150KHz, 3A PWM BUCK DC/DC CONVERTER

FEATURES

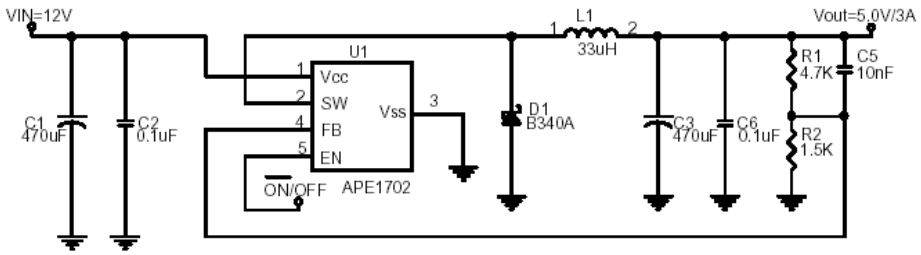
- **Output Voltage : 3.3V, 5V, 12V and Adjustable Output Voltage**
- **Adjustable Version Output Voltage Range, 1.23V to 19.5V+4%**
- **150KHz +15% Fixed Switching Frequency.**
- **Voltage Mode Non-synchronous PWM Control.**
- **Thermal-shutdown and Current-limit Protection.**
- **ON/OFF Shutdown Control Input.**
- **Short Circuit Protect(SCP)**
- **Operating Voltage can be up to 22V**
- **Output Load Current 3A**
- **5-Lead TO-263/TO-220**
- **Low Power Standby Mode.**
- **Built-in Switching Transistor on Chip**
- **RoHS Compliant**

DESCRIPTION

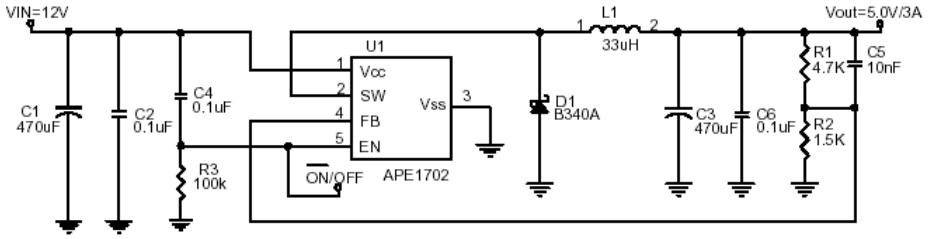
The APE1702 series are monolithic IC designed for a step-down DC/DC converter, and own the ability of driving a 3A load without additional transistor. It saves board space. The external shutdown function can be controlled by logic level and then come into standby mode. The internal compensation makes feedback control having good line and load regulation without external design. Regarding protected function, thermal shutdown is to prevent over temperature operating from damage, and current limit is against over current operating of the output switch. if current limit function occurs and VFB is down below 0.5V the switching frequency will be reduced. The APE1702 series operates at a switching frequency of 150KHz thus allow smaller sized filter components than what would be needed with lower frequency switching regulators. Other features include a guaranteed +4% tolerance on output voltage under specified input voltage and output load conditions, and +15% on the oscillator frequency. The output version included fixed 3.3V, 5V, 12V and an adjustable type. The chips are available in a 5-Lead TO-263 and 5-Lead TO-220 package.

TYPICAL APPLICATION

1. ADJUSTABLE OUTPUT VOLTAGE VERSION



2. ADJUSTABLE OUTPUT VOLTAGE VERSION WITH DELAYED STARTUP



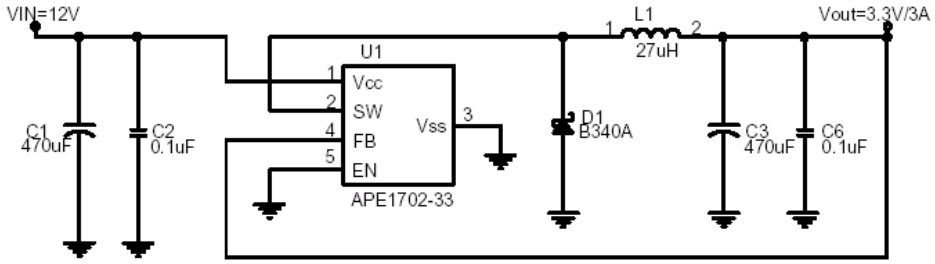
$$Vout = V_{FB} \times (1 + \frac{R1}{R2})$$

V_{FB} = 1.23V

R2 = 0.47K ~ 2.6K

TYPICAL APPLICATION

3. FIXED OUTPUT VOLTAGE VERSION



ORDERING INFORMATIO

ORDER INFORMATION

APE1702X-XX

PACKAGE TYPE	OUTPUT VOLTAGE
S : TO-263-5L	33 : 3.3V
P : TO-220-5L	50 : 5.0V
	12 : 12V
	Blank : ADJ

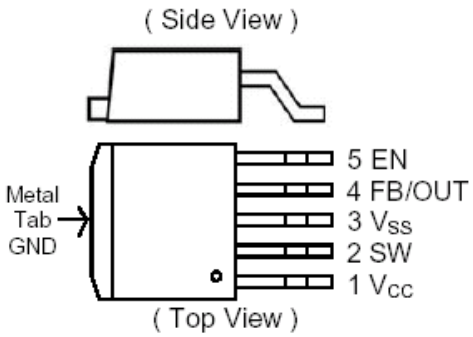
ABSOLUTE MAXIMUM RATINGS (at T_A=25°C)

Maximum Supply Voltage(VCC)	+24V
ON/OFF PIN Input Voltage(VEN)	-0.3V to V_{CC}
Feedback PIN Voltage(VFB)	-0.3V to 16V
Output Voltage to Ground(VOUT)	-0.7 to 24V
Power Dissipation(PD)	$(T_J-T_A)/Rth_{JA}$
Storage Temperature Range(TST)	-65°C To 150°C
Operating Temperature Range(TOP)	-40°C To 125°C
Operating Supply Voltage(VOP)	+4.5V to +22V
Thermal Resistance from Junction to Case(Rth_{JC})	3.5°C/W
Thermal Resistance from Junction to Ambient(Rth_{JA})	20°C/W

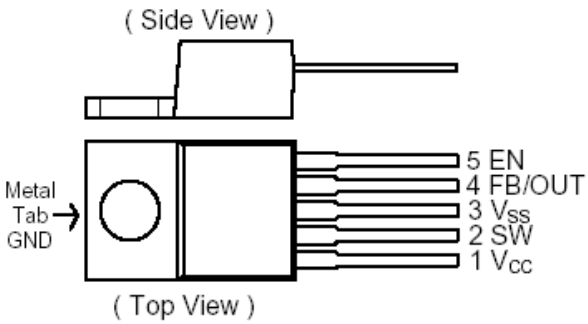
Note. Rth_{JA} is measured with the PCB copper area(need connect to Metal tab) of approx. 3 in^2 (multi-layers)

PACKAGE INFORMATION

TO-263-5L



TO-220-5L



ELECTRICAL SPECIFICATIONS

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

Parameter	SYM	TEST CONDITION	MIN	TYP	MAX	UNITS
Quiescent Current	I_{CCQ}	V_{FB}=12V force driver off	-	4	8	mA
Feedback Bias Current	I_{FB}	V_{FB}=1.3V	-	-10	-50.0	nA
		(ADJ Version Only)	-	-10	-100.0	
Shutdown Supply Current	I_{SD}	V_{EN}=5V	-	35	100	uA
		V_{CC}=22V	-	35	100	uA
Current Limit	I_{CL}	Pear Current, No outside circuit V_{FB}=0V force driver on	3.3	-	-	A
Max. Duty Cycle (ON)	DC	V_{FB}=0V force driver on	-	100	-	%
Min. Duty Cycle (OFF)		V_{FB}=12V force driver off	-	0	-	%
Oscillation Frequency	F_{OSC}		127	150	173	KHz
			110	-	173	KHz
Oscillation Frequency of Short Circuit Protect	F_{SCP}	(Adjustable) When V_{FB} < 0.5V	-	60	-	KHz
		(Fixed) When < V_{OUT} x 40%				KHz
Saturation Voltage	V_{SAT}	I_{OUT}=2A, No outside circuit	-	1.3	1.5	V
		V_{FB}=0V force driver on			1.6	

ELECTRICAL SPECIFICATIONS(Cont.)

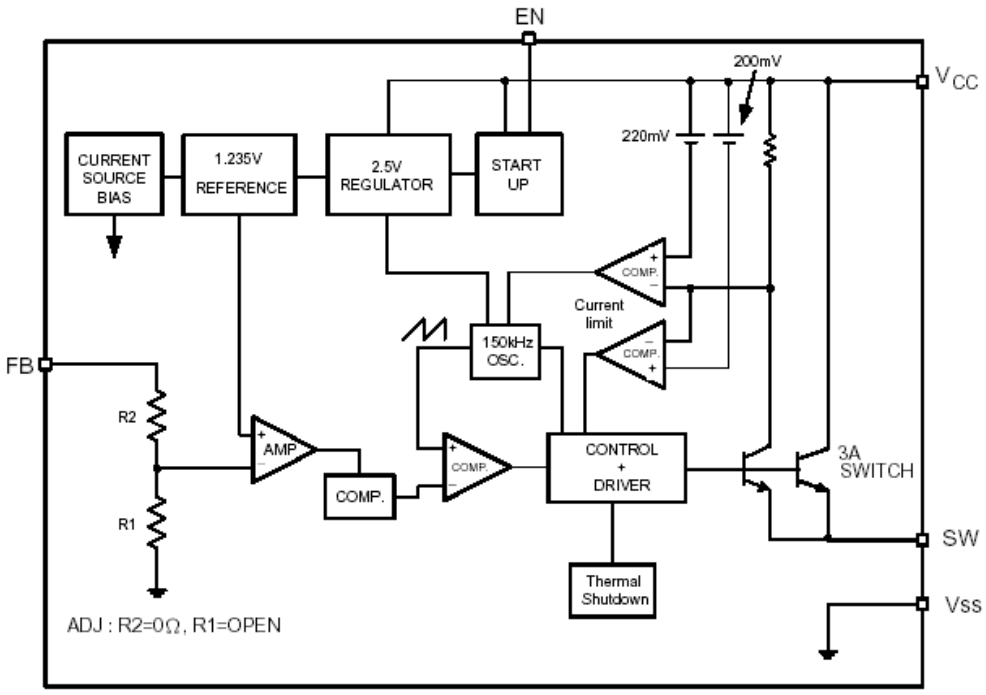
Parameter		SYM	TEST CONDITION	MIN	TYP	MAX	UNITS
EN PIN Logic Input Threshold Volta		V_{IH}	High (regulator ON)	2	1.3	-	V
		V_{IL}	Low (regulator OFF)	-		0.6	V
EN PIN Input Current		I_{SH}	V_{EN}=2.5V(OFF)	-	-0.1	-0.5	uA
		I_{SL}	V_{EN}=0.5V(ON)	-	-	-0.01	uA
SW PIN=0V	SW PIN Leakage Current	I_{SWL}	No outside circuit V_{FB}=12V force driver on	-	-	-200	uA
SW PIN=-0.8V			V_{CC}=22V force driver off	-	-5	-	mA
Thermal Shutdown Temp.		TSD		-	135	-	°C

Version	Characteristics	Symbol	Conditions	MIN	TYP	MAX	UNITS
APE1702-ADJ	**Output Feedback Voltage**	**V_{FB}**	**4.5V < V_{CC} < 22V 0.2A < I_{LOAD} <3A VOUT programmed for 3.3V**	**1.193/ 1.180**	**1.23**	**1.267/ 1.280**	**V**
	Efficiency	η	**V_{CC}=12V, I_{LOAD}=3A**	**-**	**74**	**-**	%
APE1702-3.3V	**Output Voltage**	**V_{OUT}**	**4.75V < V_{CC} < 22V 0.2A < I_{LOAD} <3A**	**3.168/ 3.135**	**3.3**	**3.432/ 3.465**	**V**
	Efficiency	η	**V_{CC}=12V, I_{LOAD}=3A**	**-**	**75**	**-**	%
APE1702-5.0V	**Output Voltage**	**V_{OUT}**	**7V < V_{CC} < 22V 0.2A < I_{LOAD} <3A**	**4.80/ 4.75**	**5.0**	**5.20/ 5.25**	**V**
	Efficiency	η	**V_{CC}=12V, I_{LOAD}=3A**	**-**	**80**	**-**	%
APE1702-12V	**Output Voltage**	**V_{OUT}**	**15V < V_{CC} < 22V 0.2A < I_{LOAD} <3A**	**11.52/ 11.4**	**12**	**12.48/ 12.6**	**V**
	Efficiency	η	**V_{CC}=15V, I_{LOAD}=3A**	**-**	**89**	**-**	%

PIN DESCRIPTIONS

PIN SYMBOL	PIN DESCRIPTION
V_{SS}	GND Pin
FB	Control Voltage Feedback Control for ADJ Version
EN	ON/OFF Shutdown
OUT	Output Voltage Feedback Control for Fixed Version
SW	Switching Output
V_{CC}	IC Power Supply Pin

BLOCK DIAGRAM



FUNCTION DESCRIPTION

PIN FUNCTION

VCC

This is positive input supply for the IC switching regulator. A suitable input bypass capacitor must be presented at this pin to minimize voltage transients and to supply the switching currents needed by the regulator.

VSS

Circuit ground.

SW

Internal Switch. The voltage at this pin switches between (+VCC - VSAT) and approximately - 0.5V, with a duty cycle of approximately VOUT / VCC. To minimize coupling to sensitive circuitry, the PC board copper area connected to this pin should be minimized.

FEEDBACK

Senses in the regulated output voltage to complete the feedback loop.

FUNCTION DESCRIPTION

EN

Allows the switching regulator circuit to be shutdown using logic level signals thus dropping the total input supple current to approximately 100uA. Pulling this pin below a threshold voltage of approximately 1.3V turns the regulator on, and pulling this pin above 1.3V (up to a maximum of VCC) shuts the regulator down. if this shutdown feature is not needed, the EN pin can be wired to the ground pin.

THERMAL CONSIDERATIONS

The TO-263-5L package needs a heat sink under most conditions. The size of the heat sink depends on the input voltage, the output voltage, the load current and the ambient temperature. The APE1702 junction temperature rises above ambient temperature for a 2A load and different input and output voltages.

The data for these curves was taken with the APE1702 (TO-263-5L package) operating as a buck-switching regulator in an ambient temperature of 25°C (still air). These temperature increments are all approximate and are affected by many factors. Higher ambient temperatures required more heat sinker.

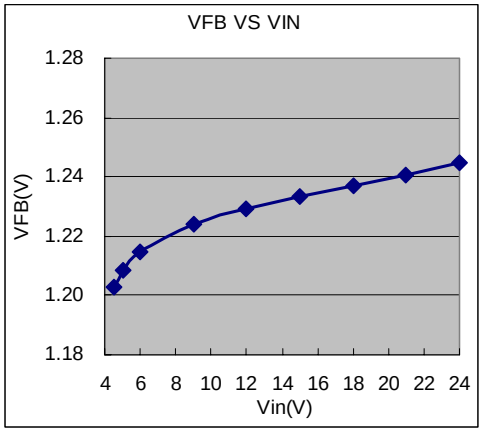
For the best thermal performance, wide copper traces and generous amounts of printed circuit board copper (need connect to the VSS pins) should be used in the board layout, (One exception is the SW pin, which should not have large areas of copper.) to the surrounding air, and moving air lowers the thermal resistance even further.

Package thermal resistance and junction temperature increments are all approximate. The increments are affected by a lot of factors. Some of these factors include board size, shape, thickness, position, location, and even board temperature. Other factors are, trace width, total printed circuit copper area, copper thickness, single or double-sided, multi-layer board and the amount of solder on the board.

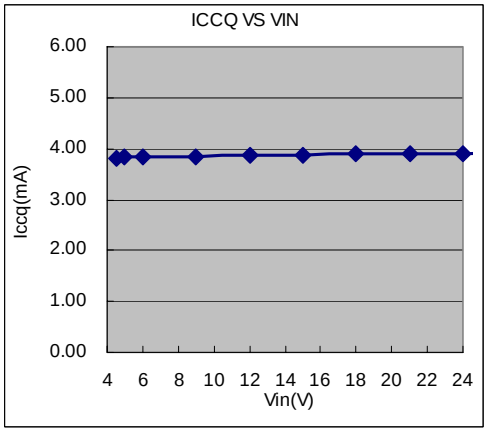
The effectiveness of the PC board to dissipate heat also depends on the size, quantity and spacing of other components on the board, as well as whether the surrounding air is still or moving. Furthermore, some of these components such as the catch diode will add heat to the PC board and the heat can vary as the input voltage changes. For the inductor, depending on the physical size, type of core material and the DC resistance, it could either act as a heat sink taking heat away from the board, or it could add heat to the board.

Typical Characteristics

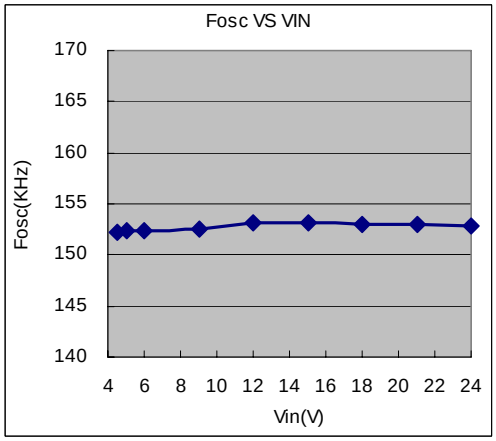
VFB VS VIN



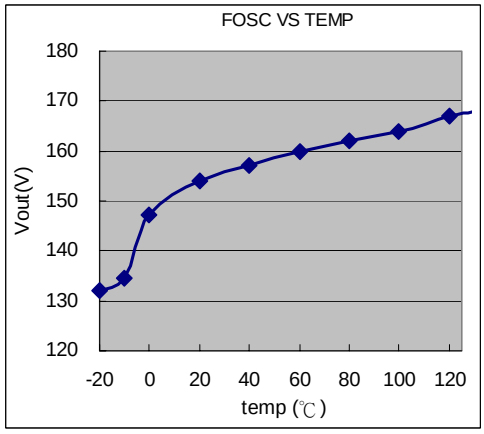
ICCQ VS VIN



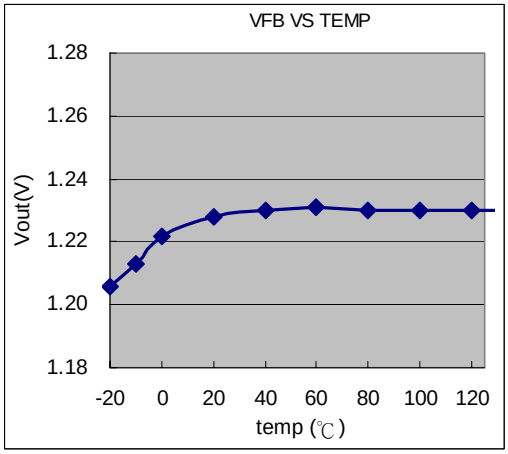
FOSC VS VIN



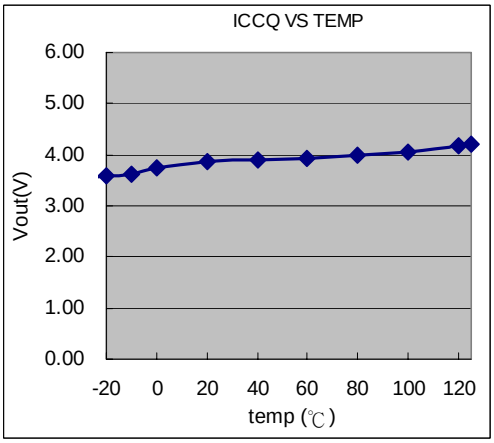
FOSC VS TEMPERATURE



VFB VS TEMPERATURE



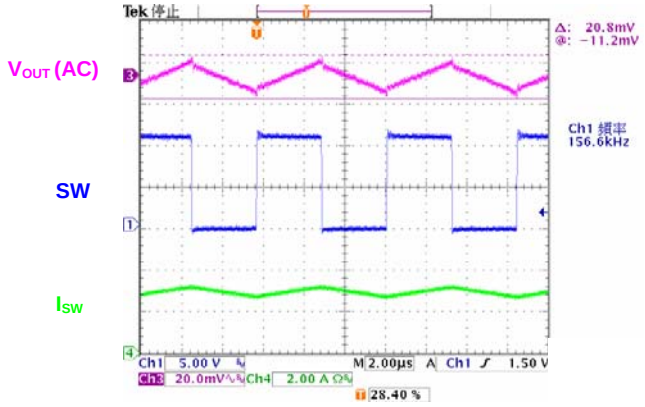
ICCQ VS TEMPERATURE



Typical Characteristics

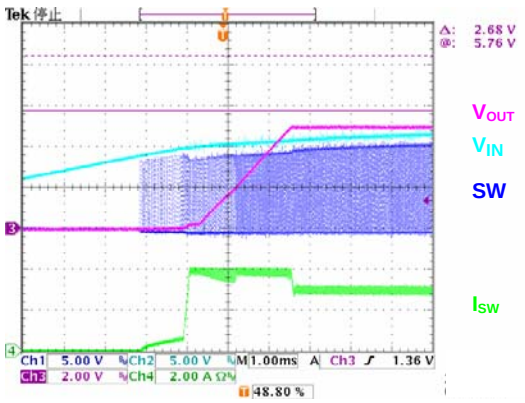
Output Ripple

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



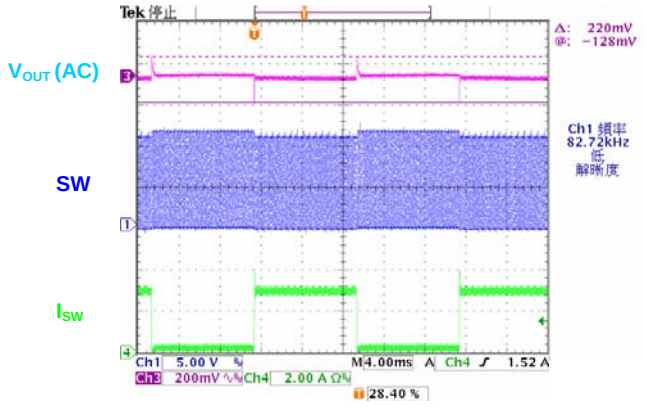
Power on test wave

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



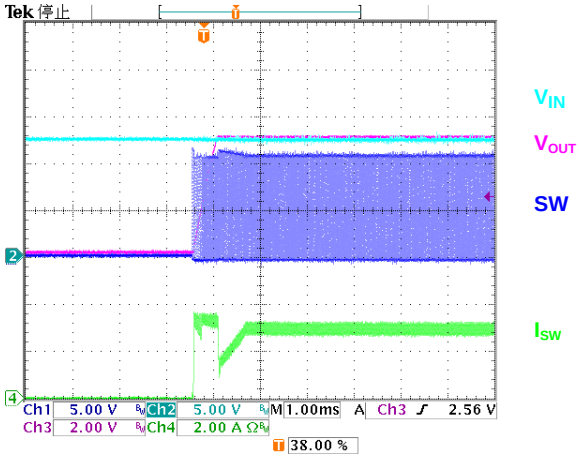
Load Transient Response

(V_{IN}=12V, V_{OUT}=5V, I_{OUT}=0.2~3A)



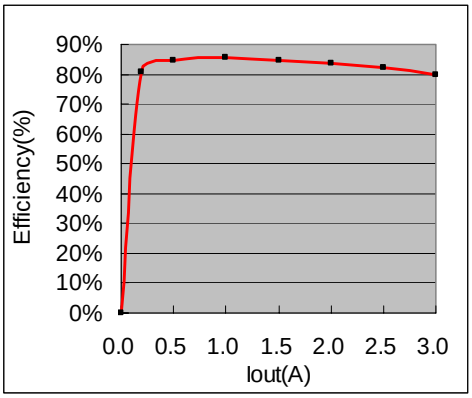
EN on test wave

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



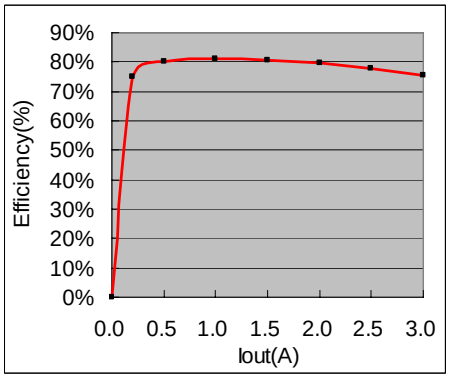
Efficiency

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

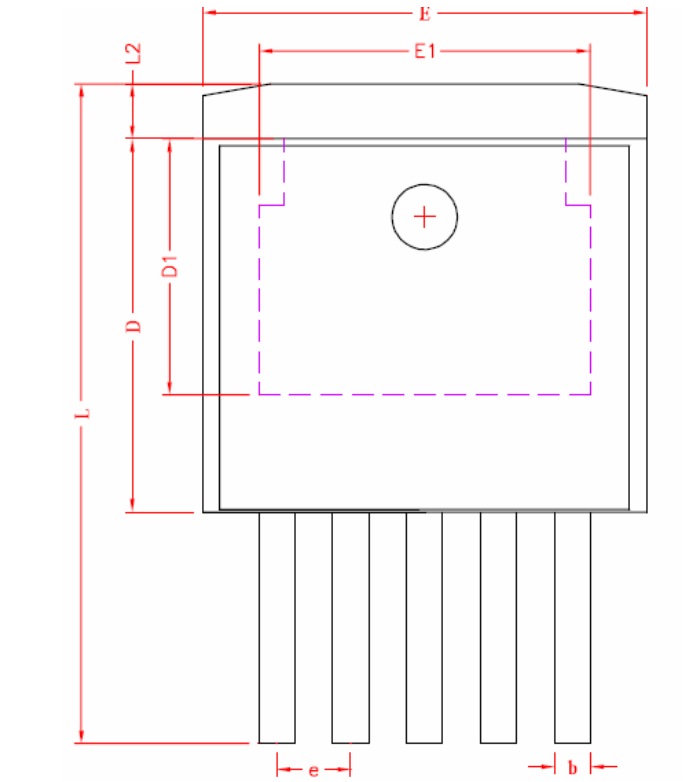


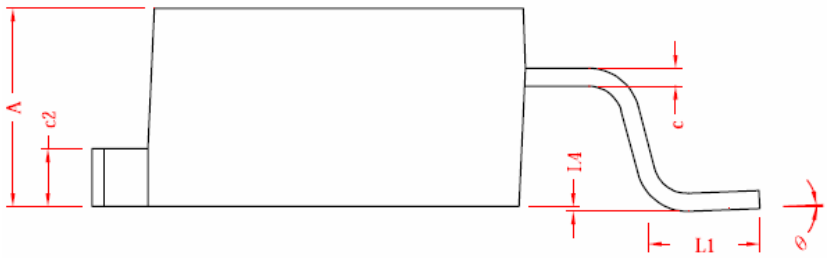
Efficiency

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



Package Outline : TO-263-5L



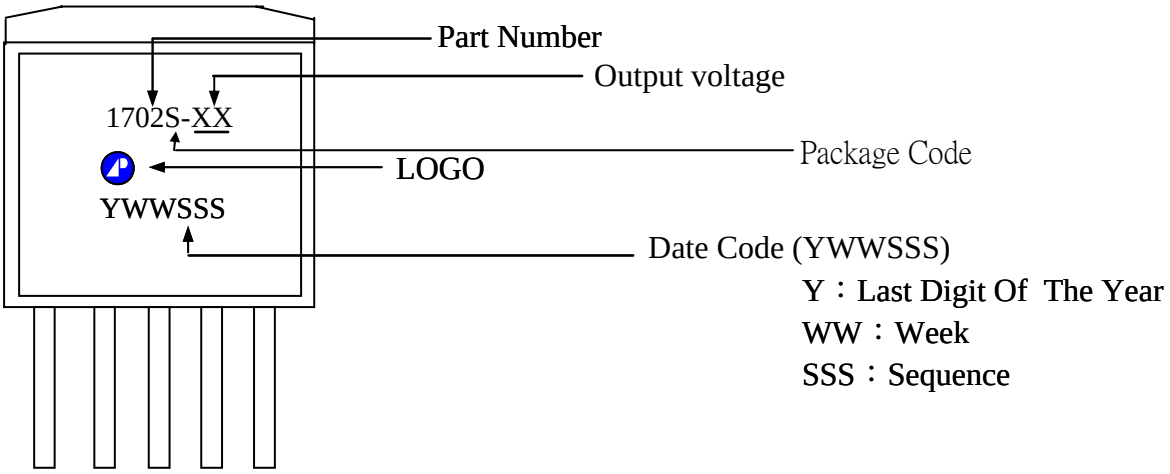


SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	4.40	4.60	4.80
b	0.66	0.79	0.91
L4	0.00	0.15	0.30
c	0.36	0.43	0.50
L1	2.29	2.54	2.79
E	9.80	10.10	10.40
E1		7.60	
c2	1.25	1.35	1.45
L2		1.27	
D	8.60	8.80	9.00
D1		5.90	
e		1.70	
L	14.60	15.20	15.80
θ	0°	4°	8°

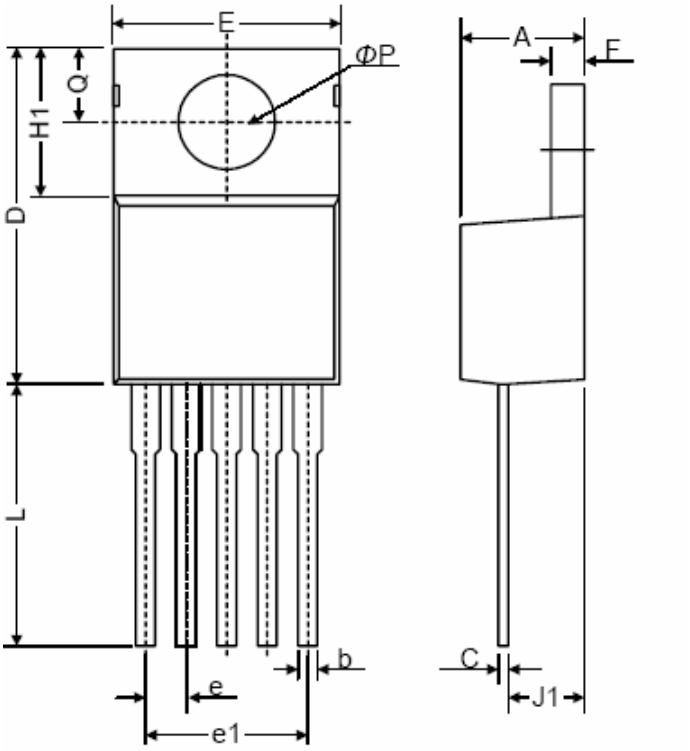
1.All Dimensions Are in Millimeters.

2.Dimension Does Not Include Mold Protrusions.

Part Marking Information & Packing : TO-263-5L



Package Outline : TO-220-5L



SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	4.07	4.45	4.82
b	0.76	0.89	1.02
C	0.36	0.50	0.64
D	14.22	14.86	15.50
E	9.78	10.16	10.54
e	1.57	1.71	1.85
e1	6.68	6.81	6.93
F	1.14	1.27	1.40
H1	5.46	6.16	6.86
J1	2.29	2.74	3.18
L	13.21	13.97	14.73
φp	3.68	3.81	3.94
Q	2.54	2.73	2.92

1.All Dimensions Are in Millimeters.

2.Dimension Does Not Include Mold Protrusions.

Part Marking Information & Packing : TO-220-5L