

General Description

The LM2596S series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving a 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.

Requiring a minimum number of external components, these regulators are simple to use and include internal frequency compensation, and a fixed-frequency oscillator.

The LM2596S series operates 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 a standard 5-lead TO-263 surface mount package.

A standard series of inductors are available from several different manufacturers optimized for use with the LM2596S series. This feature greatly simplifies the design of switch-mode power supplies.

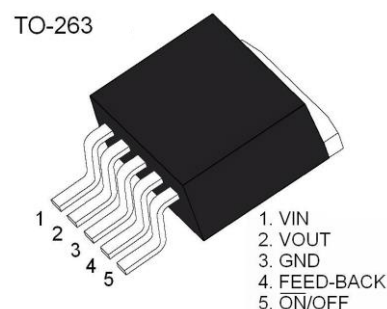
Other features include a guaranteed $\pm 4\%$ tolerance on output voltage under specified input voltage and output load conditions, and $\pm 15\%$ on the oscillator frequency. External shutdown is included, featuring typically 80 μ A standby current. Self protection features include a two stage frequency reducing current limit for the output switch and an over temperature shutdown for complete protection under fault conditions.

Applications

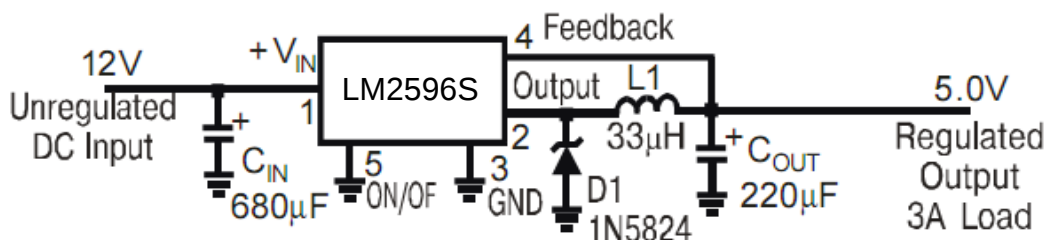
- 3.3V, 5V, 12V, and adjustable output versions
- Adjustable version output voltage range, 1.2V~ 37V
- $\pm 4\%$ max over line and load conditions
- Available in TO-263 packages
- Guaranteed 3A output load current
- Input voltage range up to 40V
- Requires only 4 external components
- Excellent line and load regulation specifications
- 150 kHz fixed frequency internal oscillator
- TTL shutdown capability
- Low power standby mode, IQ typically 80 μ A
- High efficiency
- Uses readily available standard inductors
- Thermal shutdown and current limit protection

Features

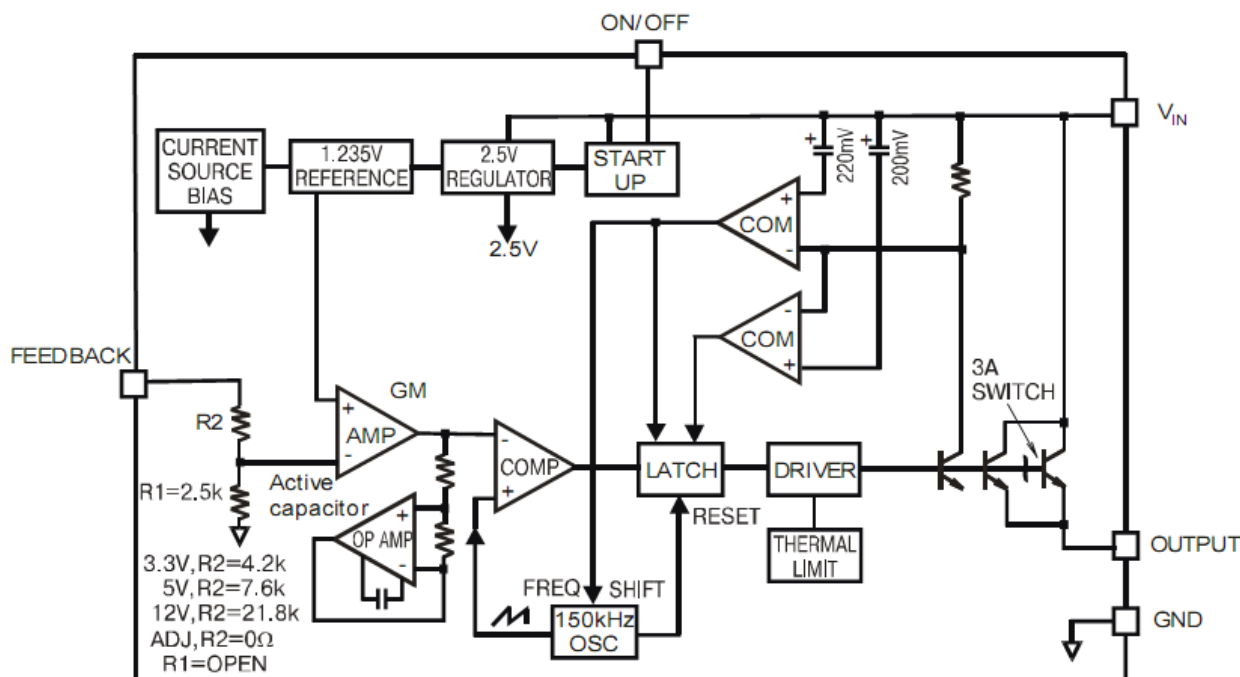
- Guaranteed 3A output current
- Requires only 4 external components
- 52 kHz fixed frequency internal oscillator
- TTL shutdown capability, low power standby mode
- High efficiency
- Uses readily available standard inductors
- Thermal shutdown and current limit protection



Typical Application (Fixed Output Voltage Versions)



Block Diagram and Typical Application



Absolute Maximum Ratings

Parameter	Symbol	Conditions	Ratings	Unit
Supply Voltage	V_{IN}		45	V
Feedback Pin Voltage	V_{FEED}		-0.3 ~ +25	V
ON/OFF Pin Input Voltage	$V_{ON/OFF}$		-0.3 ~ +25	V
Output Voltage to Ground	V_{OG}	Steady State	-1	V
Power Dissipation	P_D		Internally Limited	W
Junction Temperature	T_j		-40 ~ 125	°C
Storage Temperature	T_{srg}		-65 ~ 150	°C
Minimum ESD Rating	V_{ESD}	C=100pF, R=1.5kΩ	2	kV
Lead Temperature	T_{LEAD}	Soldering, 10 Seconds	260	°C

Notes: 1. External components such as the catch diode, inductor, input and output capacitors can affect switching regulator system performance.


Electrical Characteristics LM2596S-3.3

 Specification with standard type face are for $T_j = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Value			Unit
			Min	Typ	Max	
Output Voltage	V_{OUT}	$V_{IN}=12\text{V}$, $I_{LOAD}=0.2\text{A}$,	3.234	3.3	3.366	V
Output Voltage	V_{OUT}	$4.75\text{V} \leq V_{IN} \leq 40\text{V}$, $0.2\text{A} \leq I_{LOAD} \leq 3\text{A}$	$T_j = 25^\circ\text{C}$	3.168	3.3	3.432
			$T_j = -40 \sim 125^\circ\text{C}$	3.135	3.3	3.465
Efficiency	η	$V_{IN}=12\text{V}$, $I_{LOAD}=3.0\text{A}$,		73		%

Electrical Characteristics LM2596S-5.0

 Specification with standard type face are for $T_j = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Value			Unit
			Min	Typ	Max	
Output Voltage	V_{OUT}	$V_{IN}=12\text{V}$, $I_{LOAD}=0.2\text{A}$,	4.900	5.0	5.100	V
Output Voltage	V_{OUT}	$7\text{V} \leq V_{IN} \leq 40\text{V}$, $0.2\text{A} \leq I_{LOAD} \leq 3\text{A}$	$T_j = 25^\circ\text{C}$	4.800	5.0	5.200
			$T_j = -40 \sim 125^\circ\text{C}$	4.750	5.0	5.250
Efficiency	η	$V_{IN}=12\text{V}$, $I_{LOAD}=3.0\text{A}$,		80		%

Electrical Characteristics LM2596S-12

 Specification with standard type face are for $T_j = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Value			Unit
			Min	Typ	Max	
Output Voltage	V_{OUT}	$V_{IN}=24\text{V}$, $I_{LOAD}=0.2\text{A}$,	11.76	12	12.24	V
Output Voltage	V_{OUT}	$15\text{V} \leq V_{IN} \leq 40\text{V}$, $0.2\text{A} \leq I_{LOAD} \leq 3\text{A}$	$T_j = 25^\circ\text{C}$	11.52	12	12.48
			$T_j = -40 \sim 125^\circ\text{C}$	11.40	12	12.60
Efficiency	η	$V_{IN}=25\text{V}$, $I_{LOAD}=3.0\text{A}$,		90		%

Electrical Characteristics LM2596S-ADJ

 Specification with standard type face are for $T_j = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Value			Unit
			Min	Typ	Max	
Feedback Voltage	V_{FB}	$V_{IN}=12\text{V}$, $I_{LOAD}=0.2\text{A}$, $V_{OUT}=5\text{V}$	1.217	1.23	1.243	V
Feedback Voltage	V_{FB}	$4.5\text{V} \leq V_{IN} \leq 40\text{V}$, $0.2\text{A} \leq I_{LOAD} \leq 3\text{A}$ $V_{OUT}=5\text{V}$	$T_j = 25^\circ\text{C}$	1.193	1.23	1.267
			$T_j = -40 \sim 125^\circ\text{C}$	1.180	1.23	1.280
Efficiency	η	$V_{IN}=12\text{V}$, $I_{LOAD}=3\text{A}$, $V_{OUT}=5\text{V}$		73		%



All Output Voltage Versions

Electrical Characteristics

Unless other wise specified, $V_{IN}=12V$ for the 3.3V, 5V ,and Adjustable version and $V_{IN} =24V$ for the 12V version. $I_{LOAD} =500mA$

Parameter	Symbol	Conditions		Value			Unit
				Min	Typ	Max	
Feedback Bias Current	I_B	Adjustable Version Only, $V_{FB}=1.3V$	$T_j = 25^{\circ}C$		10	50	nA
			$T_j = -40 \sim 125^{\circ}C$			100	
Oscillator Frequency	f_{OSC}	$T_j = 25^{\circ}C$		127	150	173	kHz
		$T_j = -40 \sim 125^{\circ}C$		110		173	
Saturation Voltage	V_{SAT}	$I_{OUT} = 3A$	$T_j = 25^{\circ}C$		1.16	1.4	V
			$T_j = -40 \sim 125^{\circ}C$			1.5	
Max Duty Cycle (ON)	DC				100		%
Min Duty Cycle (OFF)					0		
Current Limit	I_{CL}	Peak Current	$T_j = 25^{\circ}C$	3.6	4.5	6.9	A
			$T_j = -40 \sim 125^{\circ}C$	3.4		7.5	
Output Leakage Current	I_L	Output = 0 V				50	μA
		Output = -1.0 V			2	30	mA
Quiescent Current	I_Q				5	10	mA
Standby Quiescent Current	I_{stby}	$\overline{ON/OFF}$ Pin=5.0V ("off")	$T_j = 25^{\circ}C$		80	200	μA
			$T_j = -40 \sim 125^{\circ}C$			250	
$\overline{ON/OFF}$ Pin Logic Input Level	V_{IH}	$V_{OUT} = 0$	$T_j = 25^{\circ}C$		1.3		V
			$T_j = -40 \sim 125^{\circ}C$	0.6		2	
$\overline{ON/OFF}$ Pin Logic Input Level	V_{IL}	$V_{OUT} = \text{Nominal Output Voltage}$	$T_j = 25^{\circ}C$			1.0	V
			$T_j = -40 \sim 125^{\circ}C$			0.8	
$\overline{ON/OFF}$ Pin Input Current	I_{IH}	$V_{LOGIC}=2.5V$, (Regulator off)			5	15	μA
$\overline{ON/OFF}$ Pin Input Current	I_{IL}	$V_{LOGIC}=2.5V$, (Regulator on)			0.02	5	μA

Notes: 1. The human body model is a 100pF capacitor discharged through a 1.5k resistor to each pin.

2. External components such as the catch diode, inductor, input and output capacitors, and voltage programming resistors can affect switching regulator system performance. When the LM2596S is used as shown in the Figure test circuit, system performance will be as shown in system parameters section of Electrical Characteristics.

3. The switching frequency is reduced when the second stage current limit is activated.

4. No diode, inductor or capacitor connected to output pin.

5. Feedback pin removed from output and connected to 0V to force the output transistor switch ON.

6. Feedback pin removed from output and connected to 12V for the 3.3V, 5V, and the ADJ. version, and 15V for the 12V version, to force the output transistor switch OFF.

7. Junction to ambient thermal resistance with the TO-263 package tab soldered to a single printed circuit board with 0.5 in² of (1oz.) copper area.

8. Junction to ambient thermal resistance with the TO-263 package tab soldered to a single sided printed circuit board with 2.5 in² of (1oz.) copper area.

Typical Characteristics

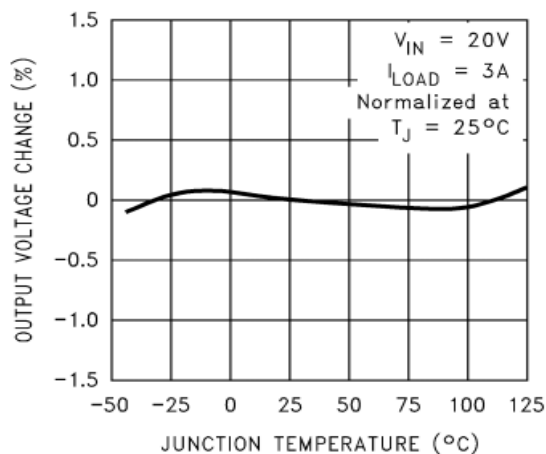


Figure 1. Normalized Output Voltage

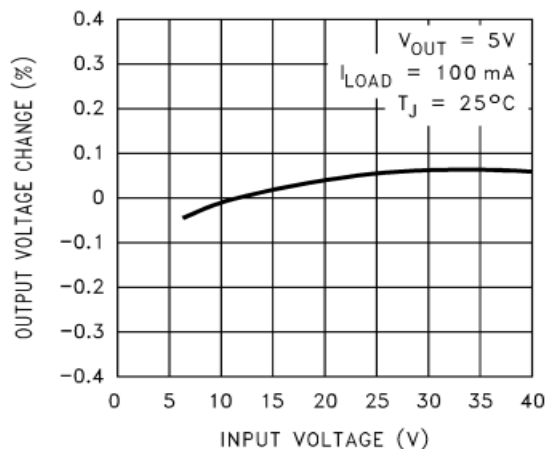


Figure 2. Line Regulation

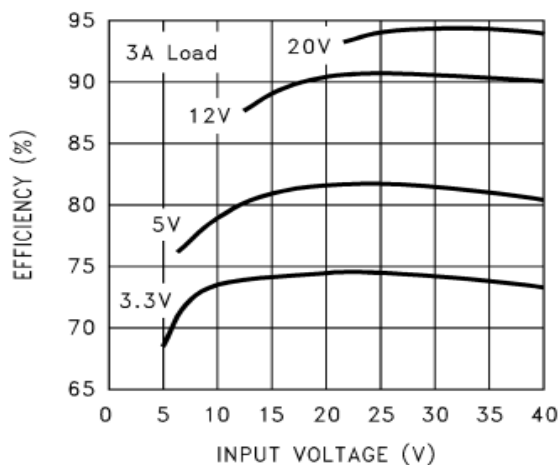


Figure 3. Efficiency

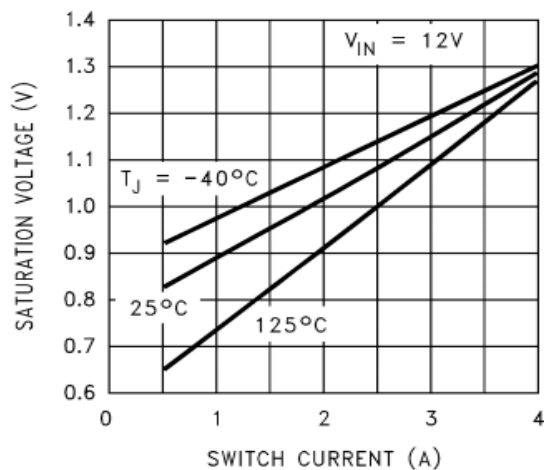


Figure 4. Switch Saturation Voltage

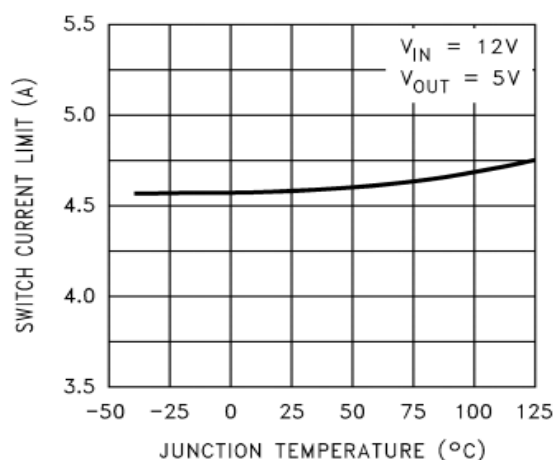


Figure 5. Switch Current Limit

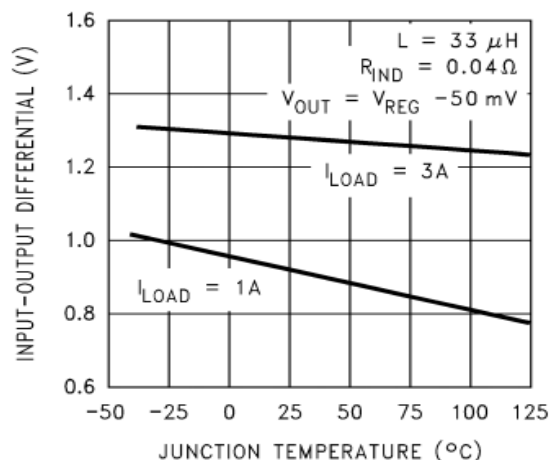
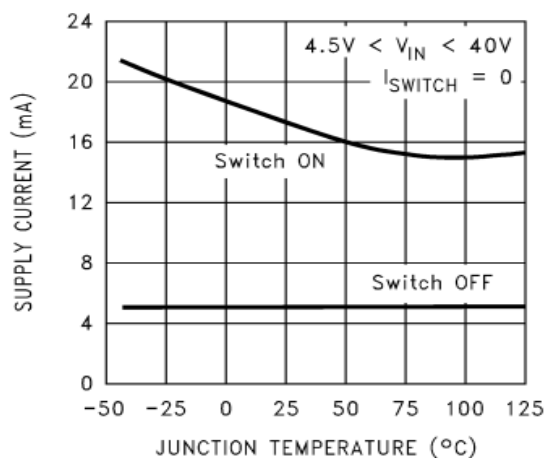
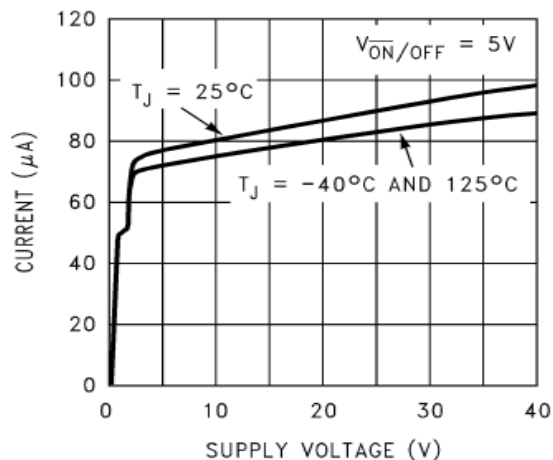
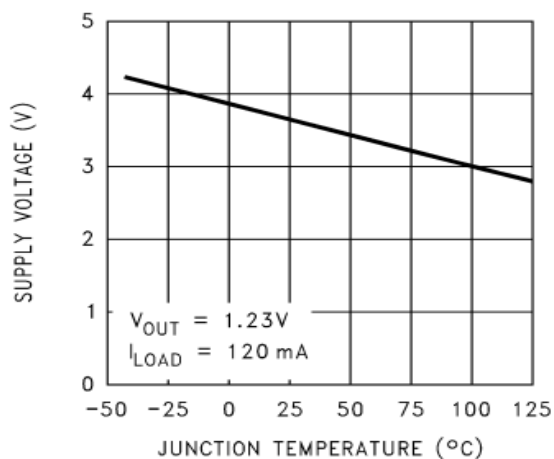
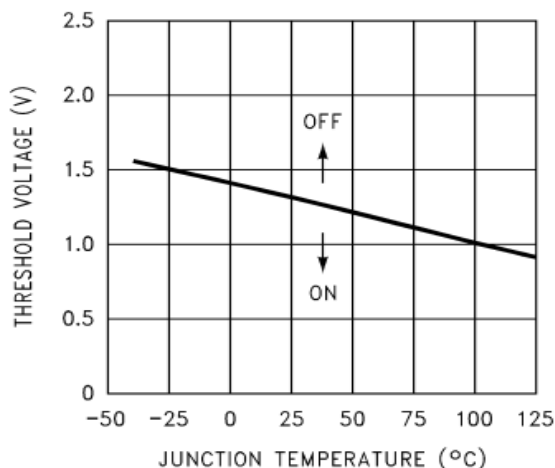
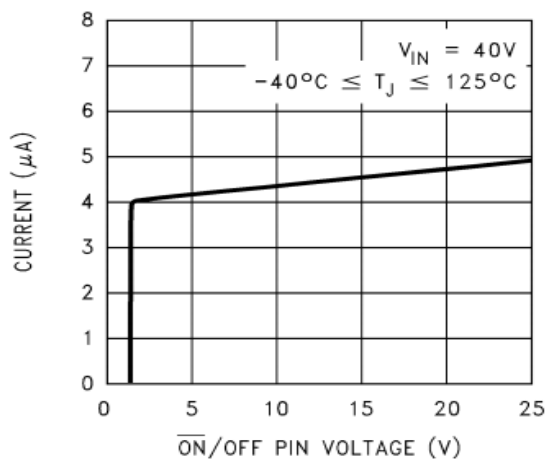
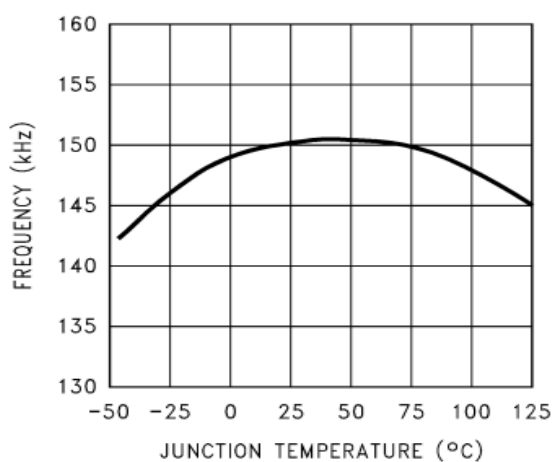
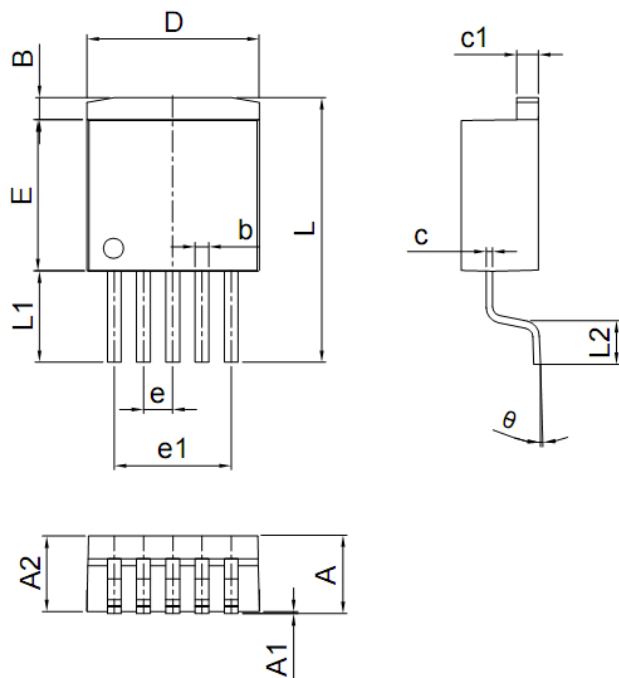


Figure 6. Dropout Voltage

**Typical Characteristics****Figure 7. Operating Quiescent Current****Figure 8. Shutdown Quiescent Current****Figure 9. Minimum Operating Supply Voltage****Figure 10. $\overline{ON}/OFF$ Threshold Voltage****Figure 11. $\overline{ON}/OFF$ Pin Current(Sinking)****Figure 12. Switching Frequency**

Package Dimensions



Dim	Millimeter		Inches	
	Min.	Max.	Min.	Max.
A	4.30	4.70	0.169	0.185
A1	0.00	0.15	0.000	0.006
A2	4.30	4.55	0.169	0.179
B	1.20	1.60	0.047	0.063
b	0.70	0.90	0.028	0.035
b1	1.20	1.50	0.047	0.059
c	0.30	0.60	0.012	0.024
c1	1.17	1.37	0.046	0.054
D	9.90	10.20	0.390	0.402
E	8.50	8.90	0.335	0.350
e	1.60	1.80	0.096	0.104
e1	6.40	7.20	0.252	0.283
L	14.60	15.00	0.575	0.590
L1	4.70	5.30	0.205	0.213
L2	2.30	2.60	0.091	0.110