





18V, 3A SYNCHRONOUS DC-DC BUCK CONVERTER

(Top View)

EΡ

(SO-8EP/ MP Package)

8

7

6

5

SS

ΕN

FB

COMP

Description

The AP3513E is a 500kHz fixed frequency, current mode, PWM synchronous buck (step-down) DC-DC converter, capable of driving a 3A load with high efficiency, excellent line and load regulation. The AP3513E exhibits high efficiency at light load. The device integrates N-channel power MOSFET switch with low on-resistance. Current mode control provides fast transient response and cycle-by-cycle current limit.

The AP3513E employs complete protection to ensure system security, including output Over Voltage Protection, input Under Voltage Lock Out, programmable Soft-start, Over Temperature Protection and hiccup mode Short Circuit Protection.

This IC is available in SO-8EP package.

Features

- Input Voltage Range: 4.5V to 18V
- Fixed 500kHz Frequency
- High Efficiency at Light Load
- Output Current: 3A
- Current Mode Control
- Built-in Over Current Protection
- Built-in Thermal Shutdown Function
- Built-in UVLO Function
- Built-in Over Voltage Protection
- Programmable Soft-start
- Hiccup Mode SCP
- Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)
- Halogen and Antimony Free. "Green" Device (Note 3)

Notes: 1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.

- 2. See http://www.diodes.com/quality/lead_free.html for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
- 3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Typical Applications Circuit



Applications

Pin Assignments

BS

IN

SW

GND

2

3

4

- Monitor
- TV
- STB
- Datacom





Pin Descriptions

Pin Number	Pin Name	Function
1	BS	Bootstrap pin. A bootstrap capacitor is connected between the BS pin and SW pin. The voltage across the bootstrap capacitor drives the internal high-side NMOS switch.
2	IN	Supply input pin. A capacitor should be connected between the IN pin and GND pin to keep the DC input voltage constant.
3	SW	Power switch output pin. This pin is connected to the inductor and bootstrap capacitor.
4	GND	Ground pin
5	FB	Feedback pin. This pin is connected to an external resistor divider to program the system output voltage. When the FB pin voltage exceeds 1.1V, the over voltage protection is triggered. When the FB pin voltage is below 0.3V, the oscillator frequency is lowered to realize short circuit protection.
6	СОМР	Compensation pin. This pin is the output of the transconductance error amplifier and the input to the current comparator. This pin is used to compensate the control loop. Connect a series RC network from this pin to GND pin. In some cases, an additional capacitor from this pin to GND pin is required.
7	EN	Enable Input. EN is a digital input that turns the regulator on or off. Drive EN high to turn on the regulator, drive it low to turn off. Pull up with $100k\Omega$ resistor for automatic startup.
8	SS	Soft-start control input pin. SS controls the soft start period. Connect a capacitor from SS to GND to set the soft-start period. A 0.1μ F capacitor sets the soft-start period to 15ms. To disable the soft-start feature, leave SS unconnected.
_	EP	Exposed pad. It should be connected to GND in PCB layout.

Functional Block Diagram







Absolute Maximum Ratings (Note 4)

Symbol	Parameter	Rating	Unit		
V _{IN}	IN Pin Voltage	-0.3 to 2	V		
V _{EN}	EN Pin Voltage	-0.3 to \	V		
V _{SW}	SW Pin Voltage	21	V		
V _{BS}	BS Pin Voltage	-0.3 to Vs		V	
V _{FB}	FB Pin Voltage	-0.3 to 6		V	
V _{COMP}	COMP Pin Voltage	-0.3 to	-0.3 to 6		
V _{SS}	SS Pin Voltage	-0.3 to 6		V	
TJ	Operating Junction Temperature	+150		٥C	
T _{STG}	Storage Temperature -65 to +150		150	٥C	
T _{LEAD}	Lead Temperature (Soldering, 10sec)	+260		٥C	
θ _{JA}	Thermal Resistance (Junction to Ambient)	SO-8EP	°C/W		
V _{HBM}	ESD (Human Body Model)	2000		V	
V _{MM}	ESD (Machine Model)	200		V	

Note 4: Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Conditions" is not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

Recommended Operating Conditions

Symbol	Parameter	Min	Мах	Unit
V _{IN}	Input Voltage	4.5	18	V
T _A	Operating Ambient Temperature	-40	+85	°C





Electrical Characteristics (V_{IN} = V_{EN} = 12V, V_{OUT} = 3.3V, T_A = +25°C, unless otherwise specified.)

Cumhal	Denometer	Conditions	Min	Ture	Max	Unit
Зутьої		Conditions	IVIIN	тур	wax	Unit
SUPPLY VOLTA	GE (IN PIN)					
VIN	Input Voltage	_	4.5	-	18	V
Ι _Q	Quiescent Current	$V_{FB} = 1V, V_{EN} = 3.3V$	_	1.2	1.4	mA
I _{SHDN}	Shutdown Supply Current	$V_{EN} = 0V$	-	0.1	1.0	μA
UNDER VOLTAG	SE LOCKOUT					
Vuvlo	Input UVLO Threshold	V _{IN} Rising	3.65	4.0	4.25	V
V _{HYS}	Input UVLO Hysteresis	-	-	0.2	-	V
ENABLE (EN PIN	N)					
-	EN Shutdown Threshold Voltage	-	1.1	1.5	2	V
_	EN Shutdown Threshold Voltage Hystere- sis (Note 5)	-	_	350	-	mV
_	EN Lockout Threshold Voltage	-	2.2	2.5	2.7	V
_	EN Lockout Hysteresis	-	-	210	-	mV
VOLTAGE REFE	RENCE (FB PIN)					
V _{FB}	Feedback Voltage	-	0.907	0.925	0.943	V
V _{FBOV}	Feedback Over Voltage Threshold	-	I	1.1	_	V
I _{FB}	Feedback Bias Current	V _{FB} = 1V	-0.1	-	0.1	μA
MOSFET						
R _{DSONH}	High-side Switch On-resistance (Note 6)	I _{SW} = 0.2A&0.7A	-	100	-	mΩ
R _{DSONL}	Low-side Switch On-resistance (Note 6)	I _{SW} = -0.2A&-0.7A	Ι	100	-	mΩ
CURRENT LIMIT						
I _{LEAKH}	High-side Switch Leakage Current	$V_{IN} = 18V, V_{EN} = 0V, V_{SW} = 0V$	_	0.1	10	μA
ILIMH	High-side Switch Current Limit	-	4.3	5.6	-	А
I _{LIML}	Low-side Switch Current Limit	From drain to source	-	50	_	mA
SWITCHING REGULATOR						
f _{OSC1}	Oscillator Frequency	-	410	500	590	kHz
fosc2	Short Circuit Oscillator Frequency	-	_	180	-	kHz
D _{MAX}	Max. Duty Cycle	V _{FB} = 0.85V	_	90	-	%
D _{MIN}	Min. Duty Cycle	V _{FB} = 1V	_	_	0	%





Electrical Characteristics (Cont. V_{IN} = V_{EN} = 12V, V_{OUT} = 3.3V, T_A = +25°C, unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Тур	Max	Unit	
ERROR AMPLI	ERROR AMPLIFIER						
A _{EA}	Error Amplifier Voltage Gain (Note 5)	-	-	400	-	V/V	
G _{EA}	Error Amplifier Transconductance	-	-	800	_	μA/V	
G _{CS}	COMP to Current Sense Transconductance	-	_	5.2	Ι	A/V	
THERMAL SHU	THERMAL SHUTDOWN						
T _{OTSD}	Thermal Shutdown (Note 5)	-	-	+160	-	°C	
T _{HYS}	Thermal Shutdown Hysteresis (Note 5)	-	-	+30	_	°C	
SOFT START (SS PIN)							
t _{SS}	Soft-start Time (Note 5)	C _{SS} = 0.1µF	-	15	_	ms	
_	Soft-start Current	-	_	5	_	μA	

Notes: 5. Not tested, guaranteed by design.

6.
$$R_{\text{DSON}} = \frac{V_{SW1} - V_{SW2}}{I_{SW1} - I_{SW2}}$$





Performance Characteristics (VIN = 12V, VOUT = 3.3V, L = 4.7µH, TA = +25°C, unless otherwise noted.)



Efficiency vs. Output Current

Feedback Voltage vs. Temperature



Load Transient Response (I_{OUT} = 0.2A to 2.5A)



Time(100µs/div)

Quiescent Current vs. Temperature



Output Ripple (Iout = 2.5A)



Time(1µs/div)

Load Transient Response (I_{OUT} = 1A to 2.5A)



Time(100µs/div)





Performance Characteristics (Cont. $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $L = 4.7\mu$ H, $T_A = +25^{\circ}$ C, unless otherwise noted.)



Power On from VIN (IOUT = 2.5A)

Time(3.20ms/div)





Time(3.20ms/div)

Short Circuit Protection (I_{OUT} = 2.5A)



Power Off from VIN (I_{OUT} = 2.5A)



Time(3.20ms/div)

Power Off from EN (I_{OUT} = 2.5A)



Time(3.20ms/div)

Short Circuit Protection Recovery (I_{OUT} = 2.5A)



Time(64ms/div)





Ordering Information



Diodes IC's Pb-free products with "G1" suffix in the part number, are RoHS compliant and green.

Package	Temperature Range	Part Number	Marking ID	Packing	
	-40 to +85°C	AP3513EMP-G1	3513EMP-G1	100/Tube	
SO-8EP		AP3513EMPTR-G1	3513EMP-G1	4000/Tape & Reel	

Marking Information

(1) SO-8EP

(Top View)



First and Second Lines: Logo and Marking ID Third Line: Date Code Y: Year WW: Work Week of Molding 4: Assembly Site Code XX: 7th and 8th digits of Batch Number





Package Outline Dimensions (All dimensions in mm(inch).)

(1) Package Type: SO-8EP



Note: Eject hole, oriented hole and mold mark is optional.

0.250(0.010)



Ζ



Suggested Pad Layout

(1) Package Type: SO-8EP



Dimensions	Z (mm)/(inch)	G (mm)/(inch)	X (mm)/(inch)	Y (mm)/(inch)
Value	6.900/0.272	3.900/0.154	0.650/0.026	1.500/0.059
Dimensions	X1 (mm)/(inch)	Y1 (mm)/(inch)	E (mm)/(inch)	
Value	3.600/0.142	2.700/0.106	1.270/0.050	





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