AP63300/AP63301-EVM

3.8V TO 32V INPUT, 3A LOW IQ SYNCHRONOUS BUCK WITH ENCHANCED EMI REDUCTION

Description

The AP63300/AP63301 is 3A, synchronous buck converter with a wide input voltage range of 3.8V to 32V. The device fully integrates a 75mΩ high-side power MOSFET and a 40mΩ low-side power MOSFET to provide high-efficiency step-down DC-DC conversion.

The AP63300/AP63301 device is easily used by minimizing the external component count due to its adoption of peak current mode control along with its integrated loop compensation network.

The AP63300/AP63301 design is optimized for Electromagnetic Interference (EMI) reduction. The device has a proprietary gate driver scheme to resist switching node ringing without sacrificing MOSFET turn-on and turn-off times, which reduces high-frequency radiated EMI noise caused by MOSFET switching. AP63300 also 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.
The device is available in a TSOT26 package.

Features

- VIN 3.8V to 32V
- 3A Continuous Output Current
- 0.8V ± 1% Reference Voltage
- 22μA Ultralow Quiescent Current (Pulse Frequency Modulation)
- 500kHz Switching Frequency
- Supports Pulse Frequency Modulation (PFM)
  - AP63300
  - Up to 88% Efficiency at 5mA Light Load
- Pulse Width Modulation (PWM) Regardless of Output Load
  - AP63301
- Proprietary Gate Driver Design for Best EMI Reduction
- Frequency Spread Spectrum (FSS) to Reduce EMI
  - AP63300
- Low-Dropout (LDO) Mode
- Precision Enable Threshold to Adjust UVLO
- Protection Circuitry
  - Undervoltage Lockout (UVLO)
  - Output Overvoltage Protection (OVP)
  - Cycle-by-Cycle Peak Current Limit
  - Thermal Shutdown
- Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)
- Halogen and Antimony Free. “Green” Device (Note 3)

Applications

- 5V, 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
- Gaming Consoles
- Consumer Electronics
- General Purpose Point of Load

Functional Block

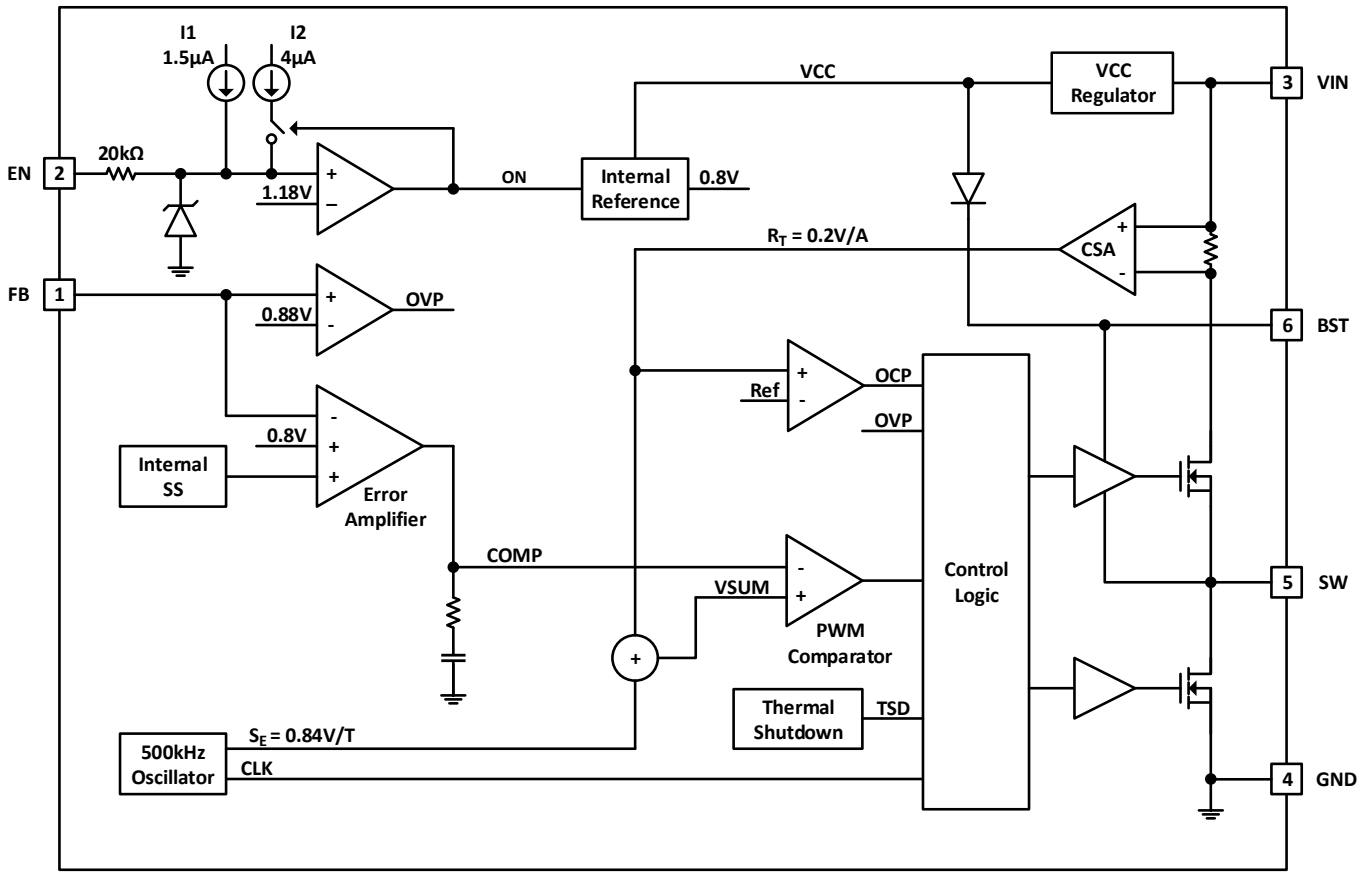


Figure 1. Functional Block Diagram

Absolute Maximum Ratings (Note 4) (At T_A = +25°C, unless otherwise specified.)

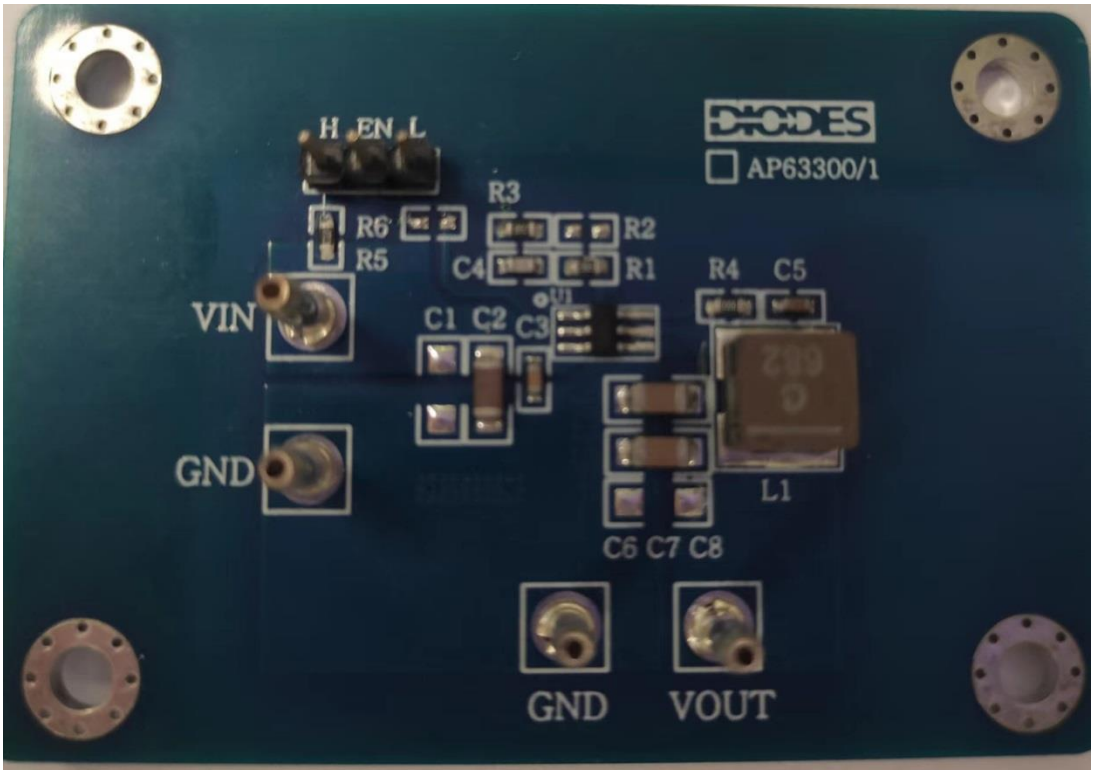
Symbol	Parameter	Rating	Unit
VIN	Supply Pin Voltage	-0.3 to +35.0 (DC)	V
		-0.3 to +40.0 (400ms)	
VFB	Feedback Voltage	-0.3V to +6.0	V
VEN	Enable/UVLO Pin Voltage	-0.3 to +35.0	V
VSW	Switch Node Voltage	-0.3 to VIN + 0.3 (DC)	V
		-2.5 to VIN + 2.0 (20ns)	V
VBST	Bootstrap Pin Voltage	VSW - 0.3 to VSW + 6.0	V
TST	Storage Temperature	-65 to +150	°C
TJ	Junction Temperature	+160	°C
TL	Lead Temperature	+260	°C
ESD Susceptibility (Note 5)			
HBM	Human Body Mode	2000	V
CDM	Charged Device Model	1000	V

Notes: 4. Stresses greater than the Absolute Maximum Ratings specified above may cause permanent damage to the device. These are stress ratings only; functional operation of the device at these or any other conditions exceeding those indicated in this specification is not implied. Device reliability maybe affected by exposure to absolute maximum rating conditions for extended periods of time.
5. Semiconductor devices are ESD sensitive and may be damaged by exposure to ESD events. Suitable ESD precautions should be taken when handling and transporting these devices.

Recommended Operating Conditions (At T_A = +25°C, unless otherwise specified.)

Symbol	Parameter	Min	Max	Unit
VIN	Supply Voltage	3.8	32	V
VOUT	Output Voltage	0.8	31	V
TA	Operating Ambient Temperature Range	-40	+85	°C
TJ	Operating Junction Temperature Range	-40	+125	°C

Evaluation Board



Quick Start Guide

The AP63300/1-EVM has a simple layout and allows access to the appropriate signals through test points. To evaluate the performance of the AP63300, follow the procedure below:

1. For evaluation board configured at V_{OUT}=5V, connect a power supply to the input terminals VIN and GND. Set VIN to 12V.
2. Connect the positive terminal of the electronic load to VOUT 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 5V output voltage.
5. Check for the proper output voltage of 5V (±1%) at the output terminals VOUT and GND. Measurement can also be done with a multimeter with the positive and negative leads between VOUT and GND.
6. Set the load to 3A 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.

Setting the Output Voltage of AP63300/AP63301

(1) Setting the output voltage

The AP63300/1 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 AP63300/1 has the internal integrated loop compensation as shown in the function block diagram. The compensation network includes a 18k resistor and a 7.6nF capacitor. Usually, the type II compensation network has a phase margin between 60 and 90 degree. 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,

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

Table 1. Resistor selection for output voltage setting

Vo	R3	R1	C4	C6-C8
1.8V	77.5 KΩ	62 KΩ	100pF	22μFx2
2.5V	131 KΩ	62 KΩ	100pF	22μFx2
3.3V	182 KΩ	62 KΩ	100 pF	22μFx2
5V	157 KΩ	30 KΩ	100 pF	22μFx2
12V	249 KΩ	18 KΩ	56 pF	22μFx4

External Component Selection:

1) Input & output Capacitors (Cin, Cout)
   (1) For lower output ripple, low ESR is required.
   (2) Low leakage current needed, X5R/X7R ceramic recommend, multiple capacitor parallel connection.
   (3) The Cin and Cout capacitances are greater than 22μF and 44μF respective.
2) Bootstrap Voltage Regulator
   (1) An external 0.1μF ceramic capacitor is required as bootstrap capacitor between BST and SW pin to work as high side power MOSFET gate driver.
3) Inductor (L)
   (1) Low DCR for good efficiency
   (2) Inductance saturate current must higher than the output current
   (3) The recommended inductance is shown in the table 2 below.

Evaluation Board Schematic

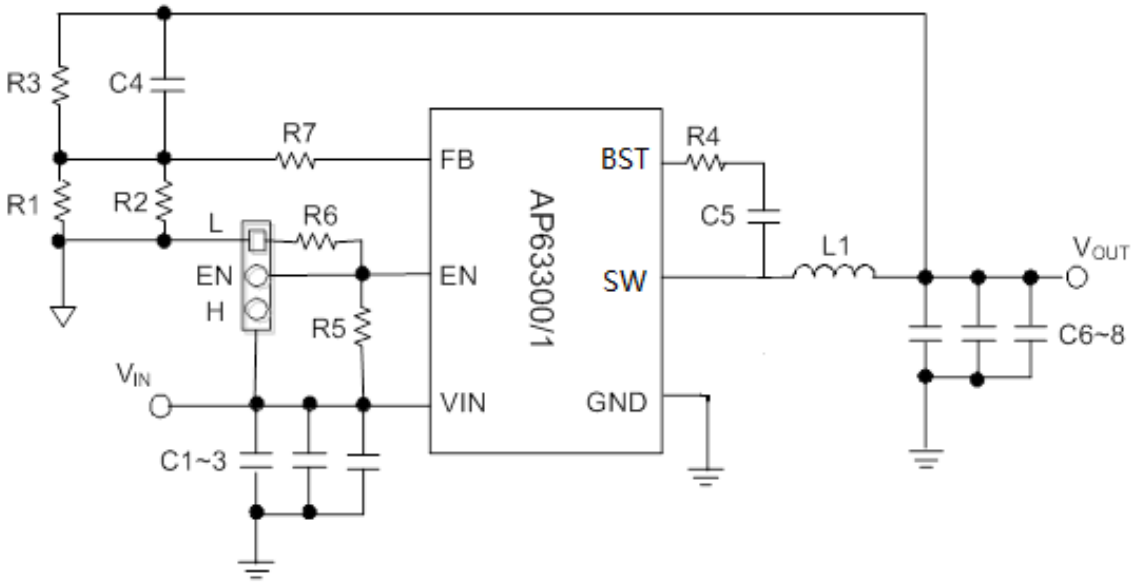


Figure 2. Typical Application Circuit

PCB Top Layout

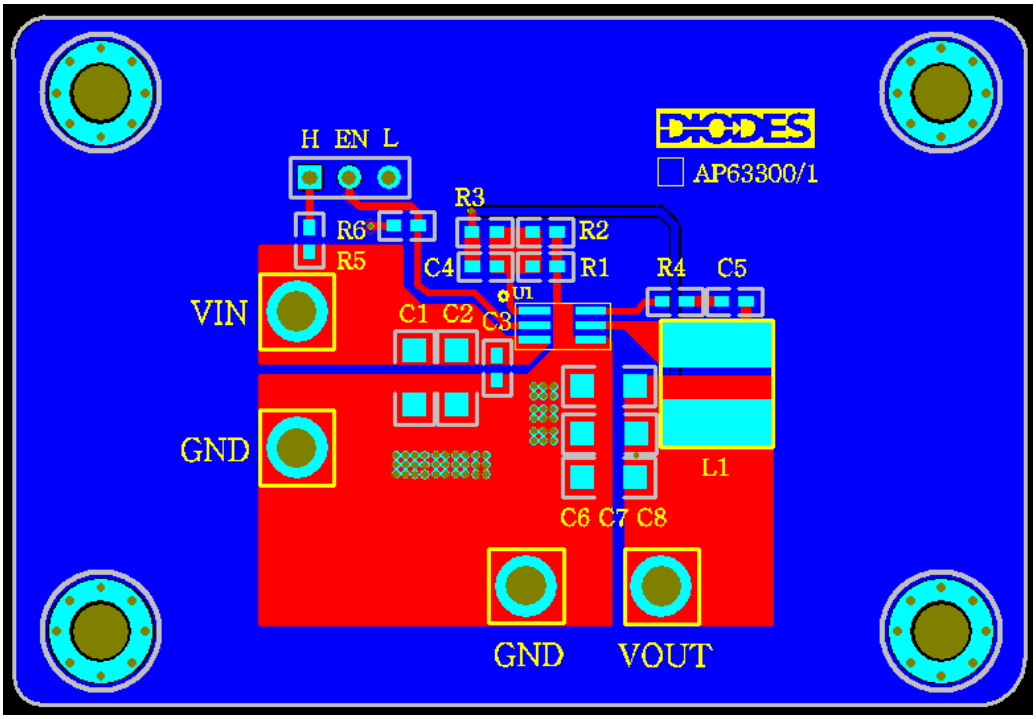


Figure 3. AP63300/1-EVM – Top Layer

PCB Bottom Layout

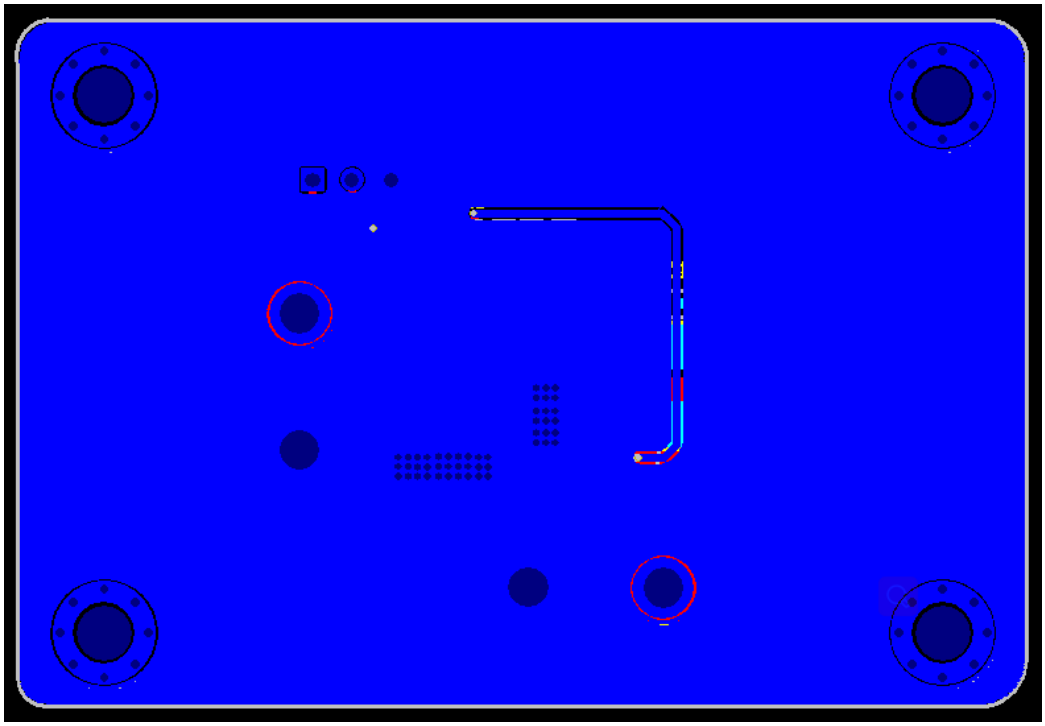


Figure 4. AP63300/1 -EVM – Bottom Layer

Bill of Materials for AP63300/AP63301-EVM

Table 2. Bill of Materials

Item	Value	Type	Rating	Description
C2	22µF	X5R/X7R, Ceramic/1206	35V	Input CAP
C3	0.1µF	X5R/X7R, Ceramic/0603	50V	Input CAP
C4	100pF	0603	100V	Feedback CAP
C5	0.1µF	X5R/X7R, Ceramic/0603	50V	Bootstrap CAP
C6 & C7	22µF	X5R/X7R, Ceramic/1206	25V	Output CAP
L1	6.8µH	6060	6.5A	Inductor
R1	30K	0603	1%	Voltage set RES*
R3	162K	0603	1%	
R4	0	0603	1%	Bootstrap RES
R5	100K	0603	1%	EN pull high RES
U1		AP63300/1		Diodes BCD

***Note: The present value of R3/R1 are based on Vout=5.0V

Typical Performance Characteristics

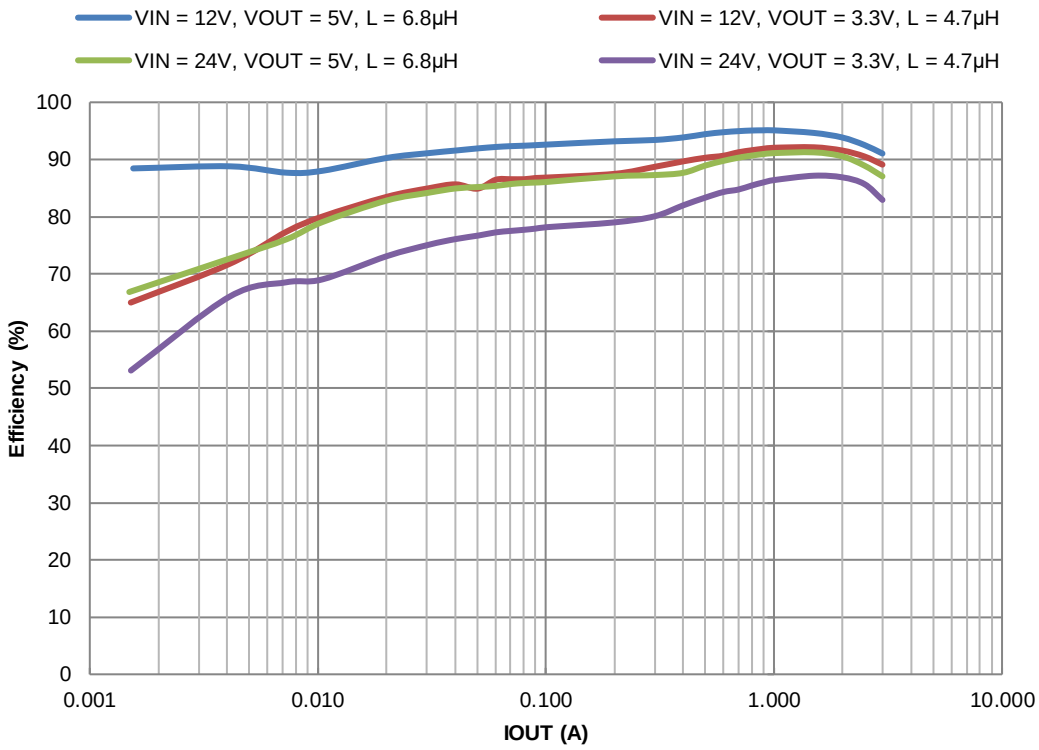


Figure 5. AP63300 Efficiency vs. Output Current

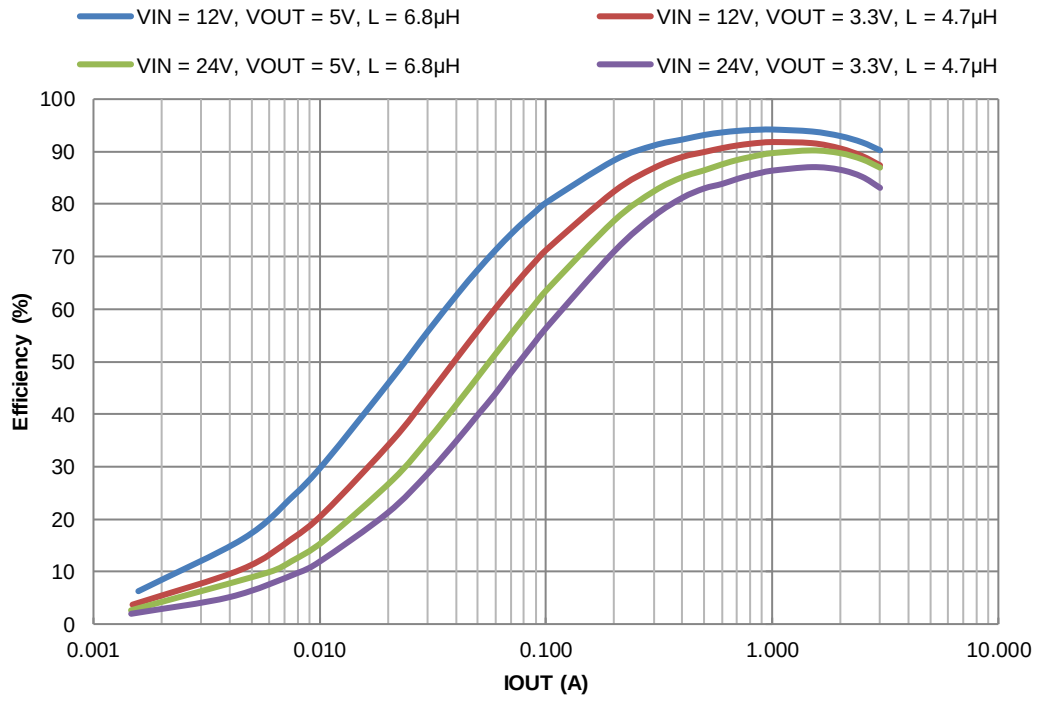


Figure 6. AP63301 Efficiency vs. Output Current

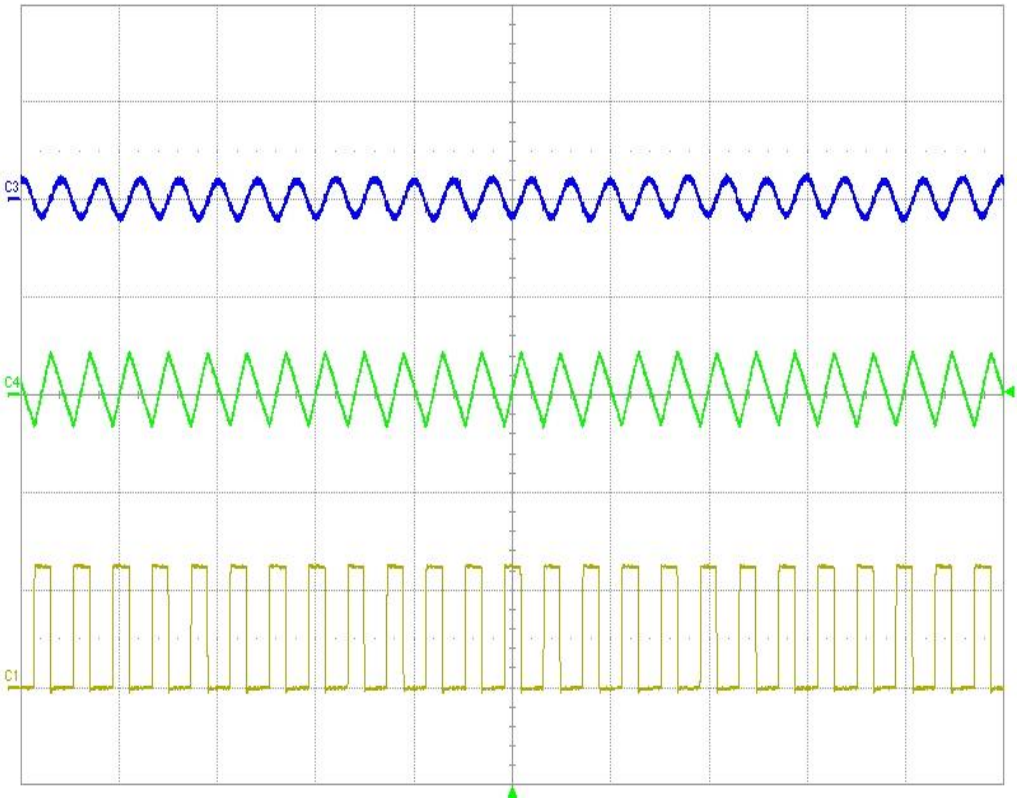


Figure 7. AP63301 Vin=12 Vout=5V Output Voltage Ripple, IOUT = 50mA

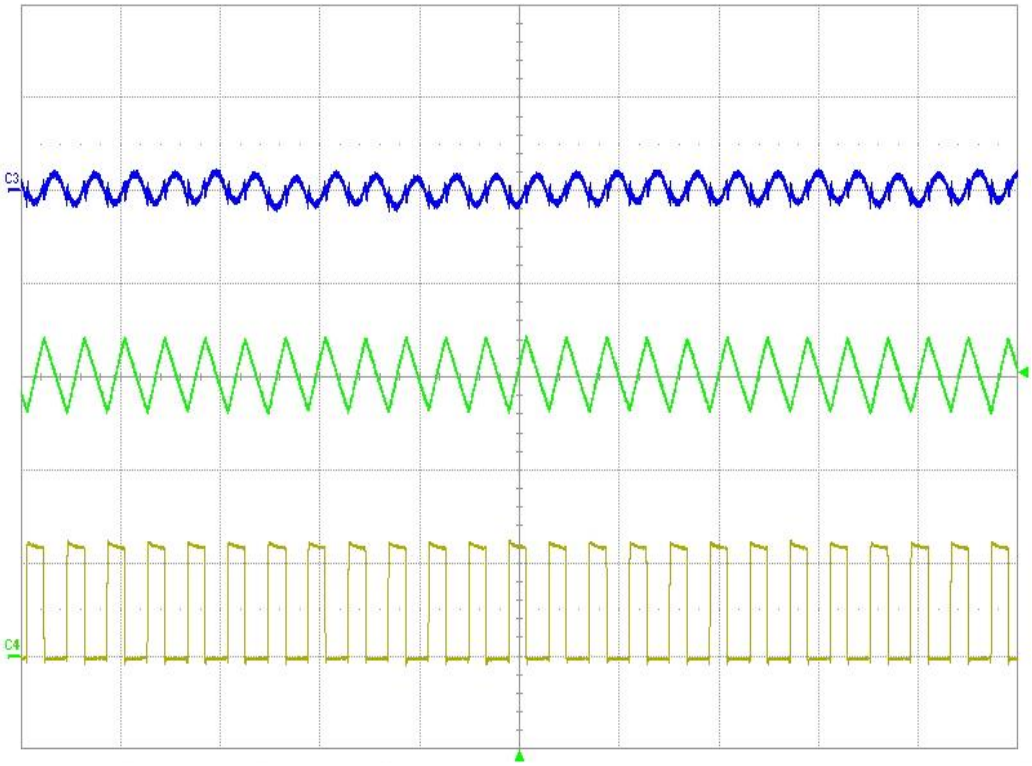


Figure 8. AP63301 Vin=12 Vout=5V Output Voltage Ripple, IOUT = 3A

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