



PWM Control 2A Step-down Converter

Features

- **Input Voltage from 3.6V to 20V**
- **Output Voltage from 0.8V to V_{CC}**
- **Duty Ratio: 0% to 100% PWM control**
- **Oscillation Frequency: 330kHz typ.**
- **Soft-start (SS), Current Limit (CL), Enable Functions.**
- **Thermal Shutdown Function.**
- **Short Circuit Protection (SCP).**
- **Built-in Internal P-channel MOSFET Switch.**
- **Low ESR output capacitor (Multi-layer chip capacitor (MLCC)) application.**
- **RoHS-compliant, halogen-free SO-8 package.**

Description

The APE1806M-HF-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.

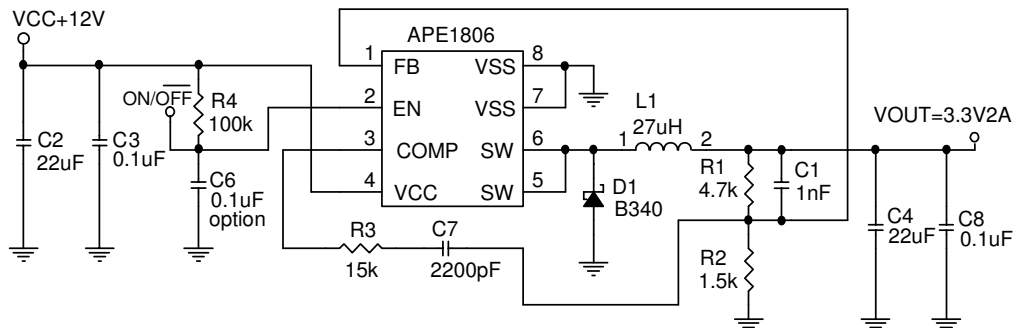
The APE1806M-HF-3 provides low-ripple power, high efficiency, and excellent transient characteristics. The PWM control circuit can adjust the duty ratio linearly from 0 up to 100%. This converter also contains an error amplifier circuit as well as a soft-start circuit that prevents overshoot at startup.

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 APE1806M-HF-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 20V, it is also suitable for operation from a typical AC adapter.

Typical Application



$$V_{OUT} = V_{FB} \times \left(1 + \frac{R1}{R2}\right)$$

Ordering information

APE1806M-HF-3TR RoHS-compliant, halogen-free SO-8, shipped on tape and reel (3000 pcs/reel)



Absolute Maximum Ratings (at T_A = 25 °C)

V _{CC} PIN Voltage (V _{CC})	V _{SS} -0.3V to V _{SS} + 22V
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°C To 150°C
Operating Temperature Range (T _{OP})	-20°C To 125°C
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 (R _{th,JC})	25 °C/W
Thermal Resistance from Junction to Ambient (R _{th,JA})	70 °C/W

Note. R_{th,JA} is measured with the PCB copper area (connected to SW pins) of approx. 1 in² (multi-layers)

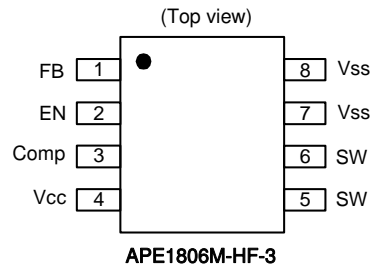
Electrical Characteristics

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

Parameter	Symbol	Conditions	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 force driver off		3	5	mA	
Feedback Bias Current	I _{FB}	I _{OUT} =0.1A	-	0.1	0.5	µA	
Shutdown Supply Current	I _{SD}	V _{EN} =0V	-	2	10	µA	
Current Limit	I _{CL}		3.0	-	-	A	
Line Regulation	ΔV _{OUT} /V _{OUT}	V _{CC} = 4V~20V, I _{OUT} =0.2A	-	0.5	1.0	%	
Load Regulation	ΔV _{OUT} /V _{OUT}	I _{OUT} = 0.1 to 2A	-	0.15	0.3	%	
Oscillation Frequency	F _{OSC}	SW pin	260	330	400	kHz	
EN Pin Logic input threshold voltage	V _{SH}	High (regulator ON)	2.0	-	-	V	
	V _{SL}	Low (regulator OFF)	-	-	0.8		
EN Pin Input Current	I _{SH}	V _{EN} =2.5V (ON)	-	20	-	µA	
	I _{SL}	V _{EN} =0.3V (OFF)	-	-10	-	µA	
Soft-Start Time	T _{SS}		0.3	4	8	ms	
Internal MOSFET R _{DSON}	R _{DSON}	V _{CC} =5V, V _{FB} =0V	-	100	150	mΩ	
		V _{CC} =12V, V _{FB} =0V	-	70	100		
Efficiency	EFFI	V _{OUT} = 5V	I _{OUT} = 1A	-	92	-	%
			I _{OUT} = 2A	-	92	-	
Thermal shutdown Temp	TSD			125		°C	



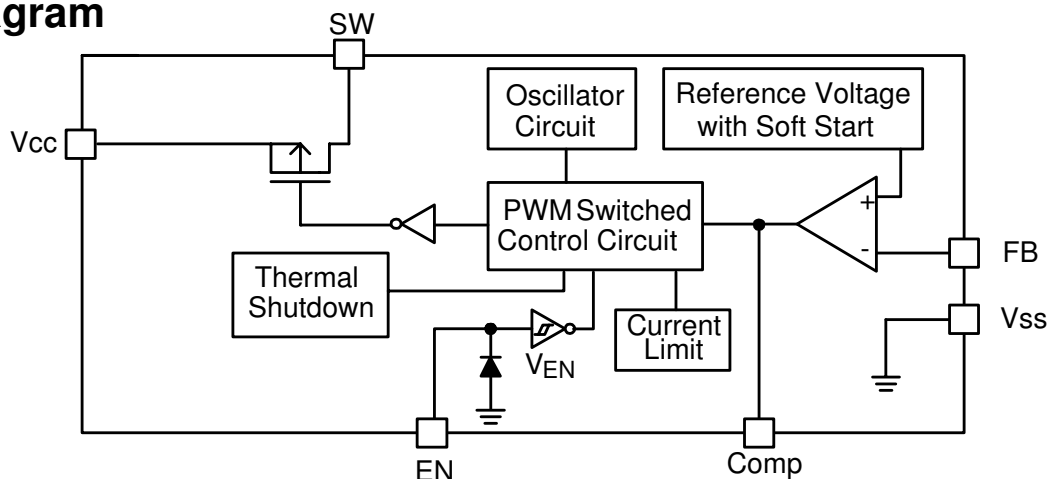
Pin Configuration



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)
Comp	Compensation pin
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.

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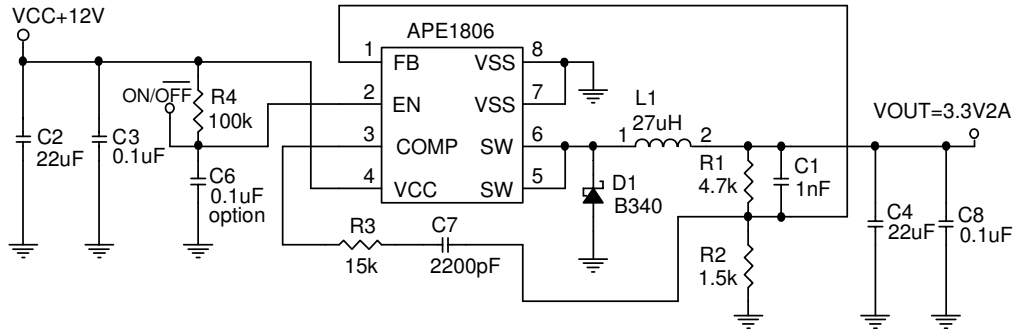
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Typical Application Circuits

1. MLCC

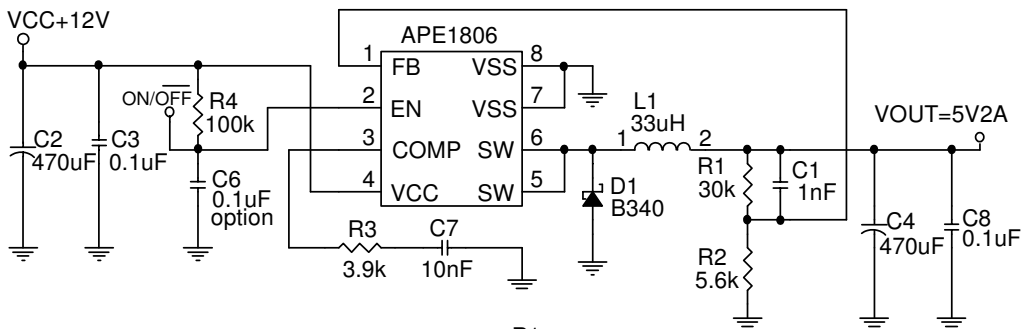


$$V_{OUT} = V_{FB} \times \left(1 + \frac{R_1}{R_2}\right)$$

V_{FB} = 0.8 V; R₂ suggested value 0.8kΩ ~ 3.0kΩ

Compensation Capacitor Selection (MLCC)				
V _{IN}	V _{OUT}	R ₃	C ₇	C ₁
12V	5.0/3.3/2.5 V	15k	2200pF	1nF
12V	1.8/1.5V	10k	4700pF	1nF
5V	3.3/2.5V	15k	2200pF	1nF
5V	1.8/1.5V	8.2k	4700pF	1nF

2. Aluminum Capacitor



$$V_{OUT} = V_{FB} \times \left(1 + \frac{R_1}{R_2}\right)$$

V_{FB} = 0.8 V; R₂ suggested value 0.8kΩ ~ 6.0kΩ

Compensation Capacitor Selection (Al capacitor)				
V _{IN}	V _{OUT}	R ₃	C ₇	C ₁
5-16V	5.0/3.3/2.5/1.8V	3.9K	10nF	1nF

L1 recommended value (V _{IN} =12V ,I _{OUT} =2A)				
V _{OUT}	1.8 V	2.5V	3.3V	5V
L1	22uH	22uH	33uH	33uH



Functional Description

PWM CONTROL

The APE1806 consists of a DC/DC converter that employs a pulse-width modulation (PWM) system. In converters like the APE1806, 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 internally.

Setting the Output Voltage

The application circuits shown on the previous page use the APE1806 adjustable-output version. The external resistor sets the output voltage according to the following equation:

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

Table 1 Resistor selection for setting output voltage

VOUT	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	2.0k
1.2V	3k	1.5k

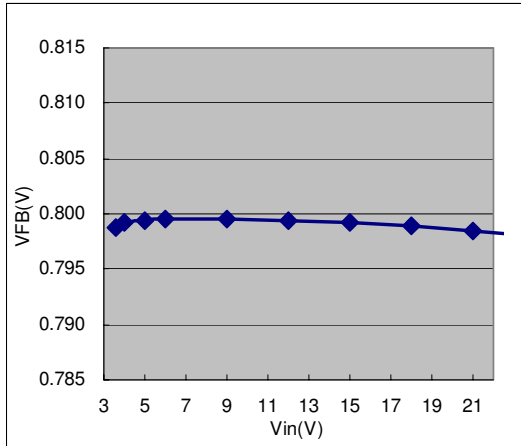
PCB Layout Guidelines

- 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 R4 to VCC PIN as closely as possible.
- 4) Connect ground side of C2 and D1 as closely as possible.

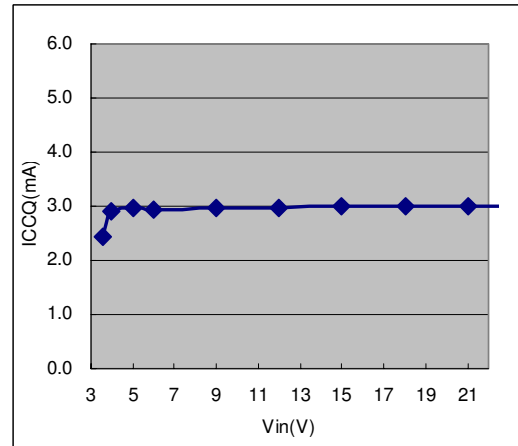


Typical Characteristics

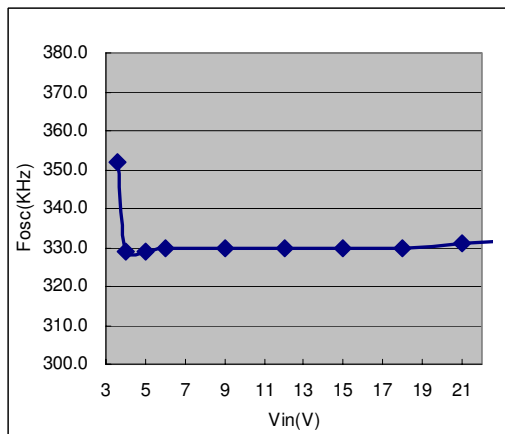
VFB vs. VIN



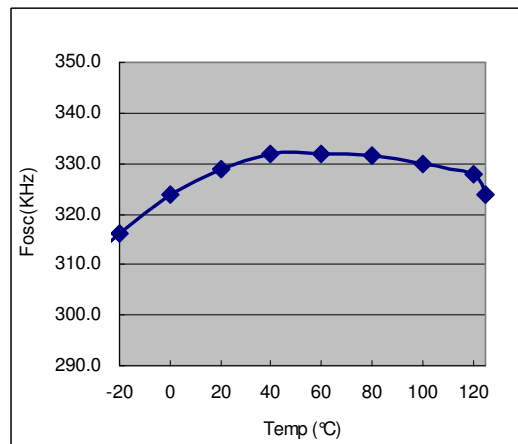
ICCQ vs. VIN



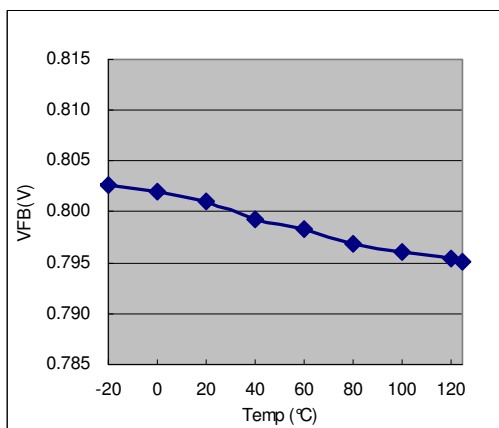
FOSC vs. VIN



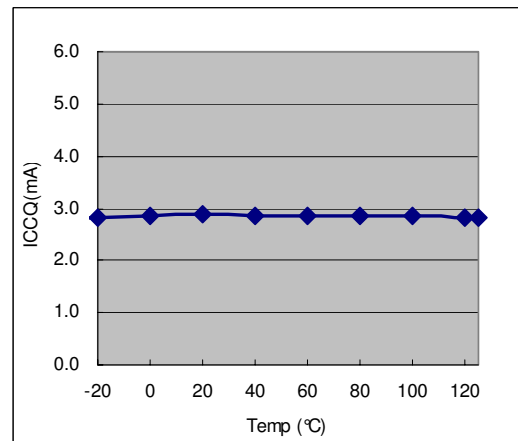
FOSC vs. Temperature



VFB vs. Temperature



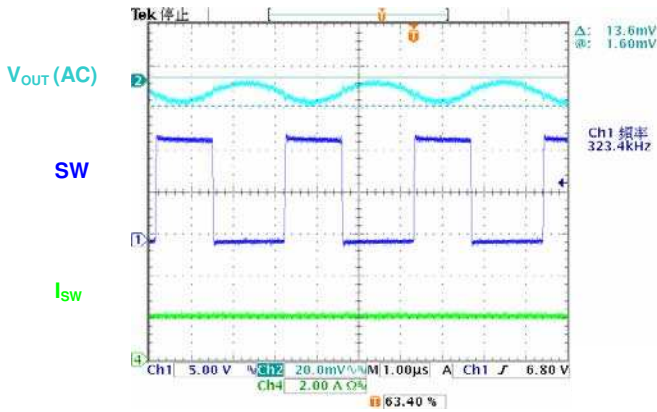
ICCQ vs. Temperature



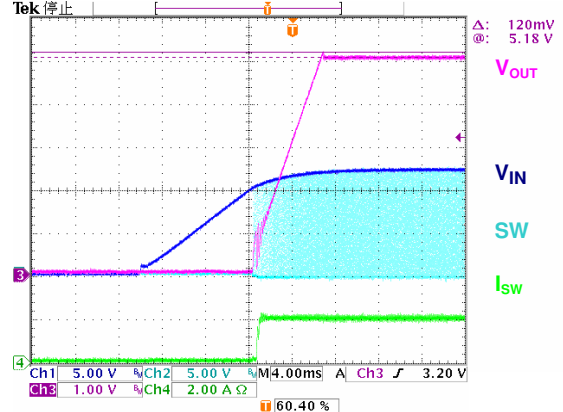


Typical Characteristics (MLCC)

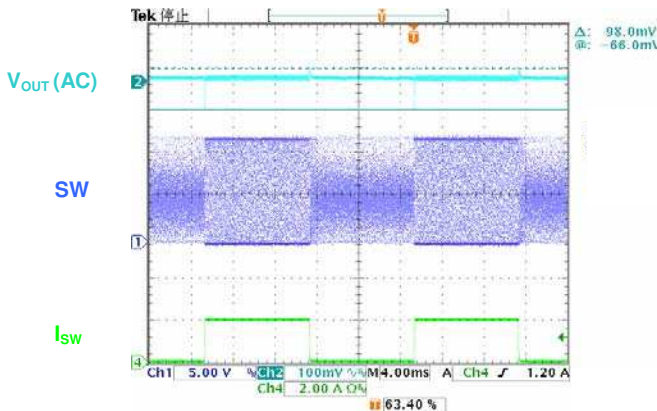
Output Ripple
($V_{IN}=12V, V_{OUT}=5V, I_{OUT}=2A$)



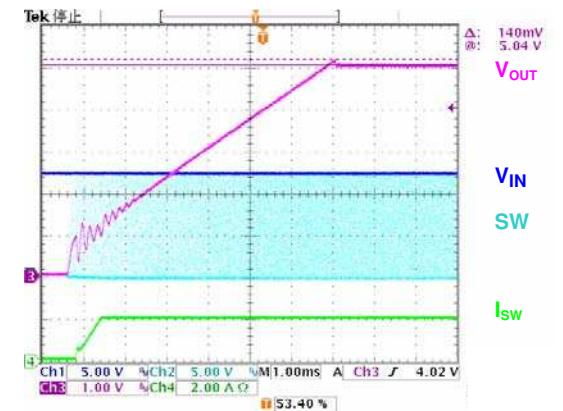
Power-on test waveform
($V_{IN}=12V, V_{OUT}=5V, I_{OUT}=2A$)



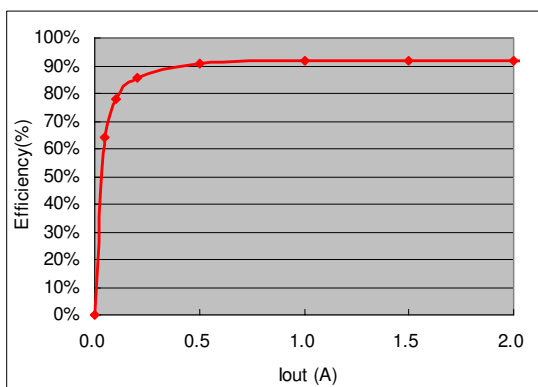
Load Transient Response
($V_{IN}=12V, V_{OUT}=5V, I_{OUT}=0.1\sim 2A$)



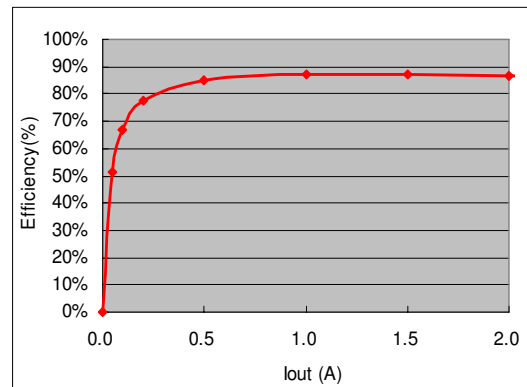
EN PIN on test waveform
($V_{IN}=12V, V_{OUT}=5V, I_{OUT}=0.2A$)



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



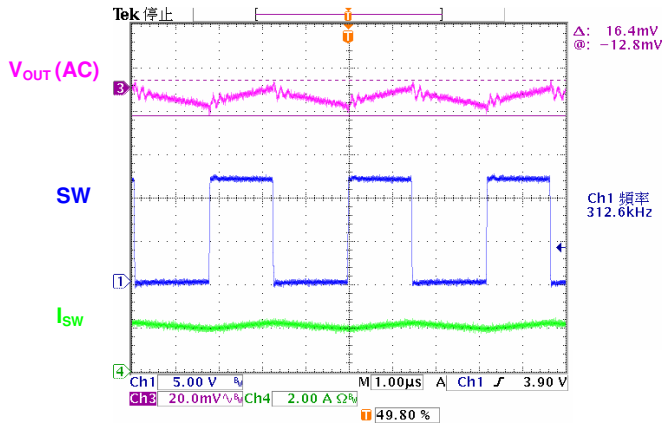
Efficiency
($V_{IN}=12V, V_{OUT}=3.3V$)



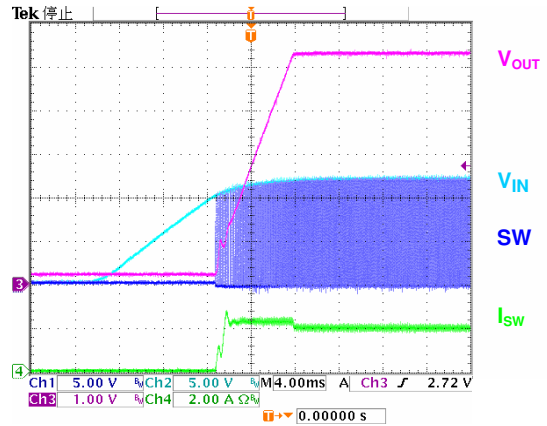


Typical Characteristics (Al capacitor)

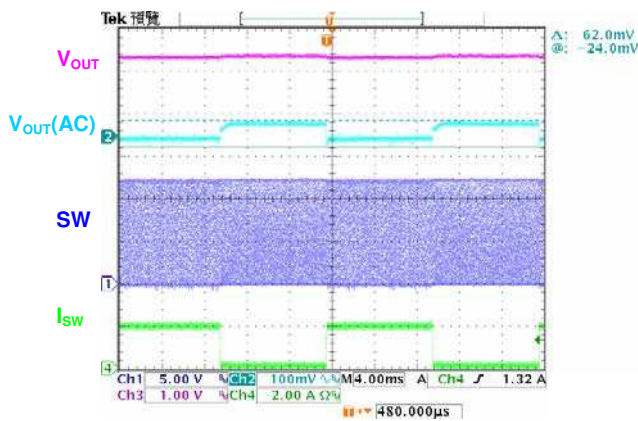
Output Ripple (VIN=12V, VOUT=5V, IOUT=2A)



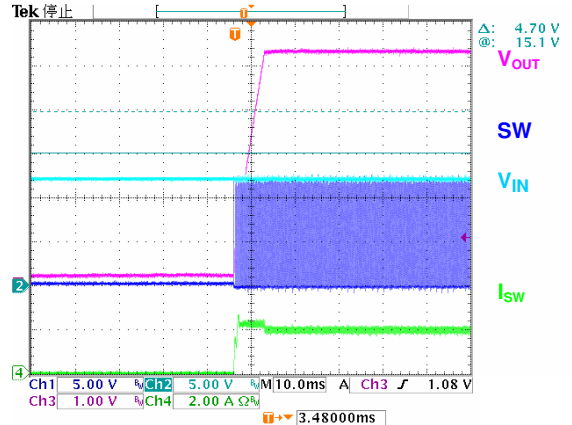
Power on test waveform (VIN=12V, VOUT=5V, IOUT=2A)



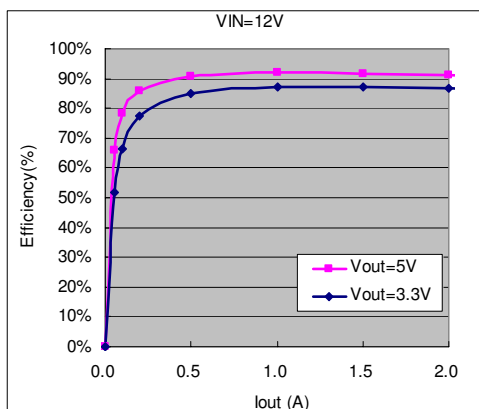
Load Transient Response (VIN=12V, VOUT=5V, IOUT=0.1~2A)



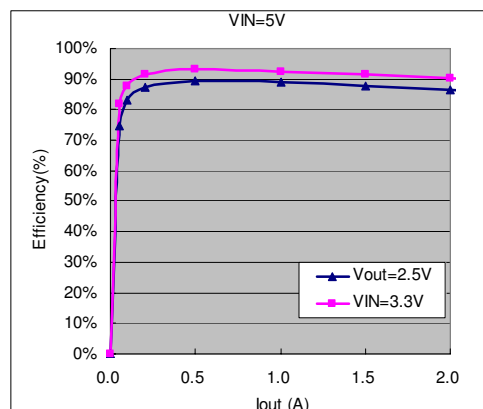
EN PIN on test waveform (VIN=12V, VOUT=5V, IOUT=2A)



Efficiency (VIN=12V, VOUT=5V/3.3V)

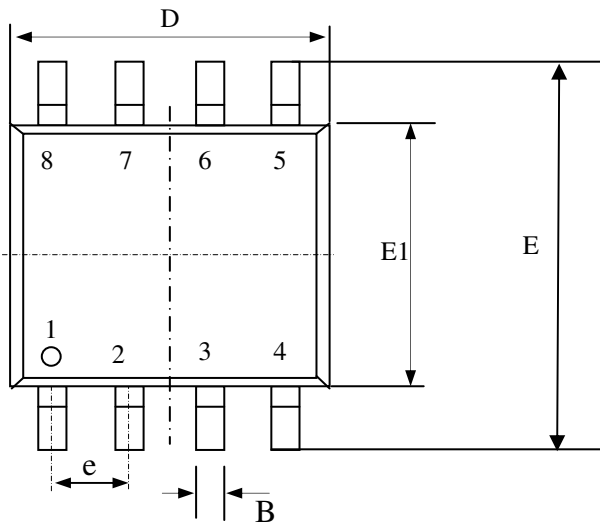


Efficiency (VIN=5V, VOUT=3.3V/2.5V)

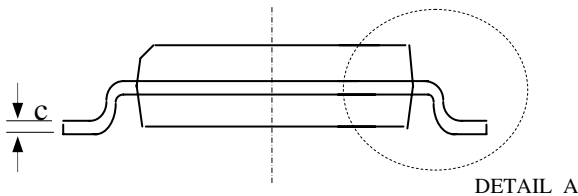
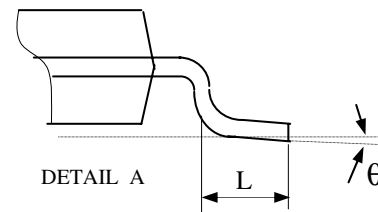
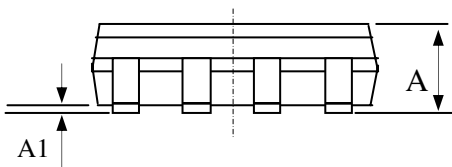




Package Dimensions: SO-8

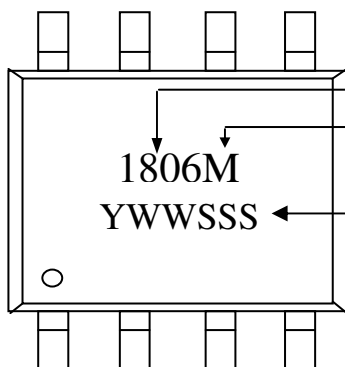


SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	1.35	1.55	1.75
A1	0.10	0.18	0.25
B	0.33	0.41	0.51
C	0.19	0.22	0.25
D	4.80	4.90	5.00
E1	3.80	3.90	4.00
E	5.80	6.15	6.50
L	0.38	0.71	1.27
θ	0	4.00	8.00
e	1.27 TYP		



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

Marking Information: SO-8



- Product: APE1806
- 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