

0.5A 150KHz 40V PWM Buck DC/DC Converter

Features

- Adjustable Output Voltage Range 1.23V~37 V
- 3.3V, 5V, 12V, and adjustable versions
- Guaranteed 0.5 A Output Load Current
- Wide Input Voltage Range up to 40 V
- 150 kHz Fixed Frequency Internal Oscillator
- TTL Shutdown Capability
- Low Power Standby Mode, typ 50 μ A
- Thermal Shutdown and Current Limit Protection
- Internal Loop Compensation
- Moisture Sensitivity Level (MSL) Equals 1
- These are Pb-Free Devices

Applications

- Simple High-Efficiency Step-Down (Buck) Regulator
- Efficient Pre-Regulator for Linear Regulators
- On-Card Switching Regulators
- Positive to Negative Converter (Buck-Boost)
- Negative Step-Up Converters
- Power Supply for Battery Chargers

Package Types

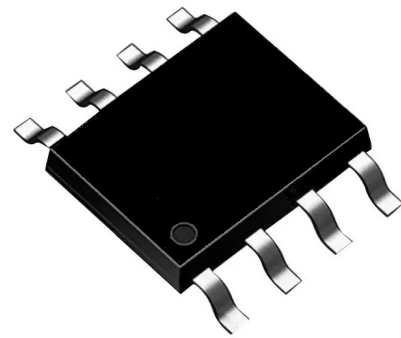


Figure 1. Package Types of LM2594

Pin Configurations

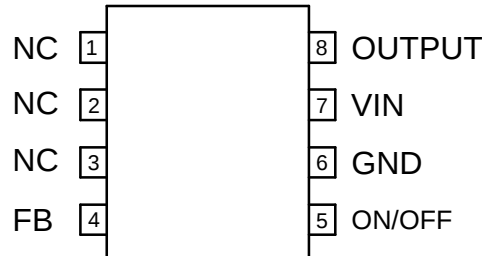


Figure 2 Pin Configuration of LM2594 (Top View)

Pin Description

Pin Number	Pin Name	Description
1/2/3	NC	Not Connected
4	FB	This pin is the direct input of the error amplifier and the resistor network R2, R1 is connected externally to allow programming of the output voltage.
5	ON/OFF	Allows the switching regulator circuit to be shut down using logic levels, thus dropping the total input supply current to approximately 50 μ A. The threshold voltage is typical. 1.6 V. Applying a voltage above this value (up to VIN) shuts the regulator off. If the voltage applied to this pin is lower than 1.6 V or if this pin is left open, the regulator will be in the "on" condition.
6	GND	Circuit ground pin. See the information about the printed circuit board layout.
7	VIN	Positive input supply for LM2594 step-down switching regulator. In order to minimize voltage transients and to supply the switching currents needed by the regulator, a suitable input bypass capacitor must be present.
8	OUTPUT	Emitter of the internal switch. The saturation voltage V _{sat} of the output switch is typically 1 V. It should be kept in mind that PCB area connected to this pin should be kept to a minimum in order to minimize coupling to sensitive circuitry.

Function Block

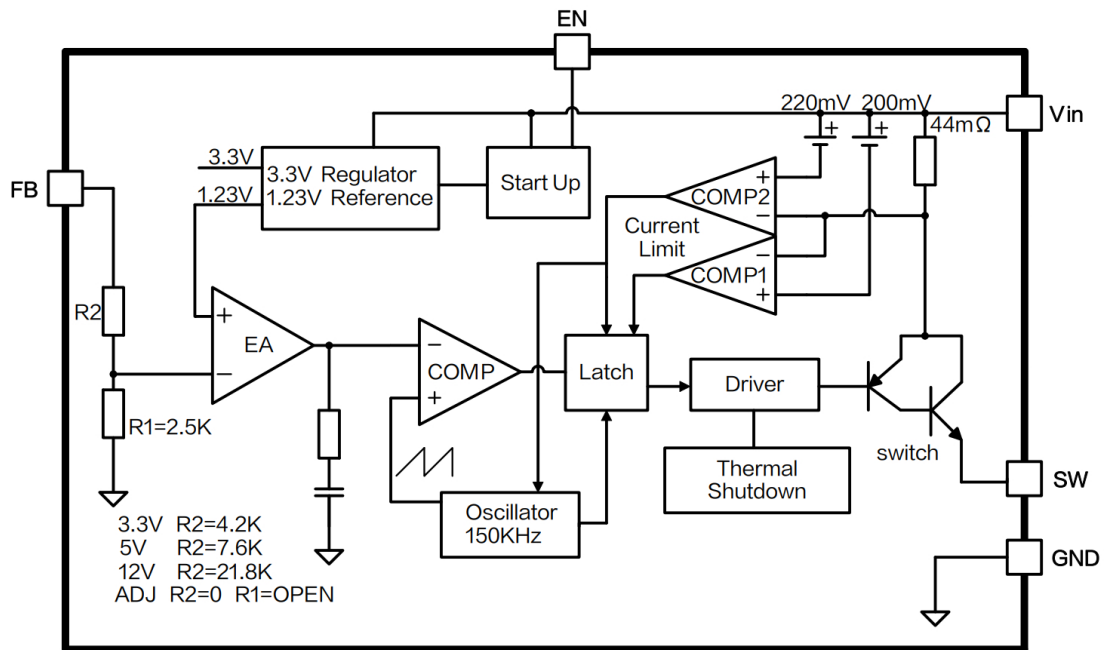


Figure 3 Function Block Diagram of LM2594

Typical Application Circuit

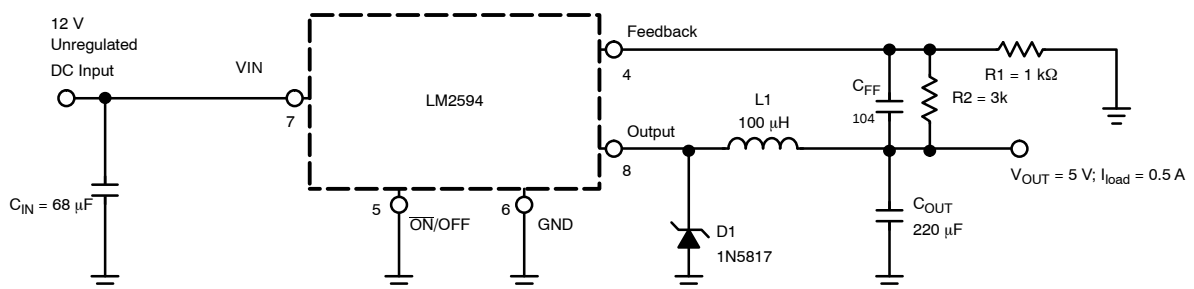


Figure4. LM2594-ADJ Typical Application Circuit (VIN=8V~40V, VOUT=5V/0.5A)

Ordering Information

Order Information	Marking ID	Package Type	Eco Plan	Packing Type Supplied As
LM2594MX-ADJ	LM2594-ADJ	SOP8L	RoHS & HF	2500 Units on Reel
LM2594MX-3	LM2594-3.3	SOP8L	RoHS & HF	2500 Units on Reel
LM2594MX-5.0	LM2594-5	SOP8L	RoHS & HF	2500 Units on Reel
LM2594MX-12	LM2594-12	SOP8L	RoHS & HF	2500 Units on Reel

Absolute Maximum Ratings

Note1: Stresses greater than those listed under Maximum Ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operation is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Parameter	Symbol	Value	Unit
Input Voltage	V_{IN}	-0.3 to 45	V
Feedback Pin Voltage	V_{FB}	-0.3 to V_{IN}	V
Enable Pin Voltage	V_{EN}	-0.3 to V_{IN}	V
Switch Pin Voltage	V_{SW}	-0.3 to V_{IN}	V
Power Dissipation	P_D	Internally limited	mW
Operating Junction Temperature	T_J	-40~125	°C
Storage Temperature	T_{STG}	-65 to 150	°C
Lead Temperature (Soldering, 10 sec)	T_{LEAD}	260	°C
ESD (HBM)		2000	V
MSL		Level3	
Thermal Resistance-Junction to Ambient	$R_{\theta JA}$	85	°C / W
Thermal Resistance-Junction to Case	$R_{\theta JC}$	45	°C / W

LM2596MX-3.3 Electrical Characteristics

T_a = 25°C; unless otherwise specified.

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
System parameters test circuit figure6						
V _{OUT}	Output Voltage	V _{in} = 8V to 40V I _{load} =0.1A to 0.5A	3.168	3.3	3.432	V
η	Efficiency	V _{in} =12V, V _{out} =3.3V I _{out} =0.5A	–	87	–	%

LM2596MX-5.0 Electrical Characteristics

T_a = 25°C; unless otherwise specified.

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
System parameters test circuit figure7						
V _{OUT}	Output Voltage	V _{in} = 8V to 40V I _{load} =0.1A to 0.5A	4.8	5	5.2	V
η	Efficiency	V _{in} =12V, V _{out} =5V, I _{out} =0.5A	–	88	–	%

LM2596MX-12 Electrical Characteristics

T_a = 25°C; unless otherwise specified.

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
System parameters test circuit figure8						
V _{OUT}	Output Voltage	V _{in} = 15V to 40V, I _{load} =0.1A to 0.5A	11.52	12	12.48	V
η	Efficiency	V _{in} =25V, V _{out} =12V, I _{out} =0.5A	–	90	–	%

LM2596MX-ADJ Electrical Characteristics

T_a = 25°C; unless otherwise specified.

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
System parameters test circuit figure9						
V _{OUT}	Output Voltage	V _{in} = 8V to 40V I _{load} =0.1A to 0.5A	1.193	1.23	1.267	V
η	Efficiency	V _{in} =12V, V _{out} =5V, I _{out} =0.5A	–	88	–	%

Electrical Characteristics (DC Parameters)

V_{in} = 12V for the 3.3V,5V,and Adjustable versions and V_{in} =24V for the 12V version, $GND=0V$, V_{in} & GND parallel connect a 220uF/50V capacitor; I_{out} =500mA, T_a = 25°C; the others floating unless otherwise specified.

Parameters	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Input operation voltage	V_{in}		4.5		40	V
Shutdown Supply Current	I_s	$V_{EN}=5V$		50	200	uA
Quiescent Supply Current	I_q	$V_{EN}=0V$, $V_{FB}=V_{in}$		4.5	10	mA
Oscillator Frequency	F_{osc}		127	150	173	Khz
Switch Current Limit	I_L	$V_{FB}=0V$		4.0		A
EN Pin Threshold	V_{EN}	High (Regulator OFF) Low (Regulator ON)		1.4 0.8		V
EN Pin Input Leakage Current	I_H	$V_{EN}=2.5V$ (OFF)		8	15	uA
	I_L	$V_{EN}=0.5V$ (ON)		0.5	5	uA
Output Saturation Voltage	V_{CE}	$V_{FB}=0V$ $I_{out}=2A$		1.2	1.5	V
Max. Duty Cycle	D_{MAX}	$V_{FB}=0V$		95		%

Test Circuit and Layout guidelines

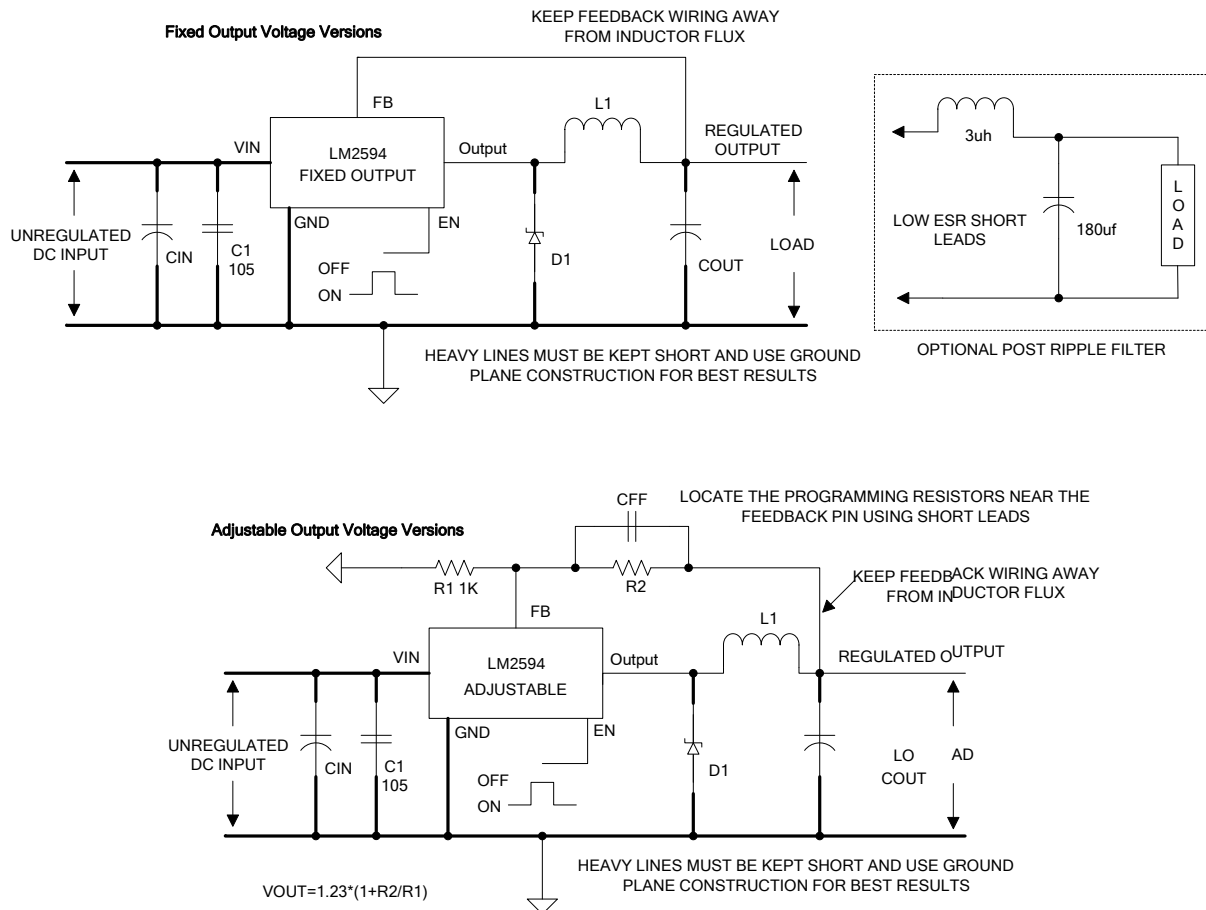


Figure4. Standard Test Circuits and Layout Guides

Select R1 to be approximately 1K, use a 1% resistor for best stability.

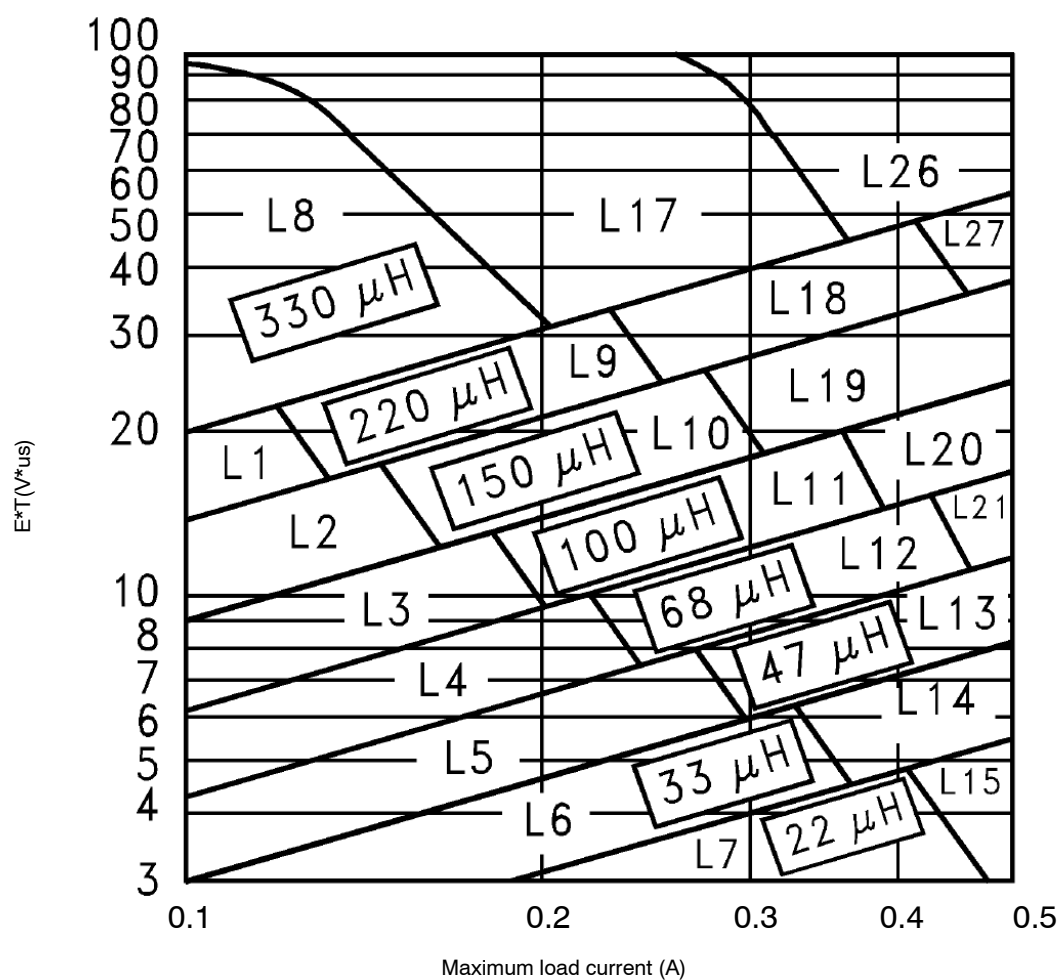
C1 and CFF are optional; in order to increase stability and reduce the input power line noise, C1 must be placed near to PIN1 and PIN3;

For output voltages greater than approximately 10V, an additional capacitor CFF is required. The compensation capacitor is typically between 100 pf and 33 nf, and is wired in parallel with the output voltage setting resistor, R2. It provides additional stability for high output voltage, low input-output voltages, and/or very low ESR output capacitors, such as solid tantalum capacitors.

$CFF = 1/(31 \cdot 1000 \cdot R_2)$; This capacitor type can be ceramic, plastic, silver mica, etc. (Because of the unstable characteristics of ceramic capacitors made with Z5U material, they are not recommended.)

LM2594 Series Buck Regulator Design Procedure (Fixed Output)

Nichicon Pm Capacitors									
V_{in} (V)	Capacity/Voltage Range / ESR[$\mu F/V/m\Omega$]								
40	1000/10/60	680/250	470/10/140	470/10/140	330/10/160	220/25/110	220/110	180/25/140	180/35/100
35	1000/10/60	680/150	470/10/140	330/10/160	180/25/140	180/25/140	180/25/140	180/25/140	180/35/100
26	1000/10/60	470/10/140	330/10/160	220/25/110	180/25/140	180/25/140	100/25/240	180/25/140	
20	1000/10/60	470/10/140	220/25/110	220/25/110	100/25/240	100/25/240	100/25/240		
18	1000/10/60	470/10/140	220/25/110	220/25/110	100/25/240	100/25/240	100/25/240		
12	470/10/140	470/10/140	220/25/110	180/25/140	100/25/240				
10	470/10/140	470/10/140	220/25/110	180/25/140					
V_{out} (V)	2	3	4	6	9	12	15	24	28
C_{FF} (nF)	15	4.7	1.5	1.5	1.5	1.5	1	0.6	0.6



LM2594 Series Buck Regulator Design Procedure (Adjustable Output)

Output Voltage (V)	Through Hole Output Electrolytic			Surface Mount Output Capacitor		
	Panasonic HFQ Series (uF/V)	Nichicon PL Series (uF/V)	Feedforward Capacitor	AVX TPS Series (uF/V)	Sprague 595D Series (uF/V)	Feedforward Capacitor
2	820/35	820/35	33nF	330/6.3	470/4	33nF
4	560/35	470/35	10nF	330/6.3	390/6.3	10nF
6	470/25	470/35	3.3nF	220/10	330/10	3.3nF
9	330/25	330/25	1.5nF	100/16	180/16	1.5nF
12	330/25	330/25	1nF	100/16	180/16	1nF
15	220/25	220/35	680pF	68/20	120/20	680pF
24	220/35	150/35	560pF	33/25	33/25	220pF
28	100/50	100/50	390pF	10/35	15/50	220pF

Schottky Diode Selection Table

V _R	1A Diodes			
	Surface Mouns		Through Hole	
	Schottky	Ultra Fast Recovery	Schottky	Ultra Fast Recovery
20 V	MBRS140	All of these diodes are rated to at least 60 V. MURS120 10BF10	1N5817	All of these diodes are rated to at least 60 V. MUR120 HER101 11DF1
30 V	10BQ040		SR102	
40 V	10MQ040		1N5818	
50 V or more	MBRS160		SR103	
	10BQ050		11DQ03	
	10MQ060		1N5819	
	MBRS1100		SR104	
	10MQ090		11DQ04	
	SGL41-60		SR105	
	SS16		MBR150	
	MBRS140		11DQ05	
	10BQ040		MBR160	

Typical System Application for 3.3V Version

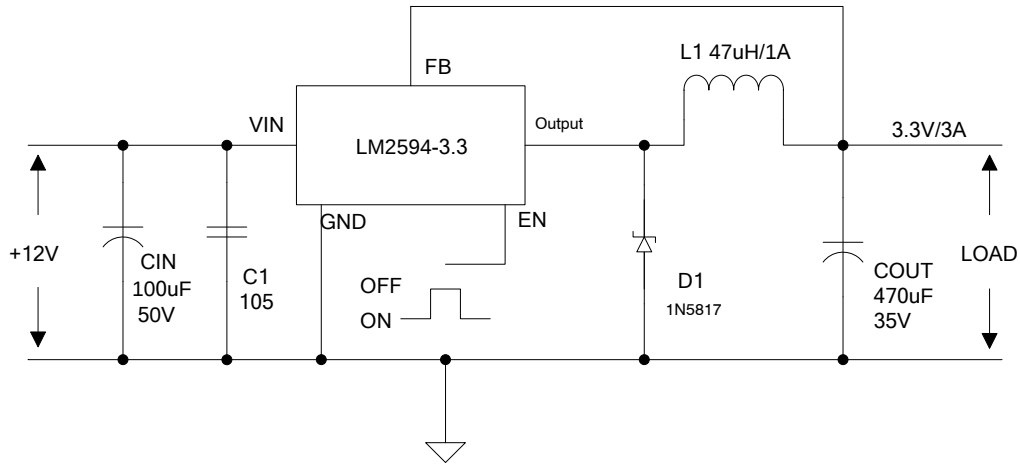


Figure5. LM2594-3.3 System Parameters Test Circuit

Typical System Application for 5V Version

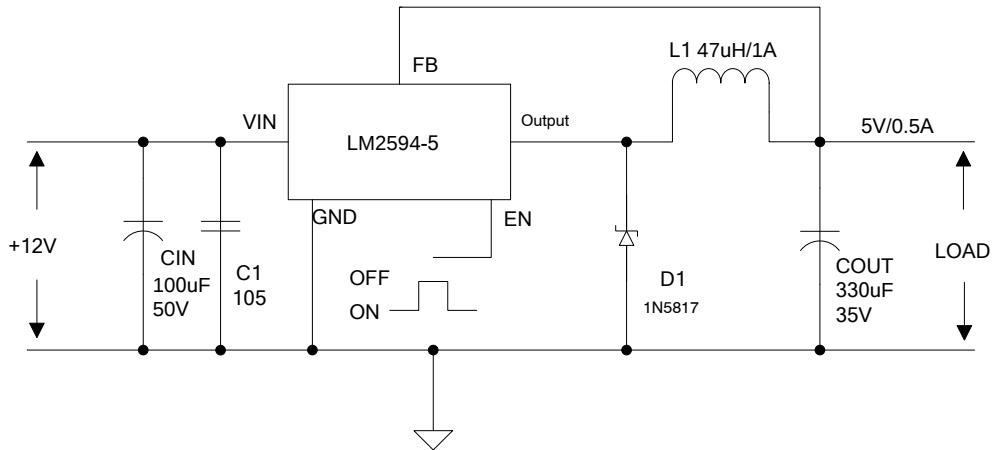


Figure6. LM2594-5.0 System Parameters Test Circuit

Typical System Application for 12V Version

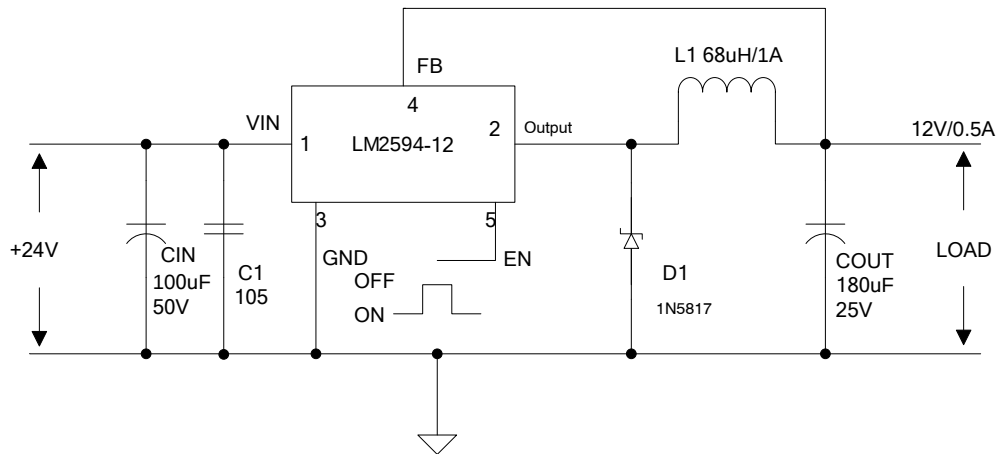


Figure7. LM2594-12 System Parameters Test Circuit

Typical System Application for ADJ Version

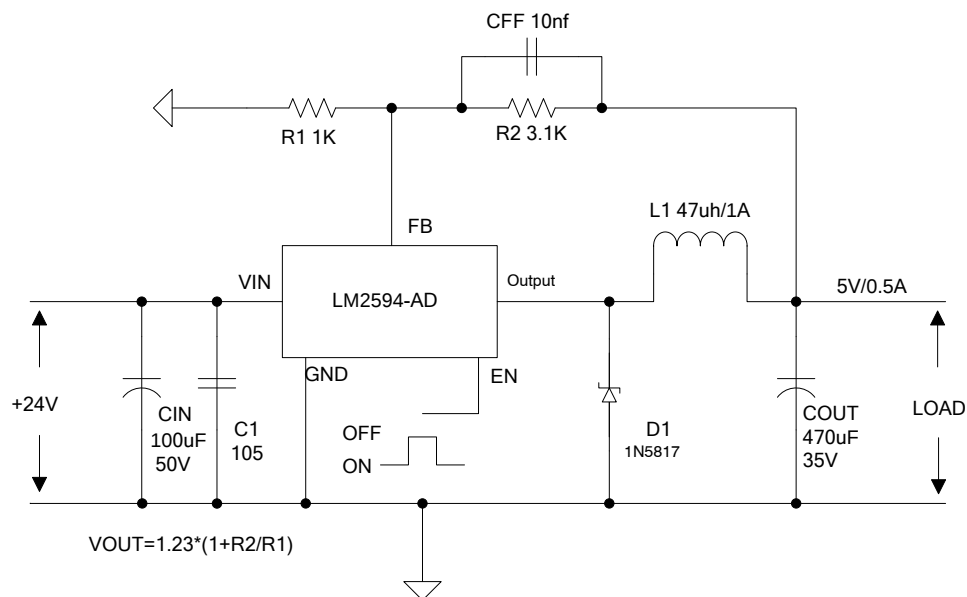
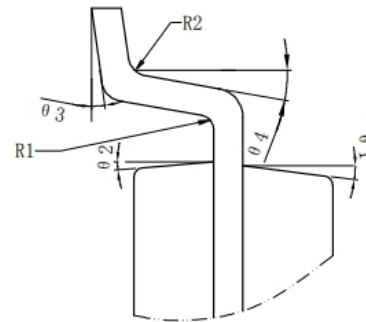
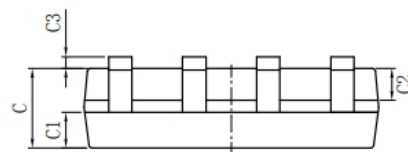
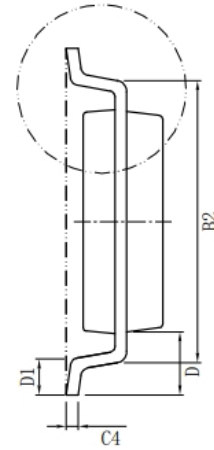
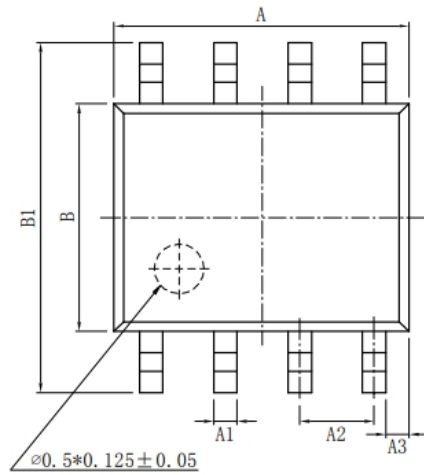


Figure8. LM2594-AD System Parameters Test Circuit

SOP8L Package Outline Dimensions



标注	尺寸	MIN(mm)	MAX(mm)	标注	尺寸	MIN(mm)	MAX(mm)
A		4.80	5.00	C3		0.05	0.20
A1		0.356	0.456	C4		0.203	0.233
A2		1.27TYP		D		1.05TYP	
A3		0.345TYP		D1		0.40	0.80
B		3.80	4.00	R1		0.20TYP	
B1		5.80	6.20	R2		0.20TYP	
B2		5.00TYP		$\theta 1$		17° TYP4	
C		1.30	1.60	$\theta 2$		13° TYP4	
C1		0.55	0.65	$\theta 3$		0° ~ 8°	
C2		0.55	0.65	$\theta 4$		4° ~ 12°	