32V, 2A, Synchronous DC/DC Buck Converter With Enhanced EMI Reduction

DESCRIPTION

The AP63200 is a 2A, synchronous buck converter with a wide input voltage range of 3.8V to 32V and fully integrates a 125mΩ high-side power MOSFET and a 68mΩ low-side power MOSFET to provide high-efficiency step-down DC/DC conversion.

The AP63200 device is easily used by minimizing the external component count due to its adoption of peak current mode control along with its integrated compensation network.

The AP63200 has optimized designs for Electromagnetic Interference (EMI) reduction. The converter features Frequency Spread Spectrum (FSS) with a switching frequency jitter of ±6%, which reduces EMI by not allowing emitted energy to stay in any one frequency for a significant period of time. It also has a proprietary gate driver scheme to resist switching node ringing without sacrificing MOSFET turn-on and turn-off times, which further reduces high-frequency radiated EMI noise caused by MOSFET switching.

The device is available in a low-profile, TSOT26 package.

FEATURES

- VIN 3.8V to 32V
- 2A Continuous Output Current
- 0.8V ± 1% Reference Voltage
- 22µA Ultralow Quiescent Current (Pulse Frequency Modulation)
- 500kHz Switching Frequency
- Supports Pulse Frequency Modulation (PFM) and Pulse Width Modulation (PWM)
- Proprietary Gate Driver Design for Best EMI Reduction
- Frequency Spread Spectrum (FSS) to Reduce EMI
- Low-Dropout (LDO) Mode
- Precision Enable Threshold to Adjust UVLO
- Protection Circuitry
    - Undervoltage Lockout (UVLO)
    - Cycle-by-Cycle Peak Current Limit
    - Thermal Shutdown

APPLICATIONS

- 12V and 24V Distributed Power Bus Supplies
- Flat Screen TV Sets and Monitors
- Power Tools and Laser Printers
- White Goods and Small Home Appliances
- FPGA, DSP, and ASIC Supplies
- Home Audio
- Network Systems
- Set Top Boxes
- Gaming Consoles
- Consumer Electronics

FUNCTIONAL BLOCK

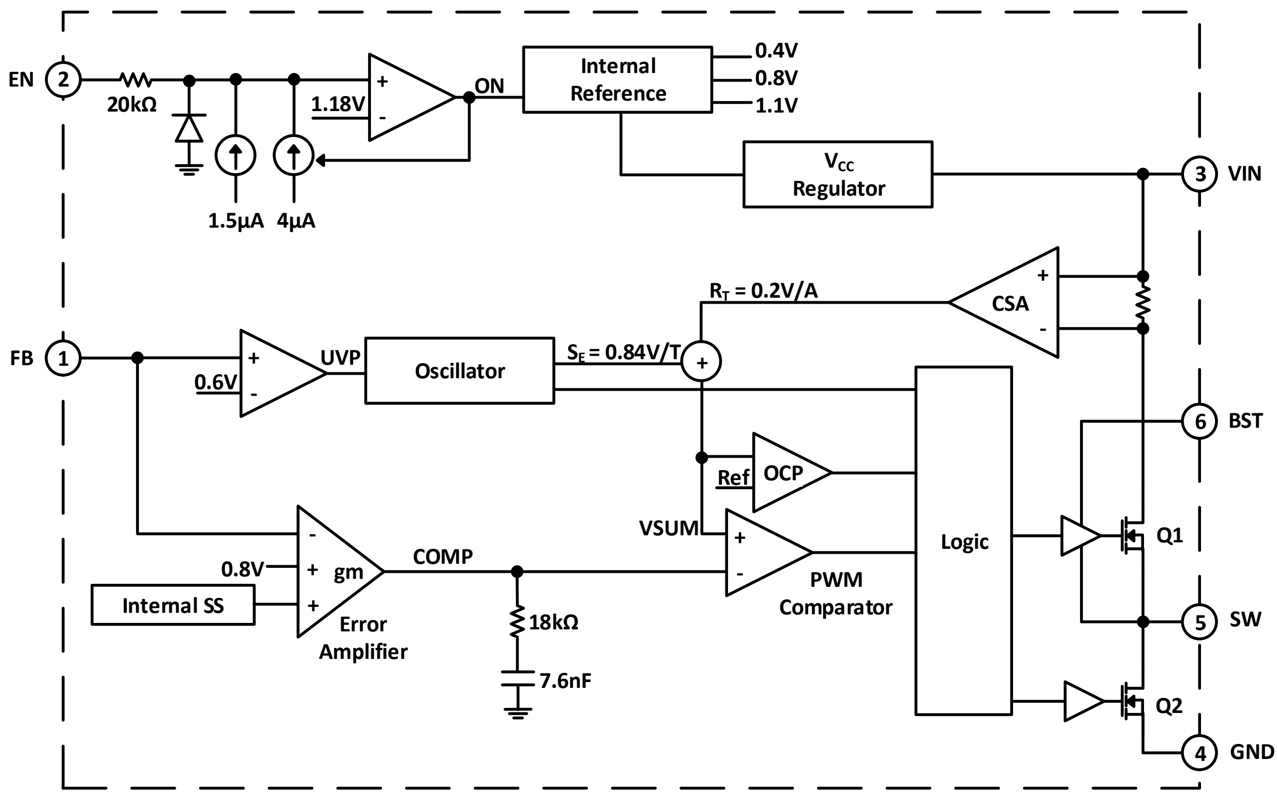

Figure 1. Functional Block Diagram

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Rating	Unit
V_{IN}	Supply Voltage	-0.3 to +35.0 (DC)	V
		-0.3 to +40.0 (400ms)	
V_{SW}	Switch Node Voltage	-1.0 to VIN + 0.3 (DC)	V
		-2.5 to VIN + 2.0 (20ns)	
V_{BST}	Bootstrap Voltage	V_{SW} - 0.3 to V_{SW} + 6.0	V
V_{FB}	Feedback Voltage	-0.3 to +6.0	V
V_{EN}	Enable/UVLO Voltage	-0.3 to +35.0	V
T_{ST}	Storage Temperature	-65 to +150	°C
T_J	Junction Temperature	+150	°C
T_L	Lead Temperature	+260	°C
ESD Susceptibility			
HBM	Human Body Mode	2000	V
CDM	Charge Device Model	1000	V

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit
V_{IN}	Supply Voltage	3.8	32	V
T_A	Operating Ambient Temperature Range	-40	+85	°C
T_J	Operating Junction Temperature Range	-40	+125	°C

EVALUATION BOARD

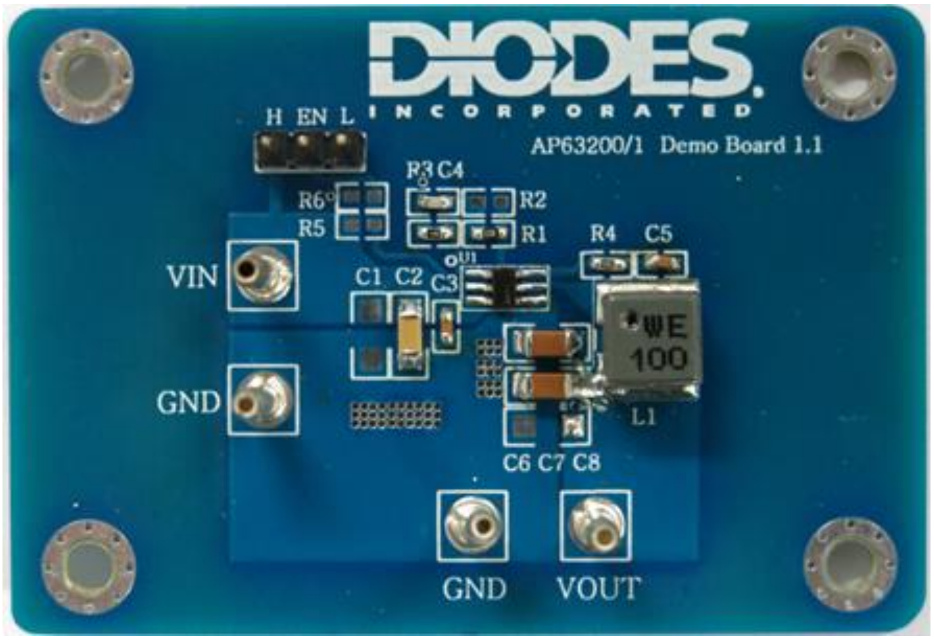

Figure 2. AP63200WU-EVM

QUICK START GUIDE

The AP63200WU-EVM has a simple layout and allows access to the appropriate signals through test points. To evaluate the performance of the AP63200WU, follow the procedure below:

1. For evaluation board configured at V_{OUT}=12V, connect a power supply to the input terminals V_{IN} and GND. Set V_{IN} to 24V.
2. Connect the positive terminal of the electronic load to V_{OUT} and negative terminal to GND.
3. For Enable, place a jumper to "H" position to enable IC. Jump to "L" position to disable IC.
4. The evaluation board should now power up with a 12V output voltage.
5. Check for the proper output voltage of 12V (±1%) at the output terminals V_{OUT} and GND. Measurement can also be done with a multimeter with the positive and negative leads between V_{OUT} and GND.
6. Set the load to 2A through the electronic load. Check for the stable operation of the SW signal on the oscilloscope. Measure the switching frequency.

MEASUREMENT/PERFORMANCE GUIDELINES:

1) When measuring the output voltage ripple, maintain the shortest possible ground lengths on the oscilloscope probe. Long ground leads can erroneously inject high frequency noise into the measured ripple.

2) For efficiency measurements, connect an ammeter in series with the input supply to measure the input current. Connect an electronic load to the output for output current.

EXTERNAL COMPONENT SELECTION:

(1) Setting the output voltage:
The AP63200WU features external programmable output voltage by using a resistor divider network R3 and R1 as shown in the typical application circuit. The output voltage is calculated as below,

$$V_{OUT} = 0.8 \times \left(\frac{R_1 + R_3}{R_1} \right)$$

First, select a value for R1 according to the value recommended in the table 1. Then, R3 is determined. The output voltage is given by Table 1 for reference. For accurate output voltage, 1% tolerance is required.

(2) Output feed-forward capacitor selection:
The AP63200WU has the internal integrated loop compensation as shown in the function block diagram. The compensation network includes an 18k resistor and a 7.6nF capacitor. Usually, the type II compensation network has a phase margin between 60 and 90 degrees. However, if the output capacitor has ultra-low ESR, the converter results in low phase margin. To increase the converter phase margin, a feed-forward cap C4 is used to boost the phase margin at the converter cross-over frequency, f_C. The feed-forward capacitor is given by Table 1 for reference. The feed-forward capacitor is calculated as below,

$$C_4 = \frac{1}{2\pi \times f_C \times R_3}$$

V_{OUT}	R3	R1	C4	C6-C8
1.8V	77.5 KΩ	62 KΩ	100pF	22uFx2
2.5V	131 KΩ	62 KΩ	100pF	22uFx2
3.3V	182 KΩ	62 KΩ	100 pF	22uFx2
5V	157 KΩ	30 KΩ	100 pF	22uFx2
12V	249 KΩ	18 KΩ	56 pF	22uFx4

Table 1. Resistor selection for common output voltages

(3) External Component Selection

a) Input & output Capacitors (C_{IN}, C_{OUT})
   (1) For lower output ripple, low ESR is required.
   (2) For low leakage current, X5R/X7R ceramic is recommend in multiple capacitor parallel connections.
   (3) The C_{IN} capacitances are greater than 10uF.
   (4) 44μF ceramic output capacitors are recommended to work for most applications, due to a capacitor's de-rating under DC bias, The 88uF is recommend for high output voltage condition. The output capacitor selection is shown in table1.

b) Bootstrap Capacitor
   An external 0.1uF ceramic capacitor is required as bootstrap capacitor between BST and SW pin to work as high side power MOSFET gate driver.

c) Inductor (L)
   (1) Low DCR for good efficiency
   (2) Inductance saturate current must higher than the output current.
   (3) The recommended inductance values are shown in table 2.

Table 2 shows a list of recommended inductors for common output voltages.

V_{OUT}	1.8V	2.5V	3.3V	5.0V	12V
Inductor	**3.3μH**	**3.3μH**	**6.8μH**	**10μH**	**15μH**
Wurth Part	744 393 440 33	744 393 440 33	744 393 460 68	744 393 461 00	744 770 915 0

Table 2. Recommended Inductor Selection

EVALUATION BOARD SCHEMATIC

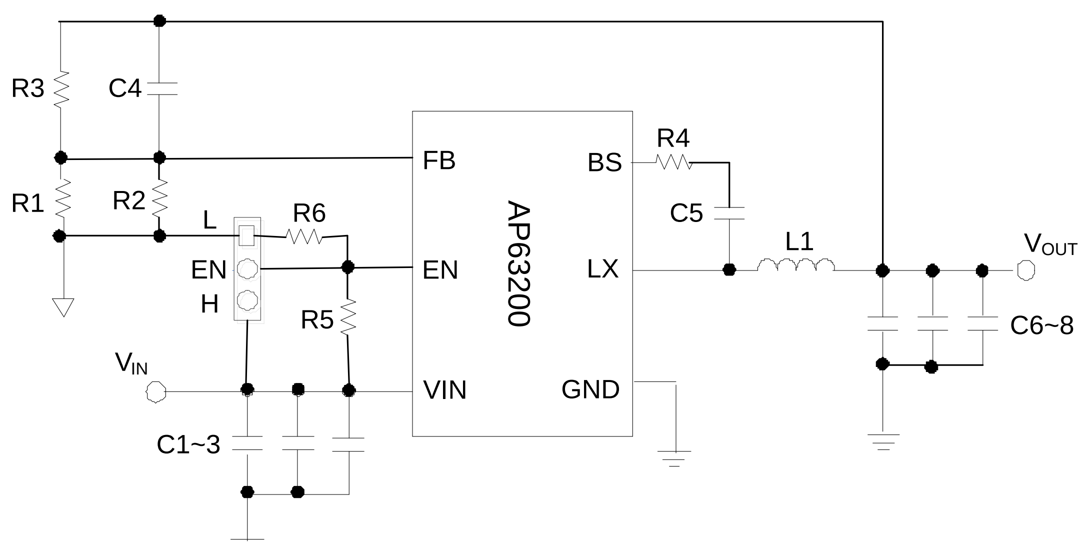

Figure 3. AP63200WU-EVM Schematic

PCB TOP LAYOUT

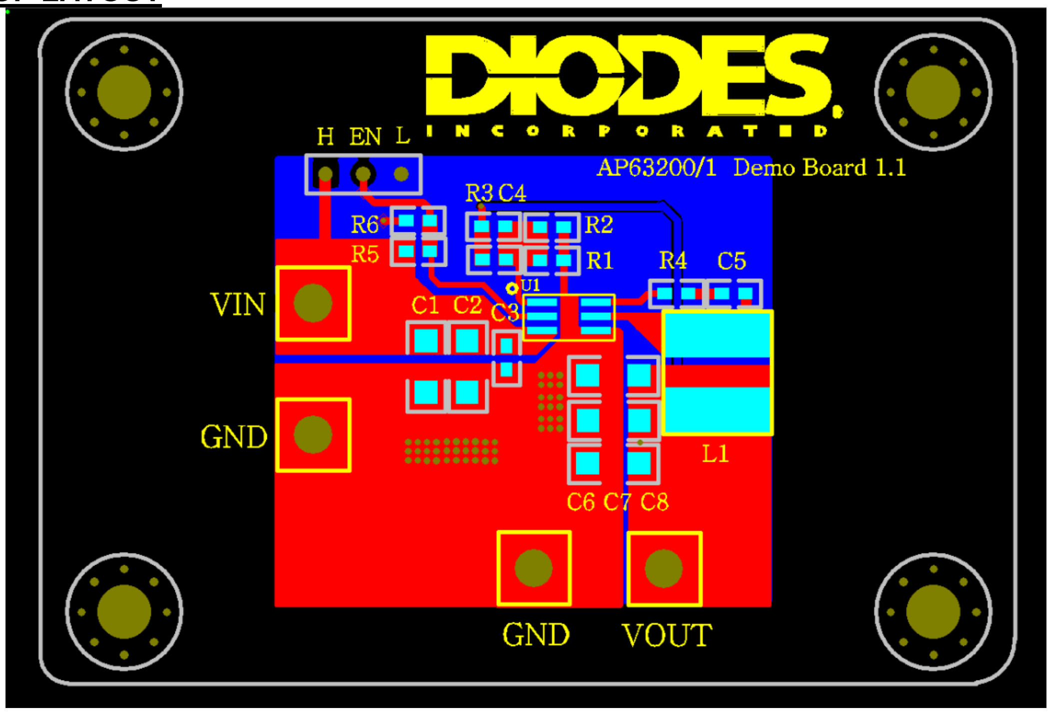

Figure 4. AP63200WU-EVM – Top Layer

PCB BOTTOM LAYOUT

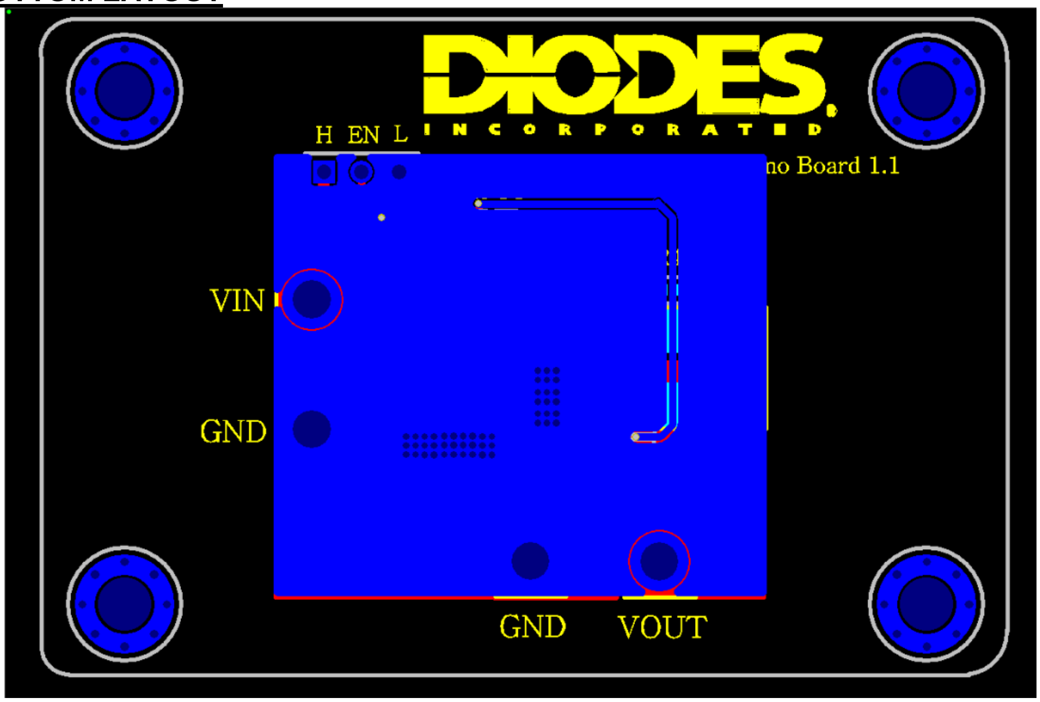

Figure 5. AP63200WU-EVM – Bottom Layer

BILL OF MATERIALS for AP63200WU-EVM (V_{OUT}=12V)

Item	Value	Type	Rating	Description	Manufacturer
C2	10uF	X5R/X7R, Ceramic/1206	35V	Input CAP	
C3	0.1uF	X5R/X7R, Ceramic/0603	50V	Input CAP	Würth Electronics 885 012 206 095
C4	56pF	0603	100V	Feedback CAP	
C5	0.1uF	X5R/X7R, Ceramic/0603	50V	Bootstrap CAP	Würth Electronics 885 012 206 095
C6, C7, C8	22uFx4	X5R/X7R, Ceramic/1206	25V	Output CAP*	
L1	15uH	SMD	6.5A	Inductor*	Würth Electronics 7447709150
R1	18KΩ	0603	1%	Voltage RES*	
R3	249KΩ	0603	1%		
R4	0	0603	1%	Bootstrap RES	
U1		AP63200WU		TSOT26	Diodes Inc

***Note**: The present values of R3/R1, C6, C7, C8, L1 are based on V_{OUT}=12V

TYPICAL PERFORMANCE CHARACTERISTICS

Figure 6. Efficiency for V_{IN}=12V, V_{OUT}=1.8V / 3.3V / 5.0V

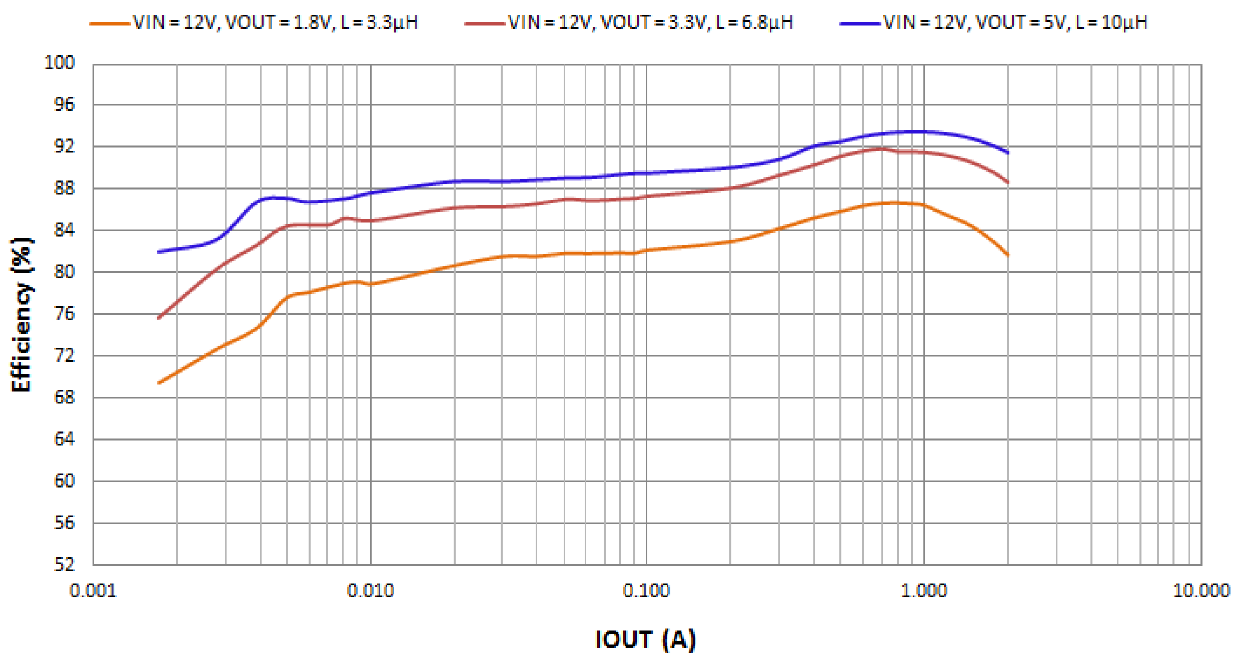

Figure 7. Efficiency for V_{IN}=24V, V_{OUT}=12V

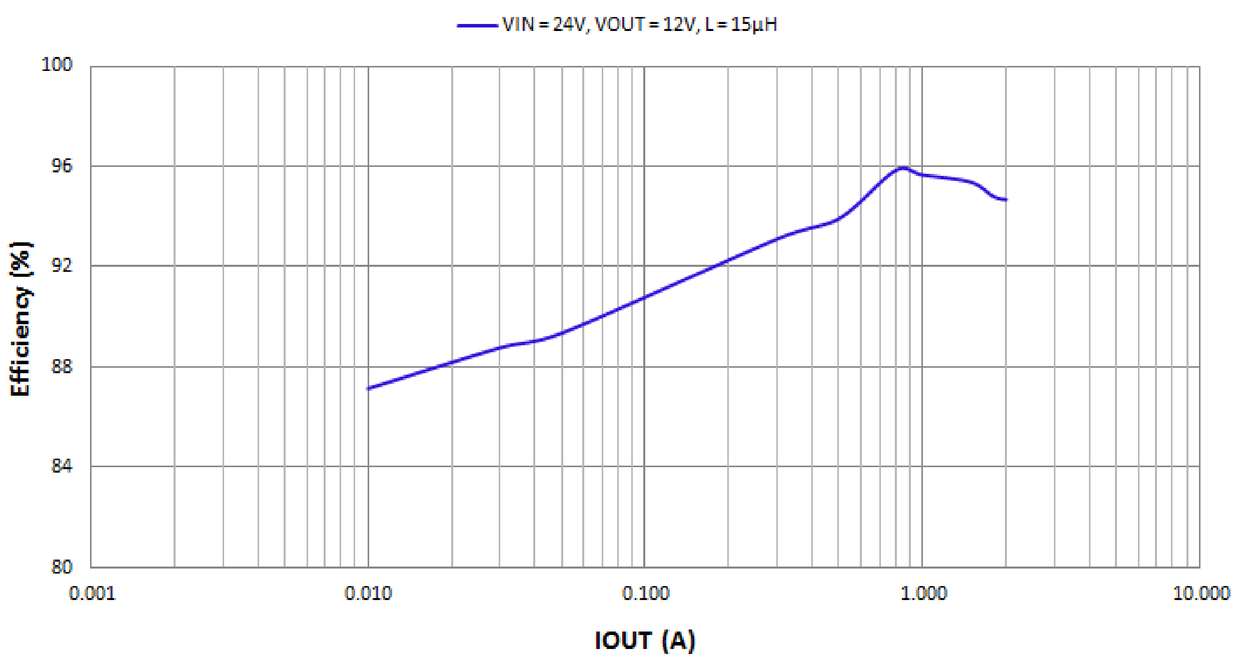

Figure 8. Output Ripple for VIN=12V, VOUT=5.0V, IOUT=2A

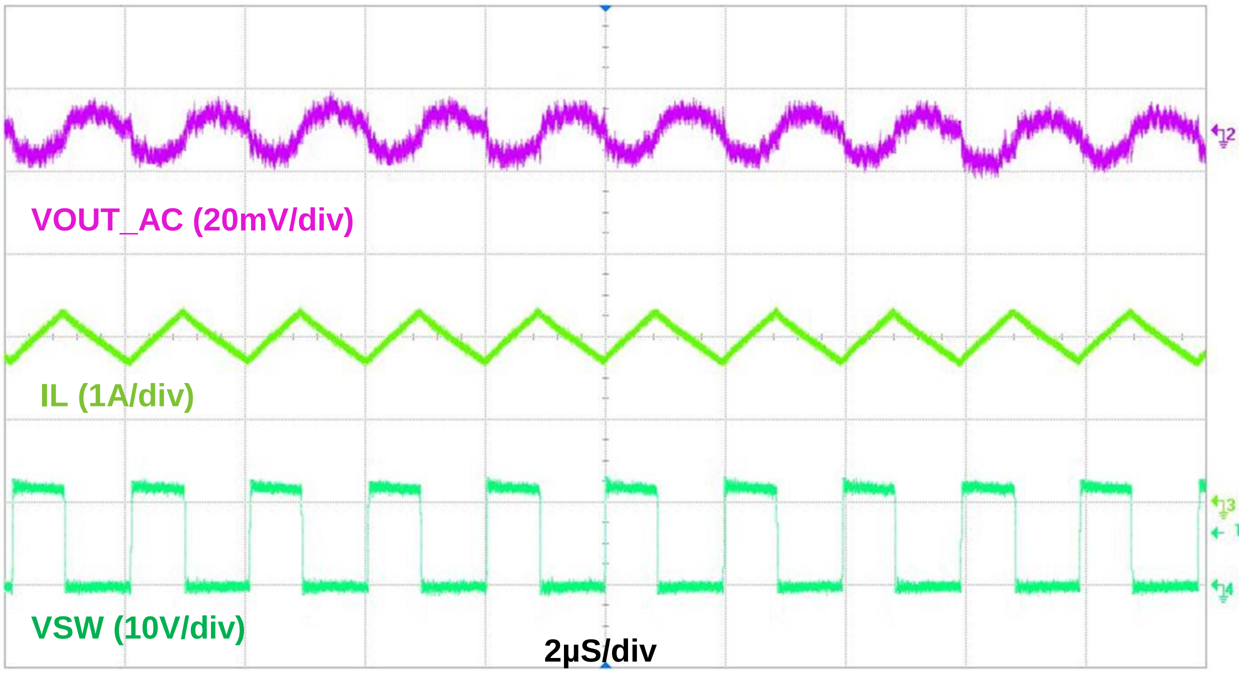

Figure 9. Output Ripple for VIN=24V, VOUT=12V, IOUT=2A