



Step-up PWM DC/DC Controller

Features

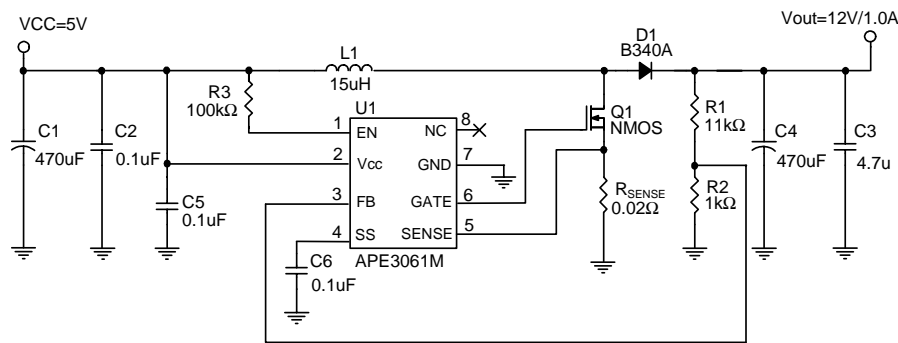
- Input voltage : 3.0V to 24V
- Output determined by external N-MOSFET
- Duty ratio: 0% to 85% PWM control
- Oscillation frequency: 500kHz (±20%)
- Programmable soft-start using an external capacitor
- Programmable current limit using an external resistor
- Thermal shutdown protection
- Enable/shutdown function
- External N-channel MOSFET switch
- RoHS-compliant halogen-free SO-8 package.

Description

The APE3061 is a highly efficient PWM step-up controller, designed to drive an external N-channel MOSFET. With an internal reference voltage of 1.0V, external resistors are used to feedback and set the output voltage as required.

The APE3061 operates at a switching frequency of 500kHz allowing for easy filtering and low noise, and reduced size of external components. Logic enable and thermal shutdown functions are built in, and to reduce overshoot at startup, a soft-start time can be programmed using an external capacitor.

Typical Application



$V_{OUT} = V_{FB} \times (1 + R1/R2)$, $V_{FB} = 1.0V$, $R2 = 1k\Omega \sim 3k\Omega$
 Capacitor C4 - recommended ESR 30mΩ ~ 100mΩ

Ordering information

APE3061M-HF-3TR

Packing Type:

TR: Tape and reel

Package Type:

M: RoHS-compliant halogen-free SO-8



Absolute Maximum Ratings (at $T_A = 25^\circ\text{C}$)

VCC Pin Voltage (V_{CC})	VSS - 0.3V to VSS + 26V
Feedback Pin Voltage(V_{FB})	VSS - 0.3V to 12V
EN Voltage (V_{EN})	VSS - 0.3V to VCC
SENSE Voltage (V_{SENSE})	VSS - 0.3V to VCC
SS Pin Voltage (V_{SS})	VSS - 0.3V to VCC
Gate Pin Voltage (V_{GATE})	VSS - 0.3V to VCC
Power Dissipation (P_D)	internally limited
Storage Temperature Range (T_{ST})	-40 to +150°C
Operating Junction Temperature Range (T_{OPJ}) ...	-20 to +125°C
Operating Supply Voltage (V_{OP})	+3V to +24V
Thermal Resistance from Junction to Case($R_{th_{JC}}$)	40°C/W
Thermal Resistance from Junction to Ambient($R_{th_{JA}}$)	120°C/W

Note. $R_{th_{JA}}$ is measured with a PCB copper area of approximately 1 in² (Multi-layer).

Electrical Characteristics

($V_{IN}=5V$, $V_{OUT}=12V$, $T_A=25^\circ\text{C}$, unless otherwise specified)

Parameter	SYM	TEST CONDITION	MIN	TYP	MAX	UNITS
Feedback Voltage	V_{FB}	$I_{OUT}=0.1A$	0.975	1	1.025	V
Quiescent Current	I_{CCQ}	$V_{FB}=1.5V$ force driver off	-	4	6	mA
Feedback Bias Current	I_{FB}	$I_{OUT}=0.1A$	-	0.1	0.5	uA
Shutdown Supply Current	I_{SD}	$V_{EN}=0V$	-	1	10	uA
Oscillation Frequency	F_{OSC}	SW pin	400	500	600	kHz
Sense Voltage	V_{SENSE}		0.05	0.06	0.07	V
Soft Start Current	I_{SS}	$V_{SS}=0V$	-	8	-	uA
EN Pin Logic Input Threshold Voltage	V_{SH}	High (regulator ON)	2	-	-	V
	V_{SL}	Low (regulator OFF)	-	-	0.8	
EN Pin Input Current	I_{SH}	$V_{EN}=2.5V$ (ON)	-	20	-	uA
	I_{SL}	$V_{EN}=0.3V$ (OFF)	-	-1	-	uA
LX Rise Time	T_{LXR}	$C_{LX}=1000pF$	-	60	-	ns
LX Fall Time	T_{LXF}	$C_{LX}=1000pF$	-	60	-	
Efficiency	EFFI	$V_{CC}=5V$, $V_{OUT}=12V$, $I_{OUT}=1A$	-	91	-	%
Maximum Duty Cycle	DC_{MAX}	$V_{FB}=0V$	-	85	-	%
Minimum Duty Cycle	DC_{MIN}	$V_{FB}=1.5V$	-	0	-	
Thermal Shutdown Temp	TSD		-	145	-	°C

THIS PRODUCT IS SENSITIVE TO ELECTROSTATIC DISCHARGE, PLEASE HANDLE WITH CAUTION.

USE OF THIS PRODUCT AS A CRITICAL COMPONENT IN LIFE SUPPORT OR OTHER SIMILAR SYSTEMS IS NOT AUTHORIZED.

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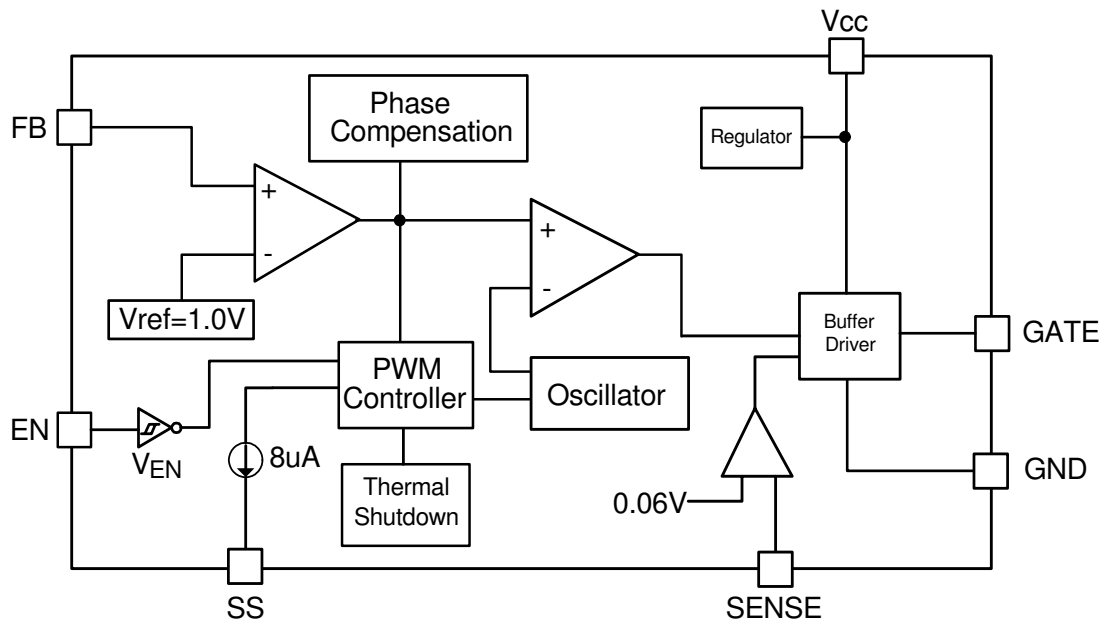
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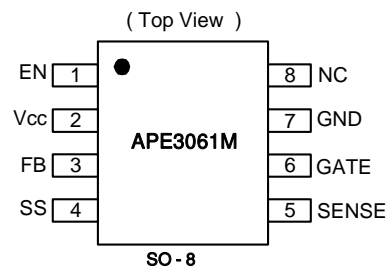
RELIABILITY, FUNCTION OR DESIGN.



Block Diagram



Pin Assignment



Pin Descriptions

PIN SYMBOL	PIN DESCRIPTON
SS	Soft-start pin
SENSE	Current-limit sense voltage
GATE	Gate drive for external N-channel MOSFET.
VCC	VCC supply pin
GND	Ground pin
FB	Feedback pin
EN	Shutdown pin
	H : Normal operation L : Shutdown
NC	No connection



Application Information

PWM Control

The APE3061 is highly efficient PWM step-up controller. In controllers like the APE3061, the pulse width varies in a range from 0 to 85%, according to the load current. The ripple voltage produced by the switching can easily be removed through a filter because the switching frequency remains constant. Therefore, the APE3061 provides low-ripple power over broad ranges of input voltage and load current.

Setting the Output Voltage

The application circuit on page 1 shows the basic application circuit for the APE3061 adjustable output version. The external resistors set the output voltage according to the following equation:

Table 1: Resistor selection for output voltage setting

$$V_{OUT} = 1V \times (1 + R1/R2)$$

V _{OUT}	R2	R1
12V	1k	11k
15V	1.5k	21k
18V	1k	17k
24V	1.3k	30k

Current Limiting Setting

The current limit threshold is set using an external resistor (R_{SENSE}) connecting from the SENSE pin to GND (refer to the application circuit). The internal current limit compared voltage is 60mV. When the SENSE voltage is larger than 60mV, an over-current condition is triggered. For setting the minimum current limit value, use the following equation :

$$I_{SW(MAX)} = 60m / R_{SENSE}$$

Note: I_{SW(MAX)} is the maximum N-MOSFET current

Inductor Selection

For most designs, low inductance values are physically smaller but require faster switching, which results in some efficiency loss. The inductor value can be derived from the following equation:

$$L = [V_{IN} \times (V_{OUT} - V_{IN})] / (V_{OUT} \times \Delta I_L \times f_{IX})$$

where ΔI_L is the inductor ripple current. Large value inductors lower ripple current and small value inductors result in higher ripple currents. Choose an inductor ripple current value approximately 15% of the maximum input current , e.g. for 3A, use $\Delta I_L = 0.45A$.

Table 2 Inductor select for output voltage setting (V_{CC}=5V)

V _{OUT}	9V	12V	15V	18V
L1 Value	18uH	15uH	10uH	10uH

The DC current rating of the inductor should be at least equal to the maximum load current plus half the ripple current to prevent core saturation, $3A + 0.25A = 3.25A$ in this example.

Input Capacitor Selection

The input capacitor reduces the surge current drawn from the input and reduces switching noise from the device. The input capacitor impedance at the switching frequency should be less than the input source impedance to prevent high frequency switching currents passing to the input. A low ESR input capacitor sized for maximum RMS current must be used.

The capacitor voltage rating should be at least 1.5 times greater than the input voltage, but much higher voltage ratings are often needed.



Application Information (cont.)

Output Capacitor Selection

The output capacitor is required to keep the output voltage ripple small and to ensure regulation loop stability. The output capacitor must have low impedance at the switching frequency. A low ESR capacitor sized for maximum RMS current must be used. The low ESR requirements are needed for low output ripple voltage.

The capacitor voltage rating should be at least 1.5 times greater than the input voltage, but much higher voltage ratings are often needed.

The ESR range of the output capacitor should be $30\text{m}\Omega \sim 100\text{m}\Omega$ at switch currents over 1.5A. Add a 4.7 μF output bypass capacitor in order to reduce output ripple effectively.

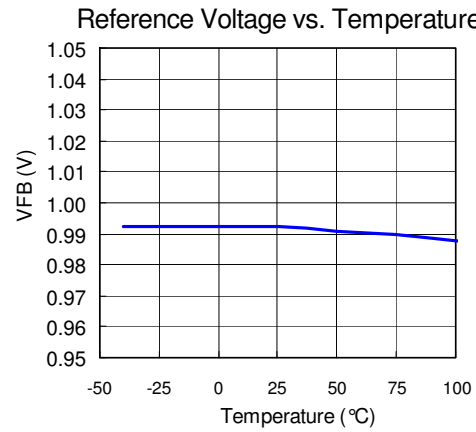
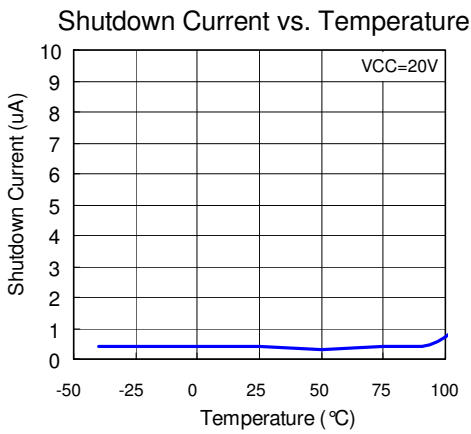
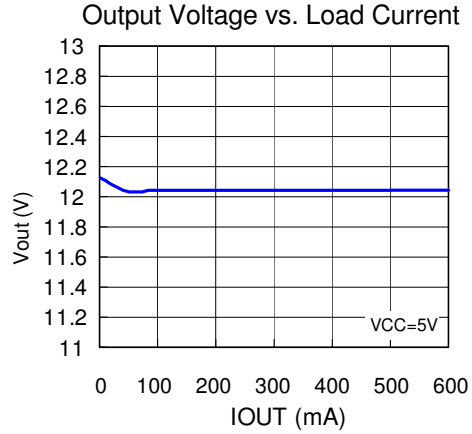
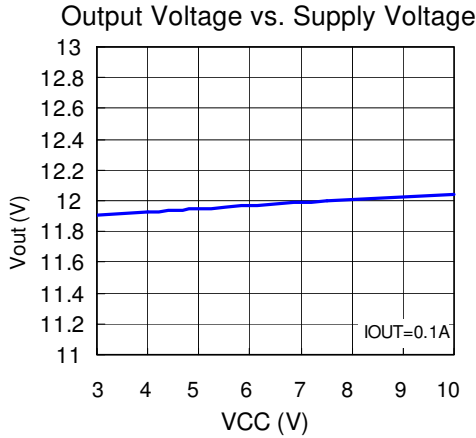
Layout Guidance

When laying out the PC board, the following suggestions should be followed to ensure proper operation of the APE3061.

1. The power traces, including the NMOS drain and source traces, the inductor and the C1 traces should be kept short, direct and wide to allow large current flows.
2. The ground area for R_{SENSE} and C1 must be kept close, and C2 kept close to the VCC pin of the APE3061 to get good stability.
3. Keep the switching node away from the sensitive FB node.
4. Do not route signal lines under the inductor.

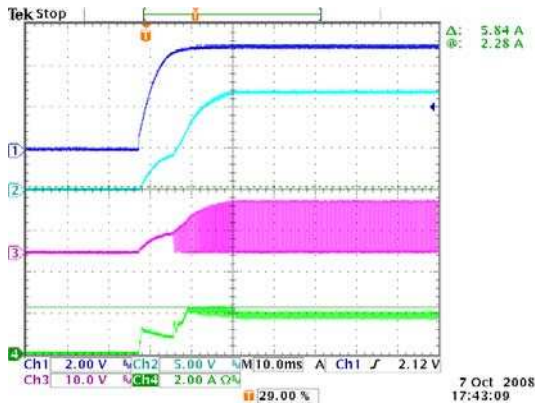


Typical Characteristics

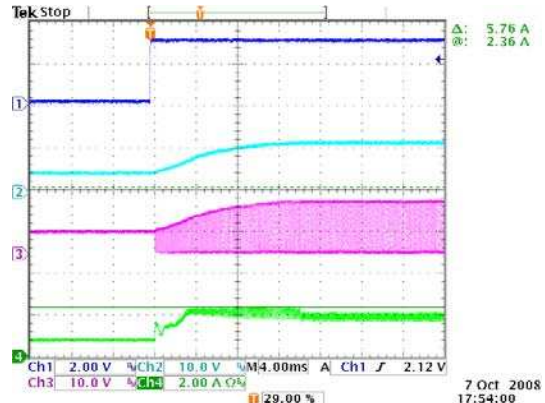


Power-ON Waveforms

V_{CC}=5V, V_{OUT}=12V, Load=0.7A, soft-start C₆=0.1uF (V_{CC}=5V, V_{OUT}=12V, Load=0.7A, soft-start C₆=0.1uF)

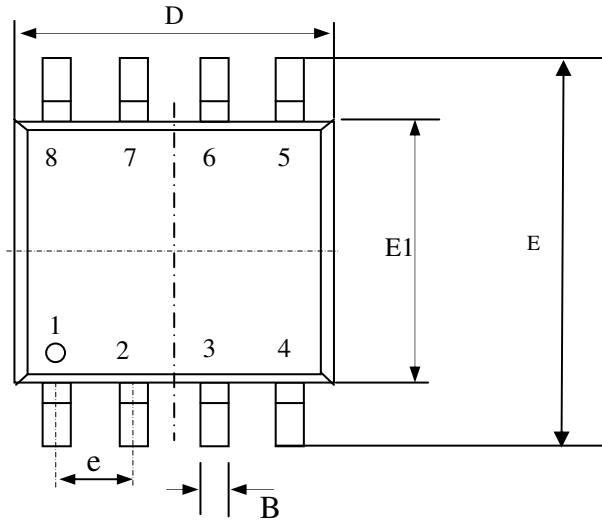


Enable-ON Waveforms

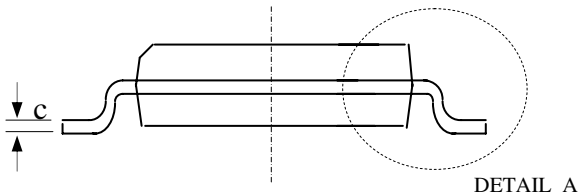
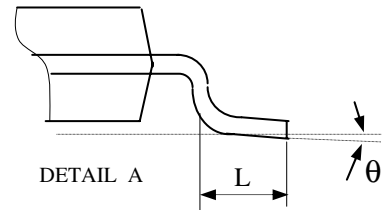
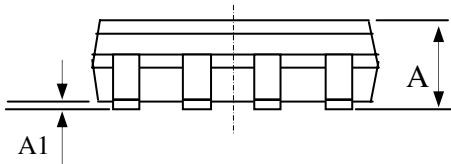




Package Dimensions: SO-8

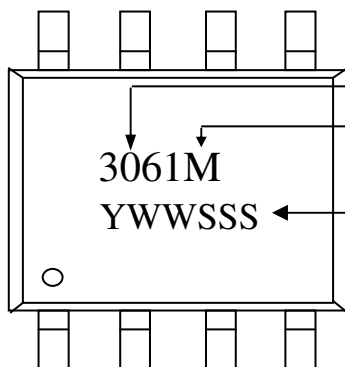


SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	1.35	1.55	1.75
A1	0.10	0.18	0.25
B	0.33	0.41	0.51
C	0.19	0.22	0.25
D	4.80	4.90	5.00
E1	3.80	3.90	4.00
E	5.80	6.15	6.50
L	0.38	0.71	1.27
θ	0	4.00	8.00
e	1.27 TYP		



1. All dimensions are in millimeters.
2. Dimensions do not include mold protrusions.

Marking Information:



- Product: APE3061
- Package: M = RoHS-compliant halogen-free SO-8
- Date/lot code (YWWSSS)
 - Y: Last digit of the year
 - WW: Work week
 - SSS: Lot code sequence