DP2596

3A 150KHz Step-Down Voltage Regulator

General Description

The DP2596 regulator is monolithic integrated circuit that provide all the active function for a step-down (buck) switching regulator, capable of driving 3A load with excellent line and load regulator. These devices are available in fixed output voltage of 3.3V, 5V, 12V, 15V, and 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 DP2596 offer a high efficiency replacement for popular three terminal linear regulators. It substantiality reduces the size of the heat sink, and in some cases no heat sink is required.

A standard series of inductors optimized for use with the DP2596 are available from several different manufacturers. This feature greatly simplifies the design of switch-mode power supplies.

Other features include a guaranteed ±4% tolerance on output voltage within specified input voltages and output load conditions, and 10% on the oscillator frequency. External shutdown is included, featuring 80uA (typical) standby current. The output switch includes cycle-by-cycle current limiting, as well as thermal shutdown for full protection under fault conditions.

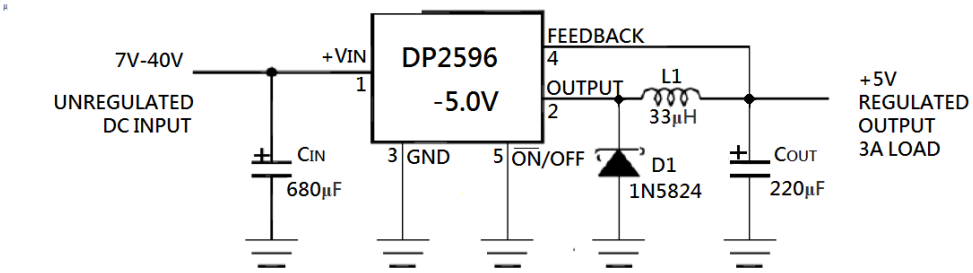
Features

- 3.3V, 5V, 12V, 15V, and adjustable output versions
- Adjustable version output voltage range, 1.23V to 37V ±4% max over line and load conditions
- Guaranteed 3A output current
- Wide input voltage range, 7V to 40V
- Requires only 4 external components
- 150KHz fixed frequency internal oscillator
- TTL shutdown capability, low power standby mode
- High efficiency
- Uses readily available standard inductors
- Thermal shutdown and current limit protection

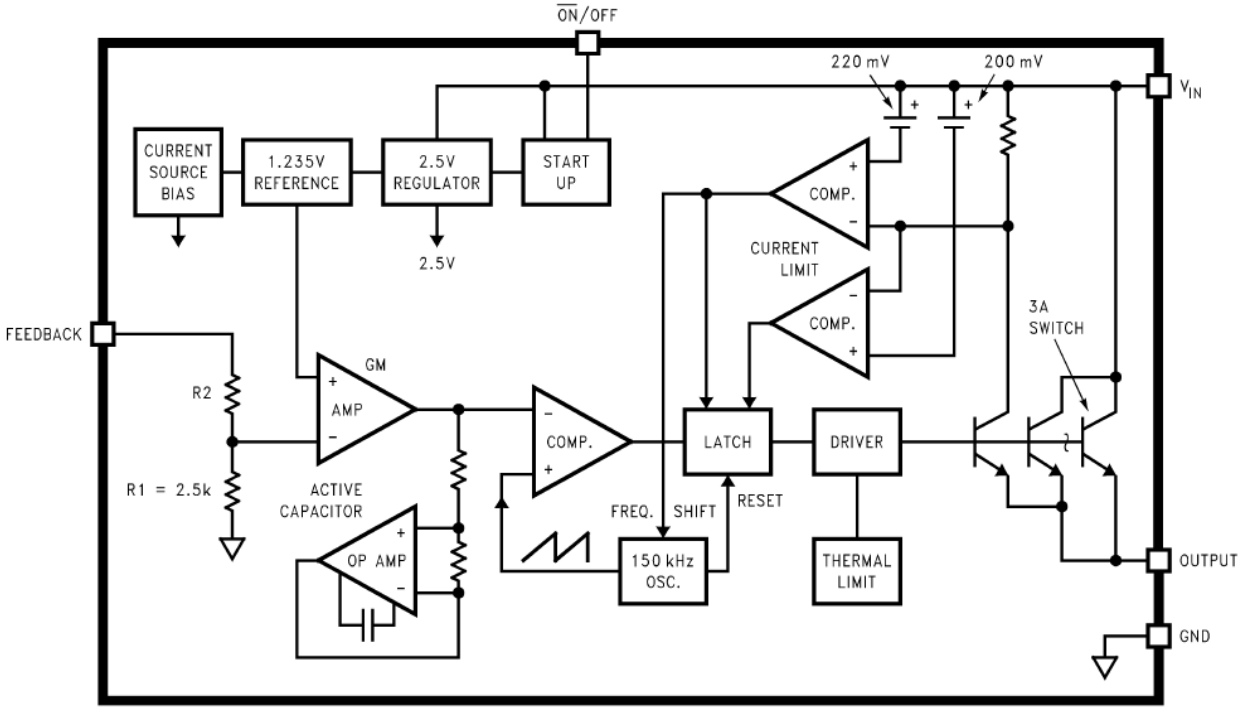
Application

- Simple high-efficiency step-down (buck) regulator
- Efficient pre-regulator for linear regulators
- On-card switching regulator
- Positive to negative converter (Buck-Boost)
- Power Supply for Battery Chargers
- Negative Step-Up Converters

Typical Application (Fixed Output Voltage Versions)



■ Block Diagram



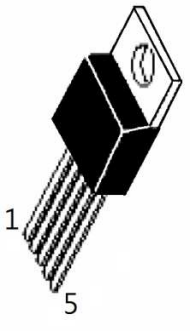
■ Pin Descriptions

Symbol	Pin No.	Description
V_{IN}	1	This pin is the positive input supply for the DP2596 Step-down switching regulator. In order to minimize voltage transients and to supply the switching current needed by the regulator, a suitable input bypass capacitor must be present.
Output	2	This is the emitter of the internal switch. The saturation voltage V_{SAT} of this output switch is typically 1.5V. It should be kept in mind that the PCB area connected to this pin should be kept to a minimum in order to minimize coupling to sensitive circuitry.
Ground	3	Circuit ground pin. See the information about the PCB layout.
Feedback	4	This pin senses regulated output voltage to complete the feedback loop. The signal is divided by the internal resistor divider network R2, R1 and applied to the non-inverting input of the internal error amplifier. In the Adjustable version of the DP2596 switching regulator 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.
ON/OFF	5	It allows the switching regulator circuit to be shut down using logic level signals, this dropping the total input supply current to approximately 80mA. The threshold voltage is typically 1.4V. Applying a voltage above this value(up to $+V_{IN}$) shuts the regulator

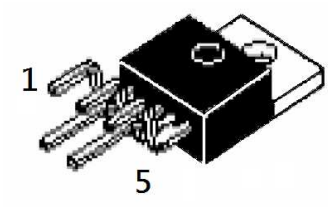
		off. If the voltage applied to this pin lower than 1.4V or if this pin is left open, the regulator will be in the “ON” condition.

■ Pin Configuration and Marking Information

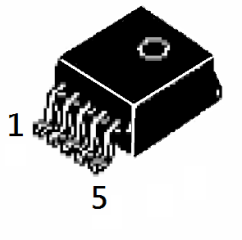
TO-220



TO-220V



TO-263



Pin Define :

1 – V_{IN}

2 – Output

3 – Ground

4 – Feedback

5 – ON/OFF

Marking information :

D2596P

–VVV

XXYWW

D2596 : Product Number

P : Package type (M : TO-220, N : TO-220V, O : TO-263)

VVV : Output Voltage (ADJ: Adjustable, 033: 3.3V, 050: 5.0V, 120: 12V, 150: 15V)

XX : Internal Code

Y : Year (keep Last digital at Year)

WW : Week (01~52)

■ Ordering Information

D P 2 5 9 6 X X X

Shipping Pack (A: Tape&Reel, B: Tube)

Output Voltage (A: Adjustable, B: 3.3V, C: 5.0V, D: E: 12V, F: 15V)

Package type (M : TO-220, N : TO-220V, O : TO-263)

Part Number	Marking	Package Type	Shipping Pack
DP2596MVB	D2596M –VVV XXYWW	TO-220	50Units/Tube
DP2596NVB	D2596N –VVV XXYWW	TO-220V	50Units/Tube
DP2596OVA	D2596O –VVV XXYWW	TO-263	800Units/Tape/Reel
DP2596OVB			50Units/Tube

■ Absolute Maximum Ratings

(About Maximum Ratings indicate limits beyond which damage to the device may occur.)

Parameter	Symbol	Value	Unit
Maximum Input Supply Voltage	V_{IN}	45	V
ON/OFF Pin Input Voltage		-0.3V≦V≦+25	V
Output Voltage to Ground	V_O	-1.0	V
Storage Temperature Range	T_{SGT}	-65 to +150	℃
Minimum ESD Rating (Human Body Model; C=100pF, R=1.5K)		2.5	KV
Lead Temperature (Soldering, 10 Seconds)		260	℃
Maximum Junction Temperature	T_J	150	℃

■ Recommended Operating Conditions

(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.)

Parameter	Symbol	Value	Unit
Operating junction Temperature Range	Tj	-40 to 125	℃
Supply Voltage	V_{IN}	40	V

■ Thermal Information

Parameter	Symbol	Package	Maximum	Unit
Thermal Resistance, Junction to Ambient	$P_{\theta JA}$	TO-220	65	℃/W
		TO-220V	65	
		TO-263	70	
Thermal Resistance, Junction to Case	$P_{\theta JC}$	TO-220	70	℃/W
		TO-220V	70	
		TO-263	5.0	

■ Electrical Characteristics ([Note 1] Test Circuit Figure 2) (Unless otherwise specified, V_{IN} = 12V for the 3,3V, 5.0V, and Adjustable version, V_{IN} = 25V for the 12V version, and V_{IN} = 30V for the 15V version. I_{LOAD} = 500mA. For typical values T_J =25°C, for min/max values T_J is the operating junction temperature range that applies [Not2 2], Unless otherwise noted.)

DP2576 3.3V Output

Symbol	Characteristics	Min	Typ	Max	Unit
V_{OUT}	Output Voltage (V_{IN}=12V, I_{LOAD}=0.5A, T_J =25°C)	3.2	3.3	3.4	V
	Output Voltage (6V≦V_{IN}≦40V, 0.5A≦I_{LOAD}≦=3A) T_J =25°C T_J = -40°C to +125°C	 3.168 3.135	 3.3	 3.432 3.465	V
η	Efficiency (V_{IN} = 12V, I_{LOAD} = 3A)		73		%

DP2576 5V Output

Symbol	Characteristics	Min	Typ	Max	Unit
V_{OUT}	Output Voltage (V_{IN}=12V, I_{LOAD}=0.5A, T_J =25°C)	4.85	5	5.15	V
	Output Voltage (8V≦V_{IN}≦40V, 0.5A≦I_{LOAD}≦=3A) T_J =25°C T_J = -40°C to +125°C	 4.8 4.75	 5	 5.2 5.25	V
η	Efficiency (V_{IN} = 12V, I_{LOAD} = 3A)		80		%

DP2576 12V Output

Symbol	Characteristics	Min	Typ	Max	Unit
V_{OUT}	Output Voltage (V_{IN}=15V, I_{LOAD}=0.5A, T_J =25°C)	11.64	12	12.36	V
	Output Voltage (15V≦V_{IN}≦40V, 0.5A≦I_{LOAD}≦=3A) T_J =25°C T_J = -40°C to +125°C	 11.52 12.4	 12	 12.48 12.6	V
η	Efficiency (V_{IN} = 15V, I_{LOAD} = 3A)		90		%

DP2576 15V Output

Symbol	Characteristics	Min	Typ	Max	Unit
V_{OUT}	Output Voltage (V_{IN}=30V, I_{LOAD}=0.5A, T_J =25°C)	14.7	15	15.3	V
	Output Voltage (18V≦V_{IN}≦40V, 0.5A≦I_{LOAD}≦=3A) T_J =25°C T_J = -40°C to +125°C	 14.4 14.25	 15	 15.6 15.75	V
η	Efficiency (V_{IN} = 18V, I_{LOAD} = 3A)		98		%

DP2576 ADJ Output

Symbol	Characteristics	Min	Typ	Max	Unit
V_{OUT}	Feedback Voltage (V_{IN}=12V, I_{LOAD}=0.5A, T_J =25°C)	1.217	1.23	1.243	V
	Feedback Voltage (8V≦V_{IN}≦40V, 0.5A≦I_{LOAD}≦=3A, V_{OUT}=5V) T_J =25°C T_J = -40°C to +125°C	 1.193 1.18	 1.23	 1.267 1.28	V
η	Efficiency (V_{IN} = 12V, I_{LOAD} = 3A, V_{OUT}=5V)		73		%

All Output Voltage Versions

Symbol	Characteristics	Min	Typ	Max	Unit
I_b	Feedback Bias Current, V_{OUT}=5V (Adjustable Version only) T_J =25°C T_J = 0°C to +125°C	 - -	 10 -	 50 100	nA
f_{OSC}	Oscillator Frequency (I_{OUT} = 3.0A [Note 4]) T_J =25°C T_J = 0°C to +125°C	 127 110	 150 -	 173 173	KHz
V_{SAT}	Saturation Voltage (I_{OUT} = 3.0A [Note 4])	- -	1.16 -	1.4 1.5	V
DC	Max Duty Cycle (ON [Note 5])	-	100	-	%
I_{CL}	Current Limit (Peak Current [Note 3&4]) T_J =25°C T_J = 0°C to +125°C	 3.6 3.4	 4.5 -	 6.9 7.5	A
I_L	Output Leakage Current [Note 6&7], T_J =25°C Output = 0V Output = -1.0V	 - -	 - 2	 50 30	mA
I_Q	Quiescent Current [Note 6] T_J =25°C T_J = -40°C to +125°C	 - -	 5 -	 - 10	mA
I_{STBY}	Standby Quiescent Current, ON/OFF Pin = 5V (OFF) T_J =25°C T_J = -40°C to +125°C	 - -	 80 -	 200 250	μA

ON/OFF CONTROL					
V_{IH}	ON/OFF Pin Logic Input Level, V_{OUT} = 0V T_J =25°C T_J = 0°C to +125°C		1.3 -	0.6 0.6	V
V_{IL}	ON/OFF Pin Logic Input Level, V_{OUT} = Nominal Output Voltage T_J =25°C T_J = 0°C to +125°C	2.0 2.0	1.3 -	- -	V
I_{IH}	ON/OFF Pin Input Current, V_{IH} = 2.5V (OFF)	-	5	15	μA
I_{IL}	ON/OFF Pin Input Current, V_{IL} = 0.5V (ON)		0.02	5	

Note 1 : External components such as the catch diode, inductor, input and output capacitors can affect switching regulator system performance. When the DP2596 is used as shown in the Figure 2 test circuit, system performance will be as shown in system parameters section of Electrical Characteristics.

Note 2 : Tested junction temperature range for the DP2596 : T_J = 0°C to +125°C

Note 3: The oscillator frequency reduces to approximately 18KHz in the event of an output short or an overload which causes the regulated output voltage to drop approximately 40% from the nominal output voltage. This self protection feature lowers the average power dissipation of the 1C by lowering the minimum duty cycle from 5% down to approximately 2%.

Note 4 : Output pin sourcing current. No diode, inductor or capacitor connected to output pin.

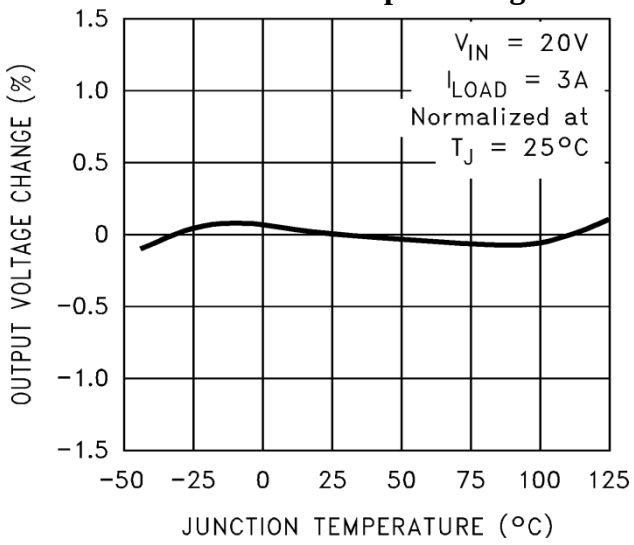
Note 5 : Feedback pin removed from output and connected to 0V.

Note 6 : Feedback pin removed from output and connected to a 12V for Adjustable, 3.3V and 5V versions, and a 25V for Adjustable, 12V and 15V versions, to force the output transistor OFF.

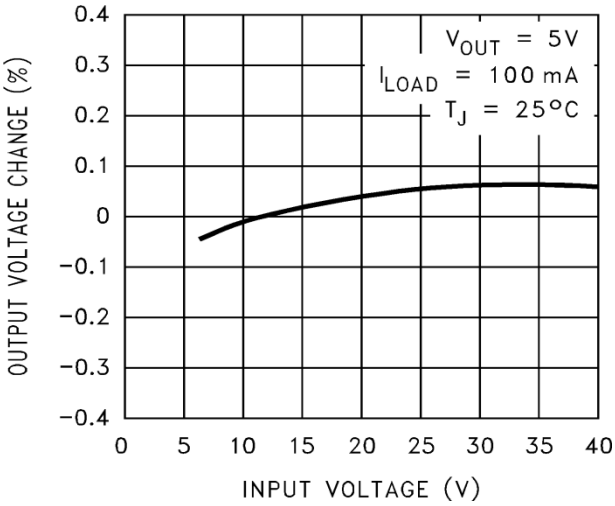
Note 7 : V_{IN} = 40V

■ Typical Operating Characteristics

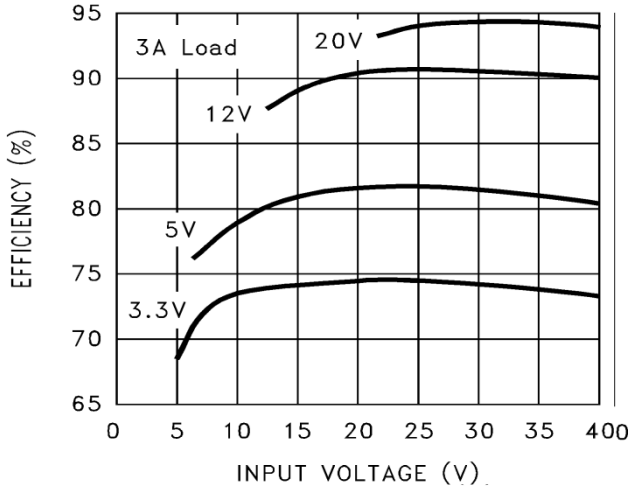
Normalized Output Voltage



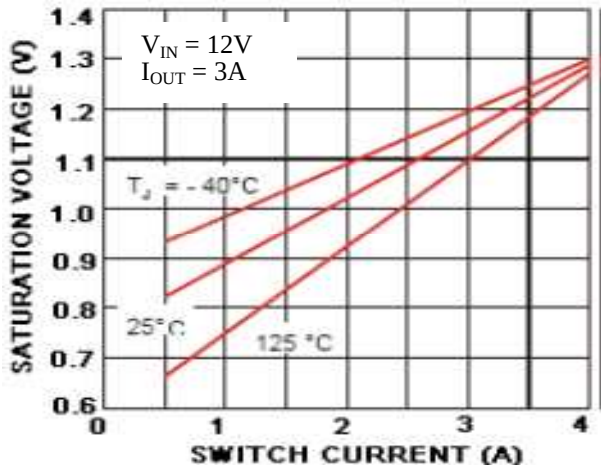
Line Regulation



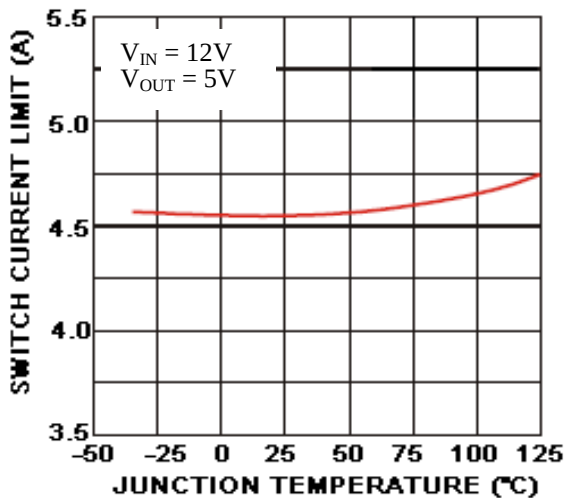
Efficiency



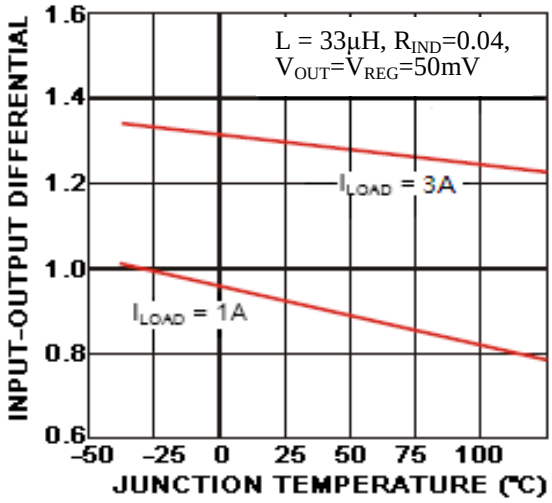
Switch Saturation Voltage



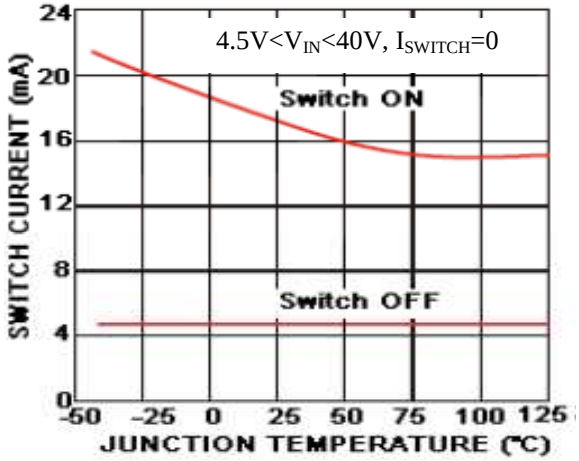
Switching Current Limit



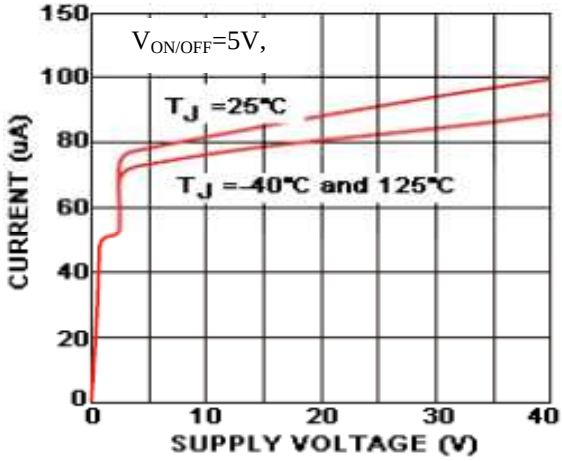
Dropout Voltage



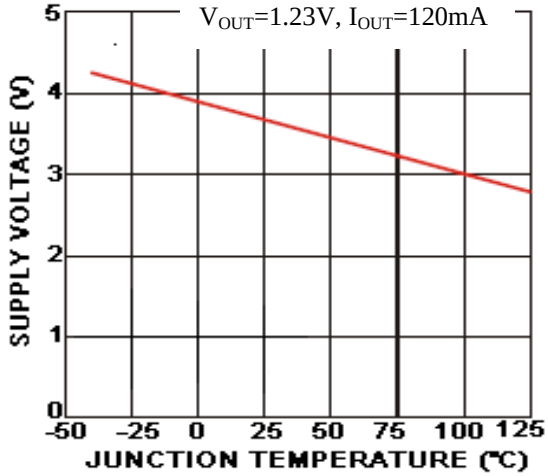
Operating Quiescent Current



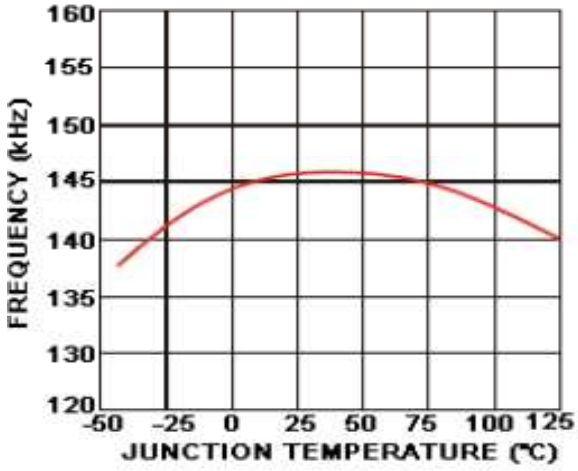
Shutdown Quiescent Current



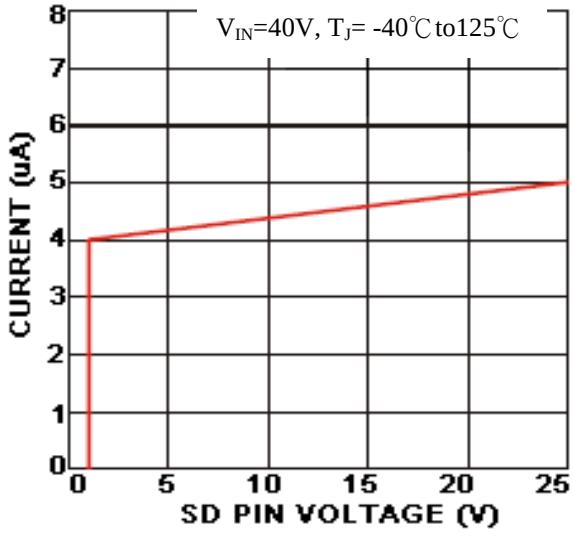
Minimum Operating Supply Voltage



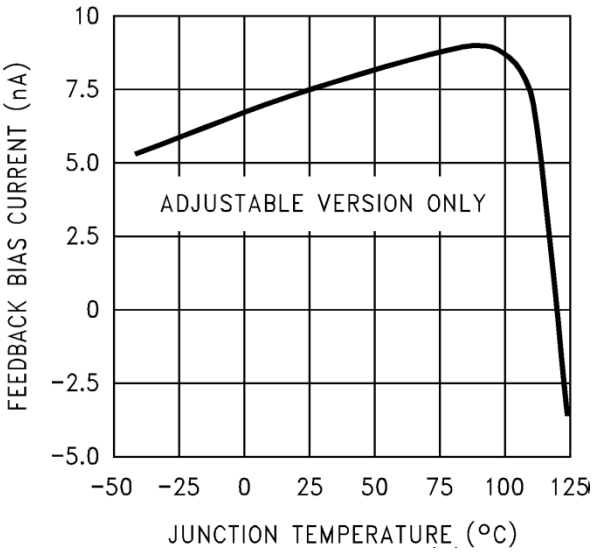
Switching Frequency



ON/OFF Pin Current (Sinking)

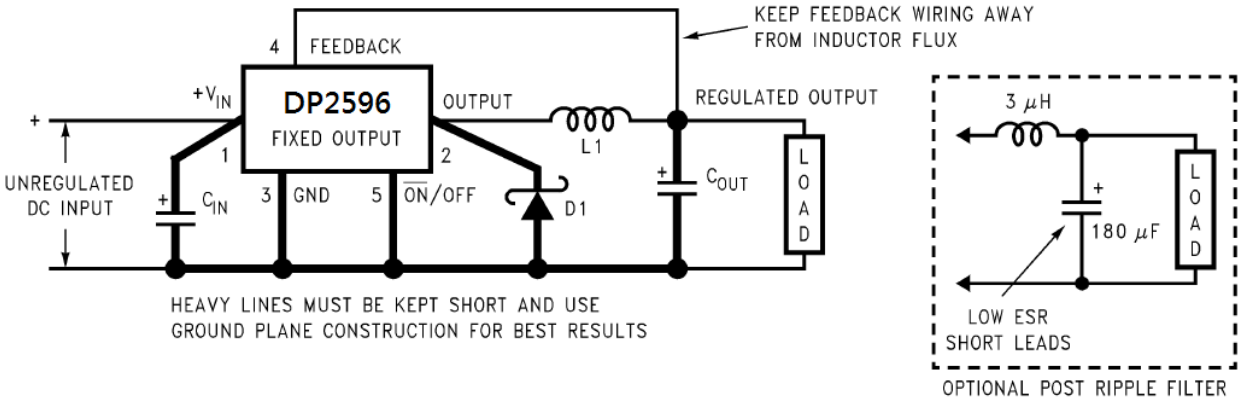


Feedback Pin Bias Current



■ Test Circuit and Layout Guidelines

Fixed Output Voltage Versions



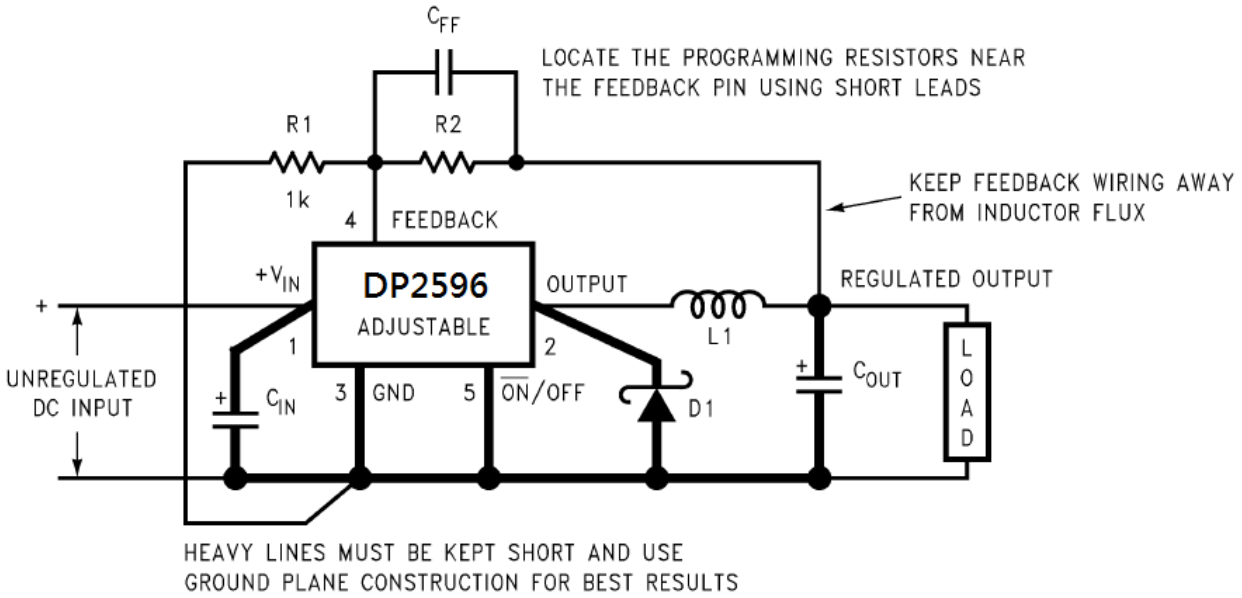
C_{IN} : 470 μ F, 50V Aluminum Electrolytic

C_{OUT} : 220 μ F, 25V Aluminum Electrolytic

D1 : 5A, 40V, Schottky, 1N5825

L1 : 68 μ H

Fixed Output Voltage Versions



$$V_{OUT} = V_{REF}\left(1 + \frac{R2}{R1}\right) , \qquad R2 = R1\left(\frac{VOUT}{VREF} - 1\right)$$

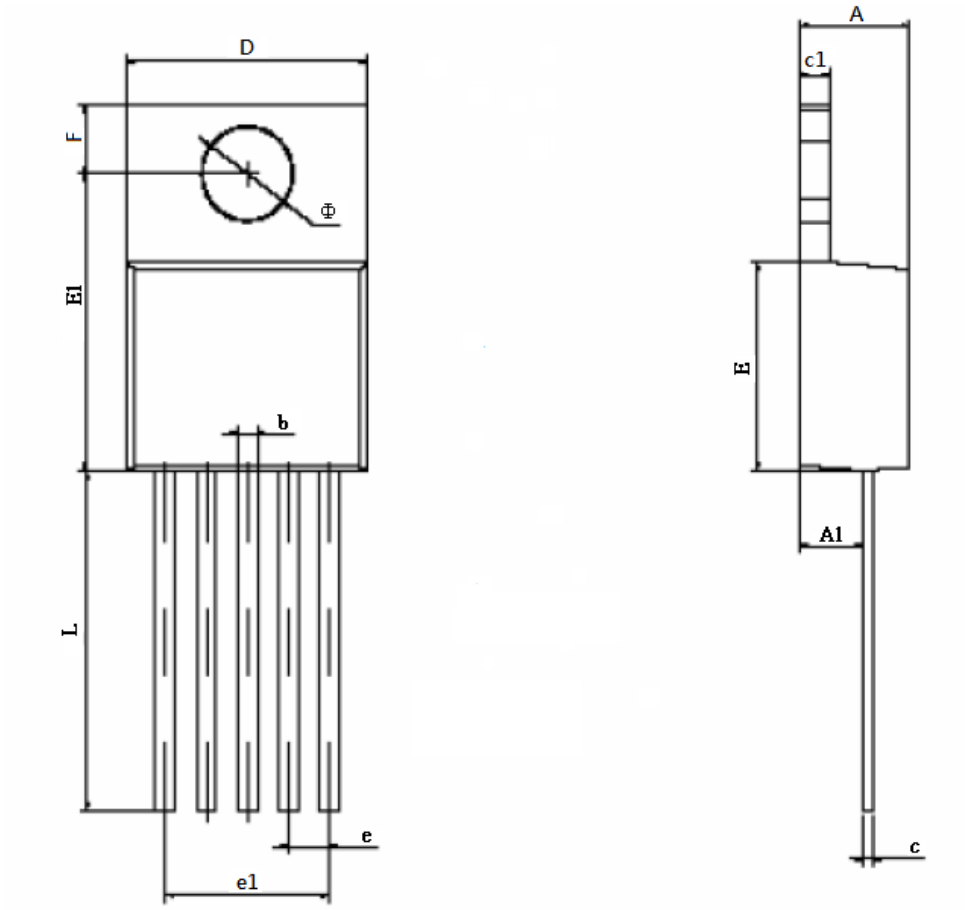
Where VREF = 1.23V,

Figure 2. Typical Test Circuit and Layout Guide

As in any switching regulator, layout is very important. Rapidly switching currents associated with wiring inductance generate voltage transients which can cause problems. For minimal inductance and ground loops, the wires indicated by heavy lines should be wide printed circuit traces and should be kept as short as possible. For best results, external components should be located as close to the switcher IC as possible using ground plane construction or single point grounding.

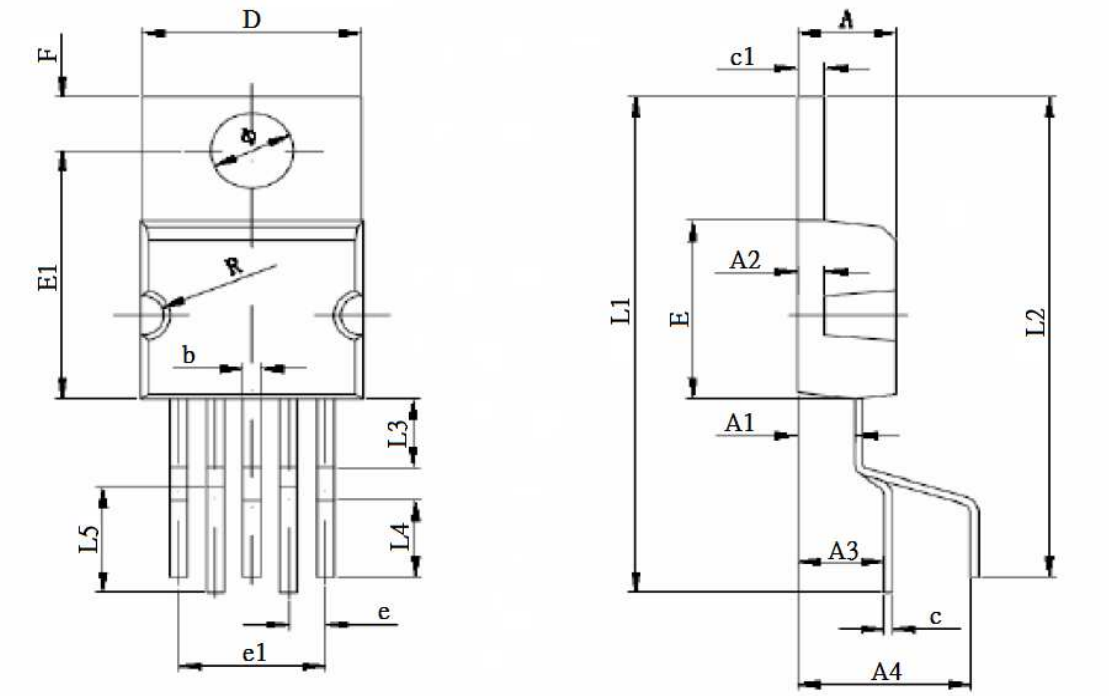
In open core inductors are used, special care must be taken as to the location and positioning of his type of inductor. Allowing the inductor flux to intersect sensitive feedback, IC ground path and C_{OUT} wiring can cause problems. When using the Adjustable version, special care must be taken as to the location of the feedback resistors and the associated wiring. Physically locate both resistors near the IC, and route the wiring away from the inductor, especially an open core type of inductor.

■ TO-220 Package Dimensions



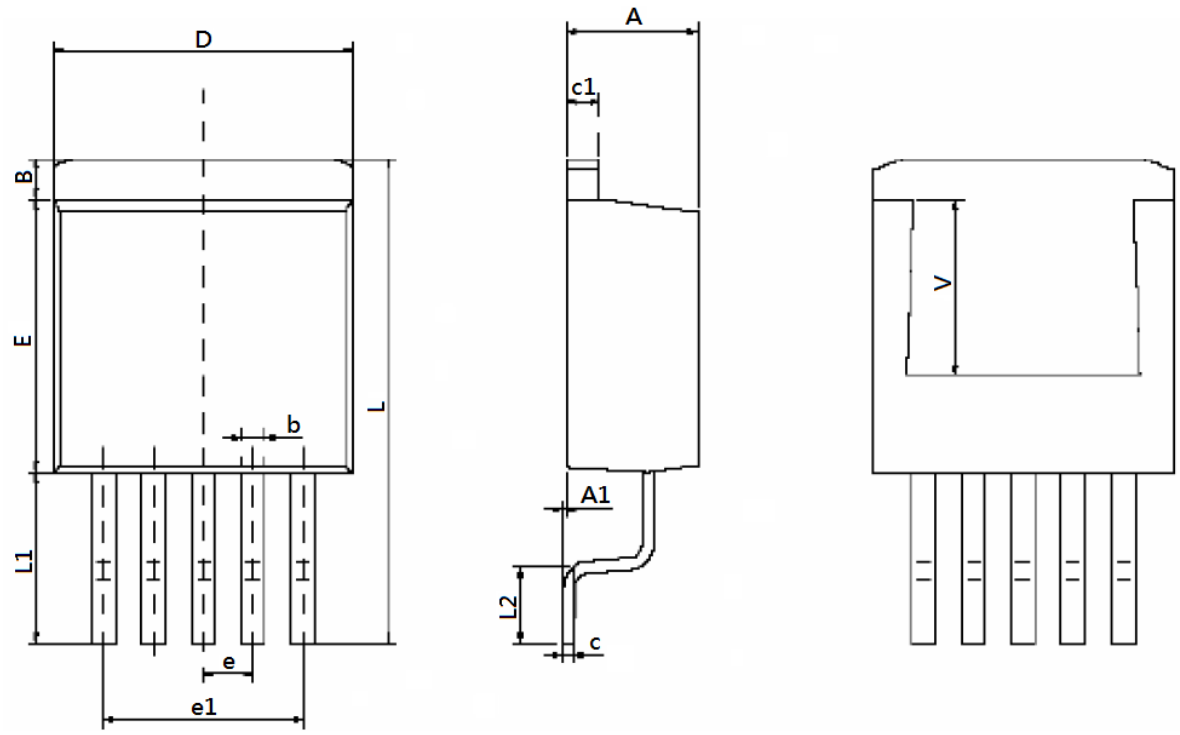
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.470	4.670	0.176	0.184
A1	2.520	2.280	0.099	0.111
b	0.710	0.910	0.028	0.036
c	0.310	0.530	0.012	0.021
c1	1.170	1.370	0.046	0.054
D	9.850	10.150	0.388	0.400
E	8.200	8.600	0.323	0.339
E1	11.760	12.160	0.463	0.479
e	1.700TYP		0.067TYP	
e1	6.700	6.900	0.264	0.272
F	2.590	2.890	0.102	0.114
L	13.500	13.900	0.531	0.547
Φ	3.790	3.890	0.149	0.153

■ TO-220V Package Dimensions



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.470	4.670	0.176	0.184
A1	2.520	2.280	0.099	0.111
A2	1.170	1.370	0.046	0.054
A3	4.250	4.550	0.167	0.179
A4	8.250	8.550	0.325	0.337
b	0.710	0.910	0.028	0.036
c	0.310	0.530	0.012	0.021
c1	1.170	1.370	0.046	0.054
D	10.010	10.310	0.394	0.406
E	8.900	9.300	0.350	0.366
E1	12.460	12.860	0.491	0.506
e	1.700TYP		0.220TYP	
e1	6.700	6.900	0.264	0.272
e2	3.300	3.500	0.130	0.138
F	2.590	2.890	0.102	0.114
L1	25.100	25.500	0.988	1.004
L2	24.300	24.700	0.957	0.972
L3	3.400	3.600	0.134	0.142
L4	3.800	4.000	0.150	0.157
L5	5.300	5.500	0.209	0.217
R	0.950	1.050	0.037	0.041

■ TO-263 Package Dimensions



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.470	4.670	0.176	0.184
A1	0.000	0.150	0.000	0.006
B	1.560	1.760	0.061	0.069
b	0.710	0.910	0.028	0.036
c	0.310	0.530	0.012	0.021
c1	1.170	1.370	0.046	0.054
D	9.880	10.180	0.389	0.401
E	8.200	8.600	0.323	0.339
e	1.700TYP		0.067TYP	
e1	6.700	6.900	0.264	0.272
L	15.140	15.540	0.596	0.612
L1	5.080	5.480	0.200	0.216
L2	2.340	2.740	0.092	0.108
V	5.600REF		0.220REF	