PWM Control 5A Step-Down Converter

❖ GENERAL DESCRIPTION

APE1809 consists of step-down switching regulator with PWM control. These devise include a reference voltage source, oscillation circuit, error amplifier, internal PMOS and etc.

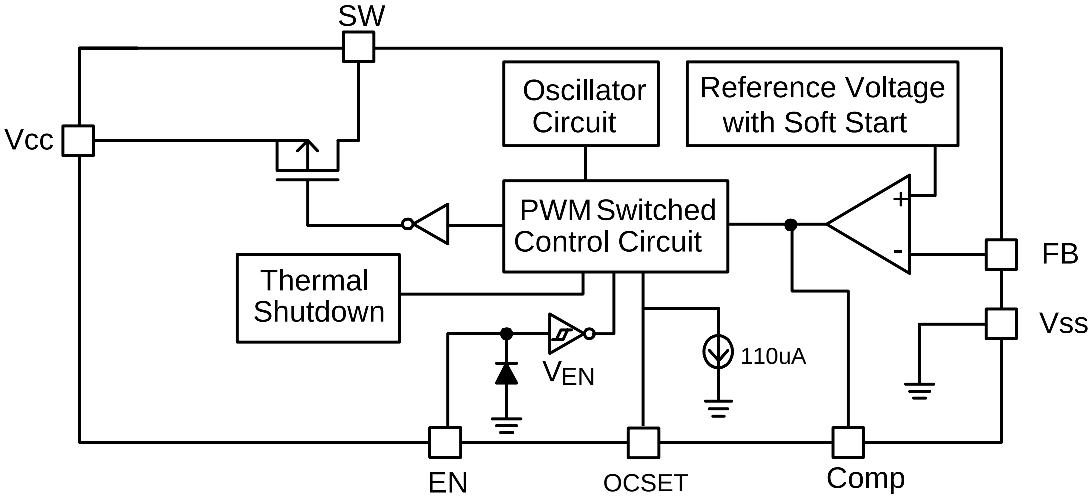
APE1809 provides low-ripple power, high efficiency, and excellent transient characteristics. The PWM control circuit is able to very the duty ratio linearly form 0 up to 100%. This converter also contains an error amplifier circuit as well as a soft-start circuit that prevents overshoot at startup. An enable function, an over current protect function and short circuit protect function are built inside, and when OCP or SCP happens, the operation frequency will be reduced. Also, an internal compensation block is built in to minimum external component count.

With the addition of an internal P-channel Power MOS, a coil, capacitors, and a diode connected externally, these ICs can function as step-down switching regulators. They serve as ideal power supply units for portable devices when coupled with the SOP-8L package, providing such outstanding features as low current consumption. Since this converter can accommodate an input voltage up to 23V, it is also suitable for the operation via an AC adapter.

❖ FEATURES

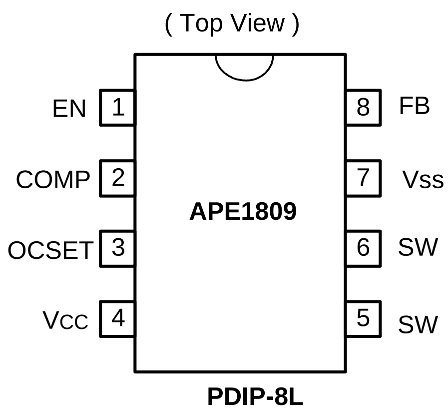
- Input voltage：4.0V to 23V
- Output voltage：0.8V to Vcc
- Duty ratio：0% to 100% PWM control
- Oscillation frequency：330KHz typ.
- Soft-start(SS), Current Limit(CL), Enable function.
- Thermal Shutdown function.
- Short Circuit Protect (SCP).
- Built-in internal SW P-channel MOS.
- Low ESR output capacitor (Multi-layer chip capacitor (MLCC)) application.
- PDIP-8L Pb-Free package.

❖ Block Diagram



❖ PIN ASSIGNMET

The package of APE1809 is PDIP-8L; the pin assignment is given by:



Name	Description
EN	Power-off pin H : normal operation(Step-down) L : Step-down operation stopped (All circuits deactivated)
Comp	Compensation pin
OCSET	Add an external resistor to set max switch output current.
V_{CC}	IC power supply pin
SW	Switch pin. Connect external inductor/diode here.
V_{SS}	GND pin
FB	Feedback pin

❖ ORDER/MARKING INFORMATION

Order Information	Top Marking
APE1809X Package Type D: PDIP-8L	1809D ► Part number YWWSSS ► ID code: internal WW: 01~52 Year : 6 = 2006

❖ Absolute Maximum Ratings (at Ta=25℃)

Characteristics	Symbol	Rating	Unit
VCC Pin Voltage	V_{CC}	V_{SS} - 0.3 to V_{SS} + 25	V
Feedback Pin Voltage	V_{FB}	V_{SS} - 0.3 to V_{CC}	V
ON/OFF Pin Voltage	V_{EN}	V_{SS} - 0.3 to V_{CC} + 0.3	V
Switch Pin Voltage	V_{SW}	V_{SS} - 0.3 to V_{CC} + 0.3	V
Power Dissipation	PD	Internally limited	mW
Storage Temperature Range	T_{ST}	-40 to +150	℃
Operating Temperature Range	T_{OP}	-20 to +125	℃
Operating Supply Voltage	V_{OP}	+3.6 to +23	V
Thermal Resistance from Junction to case	θ_{JC}	20	℃/W
Thermal Resistance from Junction to ambient	θ_{JA}	45	℃/W

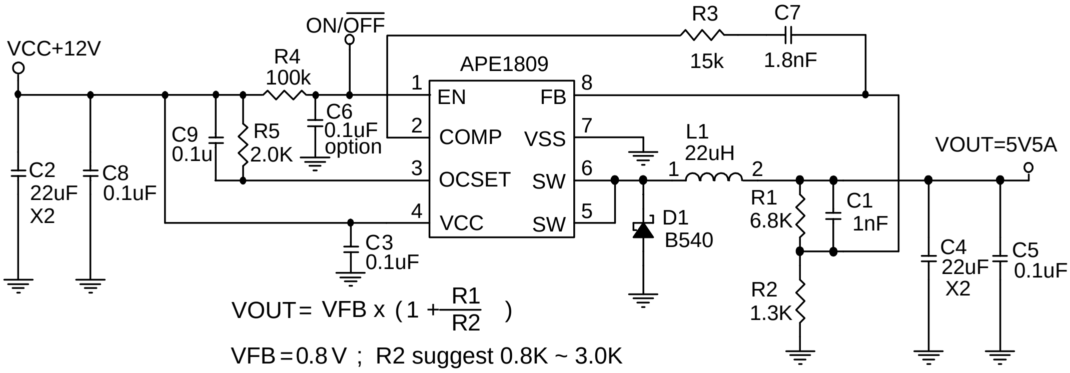
Note : θ_{JA} is measured with the PCB copper area(need connect to SW pins) of approximately 1 in^2(Multi-layer).

❖ Electrical Characteristics (VIN = 12V, Ta=25°C, unless otherwise specified)

Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Feedback Voltage	V_{FB}	I_{OUT}=0.2A	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}=0.2A	-	0.1	0.5	uA
Shutdown Supply Current	I_{SD}	V_{EN} =0V	-	2	10	uA
OCSET pin bias current	I_{OCSET}		95	110	125	uA
Switch Current	I_{SW}		6.0	-	-	A
Line Regulation	△V_{OUT}/V_{OUT}	V_{CC} = 5V~23V, I_{OUT}=0.2A	-	0.6	1.2	%
Load Regulation	△V_{OUT}/V_{OUT}	I_{OUT} = 0.2 to 5A	-	0.3	0.5	%
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	-	uA
	I_{SL}	V_{EN}=0.3V (OFF)	-	-10	-	uA
Soft-Start Time	T_{SS}		0.3	4	8	ms
Internal MOSFET R_{DSON}	R_{DSON}	V_{CC}=5V, V_{FB}=0V	-	80	140	mΩ
		V_{CC}=12V, V_{FB}=0V	-	50	90	
Efficiency	EFFI	V_{OUT} = 5V, I_{OUT} = 3A	-	91	-	%
		V_{OUT} = 5V, I_{OUT} = 4A	-	90	-	
Thermal shutdown Temp	TSD			125		℃

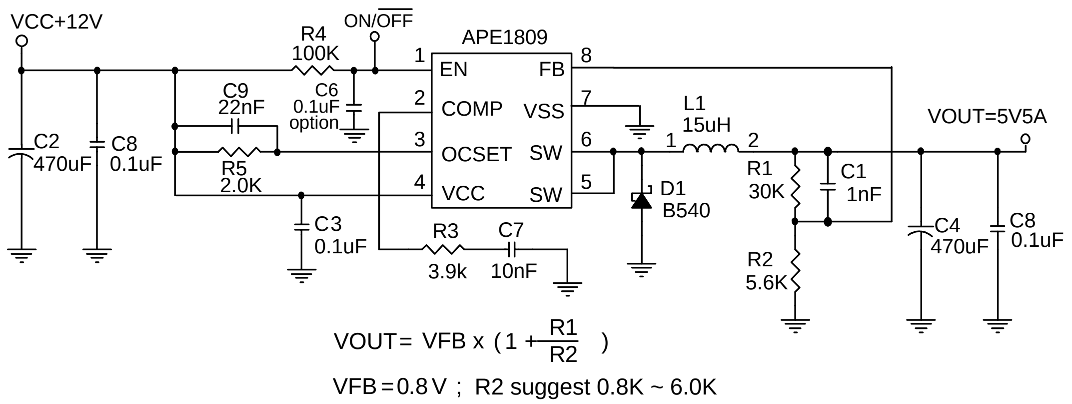
❖ Application Circuit

1. MLCC



Compensation Capacitor Selection(MLCC)					
VIN	V_{OUT}	R3	C7	C1	C9
12V	2.5/3.3/ 5.0V	15K	1800pF	1nF	Open
5V	3.3/2.5/1.8V	15K	1800pF	1nF	Open

2. EL CAP



Compensation Capacitor Selection(AL CAP)					
VIN	V_{OUT}	R3	C7	C1	C9
5-16V	5/3.3/2.5/1.8V	3.9K	10nF	1nF	Open

L1 recommend value (V_{IN}=12V)				
V_{OUT}	1.8 V	2.5V	3.3V	5V
I_{OUT}=3A	12uH	15uH	18uH	22uH
I_{OUT}=5A	8uH	10uH	12uH	15uH

❖ Function Descriptions

PWM Control

The APE1809 consists of DC/DC converters that employ a pulse-width modulation (PWM) system. In converters of the APE1809, the pulse width varies in a range from 0 to 100%, 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, these converters provide a low-ripple power over broad ranges of input voltage and load current.

RDS(ON) Current Limiting

The current limit threshold is setting by the external resistor (R5) connecting from V_{CC} supply to OCSET pin. The internal 110uA sink current crossing the resistor sets the voltage at pin of OCSET. 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:

$$I_{SW(MAX)} = \frac{I_{OCSET} \times R3 + 0.11}{R_{DS(ON)}}$$

(Normally, The $I_{SW(MAX)}$ setting more than I_{OUT} 1.5~2.5A).

Example:

I_{SW} = (110uA * 2.0k + 0.11)/ 50mΩ= 6.6A

Setting the Output Voltage

Application circuit item shows the basic application circuit with APE1809 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 select for output voltage setting

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

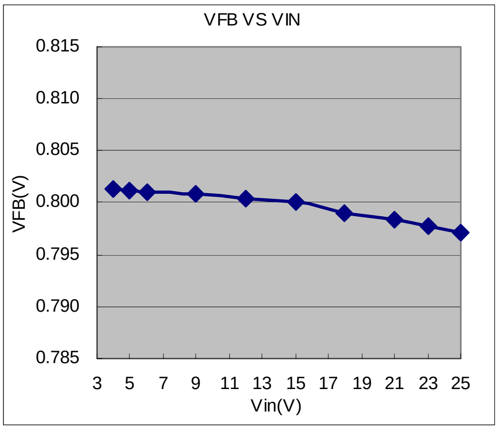
PCB Layout Guide

If you need low Tc & Tj or large PD(Power Dissipation), The dual SW pins(5&6) on the PDIP-8L package are internally connected to die pad, The PCB layout should allow for maximum possible copper area at the SW pins.

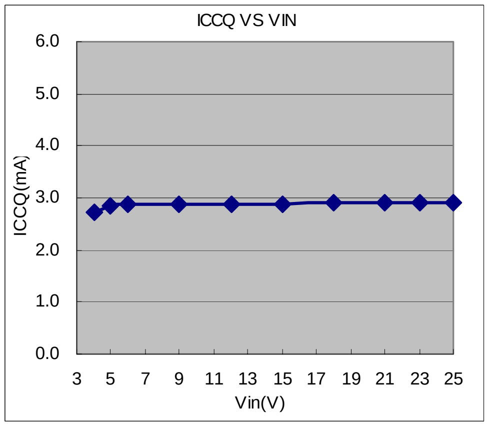
1. Connect C3 to V_{CC} pin as closely as possible to get good power filter effect.
2. Connect R5 to V_{CC} pin as closely as possible.
3. Connect ground side of the C2 & D1 as closely as possible.

❖ Typical Characteristics

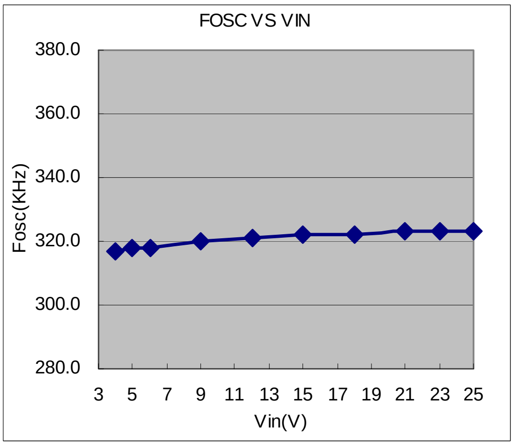
VFB VS VIN



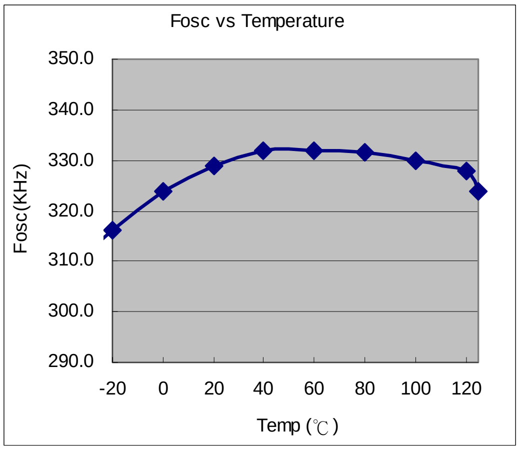
ICCQ VS VIN



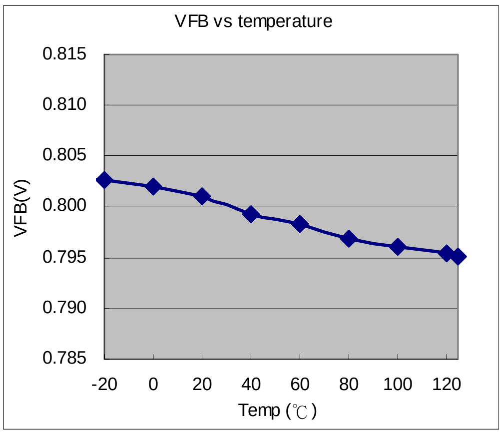
FOSC VS VIN



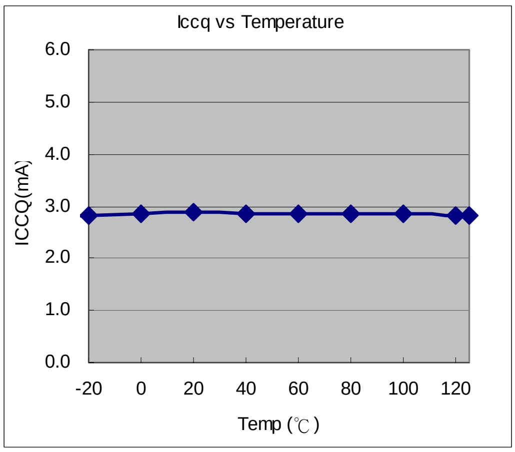
FOSC VS TEMPERATURE



VFB VS TEMPERATURE



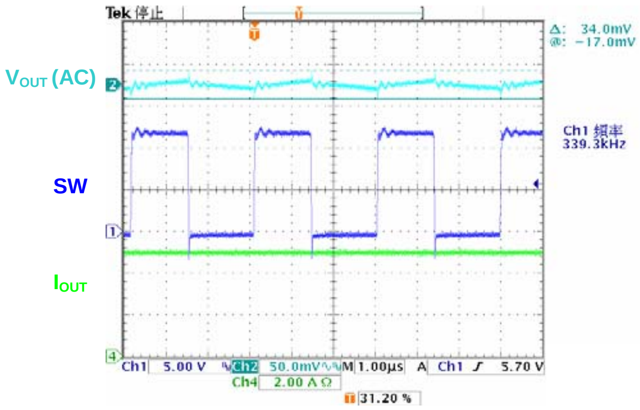
ICCQ VS TEMPERATURE



❖ Typical Characteristics

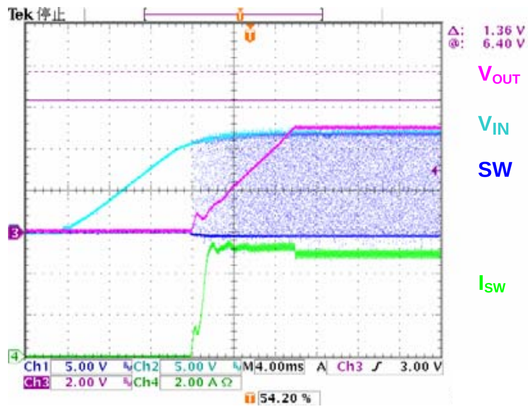
Output Ripple

(V_{IN}=12V, V_{OUT}=5.0V, I_{OUT}=5A)



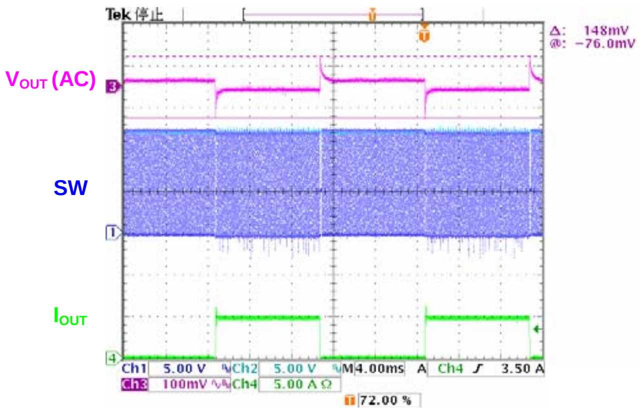
Power on test wave

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



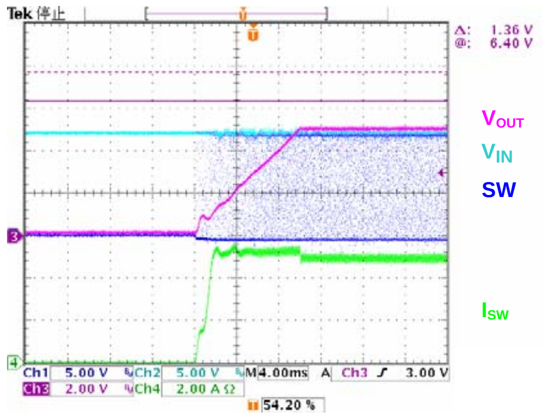
Load Transient Response

(V_{IN}=12V, V_{OUT}=5V, I_{OUT}=0.2~5A)



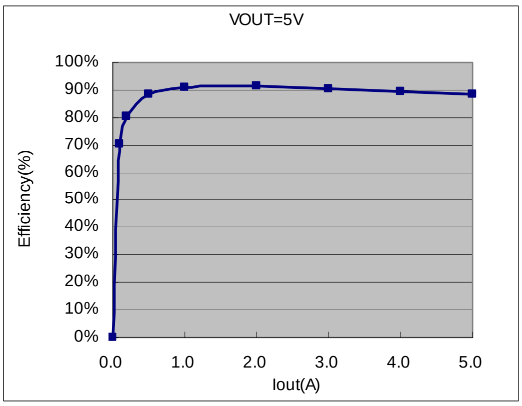
EN on test wave

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



Efficiency

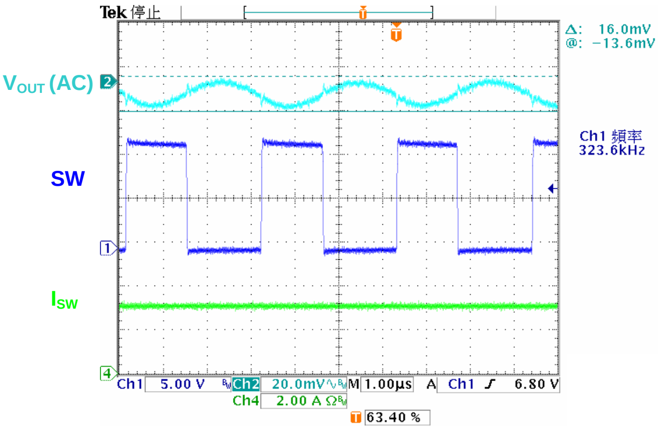
(V_{IN}=12V, V_{OUT}=5V)



❖ Typical Characteristics (MLCC)

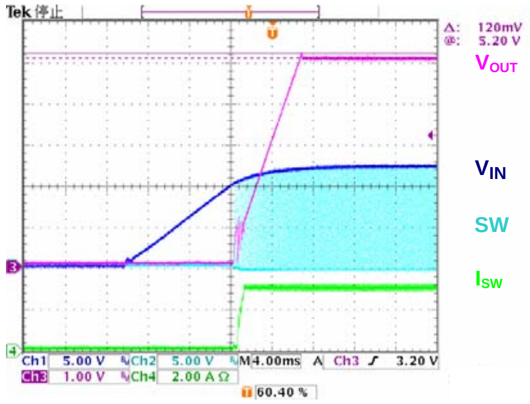
Output Ripple

(V_{IN}=12V, V_{OUT}=3.3V, I_{OUT}=3A)



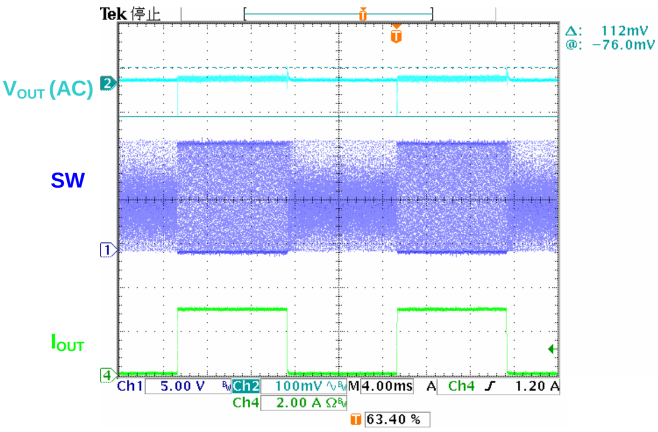
Power on test wave

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



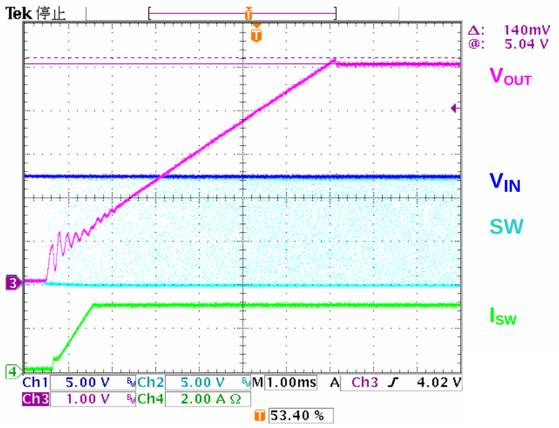
Load Transient Response

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



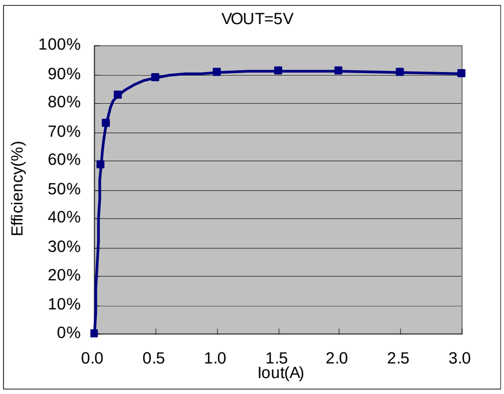
EN on test wave

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



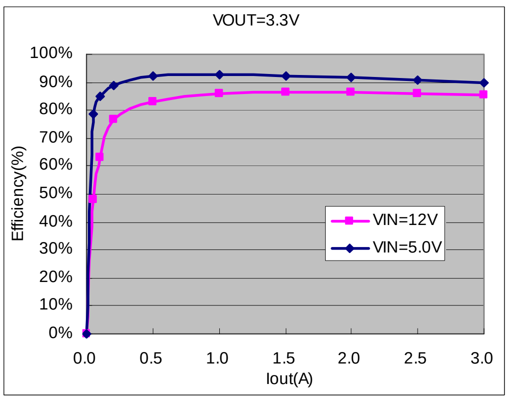
Efficiency

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

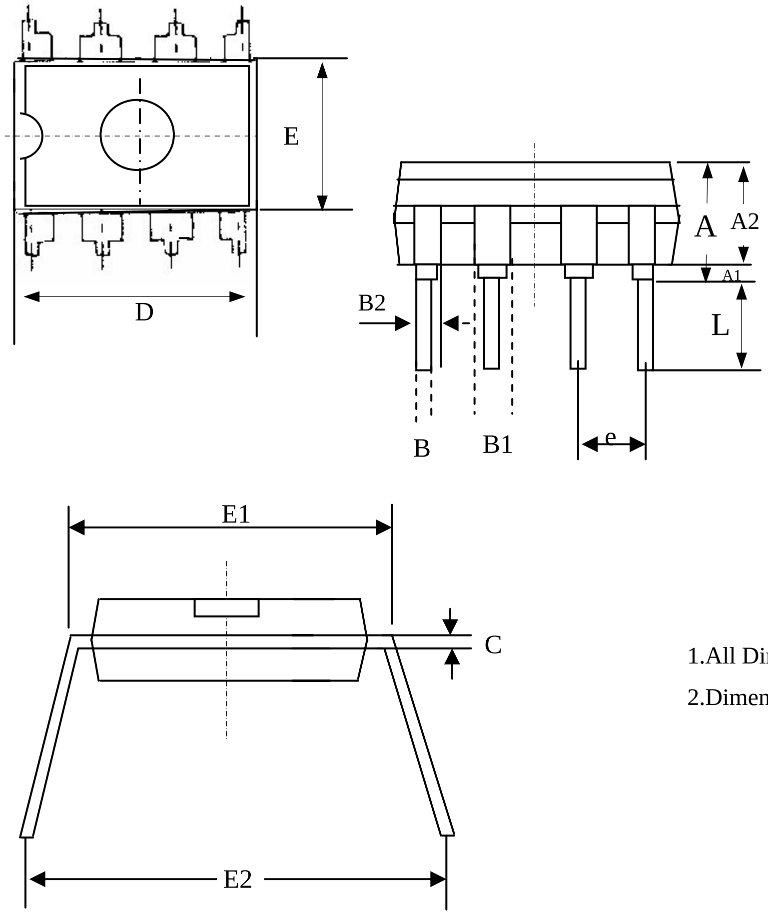


Efficiency

(V_{OUT}=3.3V)



Package Outline : PDIP-8

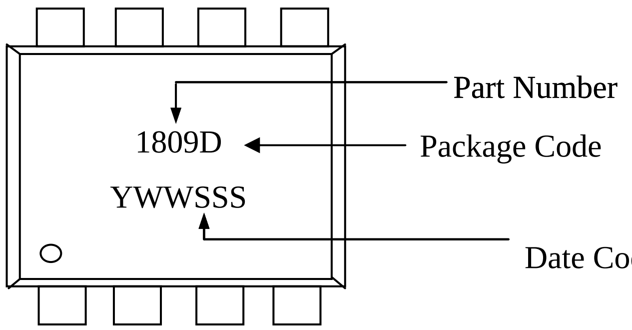


SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	3.60	4.50	5.40
A1	0.38	----	----
A2	2.90	3.95	5.00
B	0.36	0.46	0.56
B1	1.10	1.45	1.80
B2	0.76	0.98	1.20
C	0.20	0.28	0.36
D	9.00	9.60	10.20
E	6.10	6.65	7.20
E1	7.62	7.94	8.26
E2	8.30	9.65	11.00
e	2.540 BSC		
L	3.18	----	----

1.All Dimensions Are in Millimeters.

2.Dimension Does Not Include Mold Protrusions.

Part Marking Information & Packing : PDIP-8



Date Code (YWWSSS)

Y：Last Digit Of The Year

WW：Week

SSS：Sequence