150KHz, 3A PWM Buck Switching Regulator

■ General Description

The SM8303 is a monolithic integrated circuit that provide all the active functions for a step-down switching regulator, capable of driving a 3A load without additional transistor component. Requiring a minimum number of external component, the board space can be saved easily. The external shutdown function can be controlled by TTL logic level and then come into standby mode. The internal compensation makes feedback control have 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. The SM8303 operates at a switching frequency of 150KHz thus allowing 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 packages are available in a standard 5-lead TO-220(T) package and a 5-lead TO-263(S).

■ Features

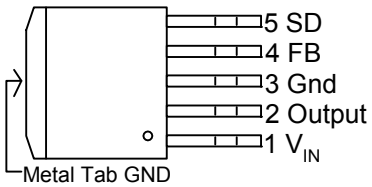
- 3.3V, 5V, 12V and adjustable output versions
- Adjustable version output voltage range, 1.23V to 28V ±4% max over line and load condition
- Available in TO220-5L and TO263-5L packages
- Voltage mode non-synchronous PWM control
- Thermal-shutdown and current-limit protection
- ON/OFF shutdown control input
- Input voltage range up to 32V
- Output load current: 3A
- 150KHz fixed frequency internal oscillator
- Low power standby mode
- Built-in switching transistor on chip

■ Applications

- Simple High-efficiency step-down(buck) regulator
- Efficient preregulator for linear regulators
- On-card switching regulators
- Positive to negative converter
- Battery Charger

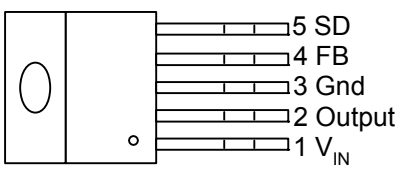
■ Pin Assignments

(Top View)



TO263-5L

(Top View)



TO220-5L

■ Pin Descriptions

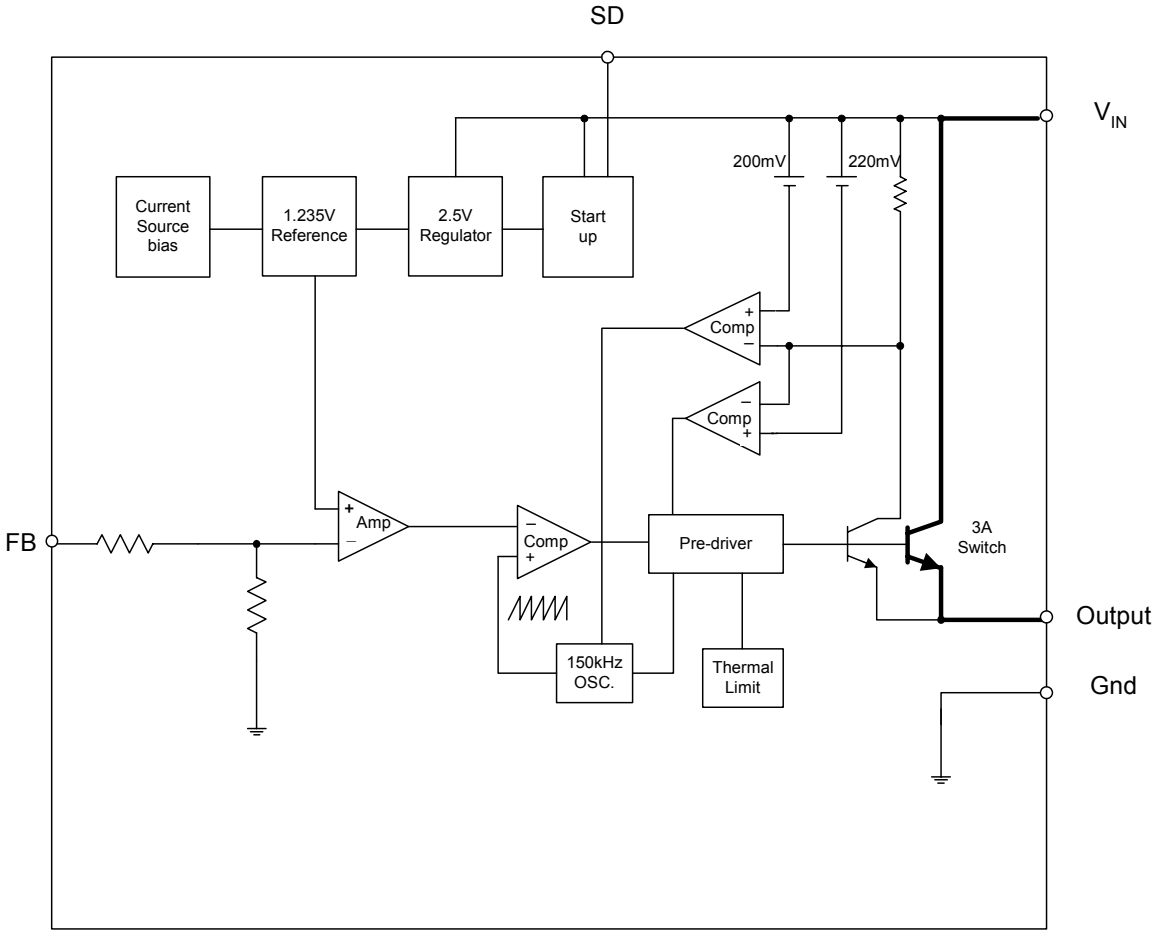
Name	Description
V_{IN}	Operating voltage input
Output	Switching output
Gnd	Ground
FB	Output voltage feedback control
SD	ON/OFF Shutdown

■ Ordering Information

SM8303 XX X X

Output version	Package	Packing
-ADJ : Adjustable -33 : 3.3V -50 : 5.0V -12 : 12V	T: TO220-5L S: TO263-5L	Blank : Tube A : Taping

■ Block Diagram



■ Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit
V_{CC}	Supply Voltage	+35	V
V_{SD}	ON/OFF Pin input voltage	-0.3 to +25	V
V_{FB}	Feedback Pin voltage	-0.3 to +25	V
V_{OUT}	Output voltage to Ground	-1	V
P_D	Power dissipation	Internally limited	W
T_{ST}	Storage temperature	-65 to +150	°C
T_{OP}	Operating temperature	-40 to +125	°C
V_{OP}	Operating voltage	+4.5 to +25	V

■ Electrical Characteristics (All Output Voltage Versions)

Unless otherwise specified, V_{IN}=12V for 3.3V, 5V, adjustable version and V_{IN}=24V for the 12V version. I_{LOAD} = 0.3A

Symbol	Parameter		Conditions		Min.	Typ.	Max.	Unit
I_B	Feedback bias current		V_{FB}=1.3V (Adjustable version only)			40	60 100	nA
F_{OSC}	oscillator frequency				127 **110**	150	173 **173**	Khz
V_{SAT}	saturation voltage		I_{OUT}=3A no outside circuit V_{FB}=0V force driver on			1.3	1.4 **1.5**	V
DC	Max. Duty Cycle(ON)		V_{FB}=0V force driver on			100		%
	Min. Duty cycle(OFF)		V_{FB}=12V force driver off			0		
I_{CL}	current limit		peak current no outside circuit V_{FB}=0 force driver on		3.6	4.5	5.5 6.5	A
I_L	Output = 0V	Output leakage current	no outside circuit V_{FB}=12 force driver off				200	uA
	Output= -1V		V_{IN}=32V			2	60	mA
I_Q	Quiescent Current		V_{FB}=12 force driver off			5	10	mA
I_{STBY}	Standby Quiescent Current		ON/OFF pin=5V V_{IN}=24V			150	250 **300**	uA
V_{IL}	ON/OFF pin logic input threshold voltage		Low (regulator ON)		-	1.3	0.6	V
V_{IH}			High (regulator OFF)		2.0		-	
I_H	ON/OFF pin logic input current		V_{LOGIC}=2.5V (OFF)			15	25	uA
I_L	ON/OFF pin input current		V_{LOGIC}=0.5V (ON)			0.02	5	
Θ_{JC}	Thermal Resistance		TO220-5L	Junction to case		2.5		°C/W
			TO263-5L			3.5		
Θ_{JA}	Thermal Resistance With copper area of approximately 3 in^2		TO220-5L	Junction to ambient		28		°C/W
			TO263-5L			23		

■ Electrical Characteristics (Continued)

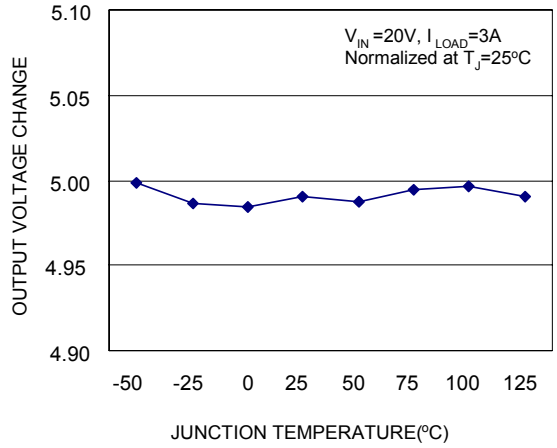
	Symbol	Parameter	Conditions	Typ.	Limit	Unit
SM8303-ADJ	V_{FB}	Output Feedback	$5V \leq V_{IN} \leq 32V$ $0.2A \leq I_{LOAD} \leq 3A$ V_{OUT} programmed for 3V	1.23	1.193/**1.18** 1.267/**1.28**	V V_{MIN} V_{MAX}
	η	Efficiency	V_{IN} = 12V, I_{LOAD}=3A	73		%
SM8303-3.3V	V_{OUT}	Output voltage	$5.5V \leq V_{IN} \leq 32V$ $0.2A \leq I_{LOAD} \leq 3A$	3.3	3.168/**3.135** 3.432/**3.465**	V V_{MIN} V_{MAX}
	η	Efficiency	V_{IN} = 12V, I_{LOAD}=3A	73		%
SM8303-5V	V_{OUT}	Output voltage	$8V \leq V_{IN} \leq 32V$ $0.2A \leq I_{LOAD} \leq 3A$	5	4.8/**4.75** 5.2/**5.25**	V V_{MIN} V_{MAX}
	η	Efficiency	V_{IN} = 12V, I_{LOAD}=3A	80		%
SM8303-12V	V_{OUT}	Output voltage	$15V \leq V_{IN} \leq 32V$ $0.2A \leq I_{LOAD} \leq 3A$	12	11.52/**11.4** 12.48/**12.6**	V V_{MIN} V_{MAX}
	η	Efficiency	V_{IN} = 15V, I_{LOAD} = 3A	90		%

Specifications with **boldface type** are for full operating temperature range, the other type are for T_J=25ºC.

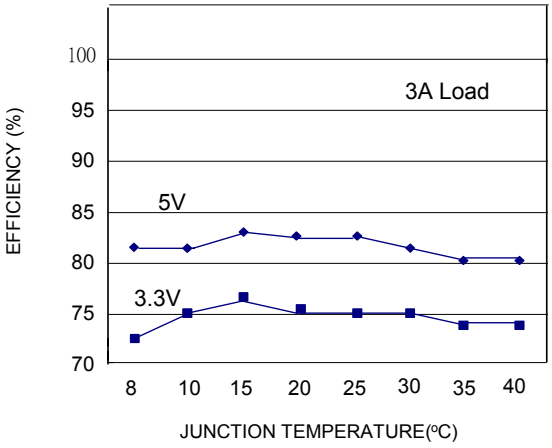
■ Typical Performance Characteristics

Typical Performance Characteristics

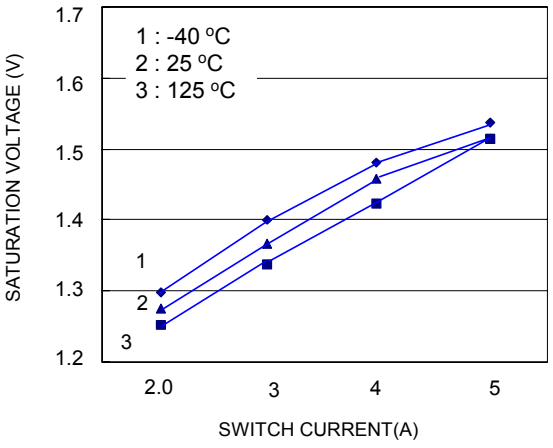
Normalized Output Voltage



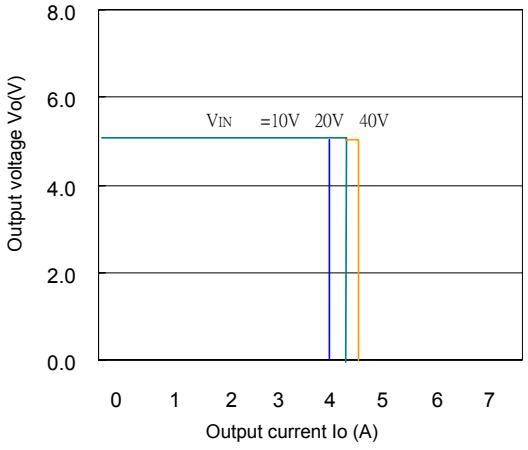
Efficiency



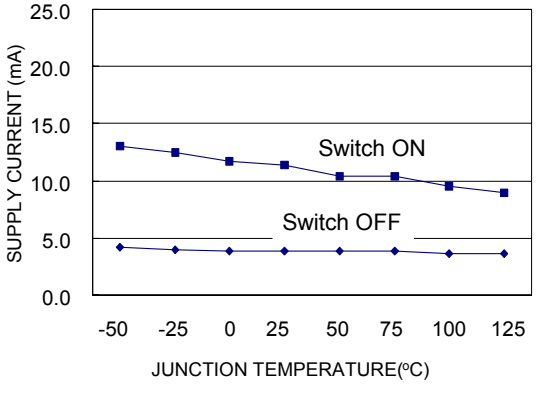
Switch Saturation Voltage



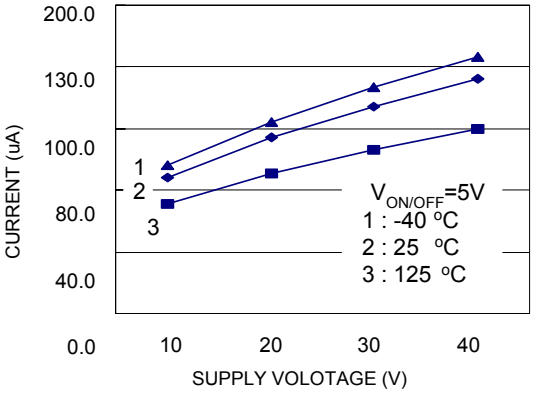
Switch Current Limit



Operating Quiescent Current

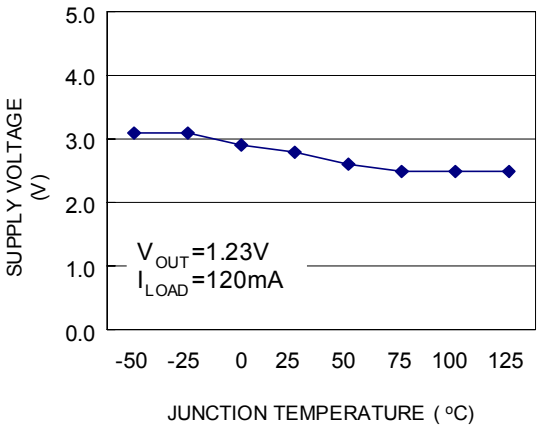


Shutdown Quiescent Current

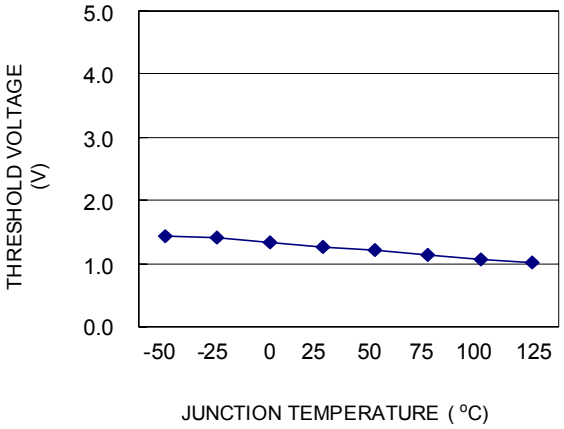


■ Typical Performance Characteristics (Continued)

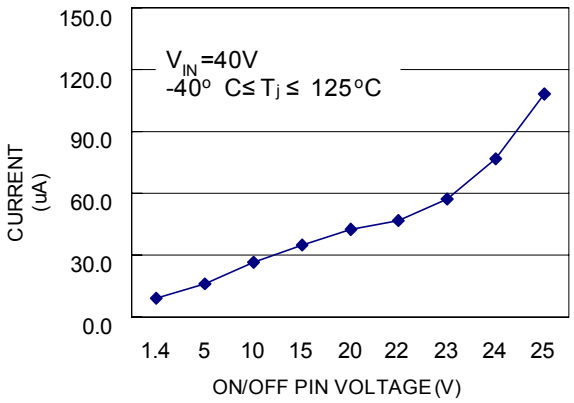
Minimum Operating Supply Voltage



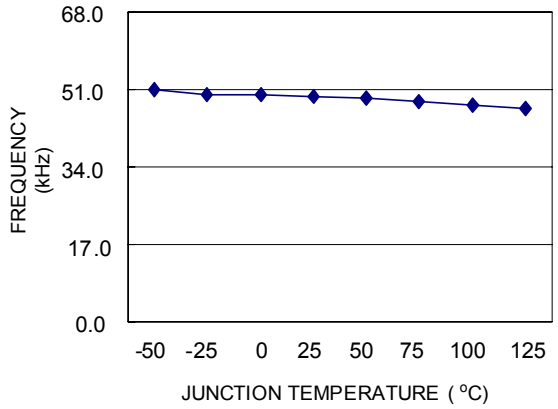
ON/OFF Threshold Voltage



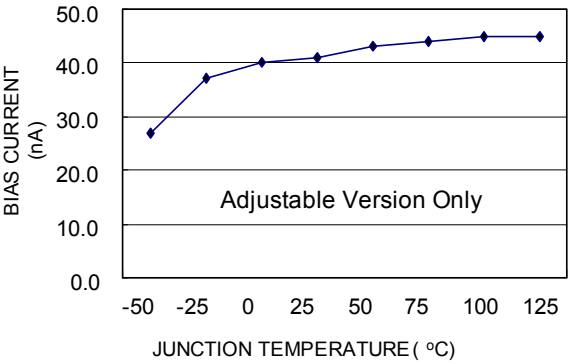
ON/OFF Pin Current (Sinking)



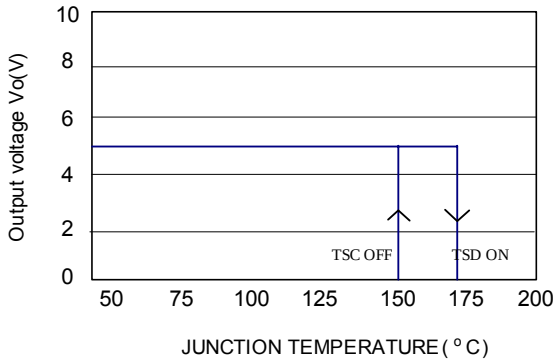
Switch Frequency



Feedback Pin Bias Current

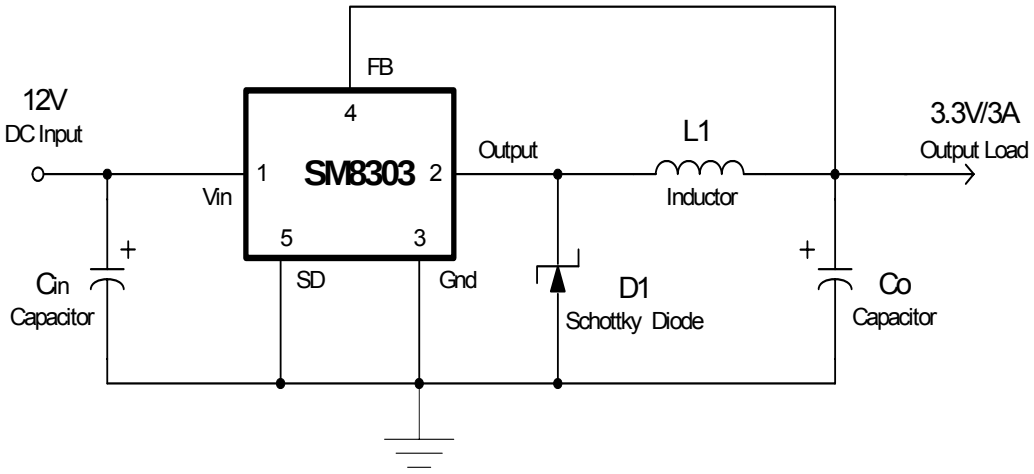


Thermal protection

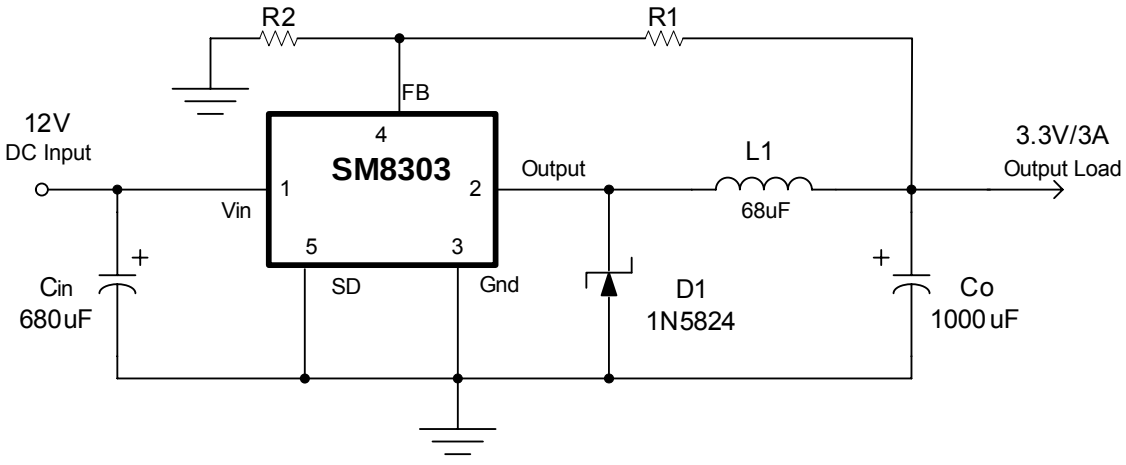


■ Typical Application Circuit

（A） Fixed Type Circuit



(B) Adjustable Type Circuit



$V_{out} = V_{FB} \times (1 + R1/R2)$ $V_{FB}=1.23V$

■ Function Description

Pin Functions

+V_{IN}

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

Output

Internal switch and power output. The voltage at this pin switches between (+V_{IN} – V_{SAT}) and approximately – 0.5V, with a duty cycle of approximately V_{OUT} / V_{IN}. The PC board copper area connected to this pin should be kept a minimum in order to reduce the coupling sensitivity to the circuitry

Ground

Circuit ground.

Feedback

Complete the feedback loop by sensing the regulated output voltage

$\overline{ON}$/OFF

Allows the switching regulator circuit to be shutdown using logic level signals thus dropping the total input supply 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 25V) shuts the regulator down. If this shutdown feature is not needed, the $\overline{ON}$/OFF pin can be wired to the ground pin or it can be left open, in either case the regulator will be in the ON condition.

Thermal Considerations

The SM8303 is available in two packages, a 5-pin TO-220 and a 5-pin surface mount TO-263.

The TO-220 package needs a heat sink under most conditions. The size of the heatsink depends on the input voltage, the output voltage, the load current and the ambient temperature. The SM8303 junction temperature rises above ambient temperature for a 3A load and different input and output voltages. The data for these curves was taken with the SM8303 (TO-220 package) operating as a buck switching regulator in an ambient temperature of 25°C (still air). These temperature rise numbers are all approximate and there are many factors that can affect these temperatures. Higher ambient temperatures require more heat sinking.

The TO-263 surface mount package tab is designed to be soldered to the copper on a printed circuit board. The copper and the board are the heat sink

for this package and the other heat producing components, such as the catch diode and inductor. The PC board copper area that the package is soldered to should be at least 0.8 in^2, and ideally should have 2 or more square inches of 2 oz. Additional copper area improves the thermal characteristics, but with copper areas greater than approximately 6 in^2, only small improvements in heat dissipation are realized. If further thermal improvements are needed, double sided, multilayer PC board with large copper areas and/or airflow are recommended.

■ Function Description (Continued)

The SM8303 (TO-263 package) junction temperature rise above ambient temperature with a 2A load for various input and output voltages. This data was taken with the circuit operating as a buck switching regulator with all components mounted on a PC board to simulate the junction temperature under actual operating conditions. This curve can be used for a quick check for the approximate junction temperature for various conditions, but be aware that there are many factors that can affect the junction temperature. When load currents higher than 3A are used, double sided or multilayer PC boards with large copper areas and/or airflow might be needed, especially for high ambient temperatures and high output voltages.

For the best thermal performance, wide copper traces and generous amounts of printed circuit board copper should be used in the board layout. (Once exception to this is the output (switch) pin, which should not have large areas of copper.) Large areas of copper provide the best transfer of heat (lower thermal resistance) to the surrounding

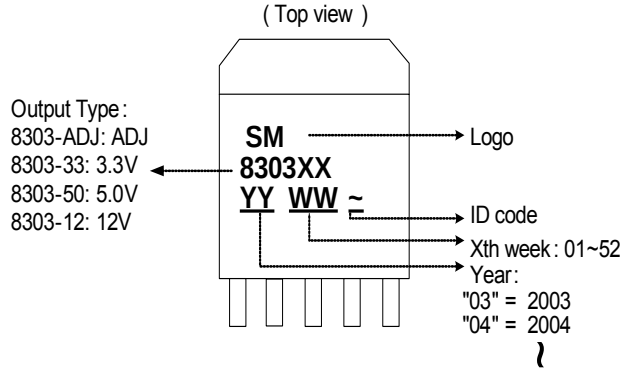
air, and moving air lowers the thermal resistance even further.

Package thermal resistance and junction temperature rise numbers are all approximate, and there are many factors that will affect these numbers. Some of these factors include board

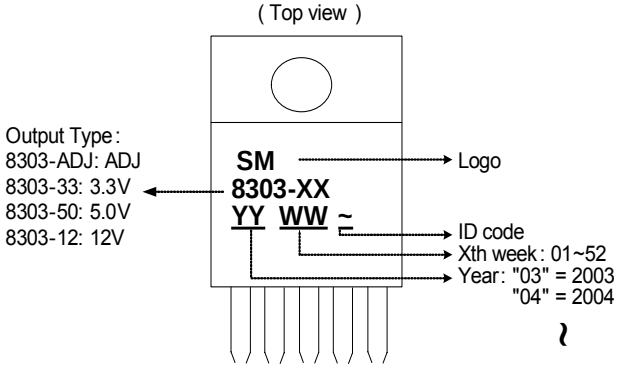
size, shape, thickness, position, location, and even board temperature. Other factors are, trace width, total printed circuit copper area, copper thickness, single or double-sided, multilayer board and the amount of solder on the board. The effectiveness of the PC board to dissipate heat also depends 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.

■ Marking Information

(1) TO263-5L

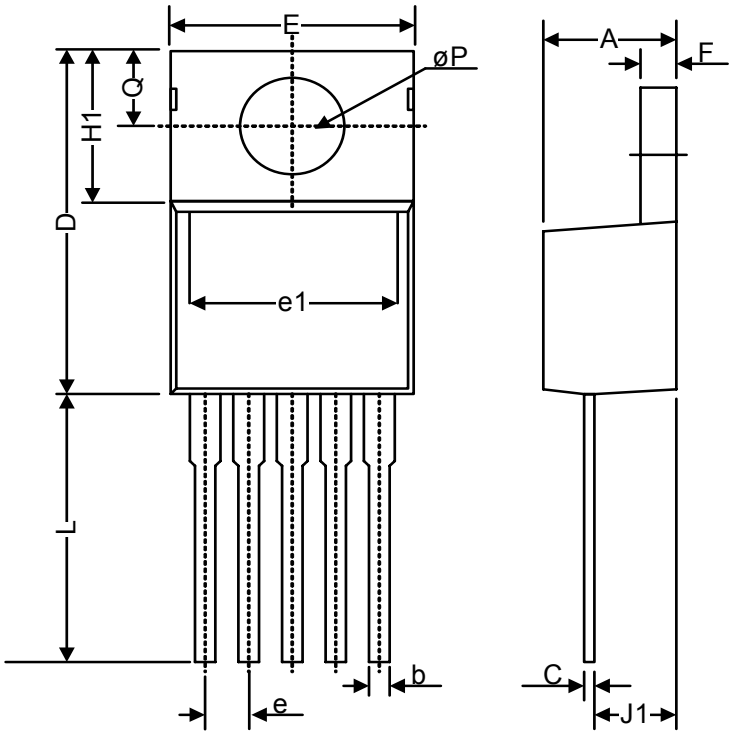


(2) TO220-5L



■ Package Information

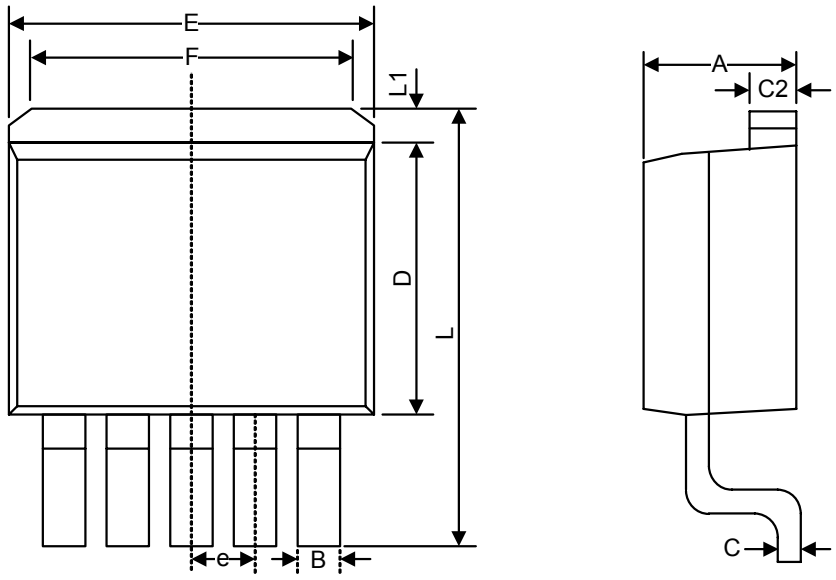
(1) Package Type: TO220-5L

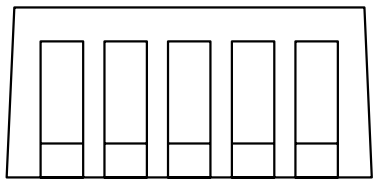


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	3.56	4.83	0.140	0.190
b	0.38	1.02	0.015	0.040
C	0.36	0.61	0.014	0.024
D	14.22	16.51	0.560	0.650
E	9.65	10.67	0.380	0.420
e	1.702 BSC		0.067 BSC	
e1	6.858	8.89	0.270	0.350
F	0.508	1.397	0.020	0.055
H1	5.84	6.86	0.230	0.270
J1	2.03	2.92	0.080	0.115
L	12.70	14.73	0.520	0.580
øP	3.53	4.10	0.139	0.161
Q	2.54	3.43	0.100	0.135

■ Package Information (Continued)

(2) Package Type: TO263-5L





Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.064	4.826	0.160	0.190
B	0.508	0.991	0.020	0.039
C	0.381	0.737	0.015	0.029
C2	1.143	1.651	0.045	0.065
D	8.382	9.652	0.330	0.380
E	9.652	10.668	0.380	0.420
e	1.702 BSC		0.067 BSC	
F	6.223	-	0.245	-
L	14.605	15.875	0.575	0.625
L1	-	1.676	-	0.066