PWM Control 3.5A Step-down Converter

Features

- **Input Voltage from 3.6V to 23V**
- **Output Voltage from 0.8V to V_{CC}**
- **Duty Ratio: 0% to 100% PWM control**
- **Oscillation Frequency: 330KHz typ.**
- **Current Limit (CL), Enable Functions.**
- **Thermal Shutdown Function.**
- **Short Circuit Protection (SCP).**
- **Built-in Internal P-channel MOSFET Switch.**
- **RoHS-compliant SO-8 package.**

Description

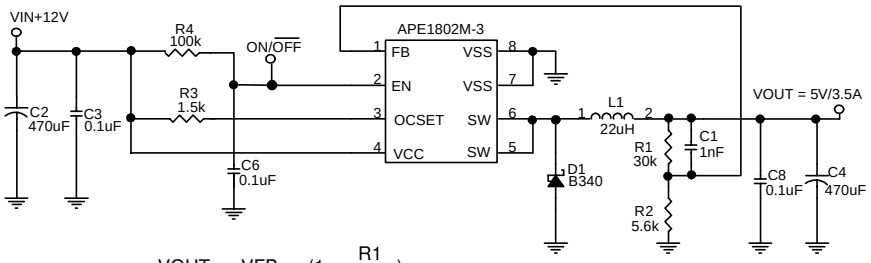
The APE1802M-3 consists of a step-down switching regulator with PWM control. This device includes a reference voltage source, oscillation circuit, error amplifier, and internal P-channel MOSFET switch.

The APE1802M provides low-ripple power, high efficiency, and excellent transient characteristics. The PWM control circuit can adjust the duty ratio linearly from 0 up to 100%. An enable function, over-current protection (OCP) and short-circuit protection (SCP) are built in, and when an over-current or short-circuit event happens, the operating frequency is reduced. Also, an internal compensation block is built in to minimize the external component count.

Using the internal P-channel MOSFET, and adding an external coil, capacitors, and a diode, the APU1802M-3 can function as a step-down switching regulator. With its small SO-8 package and low current consumption, it serves as an ideal power supply unit for portable devices.

Since this converter can accommodate an input voltage up to 23V, it is also suitable for operation from a typical AC adapter.

Typical Application



$$VOUT = VFB \times (1 + \frac{R1}{R2})$$

VFB = 0.8V; R2 suggested value from 800Ω to 6kΩ

L1 recommended value (V_{IN}=12V)				
V_{OUT}	1.8 V	2.5V	3.3V	5V
I_{OUT}=3.5A	12uH	15uH	18uH	22uH

Ordering information

APE1802M-3TR RoHS-compliant SO-8, shipped on tape and reel (3000 pcs/reel)

Absolute Maximum Ratings

V_{CC} PIN Voltage (V_{CC}) ---------- V_{SS} - 0.3V to V_{SS} + 25V
Feedback PIN Voltage (V_{FB}) ---------- V_{SS} - 0.3V to V_{CC}
ON/OFF PIN Voltage (V_{EN}) ---------- V_{SS} - 0.3V to V_{CC} + 0.3V
Switch PIN Voltage (V_{SW}) ---------- V_{SS} -0.3V to V_{CC} + 0.3V
Power Dissipation (P_D) ---------- Internally Limited
Storage Temperature Range (T_{ST}) ---------- -40℃ To 150℃
Operating Temperature Range (T_{OP}) ---------- -20℃ To 125℃
Operating Supply Voltage (VOP) ---------- +3.6V to +23V
Output Current (I_{OUT}) ---------- 0 to 3.5A
Peak Current (I_{peak}) ---------- 6A
Thermal Resistance from Junction to Case (Rth_{JC}) 25℃/W
Thermal Resistance from Junction to Ambient (Rth_{JA}) 70℃/W

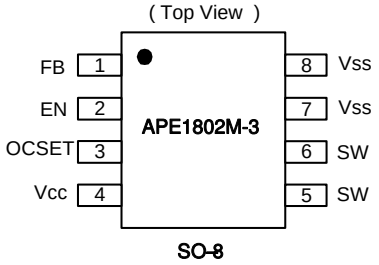
Note. Rth_{JA} is measured with the PCB copper area (need to connect to SW pins) of approx. 1 in ^{2} (multi-layers)

Electrical Characteristics

(V_{IN}=12V, T_A=25℃ unless otherwise specified)

Parameter	SYM	TEST CONDITION	MIN	TYP	MAX	UNITS
Feedback Voltage	V_{FB}	I_{OUT}=0.1A	0.784	0.8	0.816	V
Quiescent Current	I_{CCQ}	V_{FB}=1.2V to force driver off	-	3	5	mA
Feedback Bias Current	I_{FB}	I_{OUT}=0.1A	-	0.1	0.5	uA
Shutdown Supply Current	I_{SD}	V_{EN}=0V	-	2	10	uA
OCSET pin bias current	I_{OCSET}		95	110	140	uA
Switch Current	I_{SW}		45	-	-	A
Line Regulation	$\triangle V_{OUT}/V_{OUT}$	V_{CC}= 8V~23V, I_{OUT}=0.2A	-	1	2	%
Load Regulation	$\triangle V_{OUT}/V_{OUT}$	I_{OUT}= 0.1A to 3.5A	-	0.2	0.5	%
Oscillation Frequency	F_{OSC}	SW PIN	260	330	400	KHz
EN PIN Logic Input Threshold Voltage	V_{SH}	High (regulator ON)	2	-	-	V
	V_{SL}	Low (regulator OFF)	-	-	0.8	V
EN PIN Input Current	I_{SH}	V_{EN}=2.5V(ON)	-	20	-	uA
	I_{SL}	V_{EN}=0.3V(OFF)	-	-10	-	uA
Internal MOSFET $R_{DS(ON)}$	$R_{DS(ON)}$	V_{CC}=5V, V_{FB}=0V	-	80	140	mΩ
		V_{CC}=12V, V_{FB}=0V	-	55	90	
Efficiency	EFFI	V_{CC}=12V, V_{OUT}=5V, I_{OUT}=2A	-	92	-	%
		V_{CC}=12V, V_{OUT}=5V, I_{OUT}=3.5A		90		

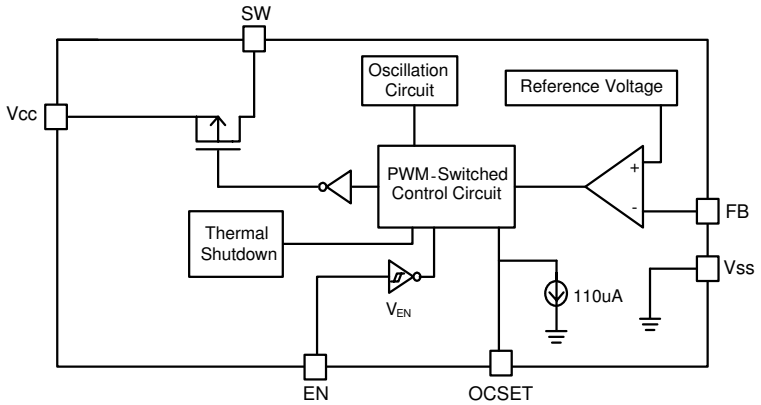
Pin Configuration



Pin Descriptions

PIN SYMBOL	PIN DESCRIPTION
V_{SS}	GND Pin
FB	Feedback Pin
EN	Power-Off Pin H : Normal Operation(Step-down) L : Step-down Operation Stopped (All circuits deactivated)
OCSET	Add an external resistor to set maximum switch output current.
SW	Switch Pin. Connect external inductor and diode here.
V_{CC}	IC Power Supply Pin

Block Diagram



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.
APEC DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.
APEC RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION OR DESIGN.

Functional Pin Description

PWM CONTROL

The APE1802 consists of a DC/DC converter that employs a pulse-width modulation (PWM) system. In converters like the APE1802, the pulse width varies from 0% to 100%, according to the load current. The ripple voltage produced by this switching can be easily removed using a filter because the switching frequency remains constant. Therefore, these converters provide low-ripple power over a broad range of input voltage and load current.

RDS(ON) CURRENT LIMITING

The current limit threshold is set by the external resistor (R3) connected from the VCC supply to the OCSET pin. The internal 110µA sink current through the resistor sets the voltage at the OCSET pin. When the PWM voltage is less than the voltage at OCSET, an over-current condition is triggered. Please refer to the formula for setting the current limit value:

$$I_{SW(MAX)} = \frac{I_{OCSET} \times R3 + 0.08}{R_{DS(ON)}}$$

(Normally, $I_{SW(MAX)}$ setting is 1.0A more than I_{OUT}).

Example:

I_{SW} = (110µ x 1.5k + 0.08)/ 55m= 4.75A (Vin=12V)

I_{SW} = (110µ x 2.7k + 0.08)/ 80m= 4.7A (Vin=5V)

Setting the Output Voltage

The application circuit below shows the basic application circuit using the APE1802 adjustable output version. The external resistor sets the output according to the following equation :

$$V_{OUT} = 0.8V \times (1+R1/R2)$$

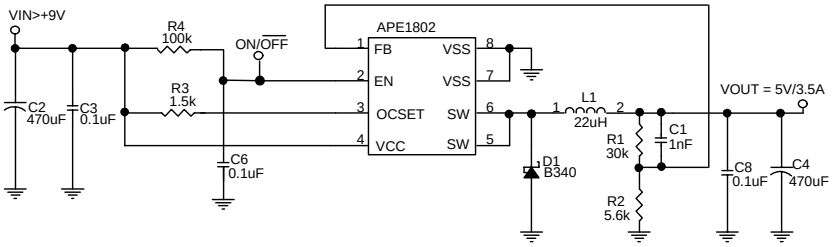


Table1 Resistor selection for setting output voltage

V_{OUT}	R2	R1
5V	1.3k	6.8k
	5.6k	30k
3.3V	1.5k	4.7k
	5.6k	18k
2.5V	2.2k	4.7k
	5.6k	12k
1.8V	2k	2.5k
1.5V	2.2k	2k
1.2V	3k	1.5k
1.0V	3k	0.75k

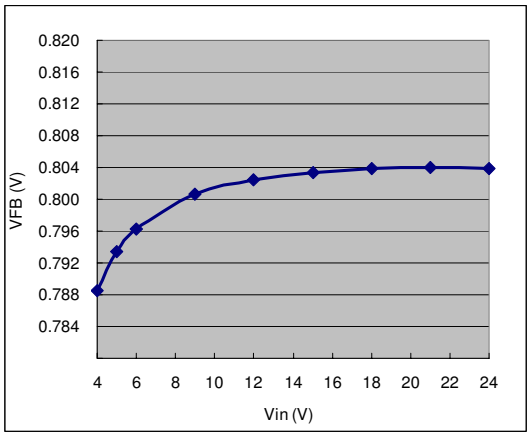
Note: by using R2 = 5.6kΩ, the system operating current (no load) can be reduced to under 4mA.

PCB Layout Guide

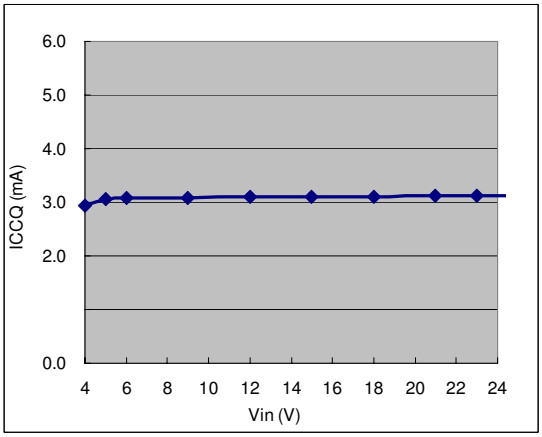
1) If you need low T_C and T_J or high power dissipation, the dual SW pins (5 and 6) on the SO-8 package are internally connected to the die pad, and the PCB layout should allow for the maximum possible copper area at the SW pins.
2) Connect C3 to VCC PIN as closely as possible to get good power filter effect.
3) Connect R3 to VCC PIN as closely as possible.
4) Connect ground side of C2 and D1 as closely as possible.

Typical Characteristics

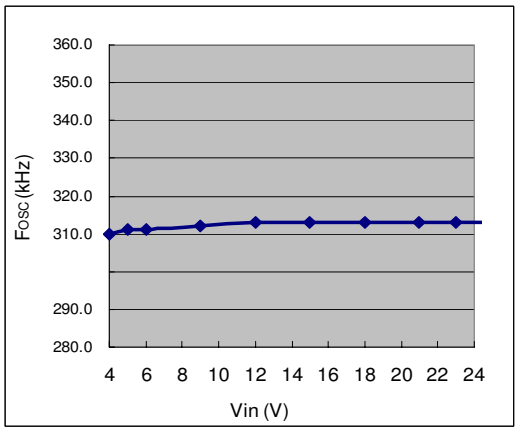
VFB vs. VIN



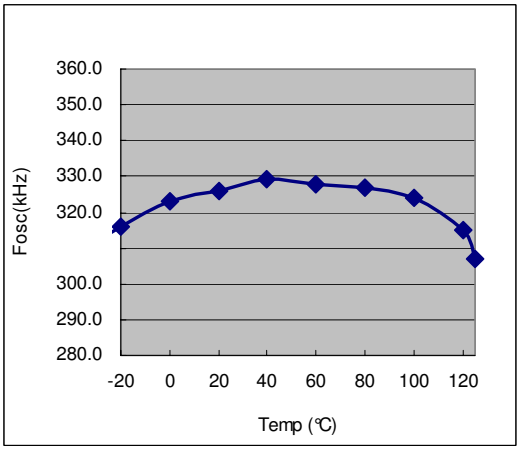
ICCQ vs. VIN



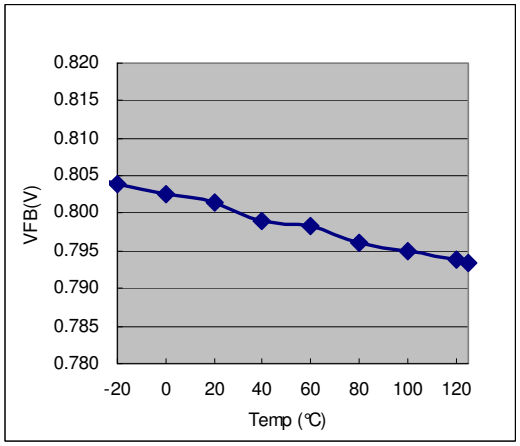
FOSC vs. VIN



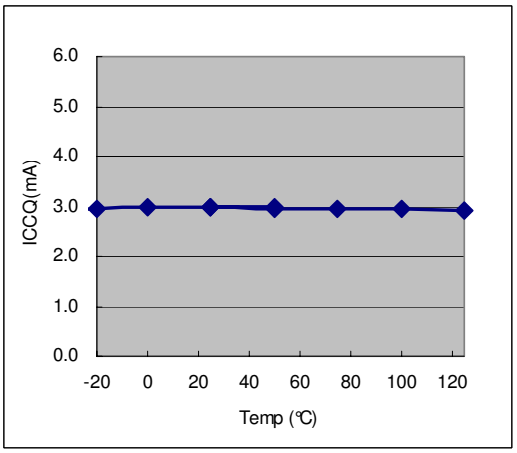
FOSC vs. Temperature



VFB vs. Temperature



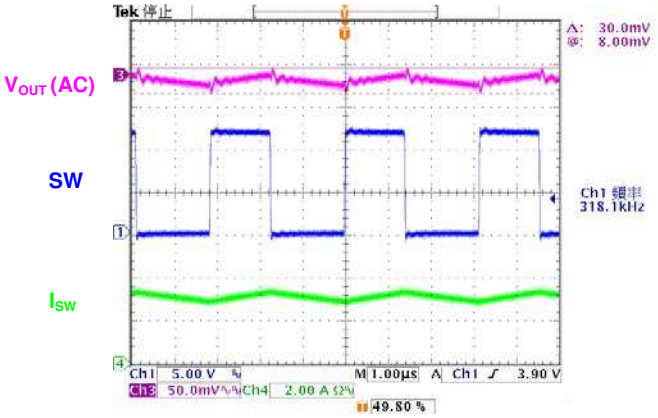
ICCQ vs. Temperature



Typical Characteristics

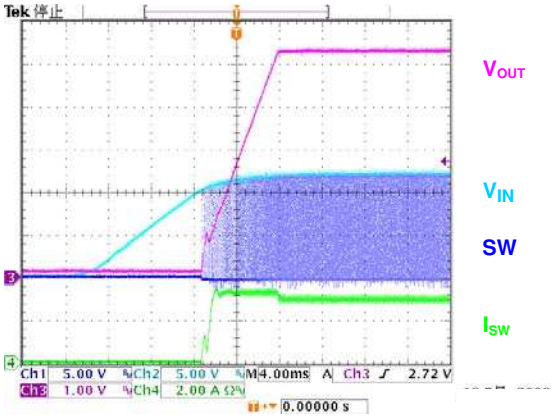
Output Ripple

(V_{IN}=12V, V_{OUT}=5V, I_{OUT}=3A)



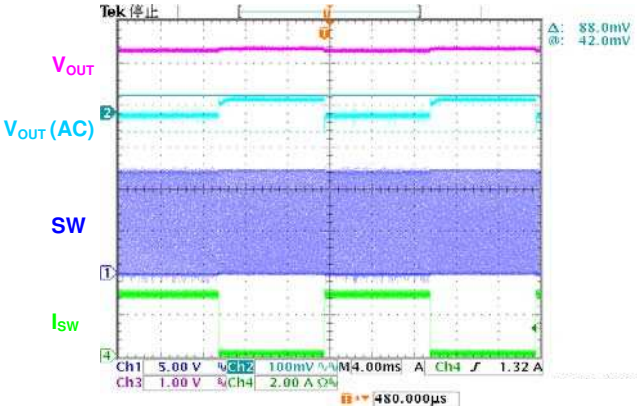
Power on test wave

(V_{IN}=12V, V_{OUT}=5V, I_{OUT}=3A)



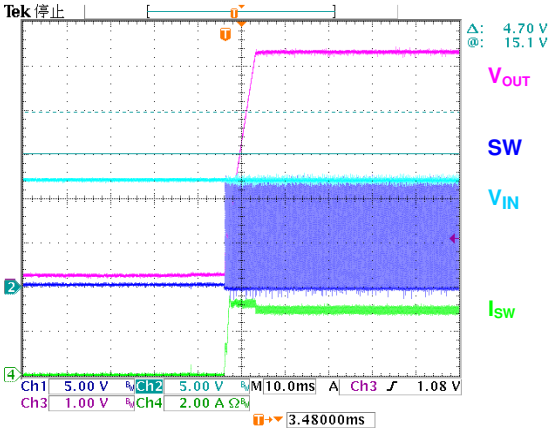
Load Transient Response

(V_{IN}=12V, V_{OUT}=5V, I_{OUT}=0.1~3A)



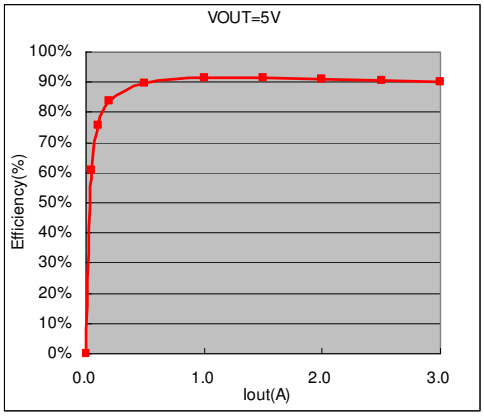
EN PIN on test wave

(V_{IN}=12V, V_{OUT}=5V, I_{OUT}=3A)



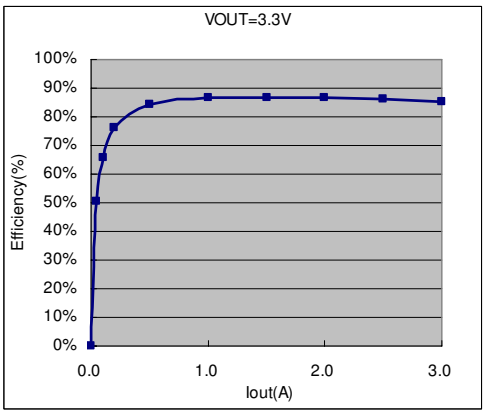
Efficiency

(V_{IN}=12V, V_{OUT}=5V)

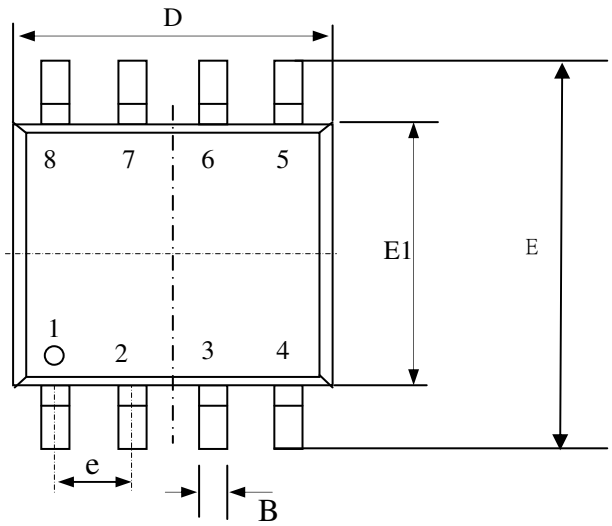


Efficiency

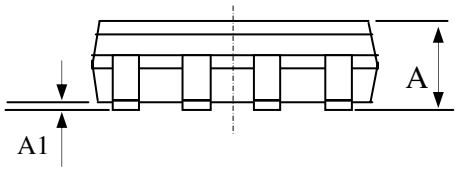
(V_{IN}=12V, V_{OUT}=3.3V)

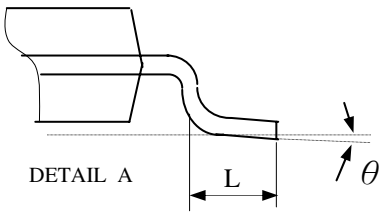


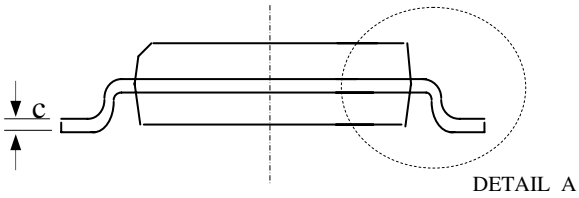
Package Dimensions: SO-8



	Millimeters		
SYMBOLS	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: SO-8