



EVQ4210-U-00B

40V, 100W Synchronous Buck-Boost Controller with I²C and Current Monitor, AEC-Q100 Qualified

DESCRIPTION

The EVQ4210-U-00B Evaluation Board is designed to demonstrate the capabilities of MPS' MPQ4210GU-AEC1.

The MPQ4210 is a synchronous, four-switch, buck-boost controller capable of regulating different output voltages with a wide input voltage range and high efficiency. It provides an I²C interface, which supports V_{OUT} voltage programmability, V_{OUT} slew-rate control, and output constant current limit programmability, making the MPQ4210 suitable for USB power delivery (PD) design in USB Type-C power supplies.

The MPQ4210 uses valley current control in buck mode and peak current control in boost mode, providing fast load transient response and smooth buck-boost mode transient. The MPQ4210 provides forced continuous conduction mode (FCCM) and a programmable average current limit, which supports flexible designs for different applications.

It also features programmable over-current protection (OCP) mode, programmable over-voltage protection (OVP) mode, and programmable V_{IN} UVLO hysteresis.

The MPQ4210 is available in a QFN-27 (5mmx5mm) package.

ELECTRICAL SPECIFICATION

| Parameter | Symbol | Value | Units |
|-------------------------------|------------------|------------|-------|
| Input Voltage ⁽¹⁾ | V _{IN} | 6 – 40 | V |
| Output Voltage ⁽²⁾ | V _{OUT} | Default: 5 | V |
| Output Current ⁽³⁾ | I _{OUT} | 0 – 5 | A |

FEATURES

- 6V to 40V Start-Up Input Voltage Range
- 5V to 40V Operation Input Voltage Range
- Flexible I²C Interface Control for:
 - 0.5V to 28V Output Voltage Range
 - 0.3V to 2.047V Reference Voltage Range with 1mV Step
 - Selectable V_{OUT} Slew Rate
 - Programmable Constant Current Limit
- Output Current Monitor Function (IMON)
- Programmable Soft-Start Time
- Switching Frequency Spread Spectrum for EMI Optimization
- Integrated V_{OUT} Discharge Function
- Selectable 200kHz, 300kHz, 400kHz, and 600kHz Switching Frequency
- Forced CCM Operation Mode
- Programmable V_{IN} UVLO Hysteresis
- OCP, SCP, and OVP
- Interrupt Indicator for OCP, OVP, and PNG
- Available in a QFN-27 (5mmx5mm) Package with Wettable Flank
- AEC-Q100 Qualified

APPLICATIONS

- USB Power Delivery
- Industrial PC Power Supplies
- Super-Capacitor Charging

All MPS parts are lead-free, halogen-free, and adhere to the RoHS directive. For MPS green status, please visit the MPS website under Quality Assurance. "MPS" and "The Future of Analog IC Technology" are registered trademarks of Monolithic Power Systems, Inc.

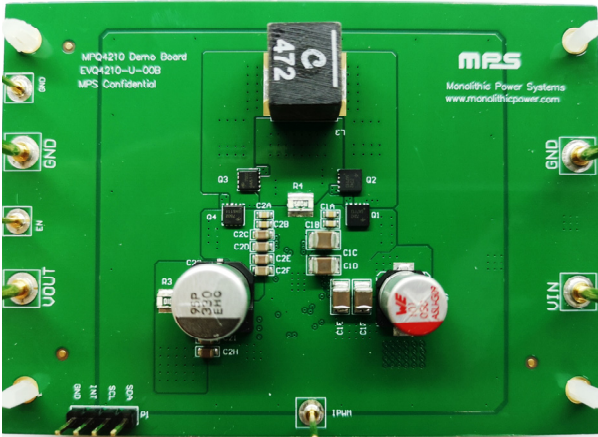
Note:

(1) V_{IN} must be 6V or higher to enable this board. After startup, it can work with 5V input voltage.

(2) EVQ4214-U-00B is default off. Using I²C interface to set board on.

(3) Default current limit is 3A. Using I²C interface to set current limit if load current > 3A.

EVQ4210-U-00B EVALUATION BOARD

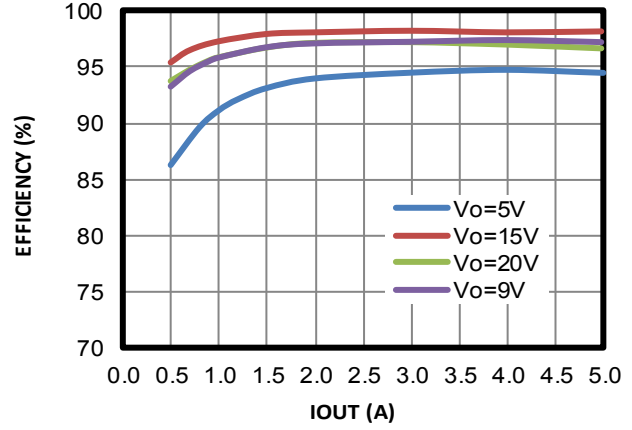


(L × W) 9.14cm x 6.6cm

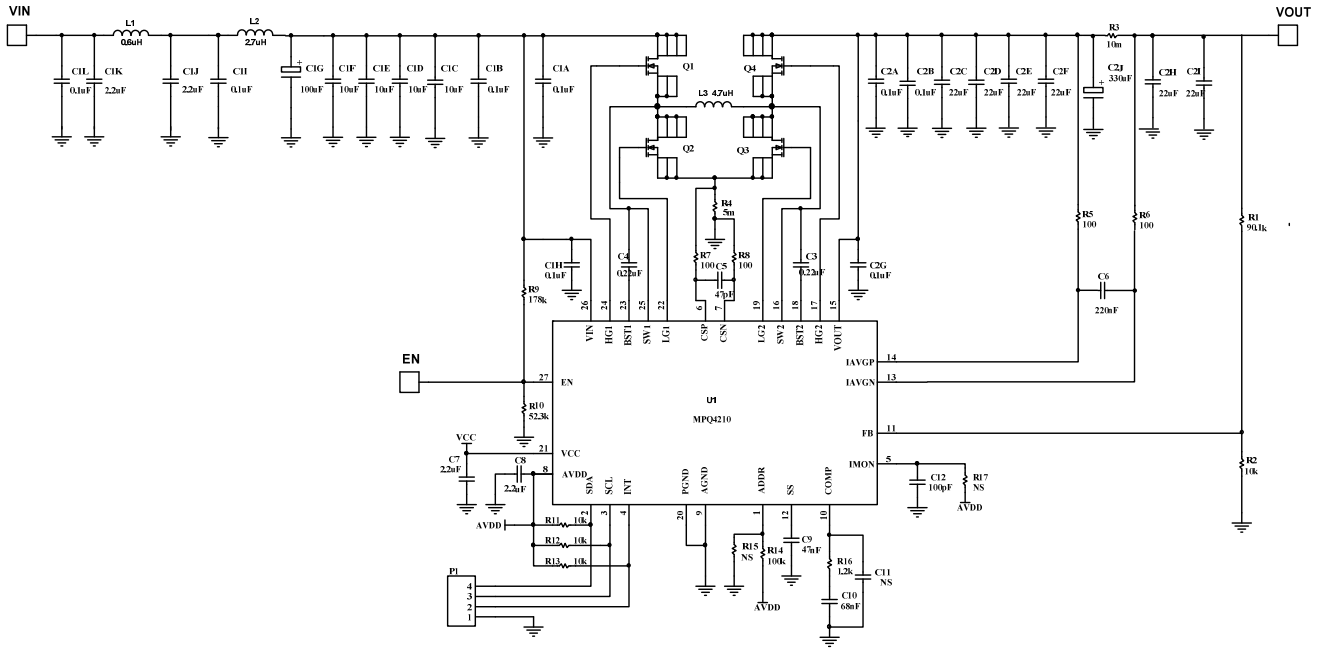
| | |
|---------------------|----------------------|
| Board Number | MPS IC Number |
| EVQ4210-U-00B | MPQ4210GU-AEC1 |

Efficiency vs. Load

V_{IN}=12V



EVALUATION BOARD SCHEMATIC



EVQ4210-U-00B BILL OF MATERIALS

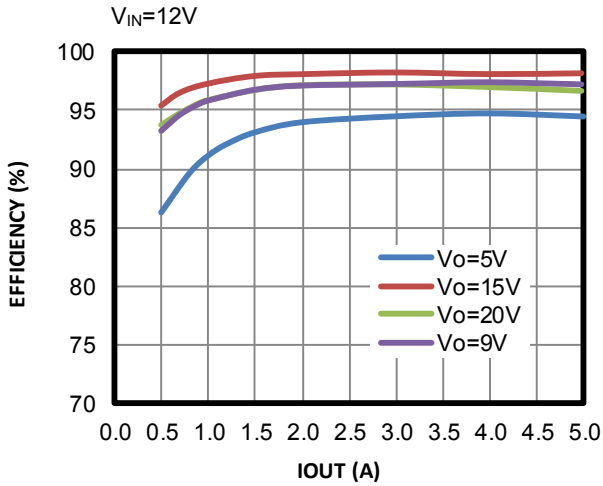
| Qty | Ref | Value | Description | Package | Manufacturer | Manufacturer PN |
|-----|--|----------|--|----------------|------------------|---------------------|
| 8 | C1A, C1B, C1H, C1I, C1L, C2A, C2B, C2G | 100nF | Ceramic Cap.,50V,X7R | 0603 | Murata | GRM188R71H104KA93D |
| 1 | C2J | 330µF | 330µF/25V, 80mΩ | SMD | NIPPON CHEMI-CON | EMZJ250ADA331MHAOG |
| 4 | C1C, C1D, C1E, C1F | 10µF | Ceramic Cap.,50V,X7R | 1210 | Murata | GRM32ER71H106KA12L |
| 1 | C1G | 100µF | Alum-electrolytic Cap. 50V,460mΩ, 0.35A | SMD | Wurth | 865080653016 |
| 2 | C1J, C1K | 2.2µF | Ceramic Cap.,50V,X7R | 1210 | Murata | GRM32ER71H225KL |
| 6 | C2C, C2D, C2E, C2F, C2H, C2I | 22µF | Ceramic Cap.,25V,X5R | 0805 | Murata | GRM21BR61E226ME44L |
| 3 | C3, C4, C6 | 220nF | Ceramic Cap.,16V,X7R | 0603 | Murata | GRM188R71C224KA01D |
| 1 | C5 | 47pF | Ceramic Cap.,50V,C0G | 0603 | Murata | GRM1885C1H470JA01D |
| 1 | C7 | 2.2µF | Ceramic Cap.,16V,X7R | 0805 | Murata | GRM21BR71C225KA12L |
| 1 | C8 | 2.2µF | Ceramic Cap.,10V,X7R | 0603 | Murata | GRM188R71A225KE15D |
| 1 | C9 | 47nF | Ceramic Cap.,16V,X7R | 0603 | Murata | GRM188R71C473KA01D |
| 1 | C10 | 68nF | Ceramic Cap.,50V,X7R | 0603 | TDK | C1608X7R1H683KT000N |
| 0 | C11 | NS | | | | |
| 1 | C12 | 100pF | Ceramic Cap,50V,C0G | 0603 | Murata | GRM1885C1H101JA01D |
| 1 | L3 | 4.7µH | 4.7µH inductor | SMD | Coilcraft | XAL1010-472MED |
| 1 | L1 | 0.6µH | Inductor, DCR=4.11mΩ,Isat=19.8A | SMD | Coilcraft | XAL5030-601MEC |
| 1 | L2 | 2.7µH | 2.7µH inductor | SMD | Coilcraft | XEL6060-272MEC |
| 1 | P1 | 4PINS | 4Pins,1 row,straight | DIP | WE | 61300411121 |
| 2 | Q1, Q2 | AON72 42 | 40V, 3.2mΩ, 50A, 26.5nC, N-channel Mosfet | DFN 3.3x3.3 EP | AOS | AON7242 |
| 2 | Q3, Q4 | AON75 02 | 30V, 3.9mΩ, 30A, 15.6nC, N-channel Mosfet | DFN 3 x3 EP | AOS | AON7502 |
| 1 | R1 | 90K9 | Film Res,1% | 0603 | YAGEO | RC0603FR-0790K9L |
| 4 | R2, R11, R12, R13 | 10K | Film Res,1% | 0603 | YAGEO | RC0603FR-0710KL |
| 1 | R4 | 5m | SMD 1W 0.005Ω 1% | L1508 | Susumu | RL3720WT-R005-F |
| 1 | R3 | 10m | Film Res,1%,1W,0.01R | L1508 | Susumu | RL3720WT-R010-F |
| 4 | R5, R6, R7, R8 | 100R | Film Res,1% | 0603 | YAGEO | RC0603FR-07100RL |
| 1 | R9 | 178K | Film Res,1% | 0603 | YAGEO | RC0603FR-07178KL |
| 1 | R14 | 100K | Film Res,1% | 0603 | YAGEO | RC0603FR-07100KL |
| 1 | R10 | 52K3 | Film Res,1% | 0603 | YAGEO | RC0603FR-0752K3L |
| 0 | R15, R17 | NS | | | | |
| 1 | R16 | 1K2 | Film Res,1% | 0603 | YAGEO | RC0603FR-071K2L |
| 1 | U1 | MPQ42 10 | 40V Synchronous Buck-Boost Controller with I2C | QFN-27(5x5) | MPS | MPQ4210GU-AEC1 |

EVB TEST RESULTS

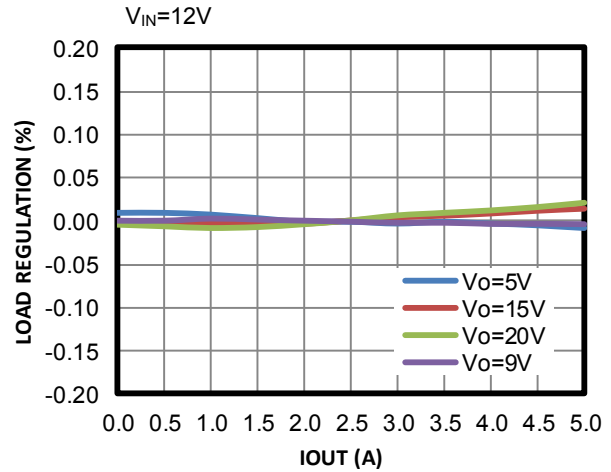
Performance curves and waveforms are tested on the evaluation board.

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

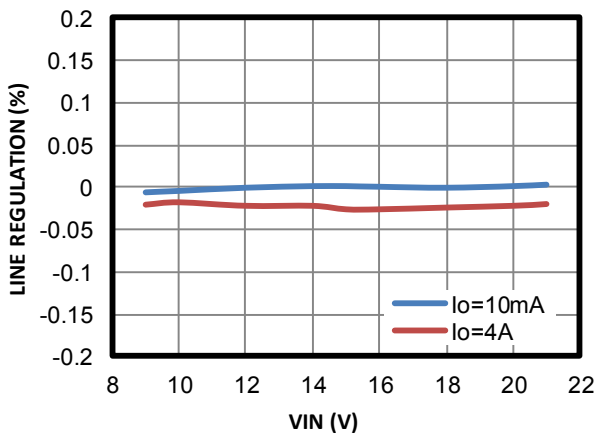
Efficiency vs. Load



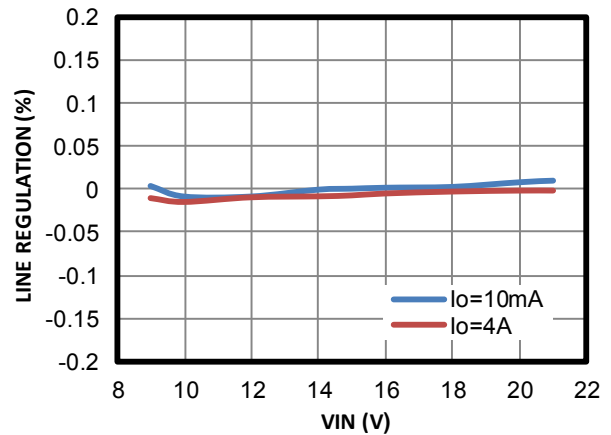
Load Regulation



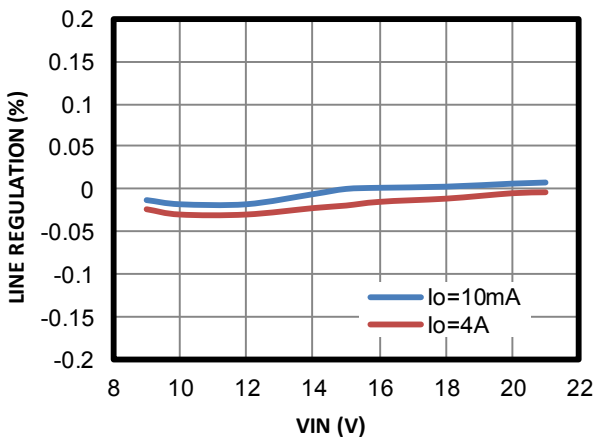
Vo=5V Line Regulation



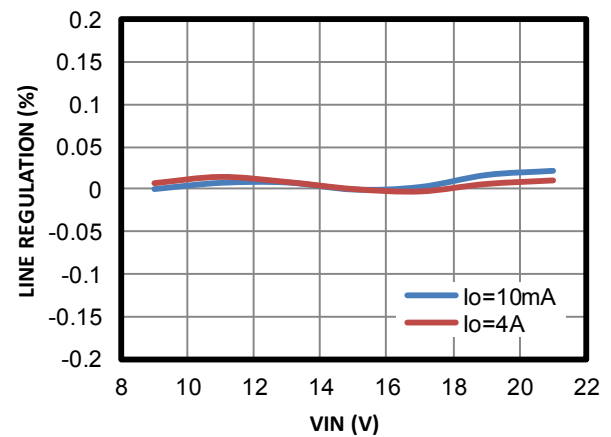
Vout=9V Line Regulation



Vout=15V Line Regulation



Vout=20V Line Regulation



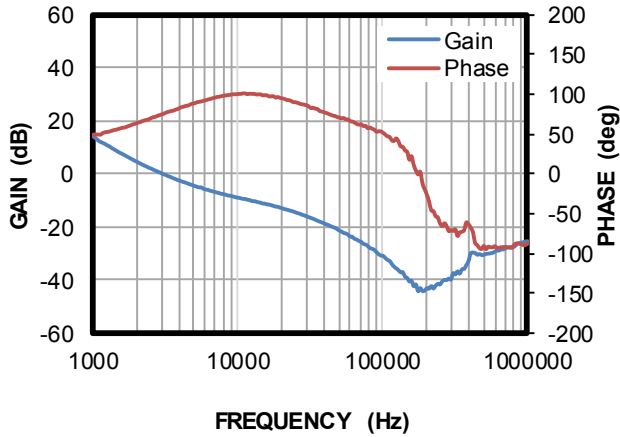
EVB TEST RESULTS (continued)

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.

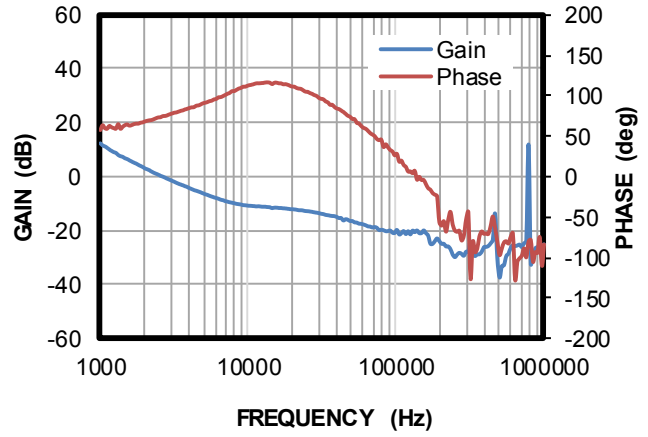
Bode Plot

V_{OUT} = 5V, I_{OUT} = 3A, BW = 3.06kHz,
PM = 73.73deg



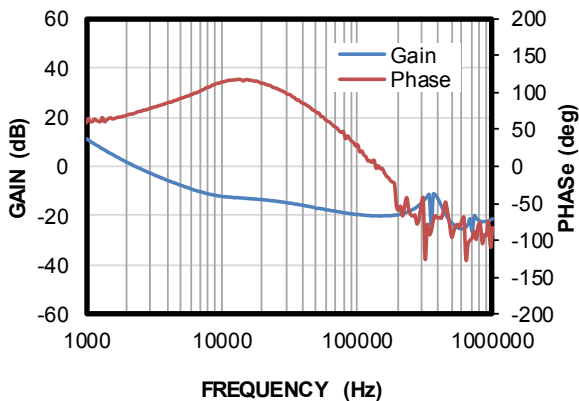
Bode Plot

V_{OUT} = 12V, I_{OUT} = 3A, BW = 2.64kHz,
PM = 75deg



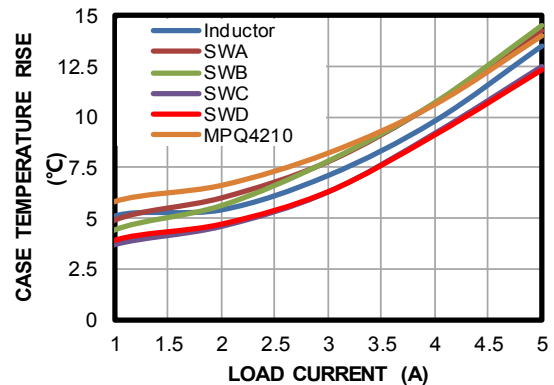
Bode Plot

V_{OUT} = 20V, I_{OUT} = 3A, BW = 2.3kHz,
PM = 64.48deg



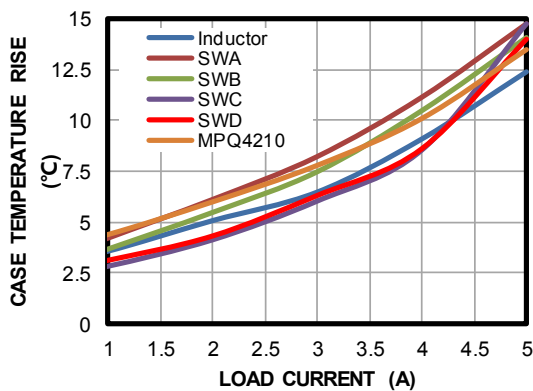
Thermal Rise

V_{IN} = 12V, V_{OUT} = 5V, f_{sw} = 400kHz,
based on EVQ4210-U-00B



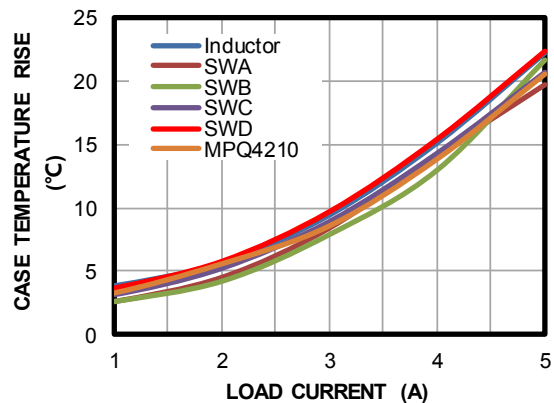
Thermal Rise

V_{IN} = 12V, V_{OUT} = 9V, f_{sw} = 400kHz,
based on EVQ4210-U-00B



Thermal Rise

V_{IN} = 12V, V_{OUT} = 15V, f_{sw} = 400kHz,
based on EVQ4210-U-00B



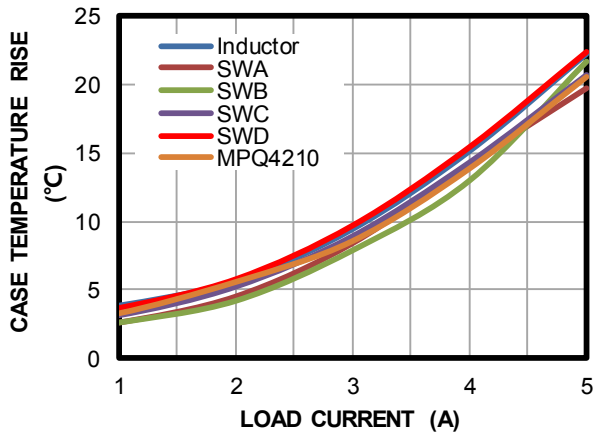
EVB TEST RESULTS *(continued)*

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.

Thermal Rise

V_{IN} = 12V, V_{OUT} = 20V, f_{SW} = 400kHz,
based on EVQ4210-U-00B

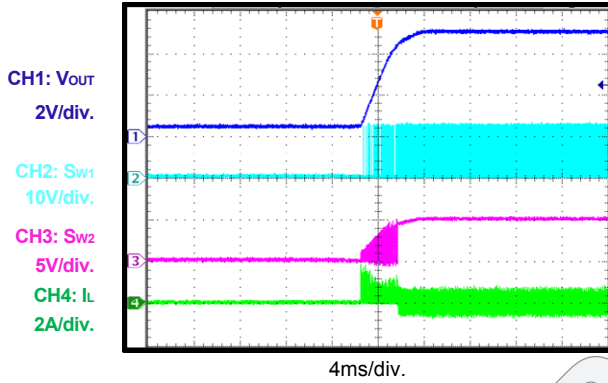


EVB TEST RESULTS (CONTINUED)

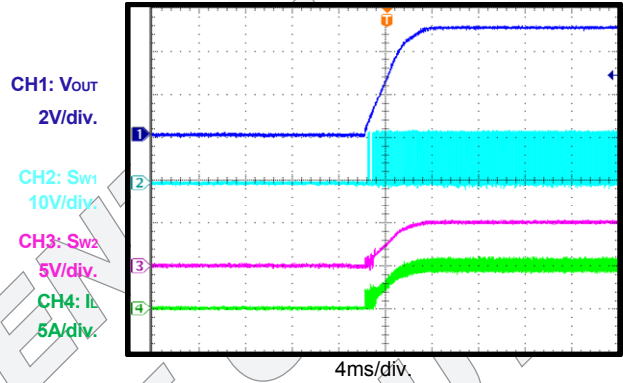
Performance curves and waveforms are tested on the evaluation board.

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

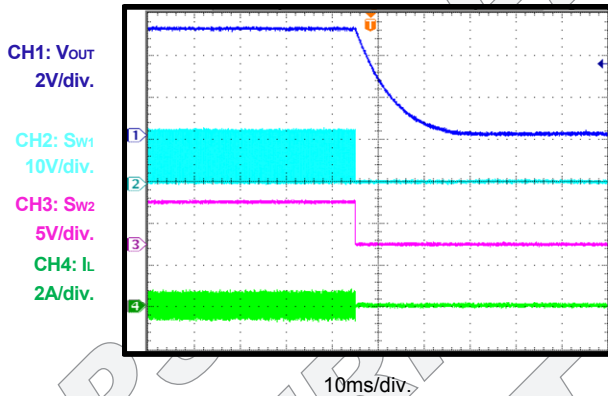
ENPWR Bit Enable through I2C Command , Load=0A



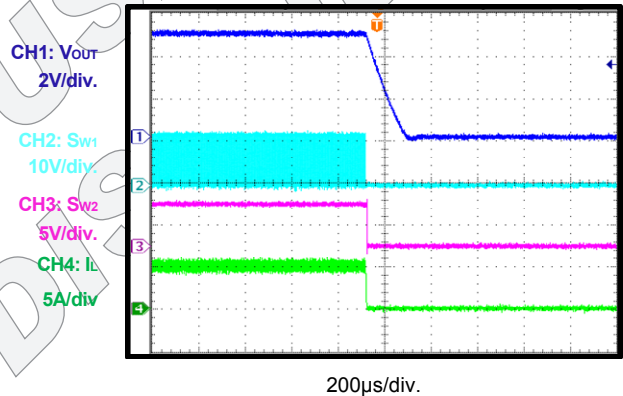
ENPWR Bit Enable through I2C Command , Load=5A



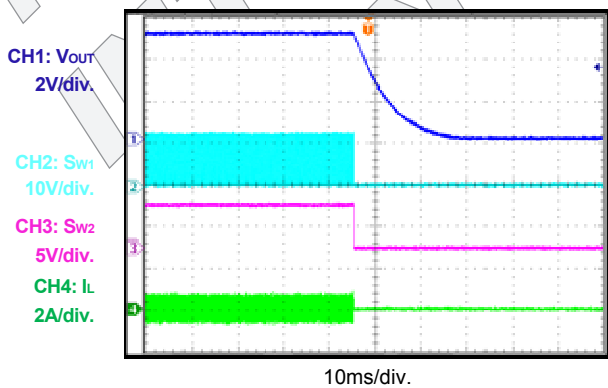
ENPWR Bit Disable through I2C Command , Load=0A



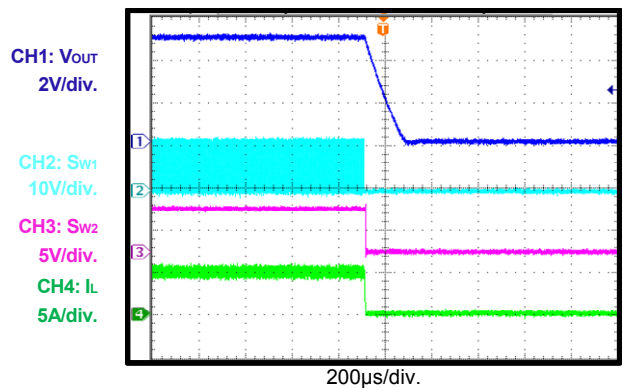
ENPWR Bit Disable through I2C Command , Load=5A



EN Pin Disable , Load=10mA



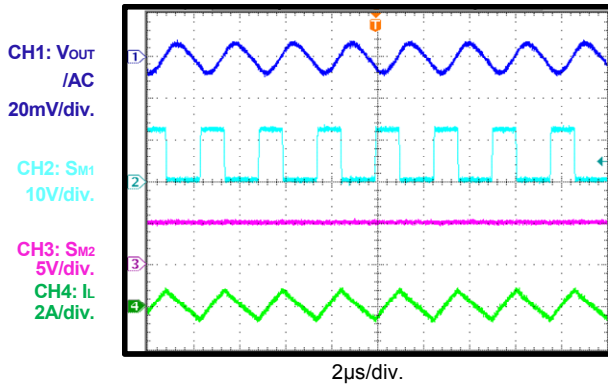
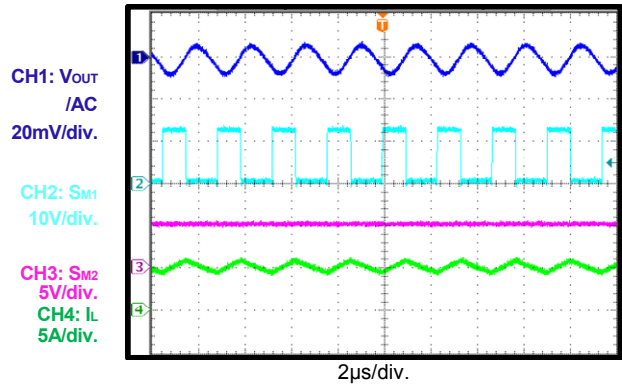
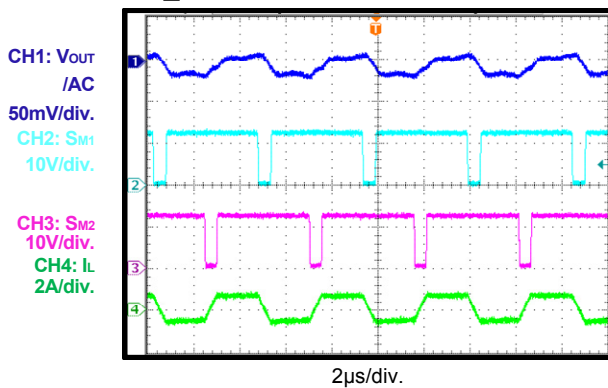
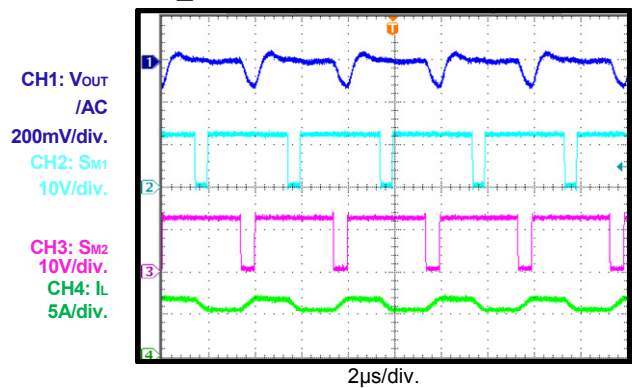
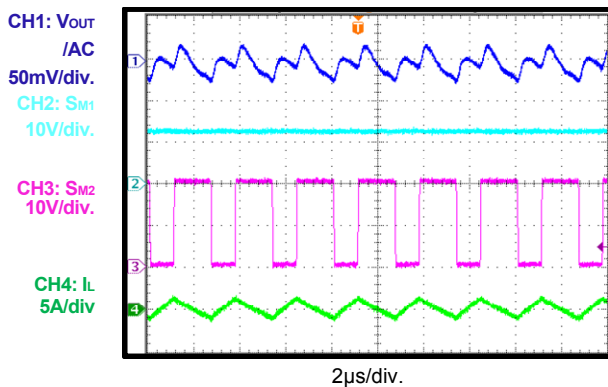
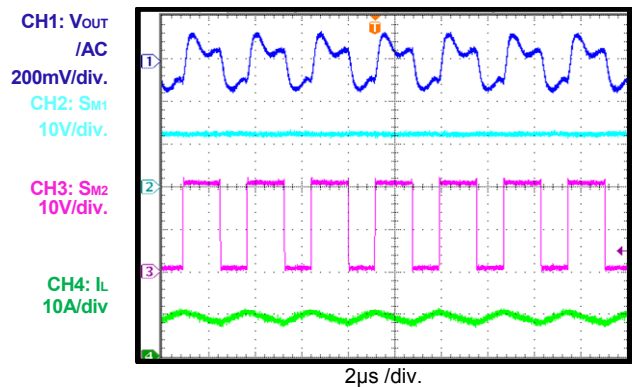
EN Pin Disable , Load=5A



EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board.

 $V_{IN} = 12V$, $V_{OUT} = 5V$, $L = 4.7\mu H$, $T_A = +25^\circ C$, unless otherwise noted.

Steady state , $V_{OUT}=5V$ Load=0A

Steady state $V_{OUT}=5V$ Load=5A

**Steady state , $V_{OUT}=12V$,
BB_FSW=1 , Load=0A**

**Steady state , $V_{OUT}=12V$,
BB_FSW=1 , Load=5A**

Steady state , $V_{OUT}=20V$, Load=0A

Steady state , $V_{OUT}=20V$ Load=5A


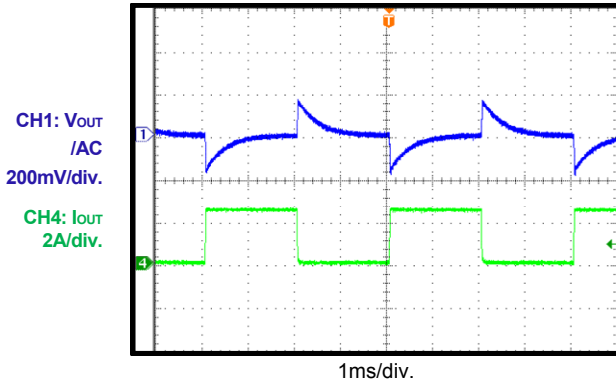
EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board.

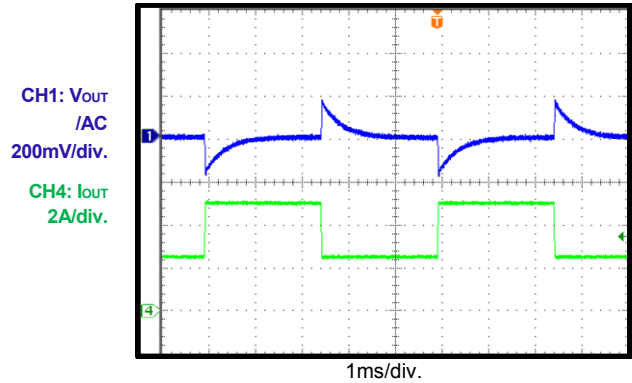
V_{IN} = 12V, V_{OUT} = 5V, L = 4.7μH, T_A = +25°C, unless otherwise noted.

Load Transient

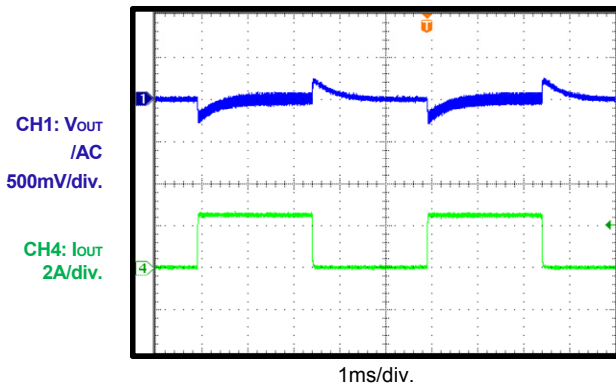
V_{IN}=12V, V_{OUT}=5V, Load=0A to 2.5A, 150mA/us



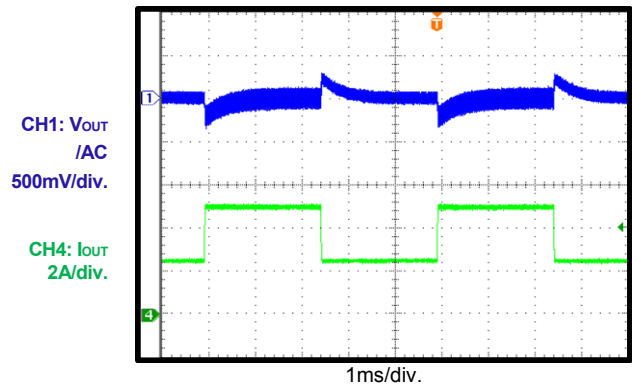
V_{IN}=12V, V_{OUT}=5V, Load=2.5A to 5A, 150mA/us



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

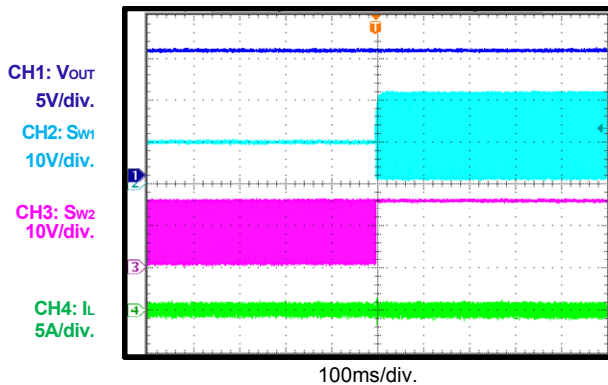


V_{IN}=12V, V_{OUT}=20V, Load=2.5A to 5A, 150mA/us



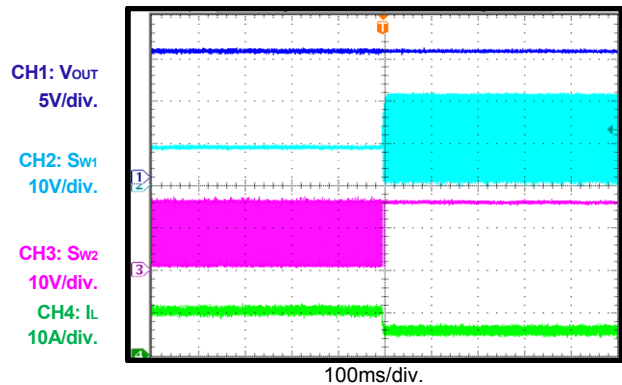
Input Voltage Transient,

V_{IN}=9V to 20V, V_{OUT}=15V, Load=0A



Input Voltage Transient,

V_{IN}=9V to 20V, V_{OUT}=15V, Load=5A

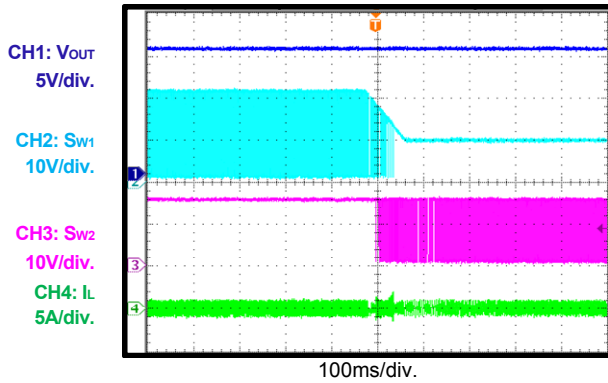


EVB TEST RESULTS (continued)

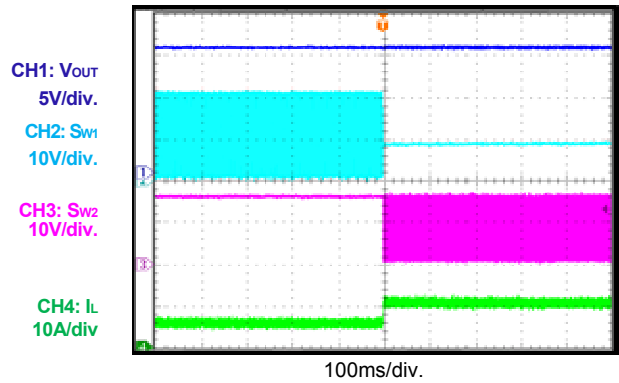
Performance curves and waveforms are tested on the evaluation board.

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

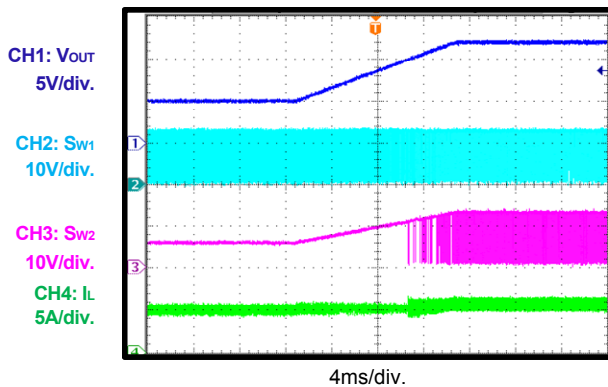
Input Voltage Transient,
V_{IN}=20V to 9V, V_{OUT}=15V, Load=0A



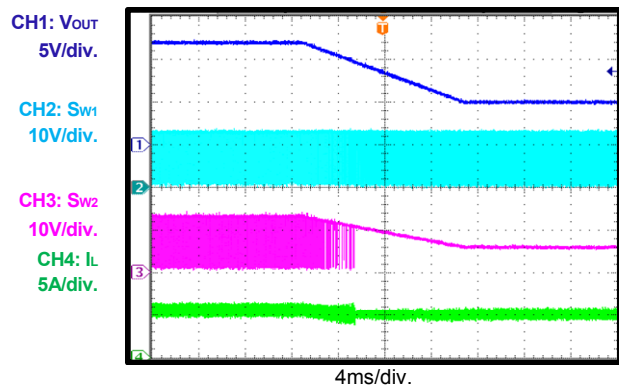
Input Voltage Transient,
V_{IN}=20V to 9V, V_{OUT}=15V, Load=5A



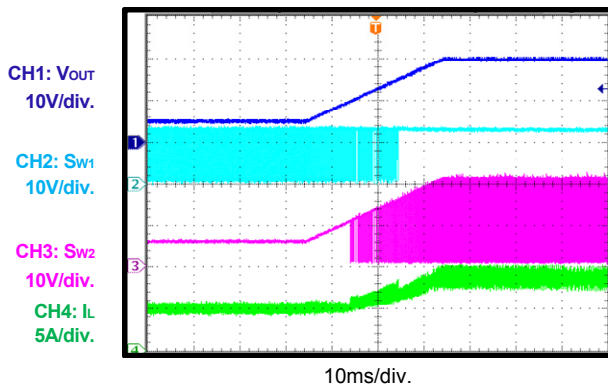
Output Voltage Transient,
V_{OUT}=5V to 12V, I_{OUT}=5A



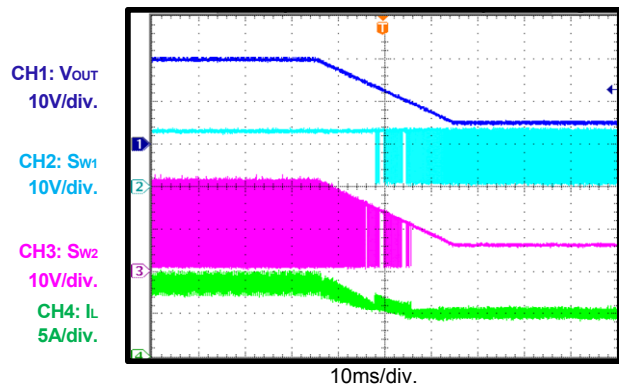
Output Voltage Transient,
V_{OUT}=12V to 5V, Load=5A



Output Voltage Transient,
V_{OUT}=5V to 20V, Load=5A



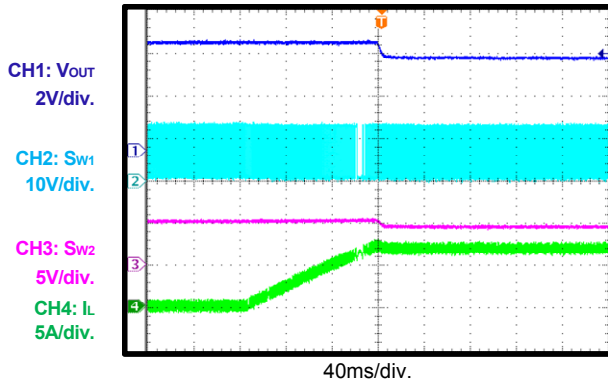
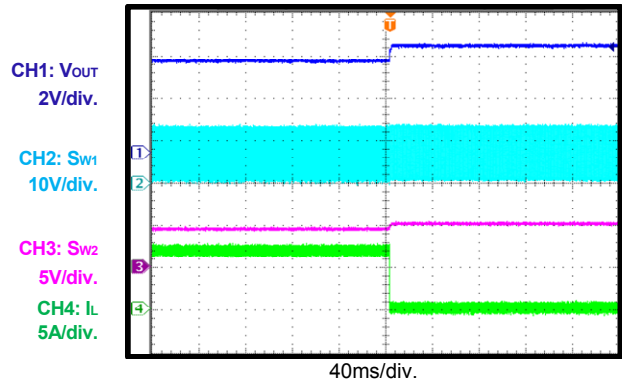
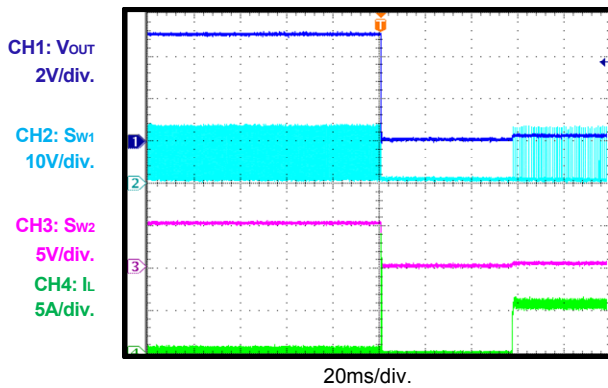
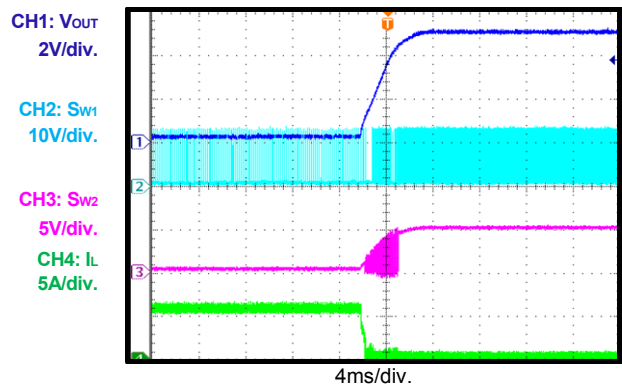
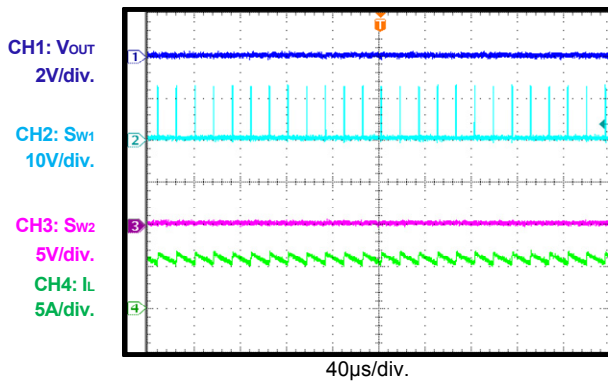
Output Voltage Transient,
V_{OUT}=20V to 5V, Load=5A



EVB TEST RESULTS (continued)

Performance curves and waveforms are tested on the evaluation board.

 $V_{IN} = 12V$, $V_{OUT} = 5V$, $L = 4.7\mu H$, $T_A = +25^{\circ}C$, unless otherwise noted.

OCP Enter

OCP recover

SCP enter

SCP recover

SCP steady state


PRINTED CIRCUIT BOARD LAYOUT

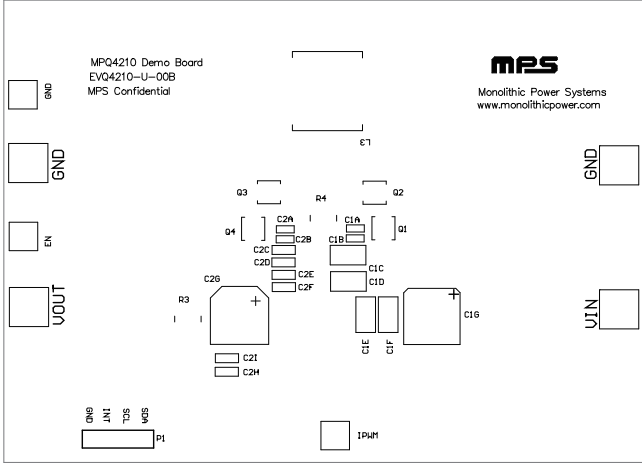


Figure 1: Top Silkscreen Layer

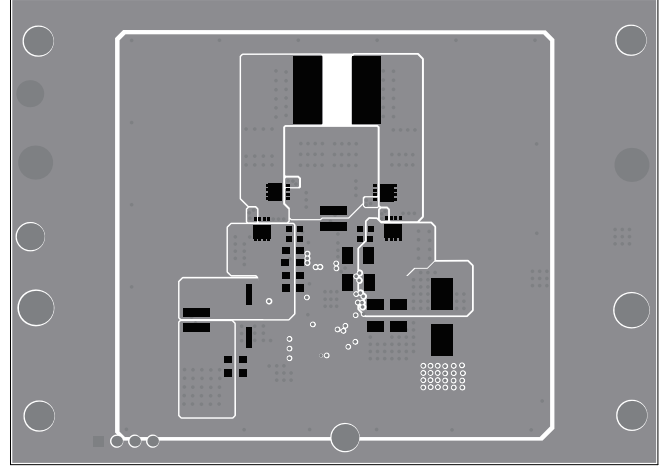


Figure 2: Top Layer

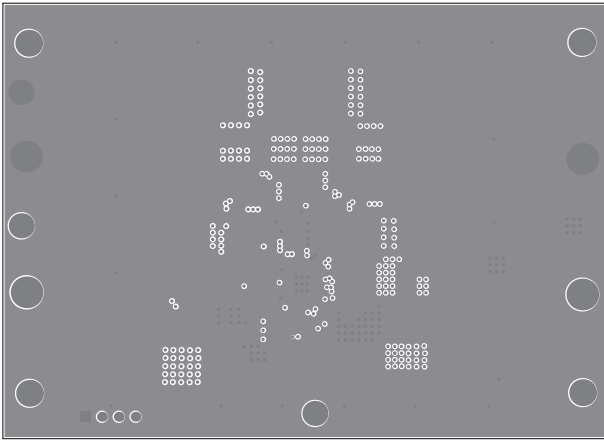


Figure 3: Middle Layer 1

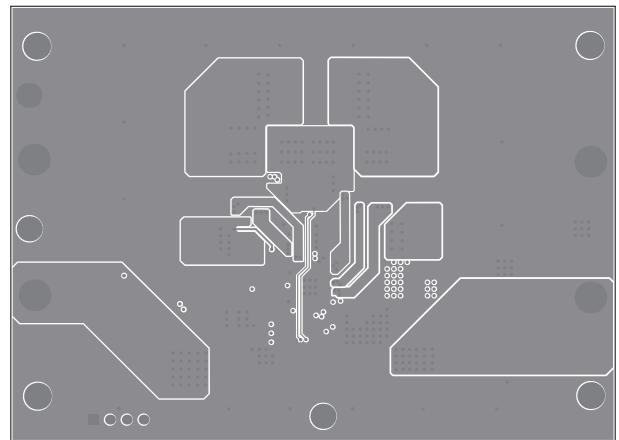


Figure 4: Middle Layer 2

PRINTED CIRCUIT BOARD LAYOUT (continued)

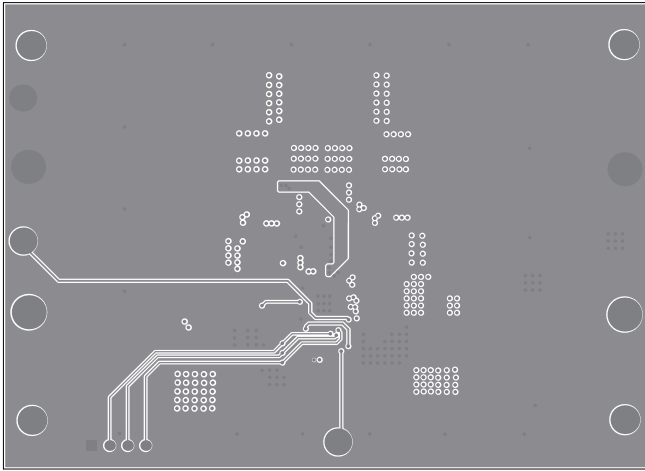


Figure 5: Middle Layer 3

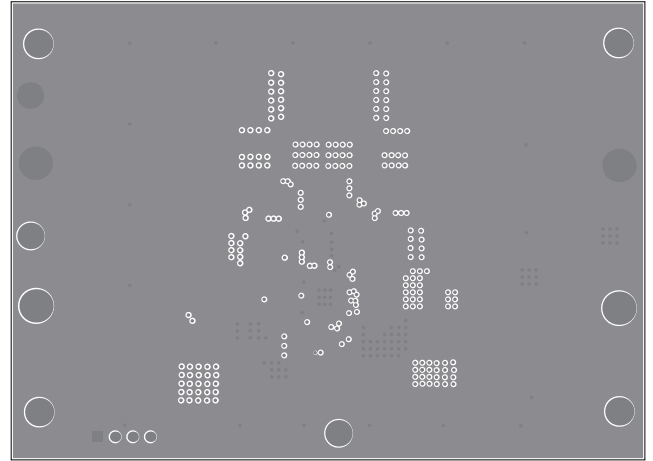


Figure 6: Middle Layer 4

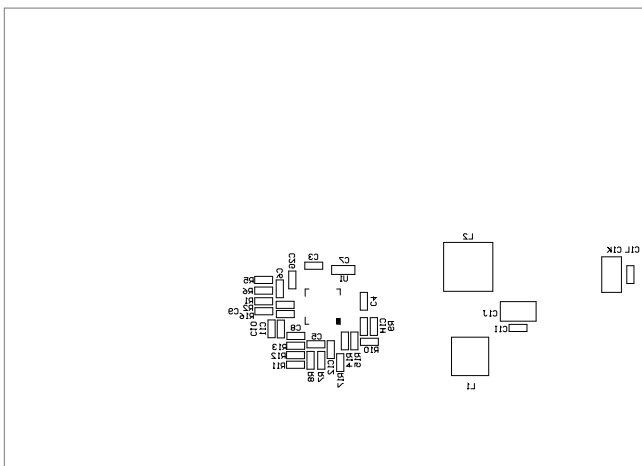


Figure 7: Bottom Silkscreen Layer

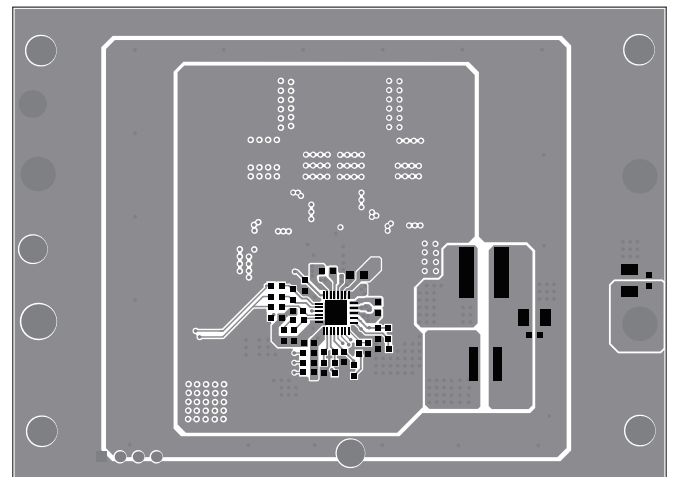


Figure 8: Bottom Layer

QUICK START GUIDE

1. Connect the positive and negative terminals of the load($\leq 3A$) to the VOUT and GND pins, respectively.
2. Preset the power supply output voltage within the range 6V~40V, and then turn off the power supply.
3. Connect the positive and negative terminals of the power supply output to the VIN and GND pins, respectively.
4. Install the MPQ4210 GUI software, connect I²C cable from host computer to the board. (MPS provides USB to IC develop dongle for MPQ4210 GUI control)
5. Turn on the power supply. And then click Detect button on the GUI.
6. Normally the GUI will indicate the connection is OK.

Then set MPQ4210 registers through I²C in following step:

- a. Set ILIM bits to 111b for >5A load current limit;
- b. Set 0x02h bit[2] to 1b before ENPWR=1;
- c. Set BB_FSW bit to 1b to get higher frequency in buck-boost mode.
- d. Set ENPWR=1 to enable MPQ4210 switching, default output voltage is 5V.
- e. If other output voltage is required, firstly set the REF bits ($V_{out}=10 \cdot V_{REF}$), then write GO_BIT=1, MPQ4210 will change V_{OUT} automatically.

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