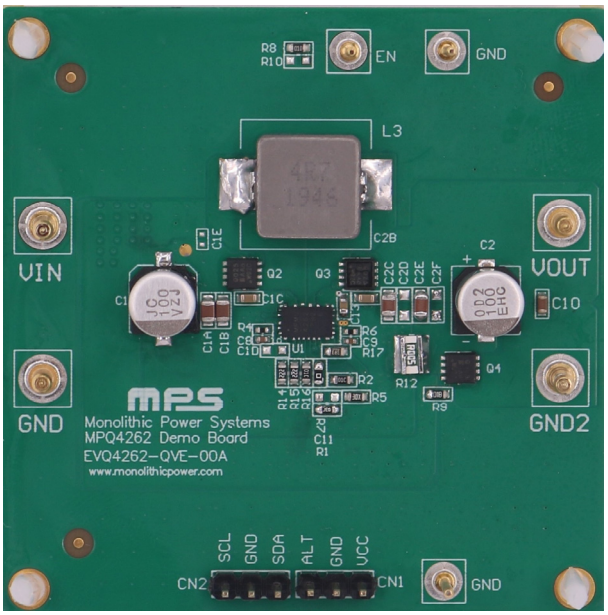
FEATURES

- 100W Buck-Boost Converter with Two Integrated Low-Side MOSFETs (LS-FETs)
- Integrated Gate Driver for High-Side MOSFETs (HS-FETs)
- 3.6V to 36V Input Voltage (V_{IN}) Range
- 1V to 36V Output Voltage (V_{OUT}) Range
- Supports 2.8V Falling V_{IN} when V_{OUT} > 3.5V
- Up to 5A Output Current (I_{OUT})
- Up to 98% Peak Efficiency
- I²C -Configurable 0.1V to 2.147V Reference Voltage (V_{REF}) Range with 1mV Resolution
- Constant Current Limit with ±5% Accuracy
- Supports USB PD 3.0
- 280kHz, 420kHz, or 580kHz Selectable Switching Frequency (f_{SW})
- Selectable Forced Pulse-Width Modulation (FPWM) Mode, Auto PWM Mode, or Auto Pulse-Frequency Modulation Mode (PFW)
- V_{CC} LDO with Output Bias for High Efficiency
- Short-to-Ground Battery Protection
- Line Drop Compensation via the SENSE resistor (R_{SENSE})
- I²C Interface and One-Time Programmable (OTP) Memory
- EN Shutdown with Passive Discharge
- Output Over-Current Protection (OCP), Over-Voltage Protection (OVP), and Thermal Shutdown
- Available in a QFN-20 (3mmx5mm) Package
- Available in a Wettable Flank Package
- Available in AEC-Q100 Grade 1

APPLICATIONS

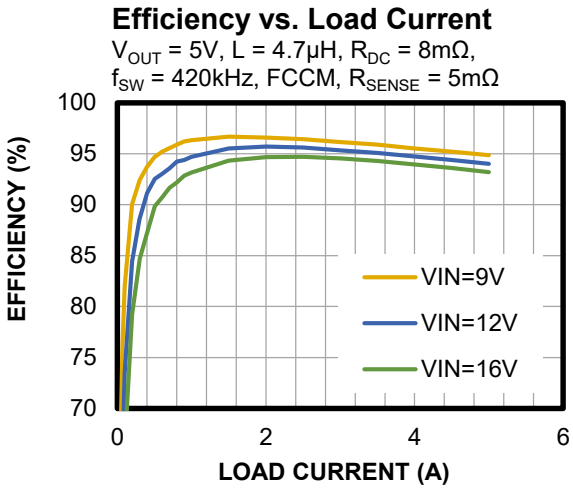
- USB Power Delivery (PD) Hubs
- USB PD Charging Ports
- Wireless Charging

EVQ4262-QVE-00A EVALUATION BOARD



LxW (6cmx6cm)

Board Number	MPS IC Number
EVQ4262-QVE-00A	MPQ4262GQVE-0000-AEC1



QUICK START GUIDE (3)

1. Connect the load terminals to:
   a. Positive (+): VOUT
   b. Negative (-): GND2
2. Preset the power supply to 12V, then turn off the power supply.
3. Connect the power supply terminals to:
   a. Positive (+): VIN
   b. Negative (-): GND
4. Turn on the power supply on. The board should start up automatically.
5. The default output voltage (V_{OUT}) is 5V, and the default reference voltage (V_{REF}) is 0.5V. To set a different V_{OUT}, configure the VOUT_COMMAND register (0x21) or adjust the FB resistor divider.
6. The default constant current (CC) limit is 5.4A. Configure the MFR_CURRENT_LIMIT register (0xD1) to set the target current limit.

Note:

3) The MPS GUI can be downloaded from the MPS website.

MPQ4262GQVE-0000-AEC1 CONFIGURATION TABLE (4)

OTP Items	Description	Default Value
OPERATION	Enables/disables the converter	1: Enabled
V_{OUT}	Output voltage	5V
Dither enable	Enables/disables frequency spread spectrum	1: Enabled
FREQ	Sets the switching frequency (f_{SW})	01: 420kHz
SWA MOSFET $R_{DS(ON)}$	External MOSFET A's $R_{DS(ON)}$ under 5V	01: 10mΩ
Output over-voltage protection (OVP) enable	Enables/disables output OVP	1: Enabled
Output discharge EN	Enables/disables output discharge during V_{IN}, I²C, and the EN off time (t_{OFF})	1: Enabled
PFM/PWM mode	Selects forced pulse-width modulation mode (FPWM), automatic pulse-frequency modulation (PFM) mode, or automatic pulse-width modulation (PWM) mode	1: FPWM
Current limit	Output current limit	5.4A
Line drop compensation gain	Sets V_{OUT} compensation vs. load current	00: No compensation
Switching current limit	SWB valley current limit and SWC peak current limit	10: SWC peak is 15A, SWB valley is 13A
R_{SENSE}	Selects the R_{SENSE} resistance	0: 5mΩ
Slew rate rise	Sets V_{REF}'s adjustable rising slew rate (V_{OUT} slew rate = V_{REF} slew rate x 10)	01: 0.16mV/μs
Slew rate fall	Set V_{REF}'s adjustable falling slew rate (V_{OUT} slew rate = V_{REF} slew rate x 10)	01: 0.04mV/μs
FREQ MODE	Sets the frequency mode during buck-boost mode	Maintains the frequency in buck-boost mode
SW2 EDGE	Selects SW2's rising speed and falling speed	1: Faster
Absolute OVP	Selects the absolute OVP threshold	0: 25.5V
OT warning function	Enables/disables the OT warning function	0: Enabled
OT warning temperature	Selects the OT warning temperature	0: 130°C
I²C address	Sets the I²C slave address (A5:A1)	00111
VOUT MSK	Masks the ALT pin indication	1: Masked
IOUT/POUT MSK		0: Not Masked
Reserved MSK		1: Masked
TEMP MSK		1: Masked
PG_STATUS# MSK		1: Masked
PG_ALT_EDGE MSK		1: Masked
GND_SHORT_VBATT MSK		1: Masked
UNKNOWN MSK		1: Masked

Note:

4) To customize the OTP configuration, contact an MPS FAE to create a unique suffix code.

EVALUATION BOARD SCHEMATIC

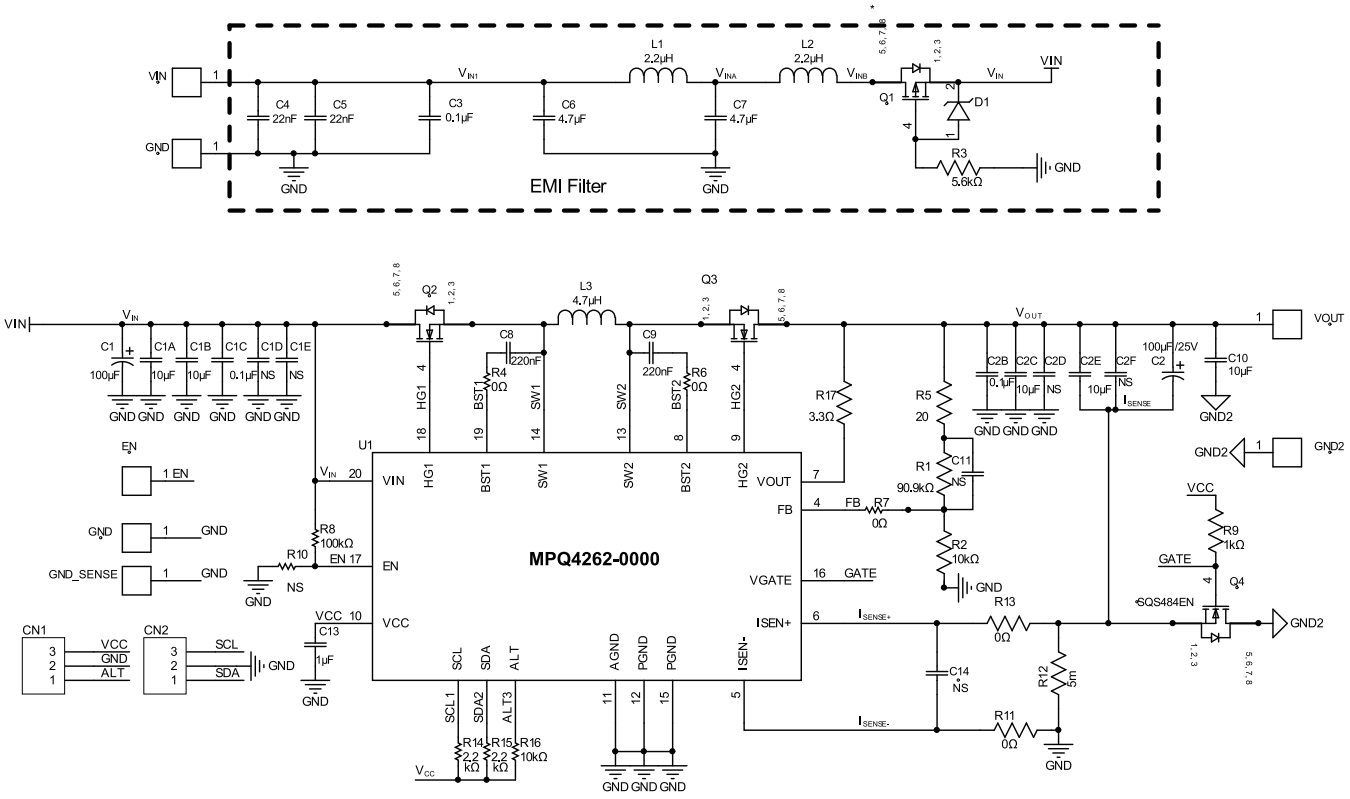


Figure 1: Evaluation Board Schematic

EVQ4262-QVE-00A BILL OF MATERIALS

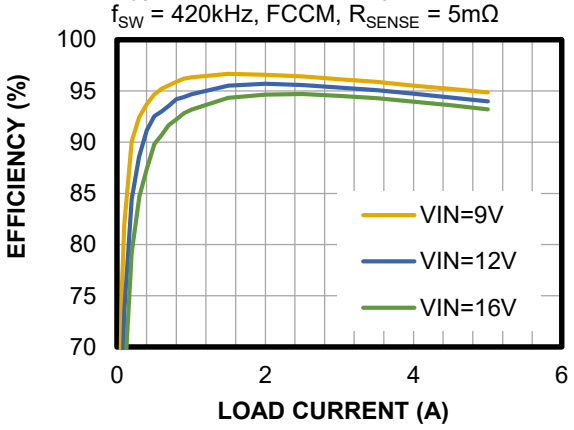
Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	C1	100µF	Capacitor, ESR = 160mΩ, 35V	SMD	Chemi-Con	EMZJ350ADA101MF80G
4	C1A, C1B, C2C, C2E	10µF	Ceramic capacitor, 50V, X5R	0805	TDK	C2012X5R1H106K125AC
3	C1C, C2B, C3	100nF	Ceramic capacitor, 50V, X7R	0603	Samsung	CL05B104KB5NNNC
1	C2	100µF	Hybrid capacitor, 25V, 20mΩ	SMD	Chemi-Con	HHXC250ARA101MF0G
2	C4, C5	22nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM155R71H223KA12D
2	C6, C7	4.7µF	Ceramic capacitor, 50V, X7S	0805	Murata	GRM21BC71H475KE11L
2	C8, C9	220nF	Ceramic capacitor, 16V, X7R	0402	Murata	GRM155R71C224KA12D
1	C10	10µF	Ceramic capacitor, 50V, X5R	0603	Murata	GRM188R61E106MA73L
1	C13	1µF	Ceramic capacitor, 16V, X5R	0603	Murata	GRM185R61C105KE44D
1	R1	90.9kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0790K9L
2	R2, R16	10kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0710KL
1	R3	5.6kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-075K6L
2	R4, R6	0Ω	Film resistor, 1%	0402	Yageo	RC0402FR-070RL
1	R5	20Ω	Film resistor, 1%	0603	Yageo	RC0603FR-0720RL
1	R7	0Ω	Film resistor, 1%	0603	Yageo	RC0603FR-070RL
1	R8	100kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07100KL
1	R9	1kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-071KL
2	R11, R13	0Ω	Film resistor, 1%	0603	Yageo	RC0603FR-070RL
1	R12	5mΩ	Long-side, current-sense resistor, 1%, 1W	L1508	Film Tech	RL3720WT-R005-F
2	R14, R15	2.2kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-072K2L
1	R17	3.3Ω	Film resistor, 1%	0603	Yageo	RC0603FR-073R3L
2	L1, L2	2.2µH	Inductor, R_{DC} = 11.4mΩ, I_{SAT} = 13A	7040	Superworld	PIFQ0703A2R2MN
1	L3	4.7µH	Inductor, R_{DC} = 8mΩ, I_{SAT} = 13A	SMD	Superworld	PIAQ1005S4R7MN
0	D1	16V	Zener diode, V_F = 16V, I_F = 5mA, 500mW	SMD	Diodes, Inc.	BZT52C16-7-F
1	Q1	30V	P-channel MOSFET, 16A	SMD	Vishay	SQS423EN-T1_GE3
3	Q2, Q3, Q4	40V	N-channel MOSFET, 16A	SMD	Vishay	SQS484EN-T1_GE3, SQS484ENW-T1_GE3
2	CN1, CN2	2.54mm	3-pin header, 1 row, straight	DIP	Wurth	61300311121
4	VIN, GND, GND2, VOUT	φ2.0	Copper pin	DIP	Custom	
3	GND，EN	φ1.0	Copper pin	DIP	Custom	
0	C1D, C1E, C11, C2F, C2D, R10, C14	NS				
1	U1	MPQ4262-AEC1	Buck-boost converter with integrated LS-FETs	QFN-20 (3mmx 5mm)	MPS	MPQ4262GQVE-0000-AEC1

EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, T_A = 25°C, unless otherwise noted.

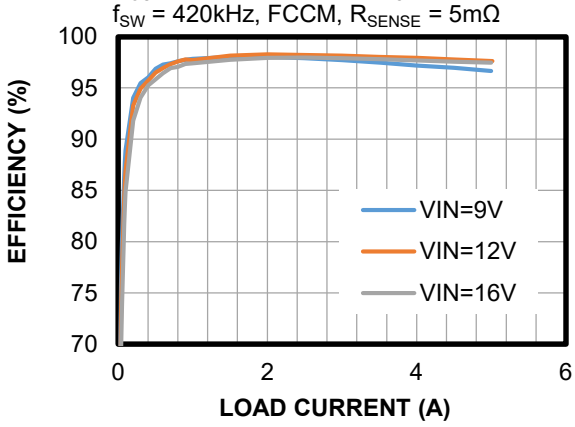
Efficiency vs. Load Current

V_{OUT} = 5V, L = 4.7µH, R_{DC} = 8mΩ, f_{SW} = 420kHz, FCCM, R_{SENSE} = 5mΩ



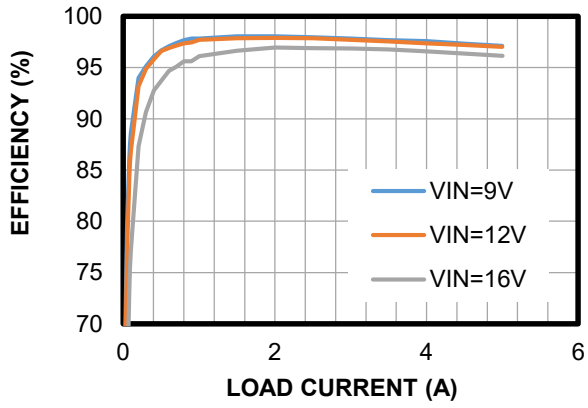
Efficiency vs. Load Current

V_{OUT} = 12V, L = 4.7µH, R_{DC} = 8mΩ, f_{SW} = 420kHz, FCCM, R_{SENSE} = 5mΩ



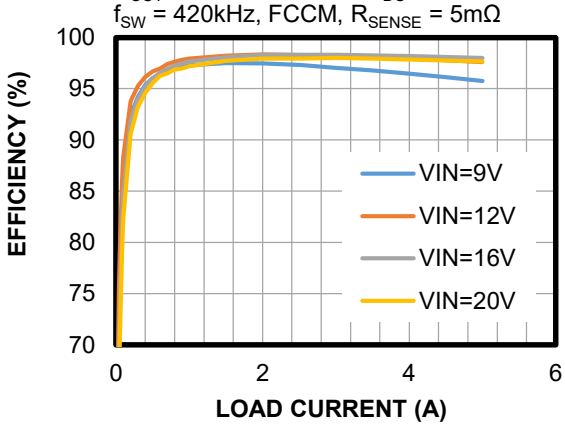
Efficiency vs. Load Current

V_{OUT} = 9V, L = 4.7µH, R_{DC} = 8mΩ, f_{SW} = 420kHz, FCCM, R_{SENSE} = 5mΩ



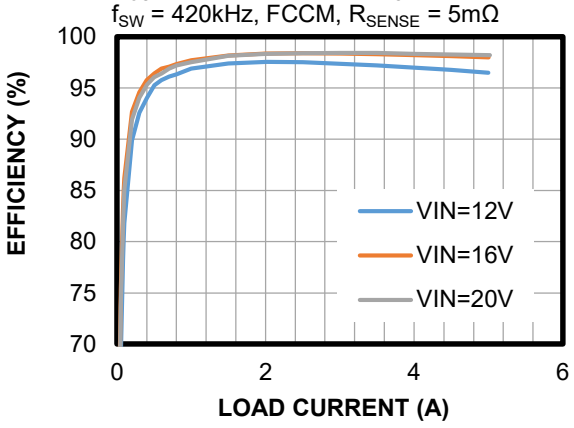
Efficiency vs. Load Current

V_{OUT} = 15V, L = 4.7µH, R_{DC} = 8mΩ, f_{SW} = 420kHz, FCCM, R_{SENSE} = 5mΩ



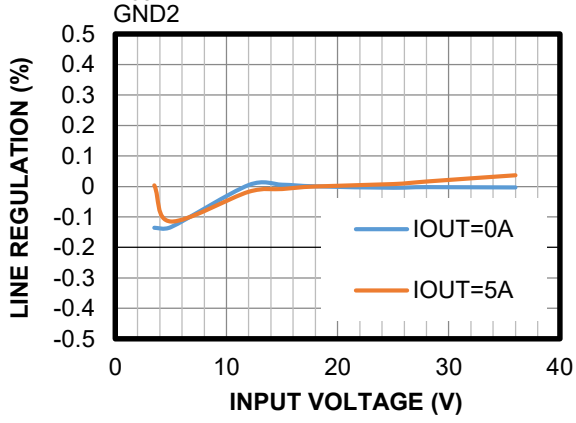
Efficiency vs. Load Current

V_{OUT} = 20V, L = 4.7µH, R_{DC} = 8mΩ, f_{SW} = 420kHz, FCCM, R_{SENSE} = 5mΩ



Line Regulation

V_{OUT} = 5V, measured between VOUT and GND2

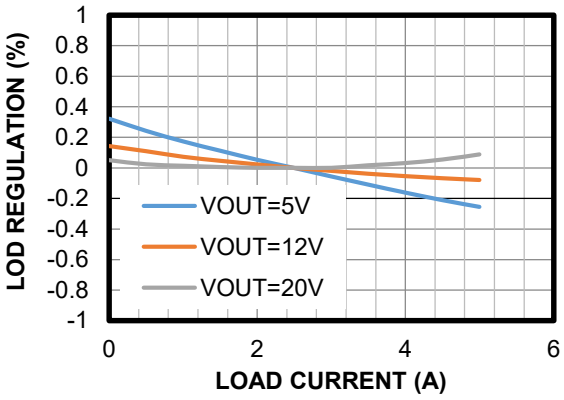


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, T_A = 25°C, unless otherwise noted.

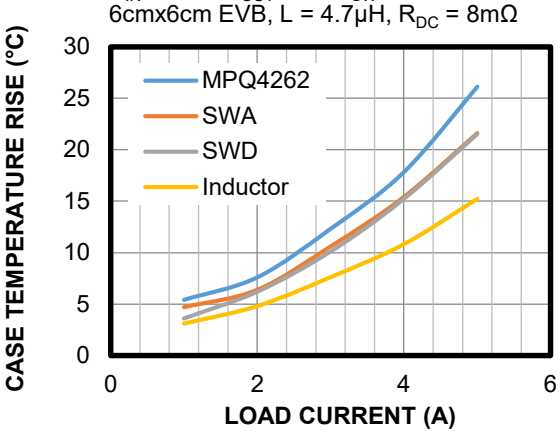
Load Regulation

R_{SENSE} = 5mΩ, no line drop compensation, measure V_{OUT} between VOUT and GND2



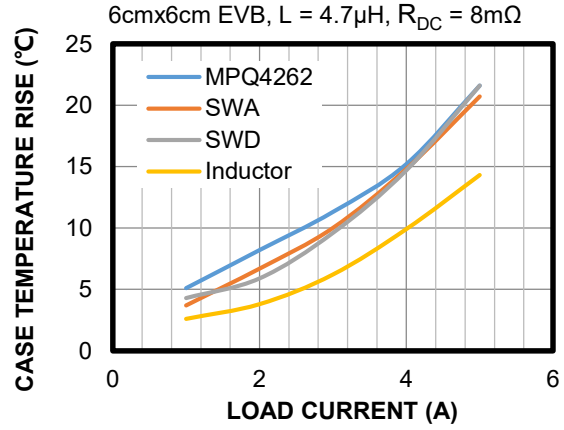
Case Temperature Rise

V_{IN} = 12V, V_{OUT} = 5V, f_{SW} = 420kHz, 6cmx6cm EVB, L = 4.7µH, R_{DC} = 8mΩ



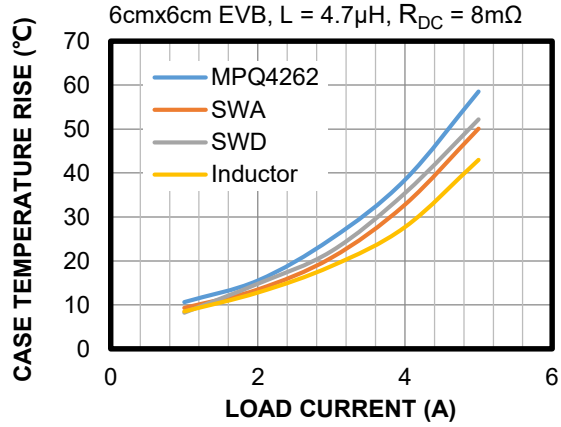
Case Temperature Rise

V_{IN} = 12V, V_{OUT} = 12V, f_{SW} = 420kHz, 6cmx6cm EVB, L = 4.7µH, R_{DC} = 8mΩ

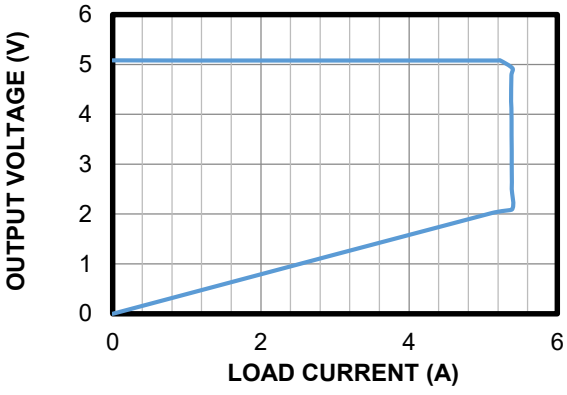


Case Temperature Rise

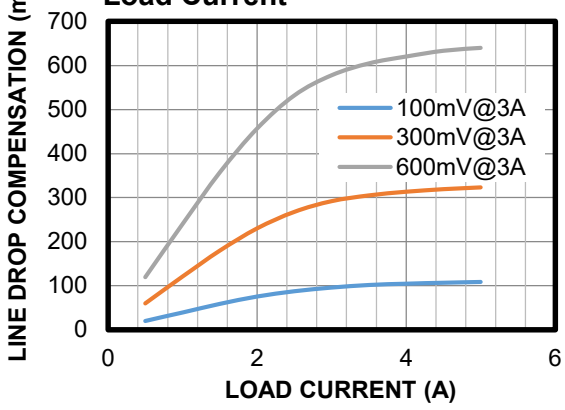
V_{IN} = 12V, V_{OUT} = 20V, f_{SW} = 420kHz, 6cmx6cm EVB, L = 4.7µH, R_{DC} = 8mΩ



CC/CV Curve



Line Drop Compensation vs. Load Current

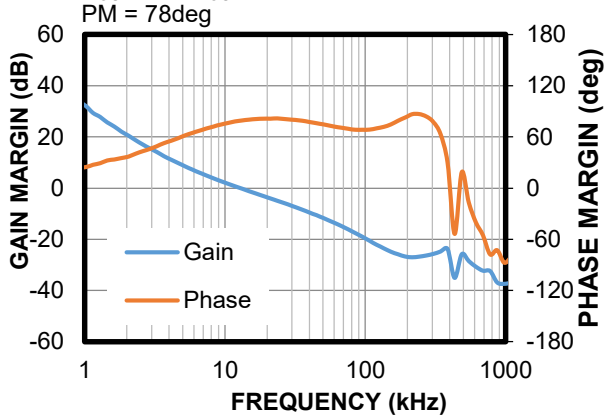


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, T_A = 25°C, unless otherwise noted.

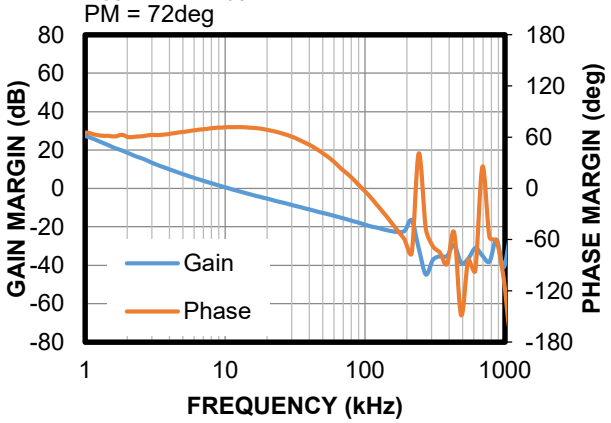
Bode Plot

V_{OUT} = 5V, I_{OUT} = 5A, BW = 12kHz, PM = 78deg



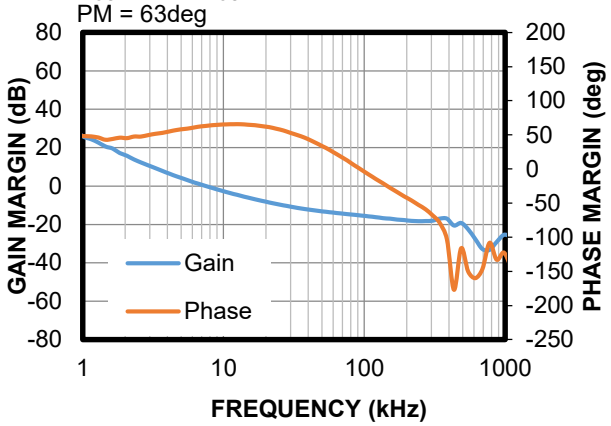
Bode Plot

V_{OUT} = 12V, I_{OUT} = 5A, BW = 10kHz, PM = 72deg



Bode Plot

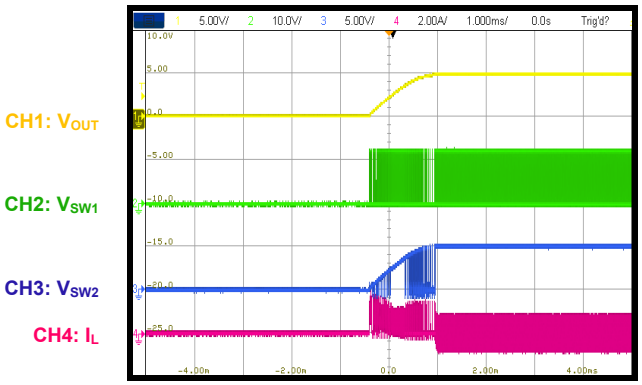
V_{OUT} = 20V, I_{OUT} = 5A, BW = 7.5kHz, PM = 63deg



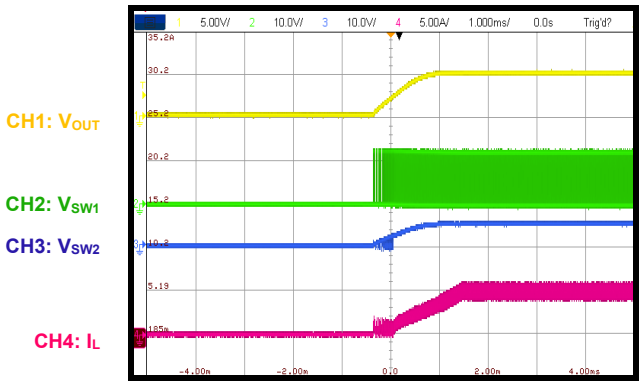
EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board. V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, f_{SW} = 420kHz, T_A = 25°C, unless otherwise noted.

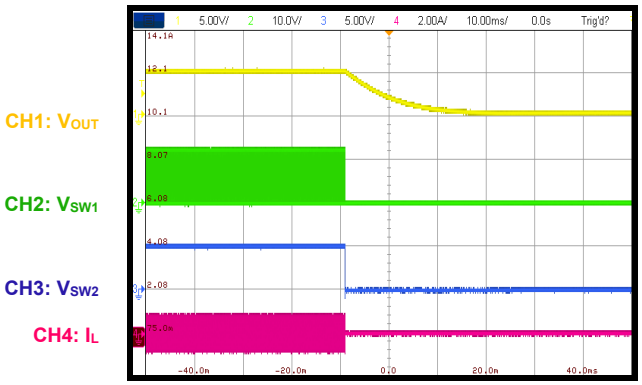
Start-Up through the I²C
Load = 0A



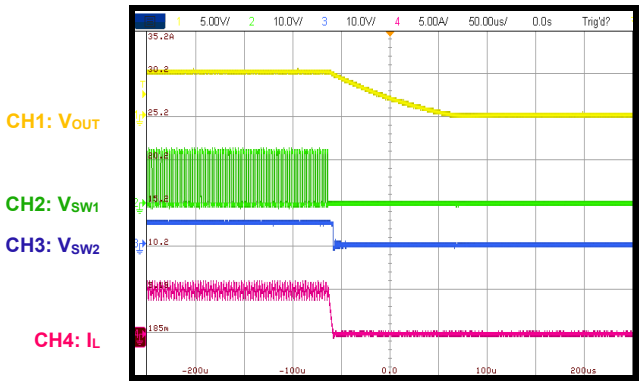
Start-Up through the I²C
Load = 5A



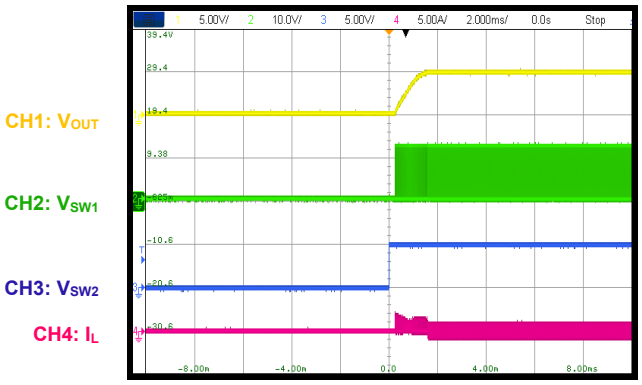
Shutdown through the I²C
Load = 0A



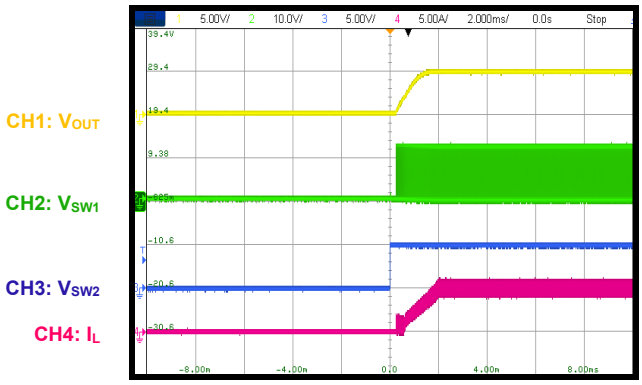
Shutdown through the I²C
Load = 5A



Start-Up through EN
Load = 0A



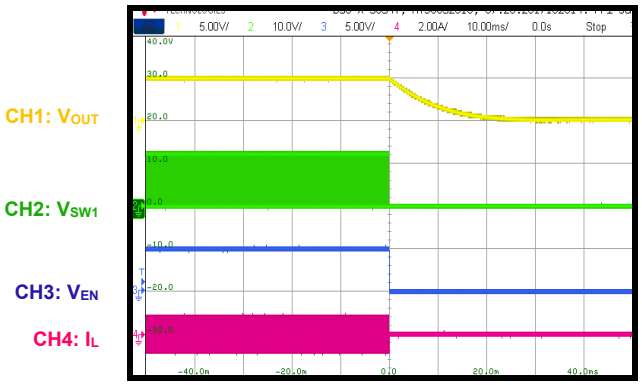
Start-Up through EN
Load = 5A



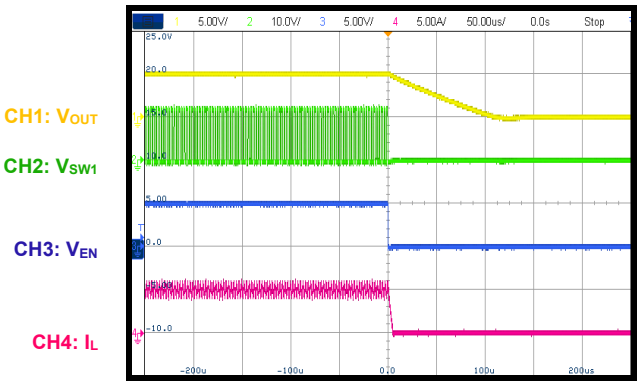
EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board. V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, f_{SW} = 420kHz, T_A = 25°C, unless otherwise noted.

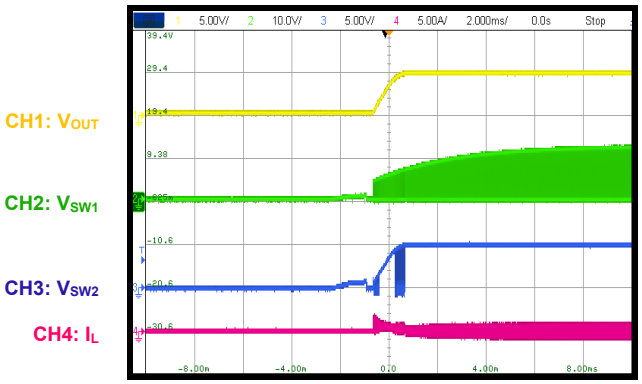
Shutdown through EN
Load = 0A



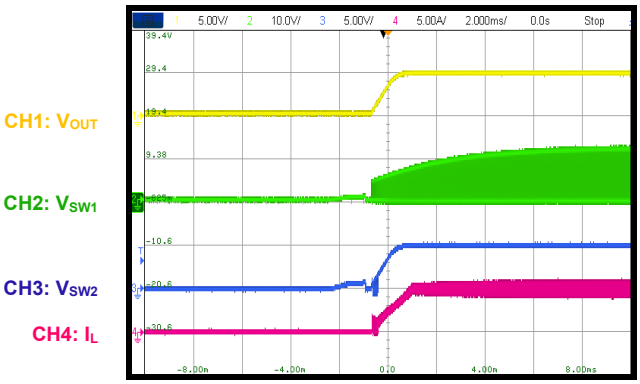
Shutdown through EN
Load = 5A



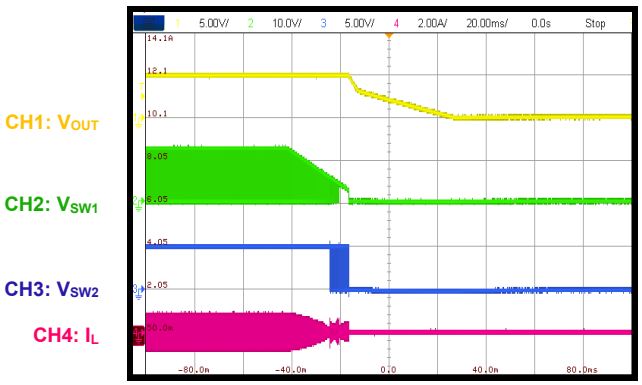
Start-Up through VIN
Load = 0A



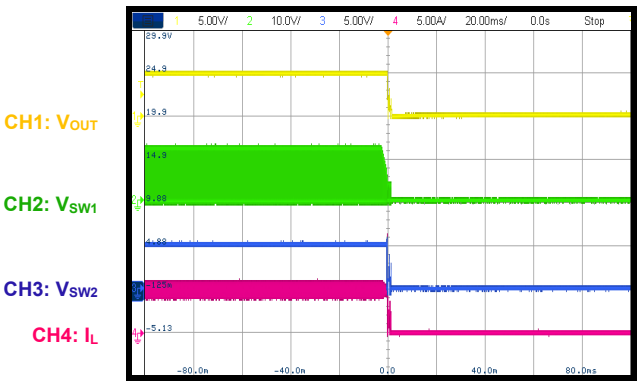
Start-Up through VIN
Load = 5A



Shutdown through VIN
Load = 10mA



Shutdown through VIN
Load = 5A

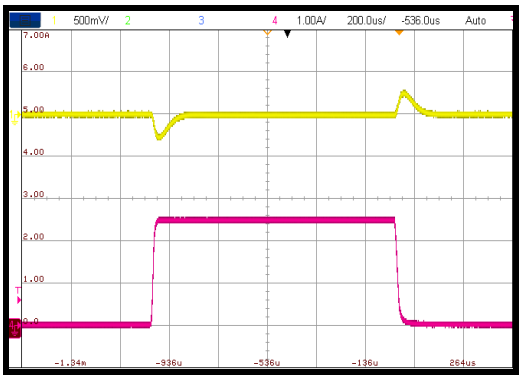


EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board. V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, f_{SW} = 420kHz, T_A = 25°C, unless otherwise noted.

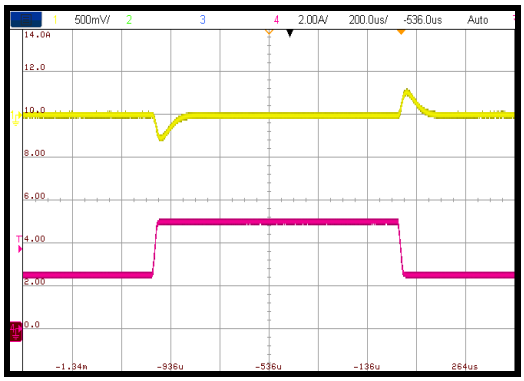
Load Transient

V_{IN} = 12V, V_{OUT} = 5V, I_{OUT} = 0A to 2.5A, 150mA/µs



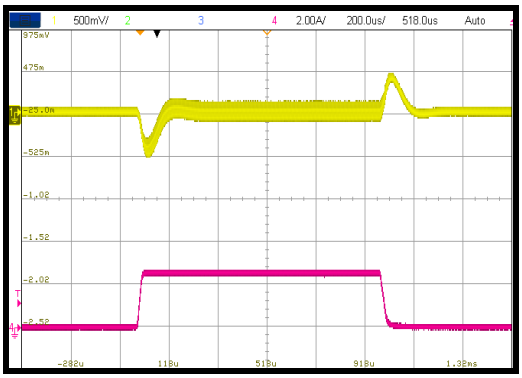
Load Transient

V_{IN} = 12V, V_{OUT} = 5V, I_{OUT} = 2.5A to 5A, 150mA/µs



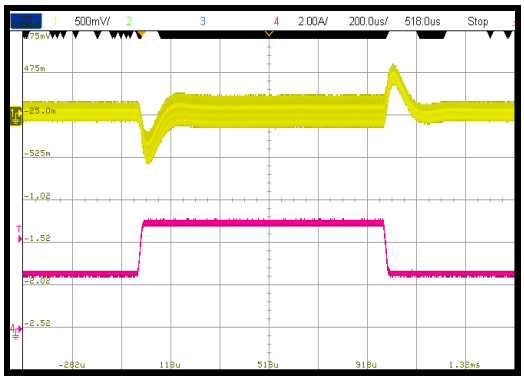
Load Transient

V_{IN} = 12V, V_{OUT} = 20V, I_{OUT} = 0A to 2.5A, 150mA/µs



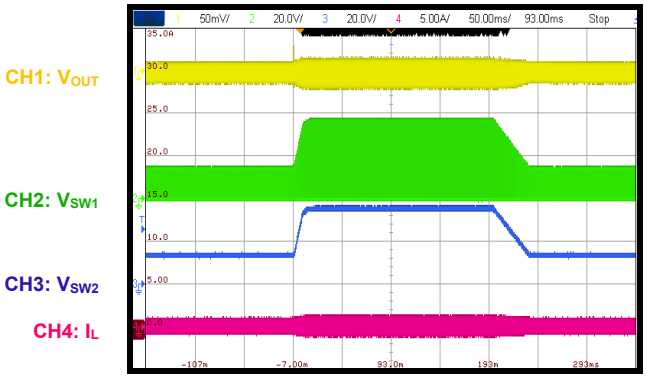
Load Transient

V_{IN} = 12V, V_{OUT} = 20V, I_{OUT} = 2.5A to 5A, 150mA/µs



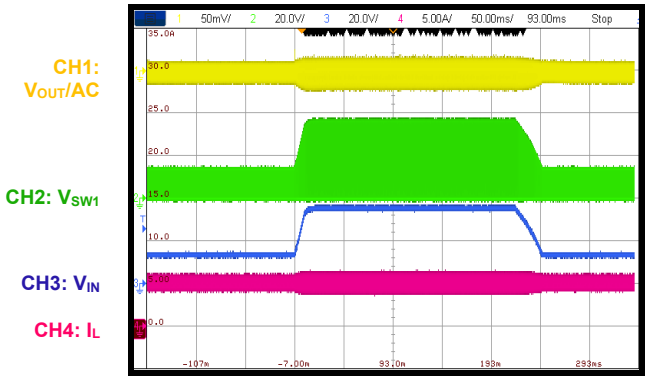
V_{IN} Transient

V_{IN} = 14V to 35V, V_{OUT} = 5V, load = 0A



V_{IN} Transient

V_{IN} = 14V to 35V, V_{OUT} = 5V, load = 5A

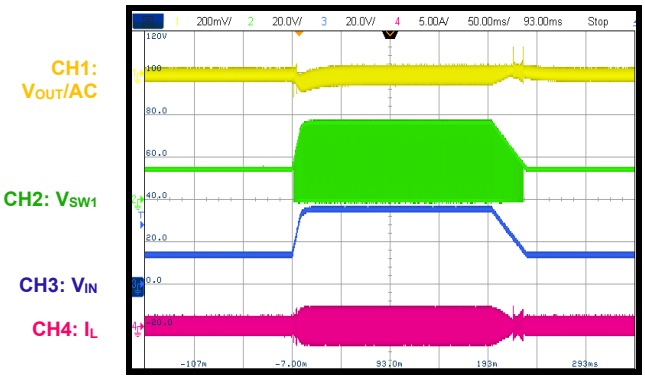


EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board. V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, f_{SW} = 420kHz, T_A = 25°C, unless otherwise noted.

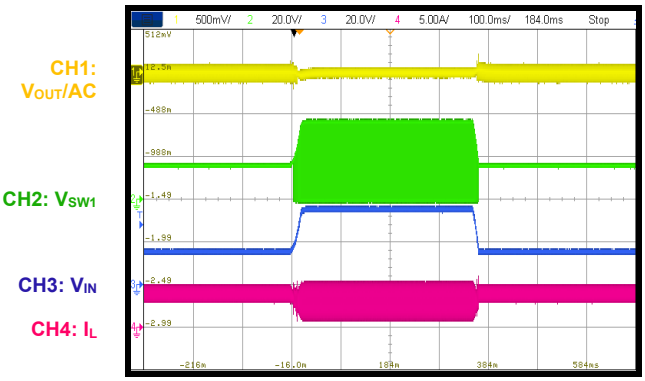
V_{IN} Transient

V_{IN} = 14V to 35V, V_{OUT} = 20V, load = 0A



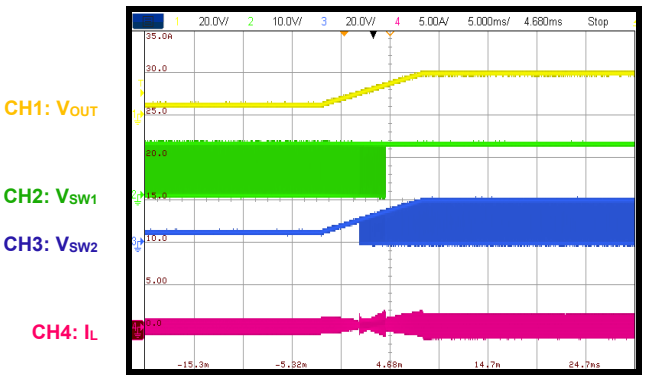
V_{IN} Transient

V_{IN} = 14V to 35V, V_{OUT} = 20V, load = 3A



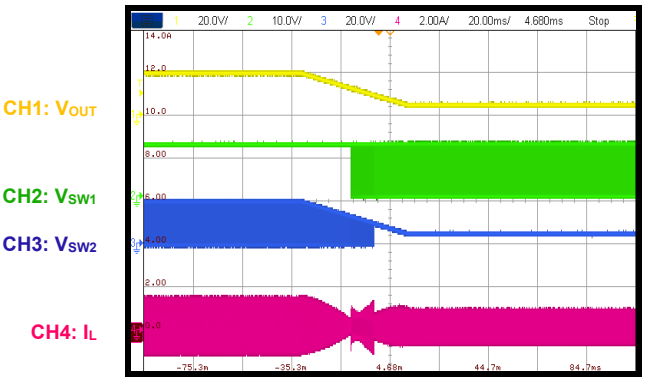
V_{OUT} Transition

V_{OUT} = 5V to 20V, I_{OUT} = 0A



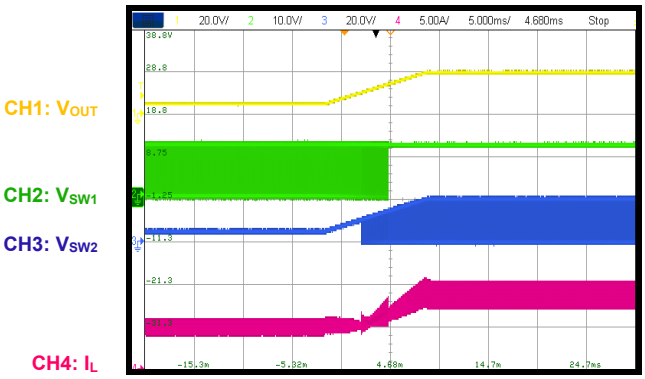
V_{OUT} Transition

V_{OUT} = 20V to 5V, I_{OUT} = 0A



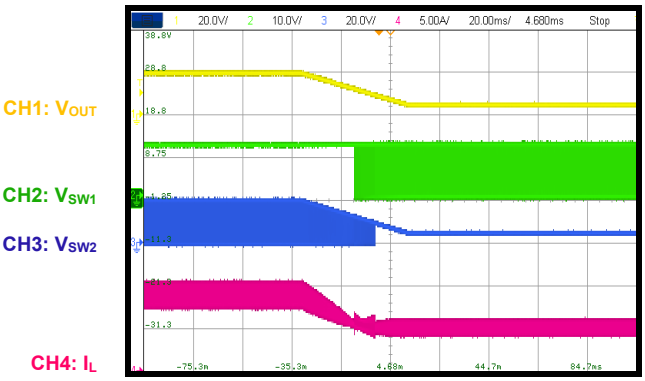
V_{OUT} Transition

V_{OUT} = 5V to 20V, I_{OUT} = 5A



V_{OUT} Transition

V_{OUT} = 20V to 5V, I_{OUT} = 5A

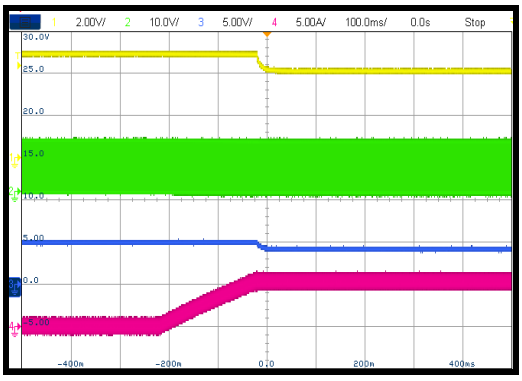


EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board. V_{IN} = 12V, V_{OUT} = 5V, L = 4.7µH, f_{SW} = 420kHz, T_A = 25°C, unless otherwise noted.

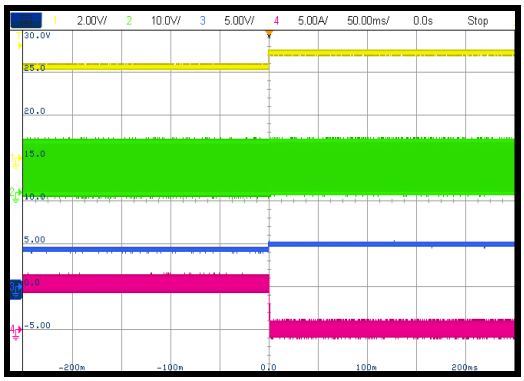
CC Entry

CV load = 4V, CC limit = 5.4A

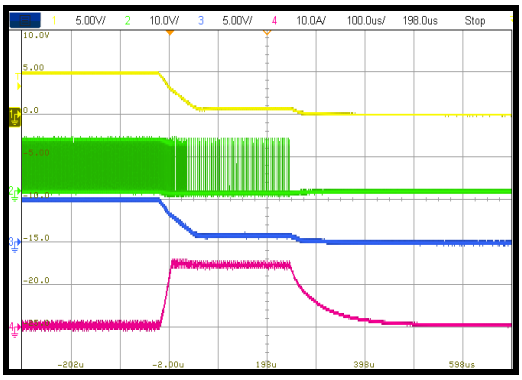


CC Recovery

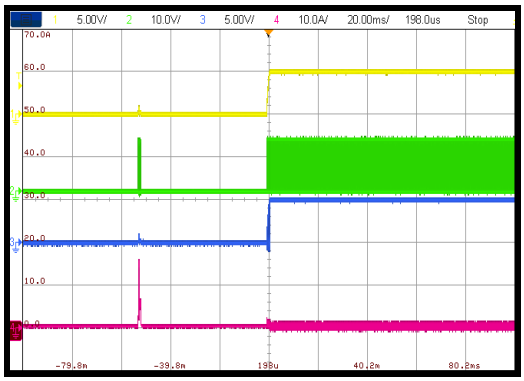
CV load = 4V, CC limit = 5.4A



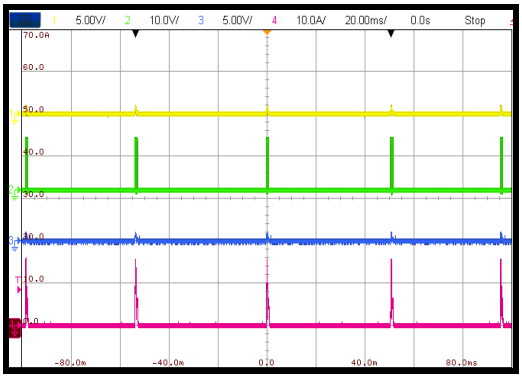
SCP Entry



SCP Recovery



SCP Steady State



PCB LAYOUT

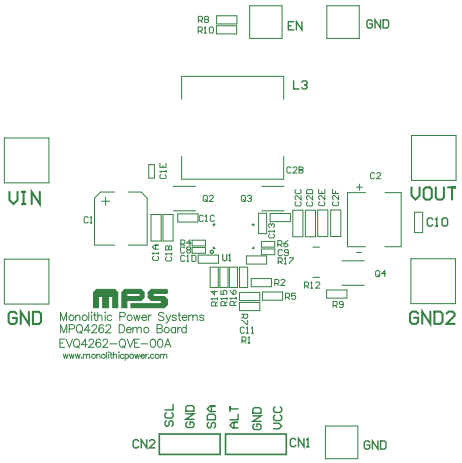


Figure 2: Top Silk

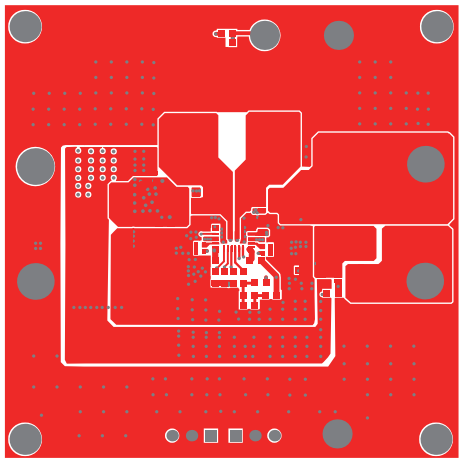


Figure 3: Top Layer

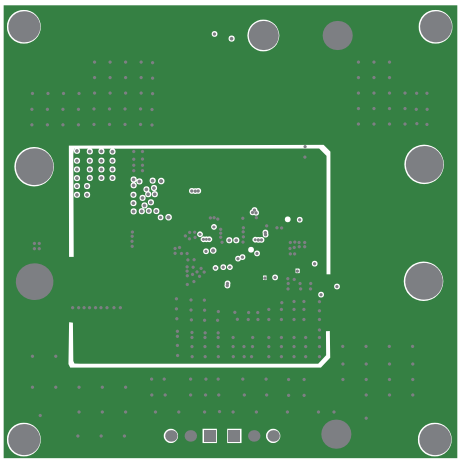


Figure 4: Mid-Layer 1

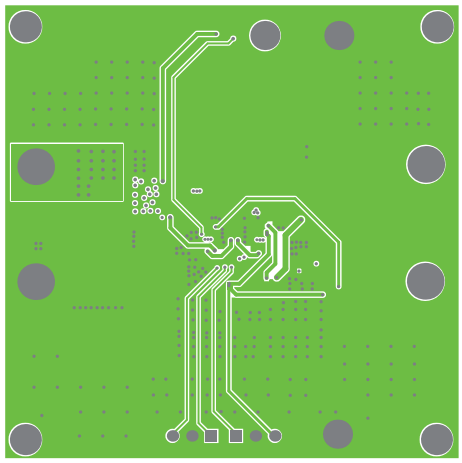


Figure 5: Mid-Layer 2

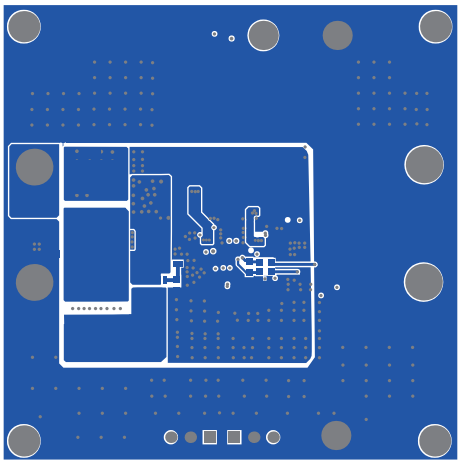


Figure 6: Bottom Layer

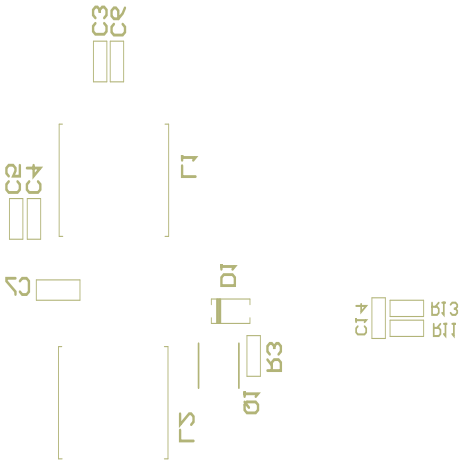


Figure 7: Bottom Silk

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	09/08/2021	Initial Release	-