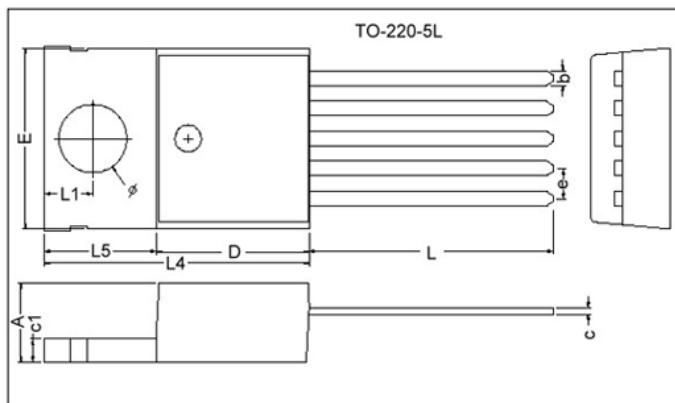


Description

The S5E2596M series of regulators are monolithic integrated circuit that provides all active functions for a step-down (buck) switching regulator, capable of driving 3A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3V, 5V, 12V and an adjustable output version. The S5E2596M series operate at a switching frequency of 150 KHz; thus allowing smaller sized filter components than what would be needed with lower frequency switching regulators. Available in standard 5-lead TO-220 package with several different lead bend options. Other features include a guaranteed $\pm 4\%$ tolerance on output voltage under specified input voltages and output load conditions. The 150 KHz $\pm 15\%$ is on the oscillator frequency. External shutdown is included, featuring 80uA(Typ.) standby current. The output switch includes cycle-by cycle current limiting, as well as thermal shutdown for full protection under fault conditions.



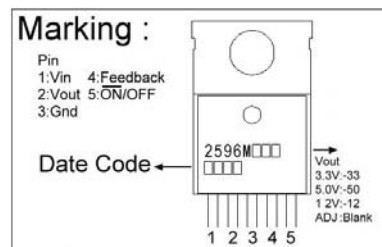
REF.	Millimeter		REF.	Millimeter	
	Min.	Max.		Min.	Max.
A	4.40	4.80	c1	1.25	1.45
b	0.76	1.00	b1	1.17	1.47
c	0.36	0.50	L	13.25	14.25
D	8.60	9.00	e	2.54 REF.	
E	9.80	10.4	L1	2.60	2.89
L4	14.7	15.3	Ø	3.71	3.96

Features

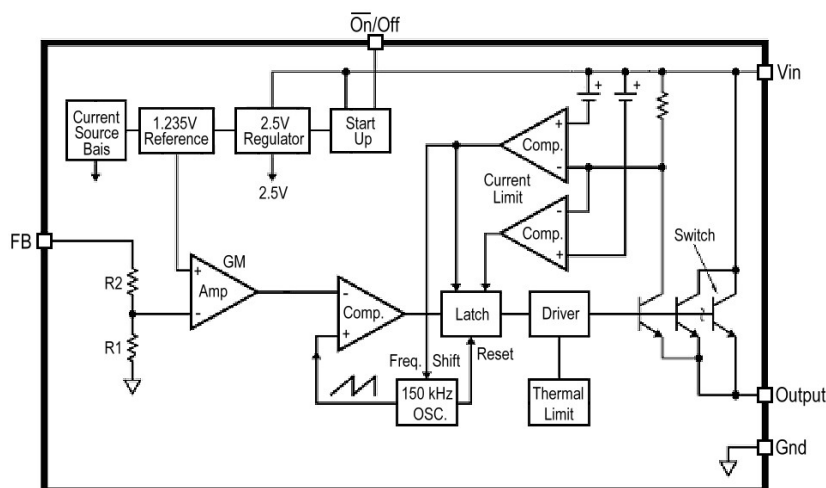
- * Uses Readily Available Standard Inductors
- * Operating Voltage Can Be Up To 22V
- * Thermal Shutdown And Current Limit Protection
- * 3.3V,5V,12V and adjustable Output Versions
- * TTL Shutdown Capability
- * Built-in TTL On/Off Control
- * Guaranteed 3A Output Current
- * 150 KHz Fixed Frequency Internal Oscillator

Applications

- * Positive To Negative Converter
- * High-Efficiency Step-Down Regulator
- * One-ch Switching Regulators Simple



Block Diagram



Pin Function

Pin Name	Pin#	Function
VIN	1	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 current needed by regulator.
Output	2	Internal switch. The voltage at this pin switches between (+VIN - VSAT) and approximately -0.5V, with a duty cycle of approximately VOUT/VIN. To minimize coupling to sensitive circuitry, the PC board copper area connected to this pin should be kept to a minimum.
Ground	3	Circuit ground
Feedback(FB)	4	Senses the regulated output voltage to complete the feedback loop.
ON/OFF(SD)	5	Allows the switching regulator circuit to be shutdown using logic level signals. Thus drop the total input supply current to approximately 150µA. 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 18V) shuts the regulator down. If this shutdown feature is not needed, ON/OFF pin can be wired to the ground pin.

Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit
Supply Voltage	VCC	24	V
ON/OFF Pin Input Voltage	VSD	-0.3 ~ +18	V
Feedback Pin Voltage	VFB	-0.3 ~ +18	V
Output Voltage to ground	VOUT	-1	V
Power Dissipation	PD	Internally Limited	W
Storage Temperature	TST	-65 ~ +150	°C
Operating temperature	TOP	-40 ~ +125	°C
Operating Voltage	VOP	+4.5 ~ +22	V

S5E2596M Electrical Characteristics

Specifications in **boldface type** are for **full operating temperature range**. The other type are for TJ=25 °C.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output Feedback	VFB	5 ≤ VIN ≤ 22V, 0.2A ≤ ILOAD ≤ 3A VOUT=3V	1.193/ 1.180	1.230	1.267/ 1.280	V
Efficiency	η	VIN=12V, ILOAD=3A, VOUT=3V		74		%

S5E2596M-33 Electrical Characteristics

Specifications in **boldface type** are for **full operating temperature range**. The other type are for TJ=25 °C.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output Feedback	VFB	5.5V ≤ VIN ≤ 22V 0.2A ≤ ILOAD ≤ 3A	3.168/ 3.135	3.3	3.432/ 3.465	V
Efficiency	η	VIN=12V, ILOAD=3A		75		%

S5E2596M-50 Electrical Characteristics

Specifications in **boldface type** are for **full operating temperature range**. The other type are for TJ=25 °C.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output Feedback	VFB	8V ≤ VIN ≤ 22V 0.2A ≤ ILOAD ≤ 3A	4.80/ 4.75	5.0	5.20/ 5.25	V
Efficiency	η	VIN=12V, ILOAD=3A		80		%

S5E2596M-12 Electrical Characteristics

Specifications in **boldface type** are for **full operating temperature range**. The other type are for TJ=25 °C.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output Feedback	VFB	15V ≤ VIN ≤ 22V 0.2A ≤ ILOAD ≤ 3A	11.52/ 11.40	12	12.48/ 12.60	V
Efficiency	η	VIN=16V, ILOAD=3A		89		%

All Output Voltage Version Electrical Characteristics

Specifications in **boldface type** are for **full operating temperature range**. The other type are for $T_J=25\text{ }^{\circ}\text{C}$.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Feedback bias current	IFB	$V_{FB}=1.3\text{V}$ (adjustable version only)	-	-10	-50/ -100	nA
Oscillator frequency	FOSC		127/110	150	173/173	kHz
Oscillator frequency of short circuit protect	FSCP	When current limit occurred and $V_{FB}<0.5\text{V}$, $T_A=25\text{ }^{\circ}\text{C}$.	5	15	25	kHz
Saturation voltage	VSAT	$I_{LOAD}=3\text{A}$ No outside circuit $V_{FB}=0\text{V}$ force drive on	-	1.4	1.6/1.7	V
Max. duty cycle (ON)	DC	$V_{FB}=0\text{V}$ force drive on	-	100	-	%
Max. duty cycle (OFF)		$V_{FB}=12\text{V}$ force drive off	-	0	-	
Current limit	ICL	Peak current No outside circuit $V_{FB}=0\text{V}$ force drive on	3.6	4.5	5.5/6.5	A
Output leakage current	IL	Output=0V, No outside circuit $V_{FB}=12\text{V}$ force drive off	-	-	-200	uA
		Output=-1V, $V_{IN}=22\text{V}$	-	-5	-	
Quiescent current	IQ	$V_{FB}=12\text{V}$ force drive off	-	5	10	mA
ON/OFF pin logic input	VIL	Low (Regulator ON)	-	-	0.6	V
Threshold Voltage	VIH	High (Regulator OFF)	2.0	-	-	
ON/OFF pin Logic input current	IH	$V_{LOGIC}=2.5\text{V}$ (Regulator OFF)	-	-	-0.01	uA
ON/OFF pin input current	IL	$V_{LOGIC}=0.5\text{V}$ (Regulator ON)	-	-0.1	-1	
Standby quiescent current	ISTBY	ON/OFF pin=5V, $V_{IN}=12\text{V}$	-	150	200	uA
Thermal Resistance	θ_{JC}	Junction to Case	-	2.5	-	$^{\circ}\text{C/W}$
	θ_{JA}	Junction to Ambient with copper area of approximately 3 in ²	-	28	-	

Unless otherwise specified, $V_{IN}=12\text{V}$ for 3.3V, 5V, adjustable version and $V_{IN}=18\text{V}$ for the 12V version. $I_{LOAD}=0.5\text{A}$

Function Description

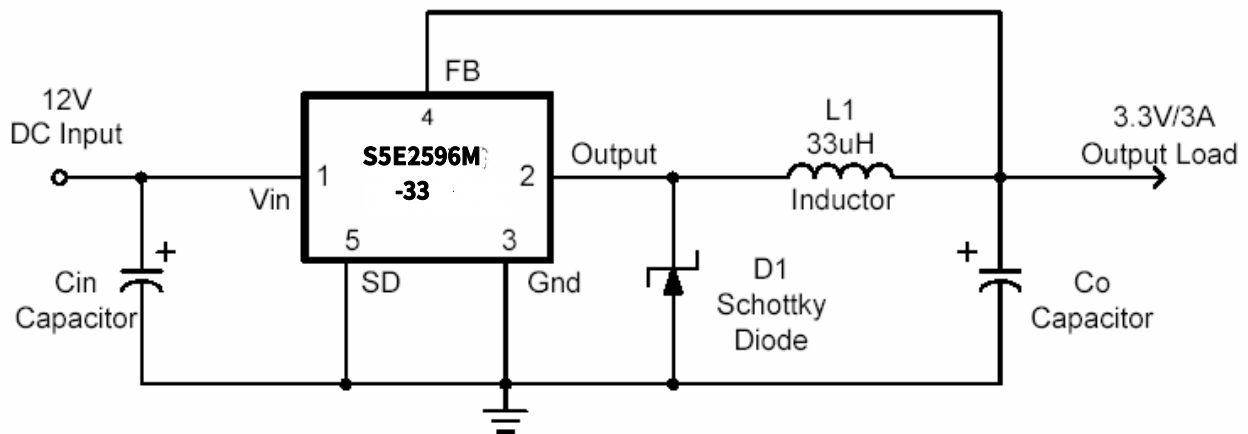
The TO-220 package needs a heat sink under most conditions. The size of the heat sink depends on the input voltage, the output voltage, the load current and the ambient temperature. The S5E2596M junction temperature rises above ambient temperature with a 3A load and different input and output voltages. The data for these curves was taken with the S5E2596M 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.

For the best thermal performance, wide copper traces and generous amounts of printed circuit board copper should be used in the board layout. (One 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.

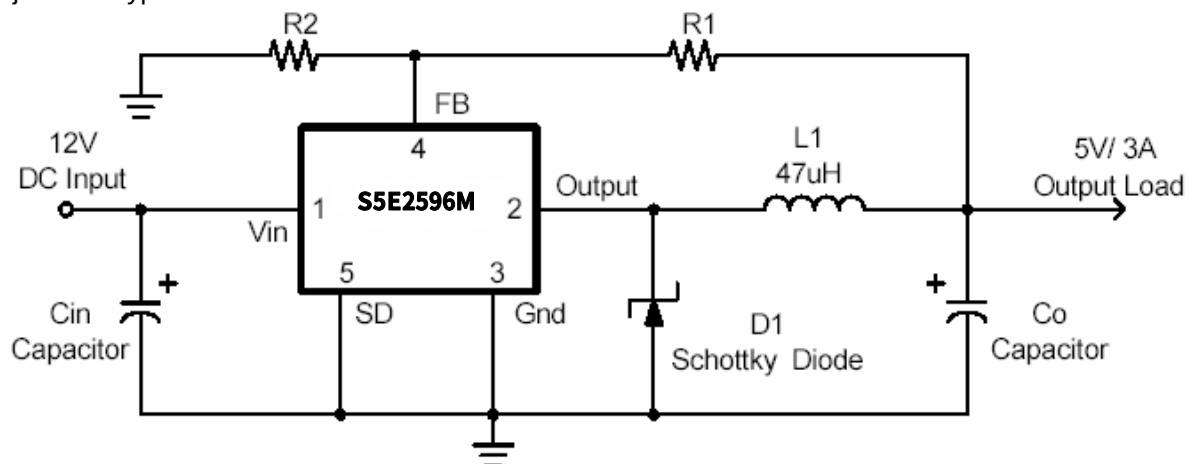
Package thermal resistance and junction temperature rise numbers are all approximate, and there are many factors will affect these numbers. Some of these factors include board size, shape, thickness, position, location and even board temperature. Other factors are, trace width, total printed circuit copper area, copper thickness, single or double-sided, 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 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 Application Circuit

(1) Fixed Type Circuit



(2) Adjustable Type Circuit

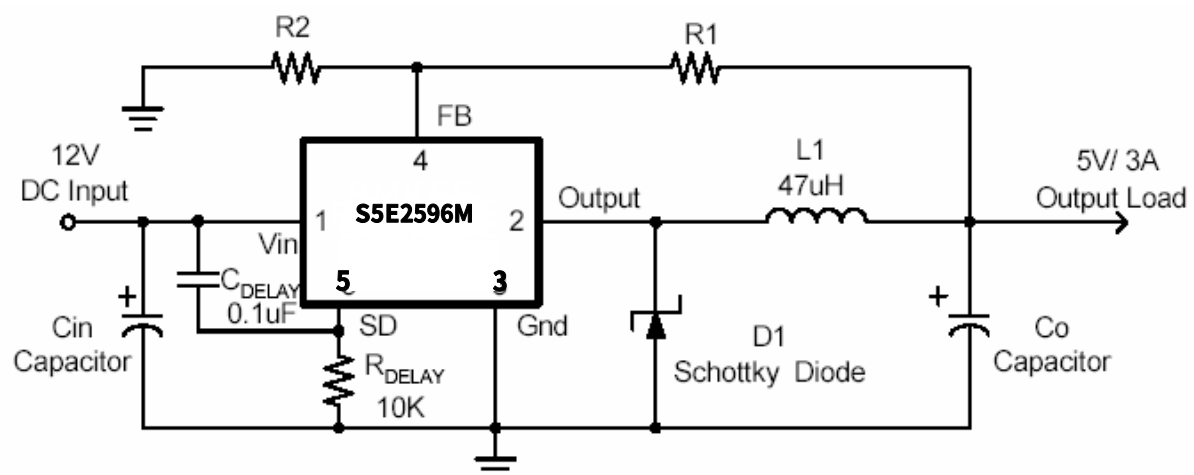


$$V_{out} = V_{FB} \times \left(1 + \frac{R1}{R2}\right)$$

$$V_{FB} = 1.23V$$

$$R2 = 1K \sim 3K$$

(3) Delay Start Circuit



Typical Performance Characteristics

