

**GENERAL DESCRIPTION**

The LM2596HV/HM1509HV 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.

Available in a standard 5-lead TO-220 package, 5-lead TO-263 surface mount package and ESOP-8L package.

External shutdown is included, featuring typically 30  $\mu$ A standby current. The output switch includes cycle-by-cycle current limiting, as well as thermal shutdown, and protection from output short for full protection under fault conditions.

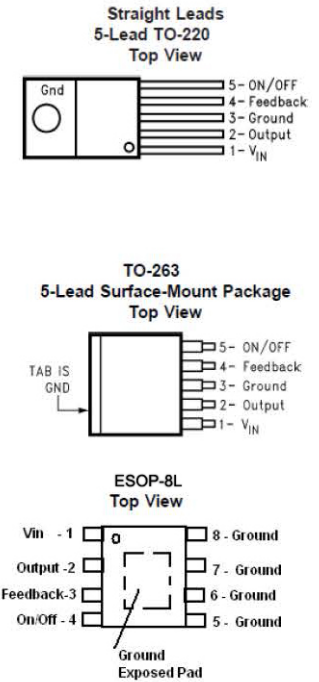
**FEATURES**

- 3.3V, 5V, 12V, and adjustable output versions
- Adjustable version output voltage range, 1.2V to 57V
- $\pm 4\%$  maximum over line and load conditions
- Available in TO-220 and TO-263 packages and ESOP-8L (for  $I_{load} < 3A$ )
- Guaranteed 3A output load current
- Input voltage range up to 60V
- Requires only 4 external components
- Excellent line and load regulation specifications
- 150 kHz fixed frequency internal oscillator
- Low power standby mode,  $I_{stb}$  typically 30  $\mu$ A
- High efficiency
- Thermal shutdown and current limit protection
- Output short protection by reduction of frequency by 3 times.

**APPLICATIONS**

- Simple high-efficiency step-down (buck) regulator
- On-card switching regulators
- Efficient pre-regulator for linear regulators

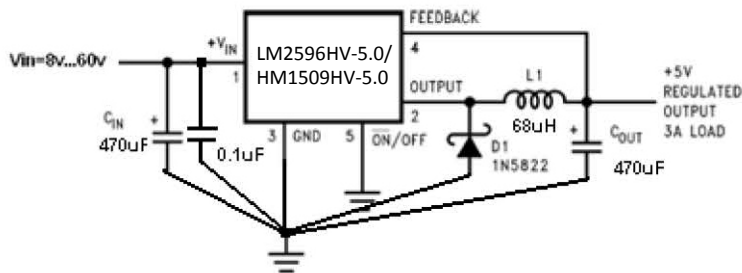
**PIN CONFIGURATION**



**PIN ASSIGNMENT**

Pin	ESOP-8L(for $I_{load} < 3A$ )	Pin	TO-220, TO-263
1	$V_{in}$	1	$V_{in}$
2	Output	2	Output
3	FB	3	Gnd
4	On/Off	4	FB
5 to 8	Gnd	5	On/Off

**Typical Application (Fixed Output Voltage Versions)**



ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Ratings	Unit
Maximum supply voltage	$V_{IN}$	63	V
ON/OFF Pin input voltage	$V_{ON/OFF}$	-0.3 to 60, $\leq V_{in}$	V
FB (Feedback) pin voltage	$V_{FB}$	-0.3 to 25, $\leq V_{in}$	V
Output voltage to GND	$V_{OUT}$	-1	V
Power dissipation	$P_D$	Internally limited	W
Minimum ESD rating HBM (C=100pF, R=1.5k)	ESD	2.0	kV
Maximum junction temperature	$T_{J,max}$	150°C	°C

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Ratings	Unit
Temperature range	$T_J$	-40°C $\leq T_J \leq$ +125°C	°C
Supply voltage	$V_{op}$	4.5 to 60	V
$I_{LOAD}$	$I_{LOAD}$	$I_{LOAD} \leq 3.0$	A

ELECTRICAL CHARACTERISTICS

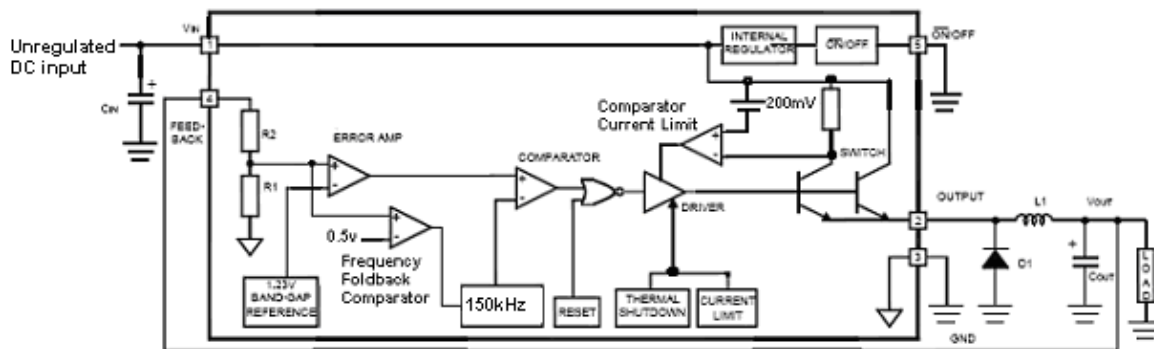
Unless specified otherwise,  $V_{IN}=12V$  for the 3.3V, 5V and adjustable versions,  $I_{LOAD}=0.5A$ ,  $V_{IN}=18V$  for 12V version.

The \* denotes the specifications, which apply over full operating temperature range  $T_J = -40$  to  $+125^\circ C$ .

Parameter	Symbol	Conditions	*	Min	Typ	Max	Unit	
SYSTEM PARAMETERS Test Circuit Figure 1								
Output voltage	LM2596HV-3.3 HM1509HV-3.3	$V_{OUT}$	$5.5V \leq V_{IN} \leq 60V, 0.2A \leq I_{LOAD} \leq 3A$		3.185	3.300	3.432	V
	*			3.152	3.465			
	LM2596HV-5.0 HM1509HV-5.0		$8V \leq V_{IN} \leq 60V, 0.2A \leq I_{LOAD} \leq 3A$		4.825	5.00	5.20	V
	*			4.775	5.25			
LM2596HV-12 HM1509HV-12		$15V \leq V_{IN} \leq 60V, 0.2A \leq I_{LOAD} \leq 3A$		11.58	12.00	12.48	V	
*			11.46	12.60				
LM2596HV-adj HM1509HV-adj		$8V \leq V_{IN} \leq 60V, 0.2A \leq I_{LOAD} \leq 3A$		1.193	1.230	1.273	V	
*			1.180	1.285				
Line Regulation	Line Reg	$8 \leq V_{IN} \leq 60V, I_{LOAD} = 0.2A$			0.3		%	
Load Regulation	Load Reg	$10mA \leq I_{LOAD} \leq 3A, V_{IN} = 12V$			0.3		%	
Efficiency	LM2596HV-3.3 HM1509HV-3.3	$\eta$	$V_{IN}=12V, I_{LOAD}=3A$		77		%	
	LM2596HV-5.0 HM1509HV-5.0				79			
	LM2596HV-12 HM1509HV-12				83			
	LM2596HV-adj HM1509HV-adj				79			
DEVICE PARAMETERS								
Quiescent current	$I_Q$	$V_{FB}=12V$ force driver off			5	8	mA	
Feedback bias current	$I_{FB}$	$V_{FB}=1.3V$ (Adjustable version only)		-250	-70		nA	
			*	-450				
Shutdown supply current	$I_{STB}$	$V_{ON/OFF}=5V, V_{IN}=60V$			30	220	$\mu A$	
			*			280		
Oscillator frequency	$F_{OSC}$			133	150	168	kHz	
			*	120		180		
Oscillator frequency of Short Circuit Protect (SCP)	$F_{SCP}$	When $V_{OUT}<40\%$ from nominal, $I_{OUT}= CL$			50		kHz	
Max. duty cycle	$DC_{(Max)}$	$V_{FB}=0V$ force driver on	*	100			%	
Min. duty cycle	$DC_{(Min)}$	$V_{FB}=12V$ force driver off ( $V_{FB}=15V$ for -12V version)	*			0		

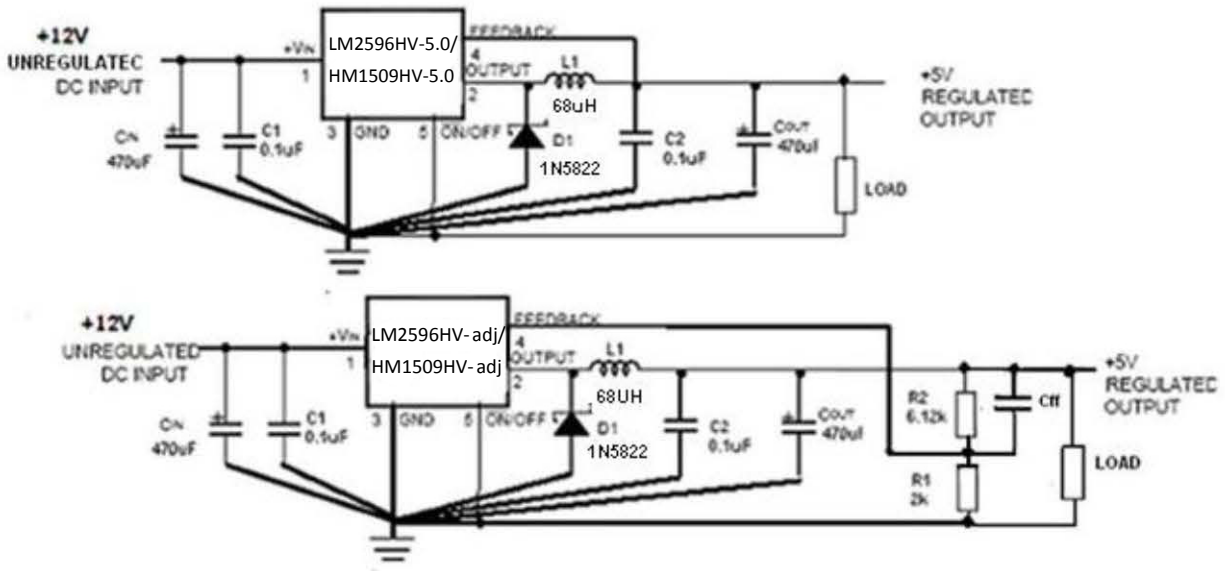
Current limit	CL	Peak current. No outside circuit. $V_{FB}=0V$		4.1	5.3	6.7	A
			*	3.8		7.0	
Saturation voltage	$V_{SAT}$	$I_{OUT}=3A$ . No outside circuit. $V_{FB}=0V$			1.35	1.50	V
			*			1.70	
Output leakage current	$I_L$	$V_{OUT}=0V$ . No outside circuit. $V_{FB}=12V$		-300	-50		$\mu A$
Output leakage current	$I_{L1}$	$V_{OUT}=-1V$ . No outside circuit. $V_{FB}=12V$		-30	-3		mA
ON/OFF input threshold	$V_{TH}$		*	0.6	1.3	2.0	V
ON/OFF input current	$I_H$	$V_{ON/OFF}=2.5V$		-5	-0.1	5	$\mu A$
ON/OFF input current	$I_L$	$V_{ON/OFF}=0.5V$		-1	-0.01	1	$\mu A$
Thermal shutdown temperature	$T_{SD}$	$T_J$			160		$^{\circ}C$

BLOCK DIAGRAM



For ADJ Version  
R1 = Open, R2 = 0 $\Omega$

TEST CIRCUIT AND LAYOUT GUIDELINES



$V_{out} = V_{ref} * (1 + R2/R1)$ , where  $V_{ref} = 1.23V$ ;  $R1$  between 1k and 5k.

FIGURE 1.

For minimal inductance and ground loops, the wires indicated by **heavy lines** should be **wide printed circuit traces and kept as short as possible**. Keep the FEEDBACK wiring away from the inductor flux.

$C_{ff} \sim 1$  to 10nF – as option.

TYPICAL CHARACTERISTICS

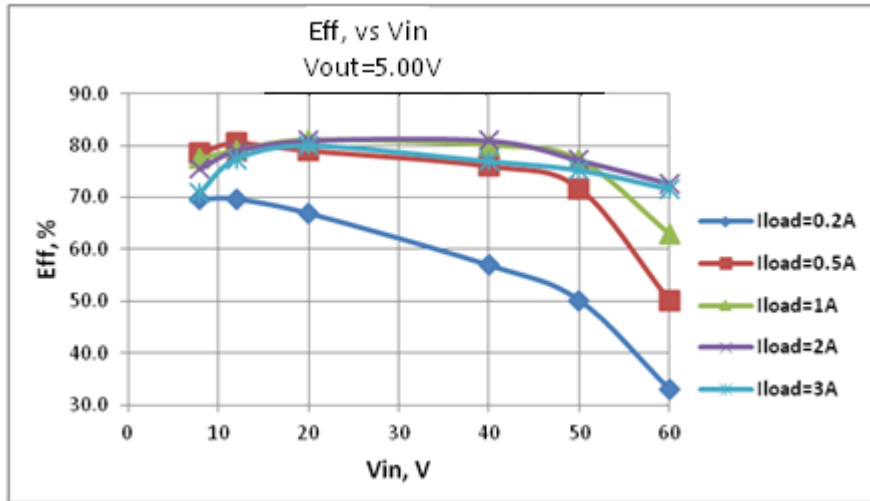


Fig.1. Eff, vs Vin

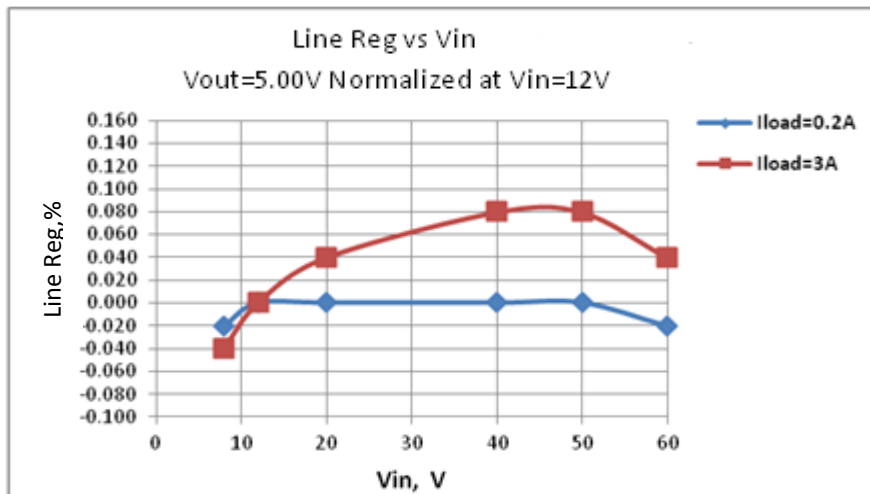


Fig.2. Line Reg vs Vin

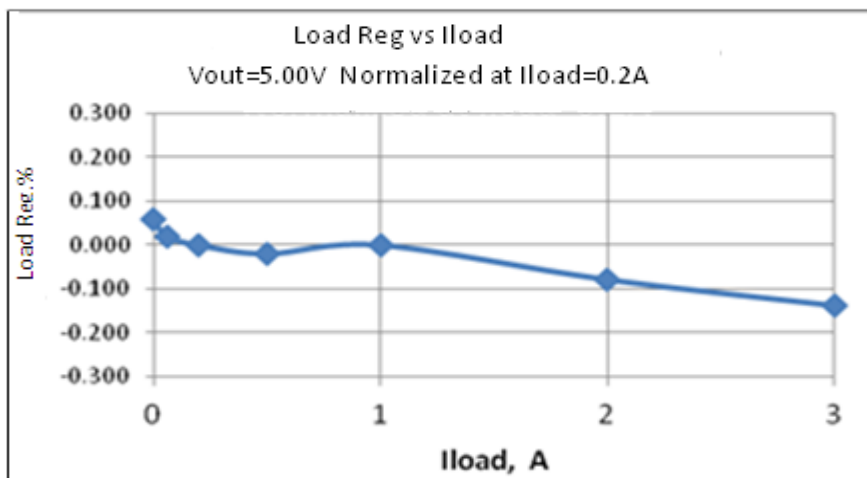


Fig.3. Load Reg vs Iload

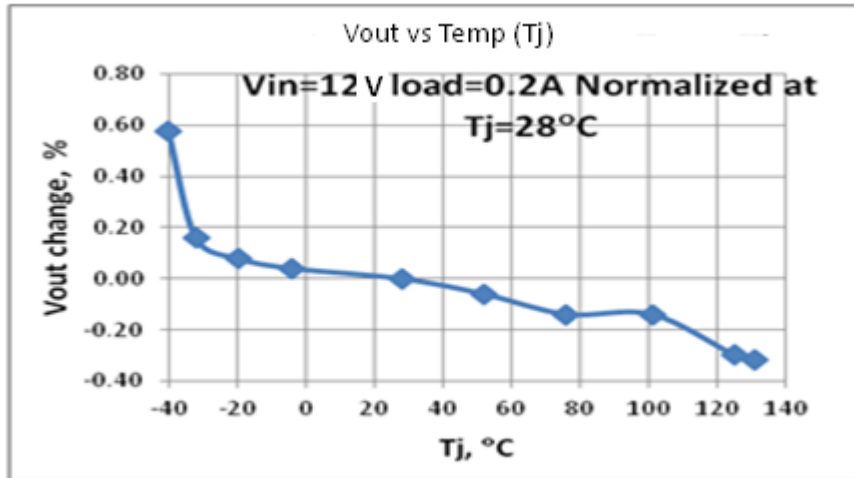


Fig.4. Vout vs Temp (Tj)

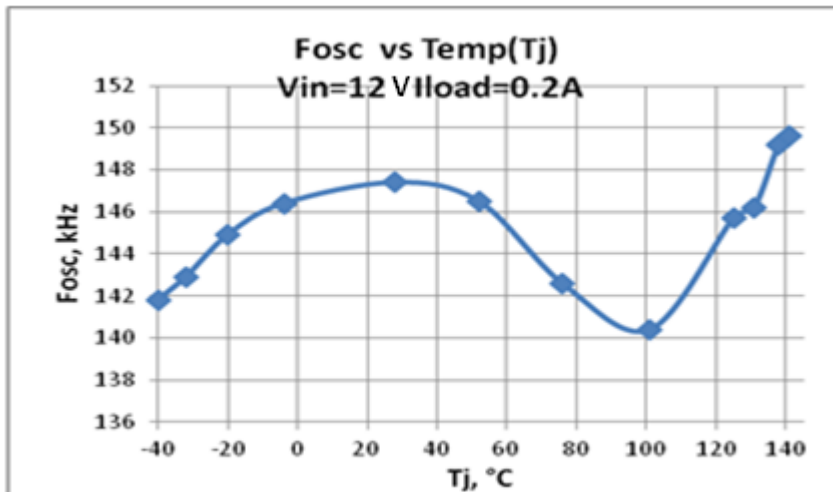


Fig.5. Fosc vs Temp (Tj)

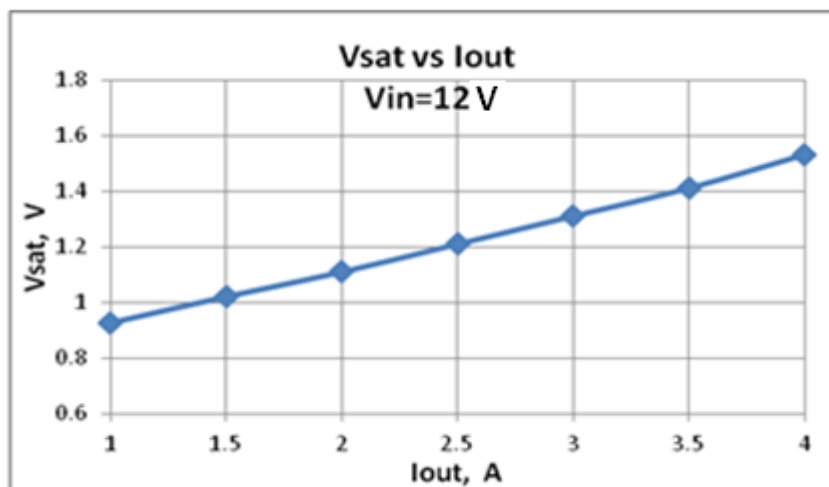


Fig.6. Vsat vs Iout

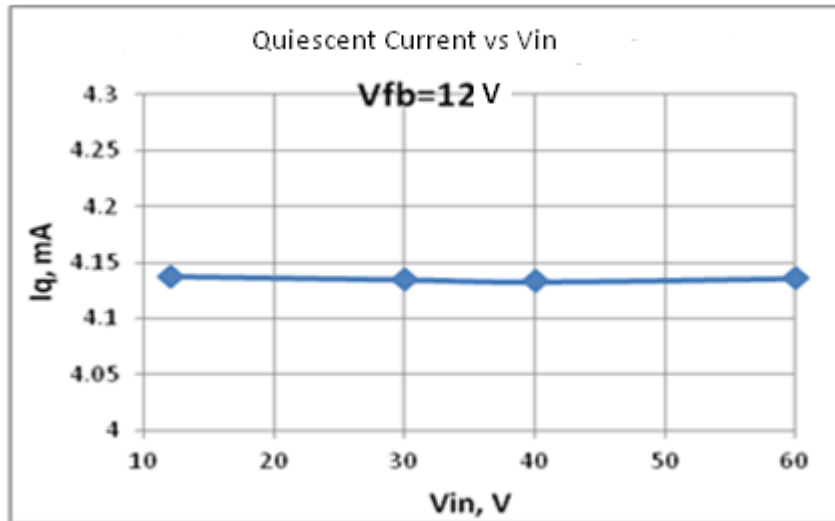


Fig.7. Quiescent Current vs Vin

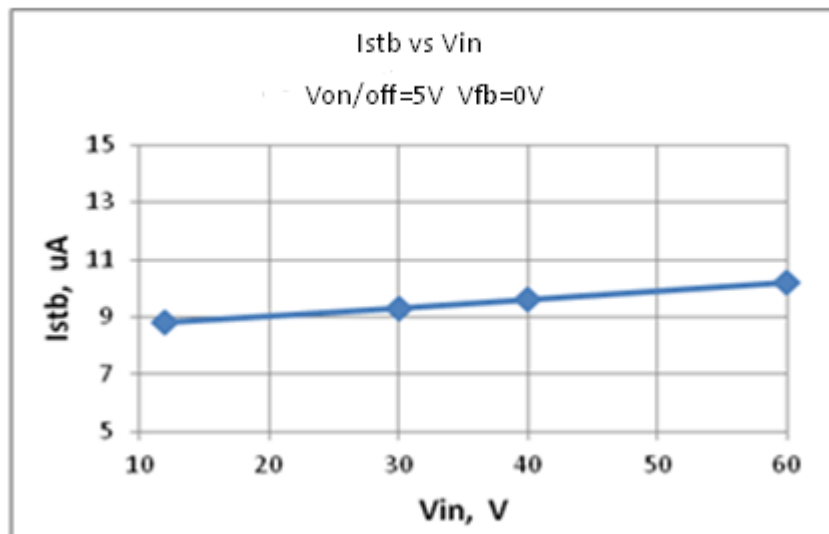
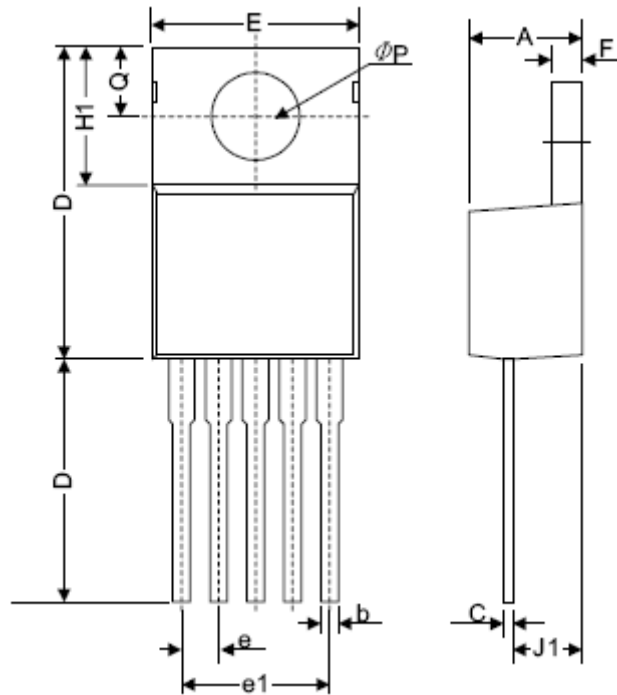


Fig.8. Istb vs Vin

Package Information

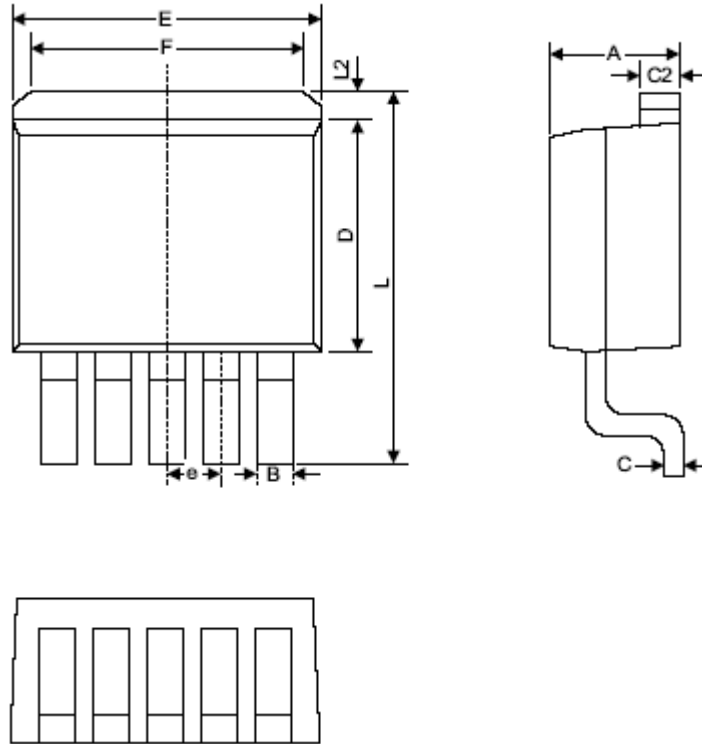
TO-220-5L



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.06	4.83	0.160	0.190
b	0.76	1.02	0.030	0.040
C	0.36	0.64	0.014	0.025
D	14.22	15.49	0.560	0.610
E	9.78	10.54	0.385	0.415
e	1.57	1.85	0.062	0.073
e(1)	6.68	6.93	0.263	0.273
F	1.14	1.40	0.045	0.055
H(1)	5.46	6.86	0.215	0.270
J(1)	2.29	3.18	0.090	0.125
L	13.21	14.73	0.520	0.580
$\phi P$	3.68	3.94	0.145	0.155
Q	2.54	2.92	0.100	0.115

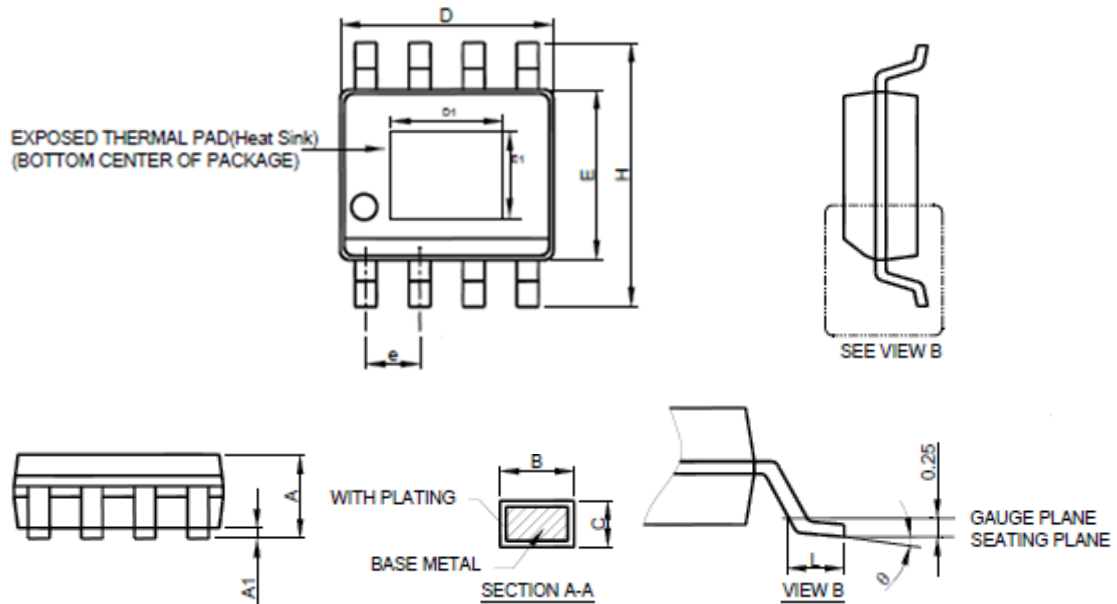


TO-263-5L



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.440	4.650	0.175	0.183
B	0.710	0.970	0.028	0.038
C	0.360	0.640	0.014	0.025
C2	1.255	1.285	0.049	0.051
D	8.390	8.890	0.330	0.350
E	9.960	10.360	0.392	0.408
e	1.550	1.850	0.061	0.073
F	6.360	7.360	0.250	0.290
L	13.950	14.750	0.549	0.581
L2	1.120	1.420	0.044	0.056

ESOP-8L



Symbol	Dimensions In Millimeters	
	Min	Max
A	1.35	1.75
A1	0.05	0.25
B	0.31	0.51
C	0.17	0.25
D	4.70	5.10
E	3.70	4.10
e	1.27BSC	
H	5.80	6.20
L	0.40	1.27
$\theta$	0°	8°
D1	3.10REF	
E1	2.21REF	