National Semiconductor

LM2594/LM2594HV
SIMPLE SWITCHER® Power Converter 150 kHz 0.5A Step-Down Voltage Regulator

General Description

The LM2594/LM2594HV series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving a 0.5A 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, and are packaged in a 8-lead DIP and a 8-lead surface mount package.

Requiring a minimum number of external components, these regulators are simple to use and feature internal frequency compensation†, a fixed-frequency oscillator, and improved line and load regulation specifications.

The LM2594/LM2594HV 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. Because of its high efficiency, the copper traces on the printed circuit board are normally the only heat sinking needed.

A standard series of inductors (both through hole and surface mount types) are available from several different manufacturers optimized for use with the LM2594/LM2594HV series. This feature greatly simplifies the design of switch-mode power supplies.

Other features include a guaranteed ±4% tolerance on output voltage under all conditions of input voltage and output load conditions, and ±15% on the oscillator frequency. External shutdown is included, featuring typically 85 µA 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.

The LM2594HV is for applications requiring an input voltage up to 60V.

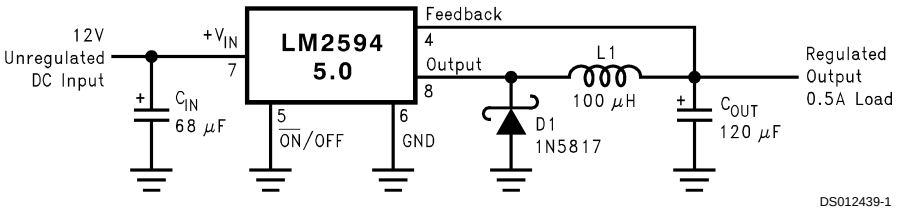
Features

- 3.3V, 5V, 12V, and adjustable output versions
- Adjustable version output voltage range, 1.2V to 37V (57V for the HV version)±4% max over line and load conditions
- Available in 8-pin surface mount and DIP-8 package
- Guaranteed 0.5A output current
- Input voltage range up to 60V
- Requires only 4 external components
- 150 kHz fixed frequency internal oscillator
- TTL Shutdown capability
- Low power standby mode, I_Q typically 85 µA
- High Efficiency
- Uses readily available standard inductors
- Thermal shutdown and current limit protection

Applications

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

Typical Application (Fixed Output Voltage Versions)



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Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Maximum Supply Voltage	
LM2594	45V
LM2594HV	60V
$\overline{ON}$ /OFF Pin Input Voltage	−0.3 ≤ V ≤ +25V
Feedback Pin Voltage	−0.3 ≤ V ≤+25V
Output Voltage to Ground (Steady State)	−1V
Power Dissipation	Internally limited
Storage Temperature Range	−65˚C to +150˚C
ESD Susceptibility	
Human Body Model (Note 2)	2 kV
Lead Temperature	
M8 Package	
Vapor Phase (60 sec.)	+215˚C
Infrared (15 sec.)	+220˚C
N Package (Soldering, 10 sec.)	+260˚C
Maximum Junction Temperature	+150˚C

Operating Conditions

Temperature Range	−40˚C ≤ T_J +125˚C
Supply Voltage	
LM2594	4.5V to 40V
LM2594HV	4.5V to 60V

LM2594/LM2594HV-3.3 Electrical Characteristics

Specifications with standard type face are for T_J = 25˚C, and those with **boldface type** apply over **full Operating Temperature Range.** V_{INmax}= 40V for the LM2594 and 60V for the LM2594HV.

Symbol	Parameter	Conditions	LM2594/LM2594HV-3.3		Units (Limits)
			Typ (Note 3)	Limit (Note 4)	
SYSTEM PARAMETERS (Note 5) Test Circuit *Figure 1*					
V_{OUT}	Output Voltage	4.75V ≤ V_{IN} ≤ V_{INmax}, 0.1A ≤ I_{LOAD} ≤ 0.5A	3.3		V
				3.168/**3.135**	V(min)
				3.432/**3.465**	V(max)
η	Efficiency	V_{IN} = 12V, I_{LOAD} = 0.5A	80		%

LM2594/LM2594HV-5.0 Electrical Characteristics

Specifications with standard type face are for T_J = 25˚C, and those with **boldface type** apply over **full Operating Temperature Range**

Symbol	Parameter	Conditions	LM2594/LM2594HV-5.0		Units (Limits)
			Typ (Note 3)	Limit (Note 4)	
SYSTEM PARAMETERS (Note 5) Test Circuit *Figure 1*					
V_{OUT}	Output Voltage	7V ≤ V_{IN} ≤ V_{INmax}, 0.1A ≤ I_{LOAD} ≤ 0.5A	5.0		V
				4.800/**4.750**	V(min)
				5.200/**5.250**	V(max)
η	Efficiency	V_{IN} = 12V, I_{LOAD} = 0.5A	82		%

LM2594/LM2594HV-12 Electrical Characteristics

Specifications with standard type face are for T_J = 25˚C, and those with **boldface type** apply over **full Operating Temperature Range**

Symbol	Parameter	Conditions	LM2594/LM2594HV-12		Units (Limits)
			Typ (Note 3)	Limit (Note 4)	
SYSTEM PARAMETERS (Note 5) Test Circuit *Figure 1*					
V_{OUT}	Output Voltage	15V ≤ V_{IN} ≤ V_{INmax}, 0.1A ≤ I_{LOAD} ≤ 0.5A	12.0		V
				11.52/**11.40**	V(min)
				12.48/**12.60**	V(max)
η	Efficiency	V_{IN} = 25V, I_{LOAD} = 0.5A	88		%

LM2594/LM2594HV-ADJ Electrical Characteristics

Specifications with standard type face are for T_J = 25˚C, and those with **boldface type** apply over **full Operating Temperature Range**

Symbol	Parameter	Conditions	LM2594/LM2594HV-ADJ		Units (Limits)
			Typ (Note 3)	Limit (Note 4)	
SYSTEM PARAMETERS (Note 5) Test Circuit *Figure 1*					
V_{FB}	Feedback Voltage	4.5V ≤ V_{IN} ≤ V_{INmax}, 0.1A ≤ I_{LOAD} ≤ 0.5A V_{OUT} programmed for 3V. Circuit of *Figure 1*	1.230	 1.193/**1.180** 1.267/**1.280**	V V(min) V(max)
η	Efficiency	V_{IN} = 12V, I_{LOAD} = 0.5A	80		%

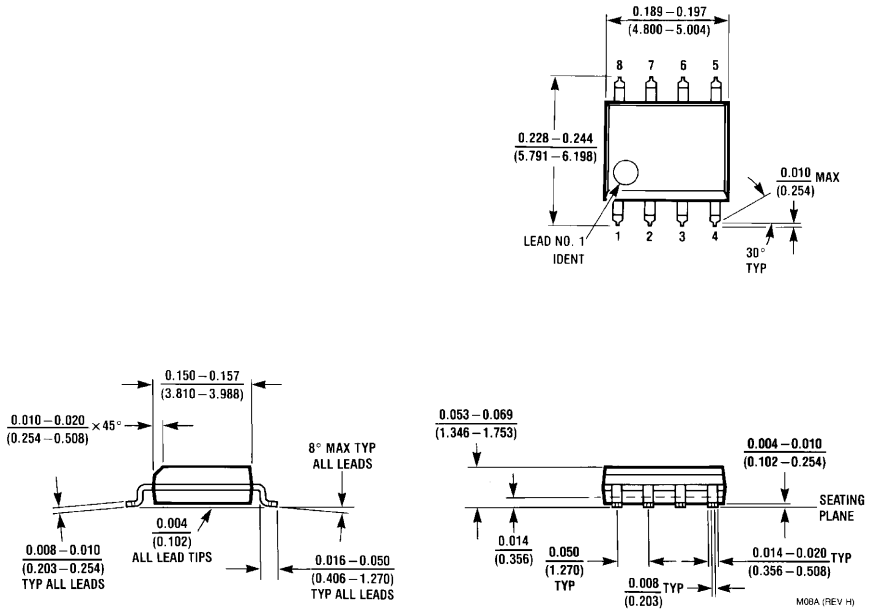
All Output Voltage Versions Electrical Characteristics

Specifications with standard type face are for T_J = 25˚C, and those with **boldface type** apply over **full Operating Temperature Range** . Unless otherwise specified, V_{IN} = 12V for the 3.3V, 5V, and Adjustable version and V_{IN} = 24V for the 12V version. I_{LOAD} = 100 mA

Symbol	Parameter	Conditions	LM2594/LM2594HV-XX		Units (Limits)
			Typ (Note 3)	Limit (Note 4)	
DEVICE PARAMETERS					
I_b	Feedback Bias Current	Adjustable Version Only, VFB = 1.3V	10	50/**100**	nA
f_O	Oscillator Frequency	(Note 6)	150	 127/**110** 173/**173**	kHz kHz(min) kHz(max)
V_{SAT}	Saturation Voltage	I_{OUT} = 0.5A (Note 7) (Note 8)	0.9	 1.1/**1.2**	V V(max)
DC	Max Duty Cycle (ON) Min Duty Cycle (OFF)	(Note 8) (Note 9)	100 0		%
I_{CL}	Current Limit	Peak Current, (Note 7) (Note 8)	0.8	 0.65/**0.58** 1.3/**1.4**	A A(min) A(max)
I_L	Output Leakage Current	(Note 7) (Note 9) (Note 10) Output = 0V Output = −1V	 2	50 15	µA(max) mA mA(max)
I_Q	Quiescent Current	(Note 9)	5	 10	mA mA(max)
I_{STBY}	Standby Quiescent Current	ON/OFF pin = 5V (OFF) (Note 10) LM2594 LM2594HV	85 140	 200/**250** 250/**300**	µA µA(max) µA(max)
θ_{JA}	Thermal Resistance	N Package, Junction to Ambient (Note 11) M Package, Junction to Ambient (Note 11)	95 150		˚C/W
ON/OFF CONTROL Test Circuit *Figure 1*					
V_{IH} V_{IL}	$\overline{ON}$ /OFF Pin Logic Input Threshold Voltage	 Low (Regulator ON) High (Regulator OFF)	1.3	 **0.6** **2.0**	V V(max) V(min)
I_H	$\overline{ON}$ /OFF Pin Input Current	V_{LOGIC} = 2.5V (Regulator OFF)	5	 15	µA µA(max)
I_L		V_{LOGIC} = 0.5V (Regulator ON)	0.02	 5	µA µA(max)

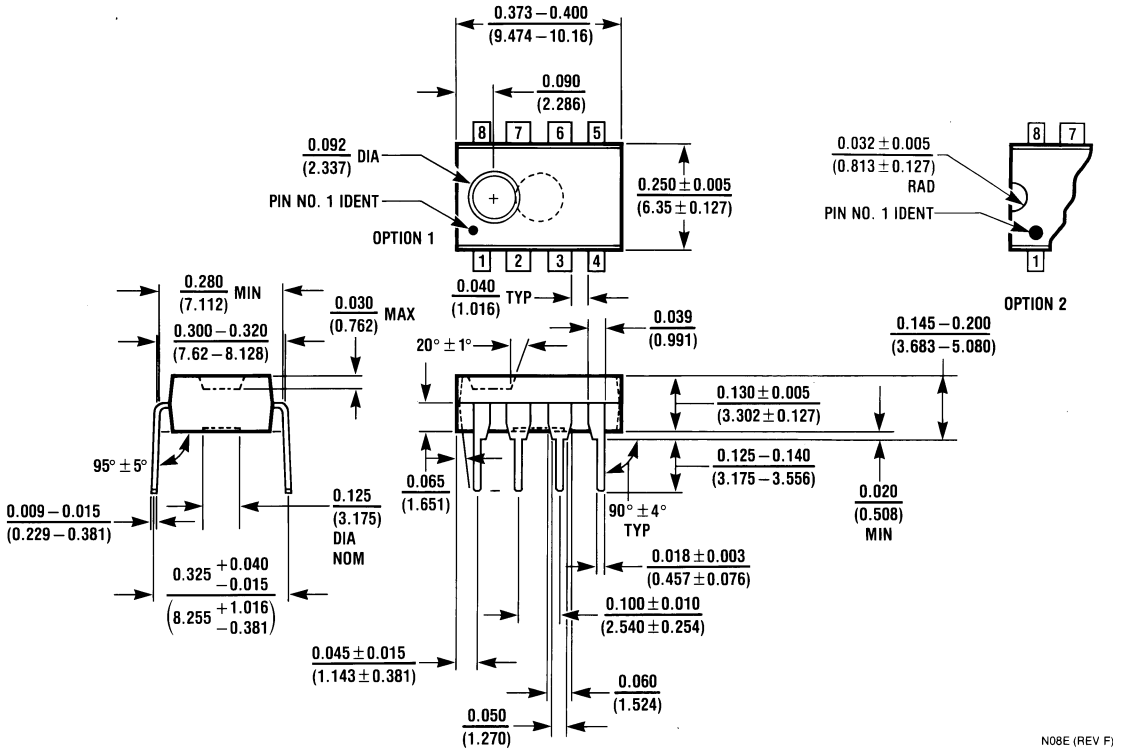
Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics.

Physical Dimensions inches (millimeters) unless otherwise noted



8-Lead (0.150" Wide) Molded Small Outline Package,
Order Number LM2594M-3.3, LM2594M-5.0,
LM2594M-12 or LM2594M-ADJ JEDEC
NS Package Number M08A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



8-Lead (0.300" Wide) Molded Dual-In-Line Package,
Order Number LM2594N-3.3, LM2594N-5.0, LM2594N-12 or LM2594N-ADJ
NS Package Number N08E

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