52kHz,3.0A,Step-Down Switching Regulator

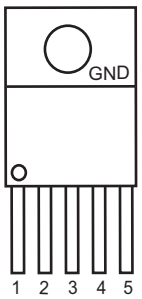
DESCRIPTION

The LM2576 series of regulators are monolithic integrated circuits ideally suited for easy and convenient design of a step–down switching regulator (buck converter). All circuits of this series are capable of driving a 3.0A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3V and 5.0V output versions.

These regulators are designed to minimize the number of external components to simplify the power supply design. Standard series of inductors optimized for use with the LM2576 are offered by several different inductor manufacturers.

Since the LM2576 converter is a switch–mode power supply, its efficiency is significantly higher in comparison with popular three–terminal linear regulators, especially with higher input voltages. In many cases, the power dissipated is so low that no heat sink is required or its size could be reduced dramatically.

PIN CONFIGURATION



1-V_{in}
2-OUTPUT
3-GND
4-FEEDBACK
5-$\overline{ON}$/OFF

(Top View)

The LM2576 features include a guaranteed 4% tolerance on output voltage within specified input voltages and output load conditions, and 10% on the oscillator frequency (±2% over 0°C to 125°C). External shutdown is included, featuring 80μA (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 and 5.0V Output Versions
- Guaranteed 3.0A Output Current
- Wide Input Voltage Range
- 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

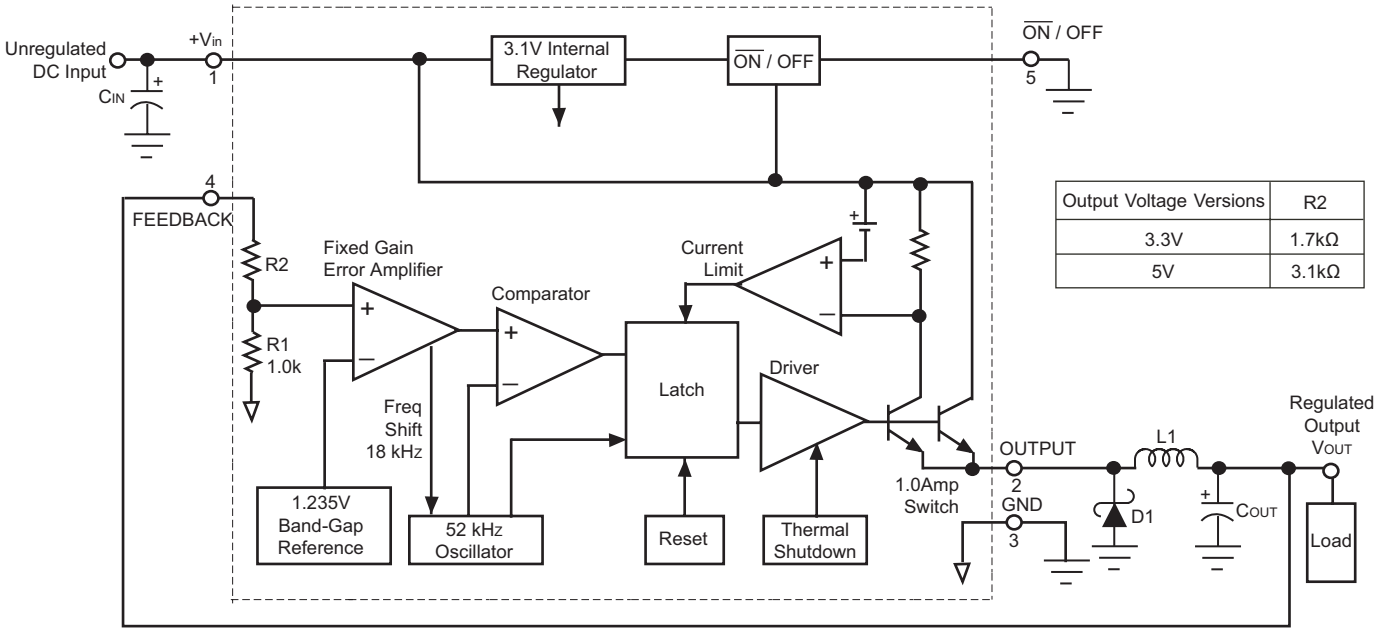
APPLICATION

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

ORDERING INFORMATION

Temperature Range	Package		Orderable Device	Package Qty
-40°C to +85°C	TO-220-5L	Pb-Free	LM2576T-3.3	50Units/Tube
			LM2576T-5.0	50Units/Tube

SCHEMATIC DIAGRAM



Output Voltage Versions	R2
3.3V	1.7kΩ
5V	3.1kΩ

Figure 1. Representative Block Diagram and Typical Application

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
Maximum Supply Voltage	V_{in}	45	V
$\overline{ON}$/OFF Pin Input Voltage	V_{ON_OFF}	–0.3 V≤ V ≤ +V_{in}	V
Output Voltage to Ground (Steady–State)	V_{OG}	-1.0	V
Power Dissipation	P_D	Internally Limited	
Thermal Resistance, Junction–to–Ambient	$R_{\theta JA}$	65	°C/W
Thermal Resistance, Junction–to–Case	$R_{\theta JC}$	5.0	°C/W
Storage Temperature Range	T_{stg}	–65 to +150	°C
Minimum ESD Rating (Human Body Model: C=100pF, R = 1.5kΩ)		2.0	kV
Lead Temperature (Soldering, 10 seconds)	T_L	260	°C
Maximum Junction Temperature	T_J	150	°C

Maximum Ratings are those values beyond which damage to the device may occur.

RECOMMENDED OPERATING CONDITIONS

Parameter		Symbol	Min	Max	Unit
Supply Voltage	3.3V version	V_{in}	8	40	V
	5.0V version		10		
Operating Junction Temperature Range		T_J	-40	+125	°C

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.

ELECTRICAL CHARACTERISTICS

(V_{in} = 12 V for the 3.3 V and 5.0 V version. I_{Load} = 500 mA, T_J = 25°C. For min/max values T_J is the operating junction temperature range that applies (Note 2), unless otherwise noted.)

Parameter	Symbol	Test Conditions		Min	Typ	Max	Unit
LM2576-3.3 (Note1)							
Output Voltage	V_{out}			3.234	3.3	3.366	V
		6.0V ≤ V_{in} ≤ 40V, 0.5A ≤I_{Load} ≤ 3.0A	T_J = 25°C	3.168	3.3	3.432	V
			T_J = -40°C to +125°C	3.135		3.465	
Efficiency	η	V_{in} = 12V, I_{Load} =3.0A			75		%
LM2576-5.0(Note1)							
Output Voltage	V_{out}			4.9	5.0	5.1	V
		8.0V ≤ V_{in} ≤ 40V, 0.5A ≤I_{Load} ≤ 3.0A	T_J = 25°C	4.8	5.0	5.2	V
			T_J = -40°C to +125°C	4.75		5.25	
Efficiency	η	V_{in} = 12V, I_{Load} =3.0A			77		%
LM2576-3.3/LM2576-5.0							
Oscillator Frequency (Note 3)	f_{osc}	T_J = 25°C			52		kHz
		T_J = -40°C to +125°C		42		63	
Saturation Voltage (Note 4)	V_{sat}	6.0V ≤ V_{in} ≤ 40V, 0.5A ≤I_{Load} ≤ 3.0A	T_J = 25°C		1.5	2.0	V
			T_J = -40°C to +125°C			2.5	
Max Duty Cycle (“on”) (Note 5)	DC			93	98		%
Current Limit (Peak Current (Notes 3, 4))	I_{CL}	T_J = 25°C		4.2	5.8	6.9	A
		T_J = -40°C to +125°C		3.5		7.5	
Output Leakage Current (Notes 6, 7)	I_L	T_J = 25°C	V_{out} = 0V		0.8	2.0	mA
			V_{out} = –1.0 V		6.0	30	
Quiescent Current (Note 6)	I_Q	T_J = 25°C			5.0	10	mA
		T_J = -40°C to +125°C				11	
Standby Quiescent Current	I_{stby}	$\overline{ON}$/OFF Pin = 5.0 V (“off”)	T_J = 25°C		80	200	μA
			T_J = -40°C to +125°C			400	
$\overline{ON}$/OFF Pin Logic High Input Level	V_{IH}	V_{out} = 0V	T_J = 25°C	2.2			V
			T_J = -40°C to +125°C	2.4			
$\overline{ON}$/OFF Pin Logic Low Input Level	V_{IL}	Vout = Nominal Output Voltage	T_J = 25°C			1.0	V
			T_J = -40°C to +125°C			0.8	

ELECTRICAL CHARACTERISTICS(COUTINUED)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
$\overline{ON}$/OFF Pin Input Current	I_{IH}	$\overline{ON}$/OFF Pin = 5.0 V (“off”), T_J = 25°C			30	μA
$\overline{ON}$/OFF Pin Input Current	I_{IL}	$\overline{ON}$/OFF Pin = 0 V (“on”), T_J = 25°C			1.0	μA

Notes 1: External components such as the catch diode, inductor, input and output capacitors can affect switching regulator system performance. When the LM2576 is used as shown in the test circuit, system performance will be as shown in system parameters section.

Notes 2: Tested junction temperature range for the LM2576: T_{low} = –40°C, T_{high} = +125°C.

Notes 3: The oscillator frequency reduces to approximately 18 kHz 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 dissipation of the IC by lowering the minimum duty cycle from 5% down to approximately 2%.

Notes 4: OUTPUT (Pin 2) sourcing current. No diode, inductor or capacitor connected to output pin.

Notes 5: FEEDBACK (Pin 4) removed from output and connected to 0V.

Notes 6: FEEDBACK (Pin 4) removed from output and connected to +12V for the Adjustable, 3.3V, and 5.0V versions, and +25V for the 12V and 15V versions, to force the output transistor “off”.

Notes 7: V_{in} = 40V.

PIN DESCRIPTION

NO.	Name	Function Description (Refer to Figure 1)
1	V_{in}	This pin is the positive input supply for the LM2576 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.
2	OUTPUT	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.
3	GND	Circuit ground pin.
4	FEEDBACK	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.
5	$\overline{ON}$/OFF	It allows the switching regulator circuit to be shut down using logic level signals, thus dropping the total input supply current to approximately 80μA. The threshold voltage is typically 1.3V. Applying a voltage above this value (up to +V_{in}) shuts the regulator off. If the voltage applied to this pin is low or if this pin is left open, the regulator will be in the “on” condition.

TYPICAL PERFORMANCE CHARACTERISTICS

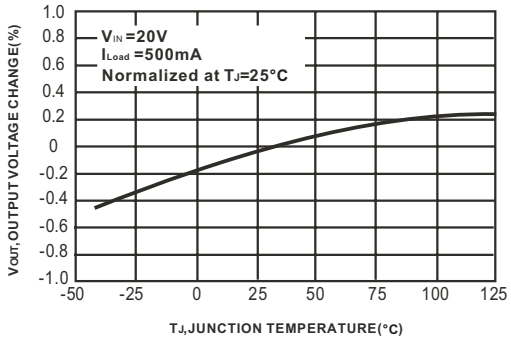


Figure 2. Normalized Output Voltage

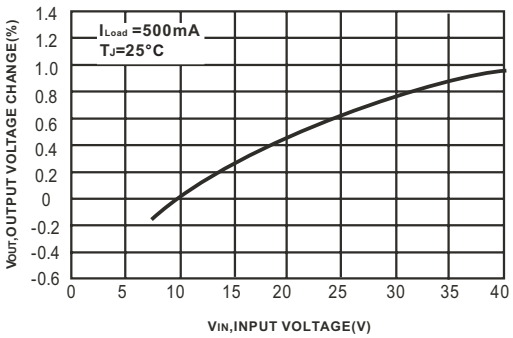


Figure 3. Line Regulation

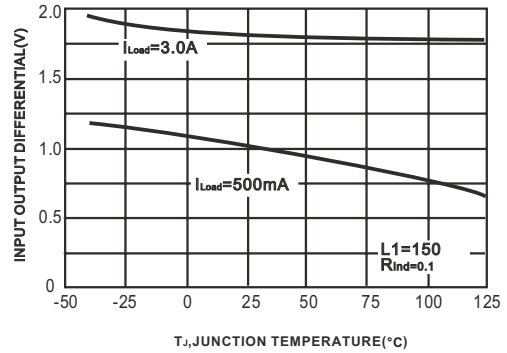


Figure 4. Dropout Voltage

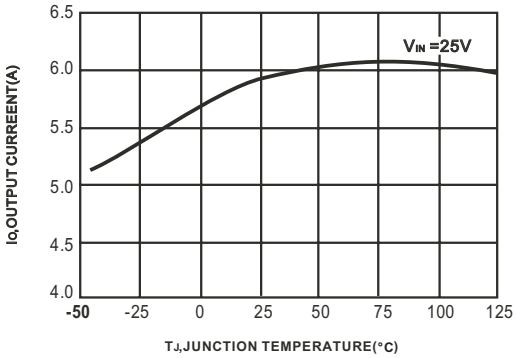


Figure 5. Current Limit

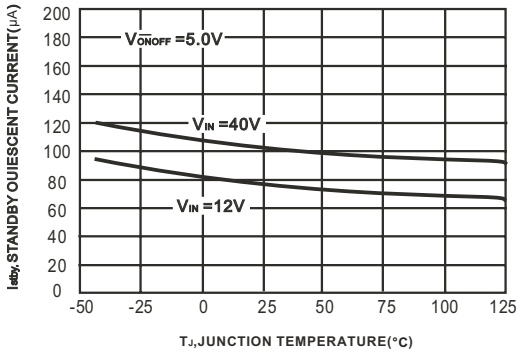


Figure 6. Standby Quiescent Current vs Junction Temperature

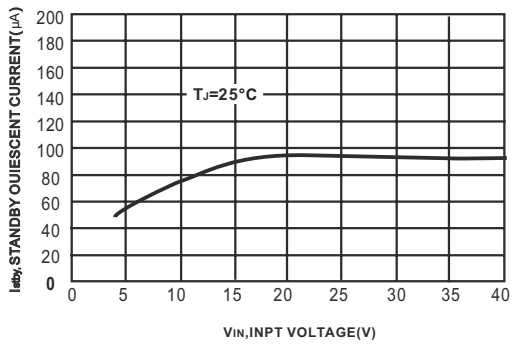


Figure 7. Standby Quiescent Current vs Input Voltage

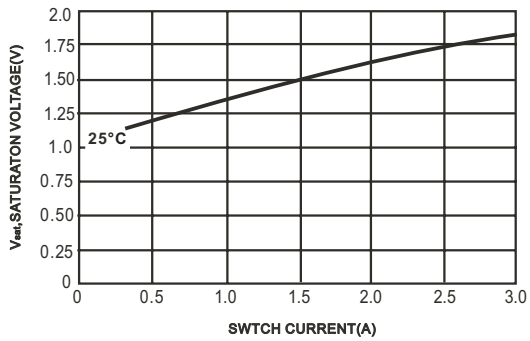


Figure 8. Switch Saturation Voltage

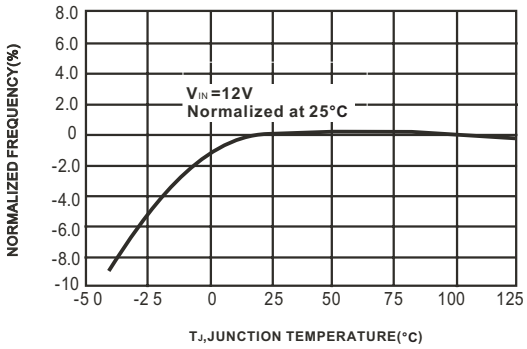
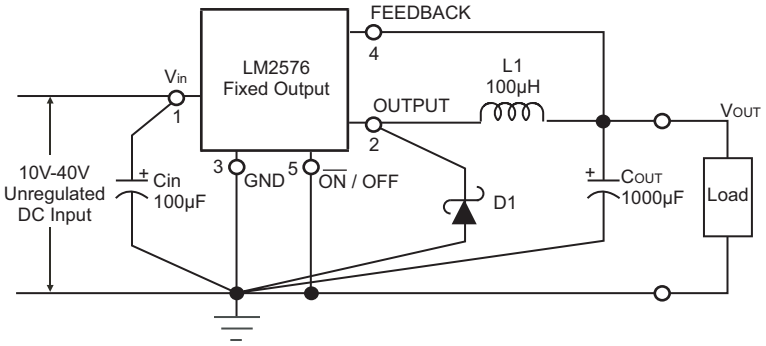


Figure 9. Oscillator Frequency

TYPICAL APPLICATION



Cin – 100µF, 75V, Aluminum Electrolytic
Cout – 1000µF, 25V, Aluminum Electrolytic
D1 – Schottky, MBR360 or 1N5822
L1 – 100µH, Pulse Eng. PE–92108

Figure 10. Typical Test Circuit (3.3V/5.0V Output Voltage Versions)

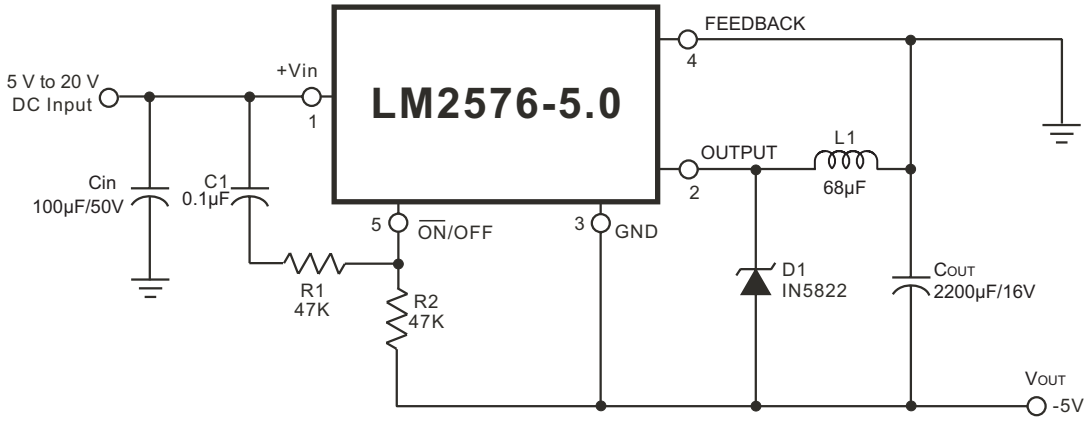
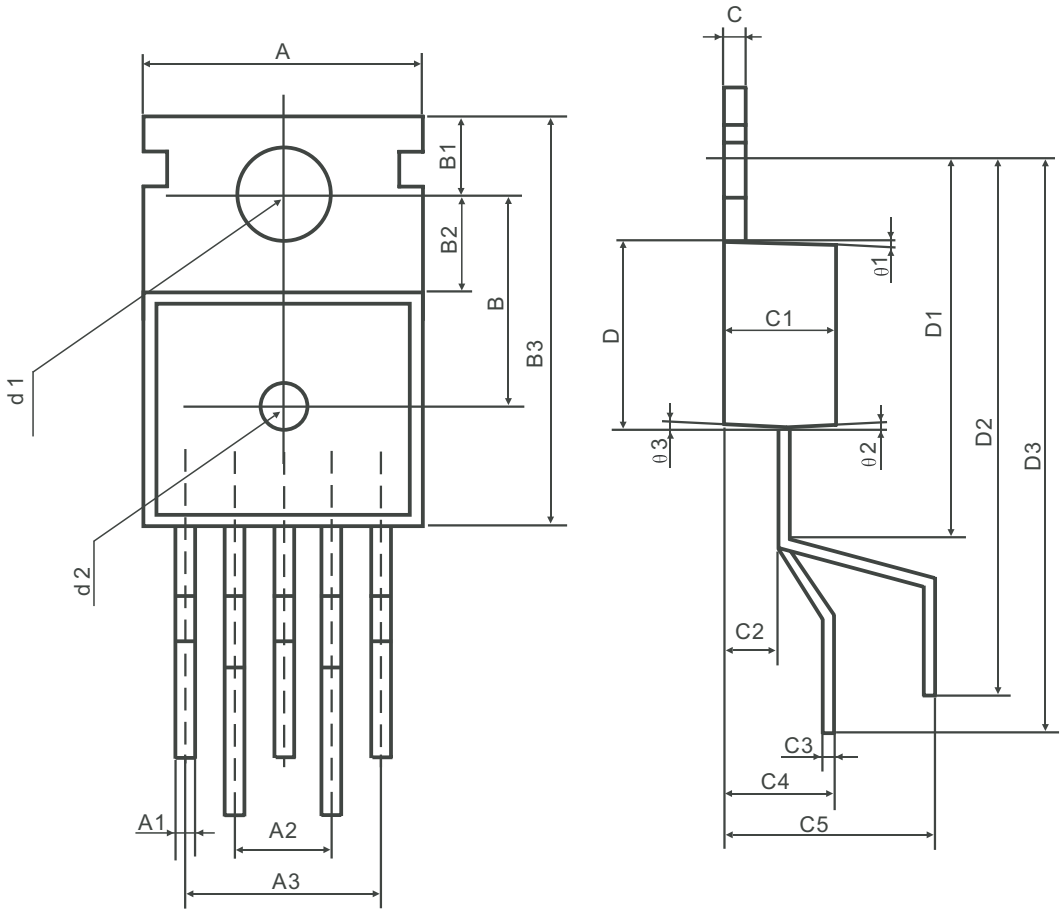


Figure 11. Inverting -5V Regulator with Delayed Startup（Buck–Boost）

PHYSICAL DIMENSIONS

TO-220-5L



Symbol	Dimension(mm)		Symbol	Dimension(mm)	
	Min	Max		Min	Max
A	10.10	10.14	C4	4.48	4.52
A1	4.19(TYP)		C5	8.48	8.52
A2	3.40(TYP)		D	9.20(TYP)	
A3	6.80(TYP)		D1	15.72	15.78
B	8.20(TYP)		D2	20.95	21.35
B1	3.55(TYP)		D3	22.27	22.67
B2	2.74(TYP)		d1	3.84(TYP)	
B3	15.48	15.52	d2	1.50(TYP)	
C	1.27(TYP)		θ1	3º(TYP)	
C1	4.58(TYP)		θ2	3º(TYP)	
C2	2.60(TYP)		θ3	3º(TYP)	
C3	0.28(TYP)				