

40V, 5A, Low IQ, Synchronous DC/DC Buck Converter with Programmable Soft-Start Time

DESCRIPTION

The AP64501 is 5A, synchronous buck converter with a wide input voltage range of 3.8V to 40V. The device fully integrates a 45m Ω high-side power MOSFET and a 20m Ω low-side power MOSFET to provide high-efficiency step-down DC/DC conversion.

The AP64501 device is easily used by minimizing the external component count due to its adoption of peak current mode control.

The AP64501 design is optimized for Electromagnetic Interference (EMI) reduction. The converter features Frequency Spread Spectrum (FSS) with a

FEATURES

- Wide Input Range: 3.8V to 40V
- 5A Continuous Output Current
- 0.8V ±1% Reference Voltage
- 25µA Ultralow Quiescent Current (Pulse Frequency Modulation)
- 570kHz Switching Frequency
- Programmable Soft-Start Time
- 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

switching frequency jitter of $\pm 6\%$, 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 reduces highfrequency radiated EMI noise caused by MOSFET switching.

The device is available in a SO-8EP package.

- Protection Circuitry
 - Undervoltage Lockout (UVLO)
 - Output Overvoltage Protection (OVP)
 - Cycle-by-Cycle Peak Current Limit
 - Thermal Shutdown
- Totally Lead-Free & Fully RoHS
 Compliant
- Halogen and Antimony Free. "Green" Device



40V, 5A, Low IQ, Synchronous DC/DC Buck Converter with Programmable Soft-Start Time

APPLICATIONS

- 5V, 12V, and 24V Distributed Power Bus Supplies
- White Goods and Small Home Appliances
- Home Audio
- Network Systems
- Consumer Electronics
- Cordless Power Tools
- Optical Communication and Networking Systems
- General Purpose Point of Load

TYPICAL APPLICATIONS CIRCUIT



Figure 1. Typical Application Circuit

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Rating	Unit	
VIN	Supply Pin Voltago	-0.3 to +42.0 (DC)	V	
VIIN	Supply Fill Voltage	-0.3 to +45.0 (400ms)	v	
V _{BST}	Bootstrap Pin Voltage	V_{SW} - 0.3 to V_{SW} + 6.0	V	
V _{EN}	Enable/UVLO Pin Voltage	-0.3 to +42.0	V	
V _{SS}	Soft-Start Pin Voltage	-0.3 to +6.0	V	
V _{FB}	Feedback Voltage	-0.3V to +6.0	V	
V _{COMP}	Compensation Pin Voltage	-0.3 to +6.0	V	
V	Switch Node Veltage	-0.3 to VIN + 0.3 (DC)	V	
V _{SW}	Switch Node Voltage	-2.5 to VIN + 2.0 (20ns)	v	
TJ	Junction Temperature	+160	°C	
TL	Lead Temperature	+260	°C	



40V, 5A, Low IQ, Synchronous DC/DC Buck Converter with Programmable Soft-Start Time

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit
VIN	Supply Voltage	3.8	40	V
VOUT	Output Voltage	0.8	39	V
T _A	Operating Ambient Temperature Range	-40	+85	°C
TJ	Operating Junction Temperature Range	-40	+125	°C

EVALUATION BOARD



Figure 2. AP64501SP-EVM



40V, 5A, Low IQ, Synchronous DC/DC Buck Converter with Programmable Soft-Start Time

QUICK START GUIDE

The AP64501SP-EVM has a simple layout and allows access to the appropriate signals through test points. To evaluate the performance of the AP64501SP, follow the procedure below:

- 1. 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 at JH6 to "ON" position to connect EN pin to V_{IN} through 100KΩ resistor to enable IC. Jump to "OFF" position to disable IC.
- 4. The evaluation board should now power up with a 5.0V output voltage.
- 5. Check for the proper output voltage of 5.0V (±1%) at the output terminals Vou⊤ and GND. Measurement can also be done with a multimeter with the positive and negative leads between Vou⊤ and GND.
- 6. Set the load to 5A 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 OUTPUT VOLTAGE:

Table 1 shows a list of recommended component selections for common output voltages.

VOUT	R1	R2	L1	R7	C7	C1, C2	C5, C6, C12
1.2V	11KΩ	22.1KΩ	1.5µH	3.74KΩ	2.7nF	2x10µF	3x22µF
1.5V	19.6KΩ	22.1KΩ	2.2µH	4.75ΚΩ	2.7nF	2x10µF	3x22µF
1.8V	27.4KΩ	22.1KΩ	2.2µH	5.62KΩ	2.7nF	2x10µF	3x22µF
2.5V	47.5KΩ	22.1KΩ	3.3µH	7.87KΩ	2.7nF	2x10µF	3x22µF
3.3V	69.8KΩ	22.1KΩ	3.3µH	10.5KΩ	2.7nF	2x10µF	3x22µF
5.0V	115KΩ	22.1KΩ	3.6µH	15.8KΩ	2.7nF	2x10µF	3x22µF
12V	309KΩ	22.1KΩ	10µH	37.4KΩ	2.7nF	2x10µF	3x22µF

 Table 1. Common Output Voltages



40V, 5A, Low IQ, Synchronous DC/DC Buck Converter with Programmable Soft-Start Time

EVALUATION BOARD SCHEMATIC







PCB TOP LAYOUT

Figure 4. AP64501SP-EVM – Top Layer

5 of 9 www.diodes.com



40V, 5A, Low IQ, Synchronous DC/DC Buck Converter with Programmable Soft-Start Time

PCB BOTTOM LAYOUT



Figure 5. AP64501SP-EVM – Bottom Layer

40V, 5A, Low IQ, Synchronous DC/DC Buck Converter with Programmable Soft-Start Time

BILL OF MATERIALS for AP64501SP-EVM for V_{OUT}=5V

Ref	Value	Description	Qty	Size	Vendor Name	Manufacturer PN
		Ceramic				
C1. C2	10uF	X7R, 10%	2	1206	Samsung	CL31B106KBHNNNE
		Ceramic	_		Currearig	
00.04	0.1	Capacitor, 50V,	0	0000	Wurth	00501000005
03, 04	0.1μΓ	Ceramic	2	0603	Electronics	885012206095
C5, C6,		Capacitor, 16V,				
C12	22µF	X7R	3	1210	Samsung	CL32B226KOJNNNE
		Ceramic Capacitor 50V				
C7	2.7nF	X7R	1	0603	Murata	GRM1885C1H272JA01D
		Ceramic				
C8	10nF	X7R	1	0603	Flectronics	885012206065
		Ceramic				
00		Capacitor, 25V,		0000	Wurth	00504000074
C9	0.1µ⊢	X/R RESISMD 1%	1	0603	Electronics	885012206071
R1	115KΩ	1/8W	1	0603	Panasonic	ERJ-3EKF1153V
		RES SMD 1%				
R2	22.1KΩ	1/8W	1	0603	Stackpole	RNCP0603F1D22K1
R3	0Ω	1/10W	1	0603	Vishay	CRCW06030000Z0EAC
		RES SMD 1%				
R4	100KΩ	1/10W	1	0603	Vishay	CRCW0603100KFKEA
		RES SMD 1%	4	0000	Deurse hee	
	13.000	BES SMD 1%	1	0603	Bourns Inc	0R0003-FA-1302ELF
R8	0Ω	1/10W	1	0603	Vishay	CRCW06030000Z0EAC
	0.0.11	DCR=12.2mΩ,		10.2x10.2x	Wurth	7447707000
L1	3.6µН	Ir=8.2A PCB Header 40	1	4.5mm	Electronics	/44//9/360
JH6		POS	1	1X3	ЗМ	2340-611TG
JH13,						
JH14,		Terminal Turret		Through	Kovetopo	
JH16	1598	(Test Points)	4	Hole	Electronics	1598-2
		Sync DC/DC				
U1	AP64501	Converter	1	SO-8EP	Diodes Inc	AP64501SP



40V, 5A, Low IQ, Synchronous DC/DC Buck Converter with Programmable Soft-Start Time

TYPICAL PERFORMANCE CHARACTERISTICS







40V, 5A, Low IQ, Synchronous DC/DC Buck Converter with Programmable Soft-Start Time

IMPORTANT NOTICE

DIODES INCORPORATED MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

Diodes Incorporated and its subsidiaries reserve the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. Diodes Incorporated does not assume any liability arising out of the application or use of this document or any product described herein; neither does Diodes Incorporated convey any license under its patent or trademark rights, nor the rights of others. Any Customer or user of this document or products described herein in such applications shall assume all risks of such use and will agree to hold Diodes Incorporated and all the companies whose products are represented on Diodes Incorporated website, harmless against all damages.

Diodes Incorporated does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.

Should Customers purchase or use Diodes Incorporated products for any unintended or unauthorized application, Customers shall indemnify and hold Diodes Incorporated and its representatives harmless against all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized application.

Products described herein may be covered by one or more United States, international or foreign patents pending. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks.

This document is written in English but may be translated into multiple languages for reference. Only the English version of this document is the final and determinative format released by Diodes Incorporated.

LIFE SUPPORT

Diodes Incorporated products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Diodes Incorporated. As used herein:

A. Life support devices or systems are devices or systems which:

1. are intended to implant into the body, or

2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

Customers represent that they have all necessary expertise in the safety and regulatory ramifications of their life support devices or systems, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of Diodes Incorporated products in such safety-critical, life support devices or systems, notwithstanding any devices- or systems-related information or support that may be provided by Diodes Incorporated. Further, Customers must fully indemnify Diodes Incorporated and its representatives against any damages arising out of the use of Diodes Incorporated products in such safety-critical, life support devices or systems.

Copyright © 2019, Diodes Incorporated

www.diodes.com