LM2576xx Series SIMPLE SWITCHER® 3-A Step-Down Voltage Regulator

1 Features

- 3.3-V, 5-V, 12-V, 15-V, and Adjustable Output Versions
- Adjustable Version Output Voltage Range,1.23 V to 37 V (57 V for HV Version) ±4% Maximum Over Line and Load Conditions
- Specified 3-A Output Current
- Wide Input Voltage Range: 40 V Up to 60 V for HV Version
- 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

2 Applications

- Simple High-Efficiency Step-Down (Buck) Regulator
- Efficient Preregulator for Linear Regulators
- On-Card Switching Regulators
- Positive-to-Negative Converter (Buck-Boost)

3 Description

The LM2576 series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, 15 V, and an adjustable output version.

Requiring a minimum number of external components, these regulators are simple to use and include fault protection and a fixed-frequency oscillator.

The LM2576 series offers a high-efficiency replacement for popular three-terminal linear regulators. It substantially 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 LM2576 are available from several different manufacturers. This feature greatly simplifies the design of switch-mode power supplies.

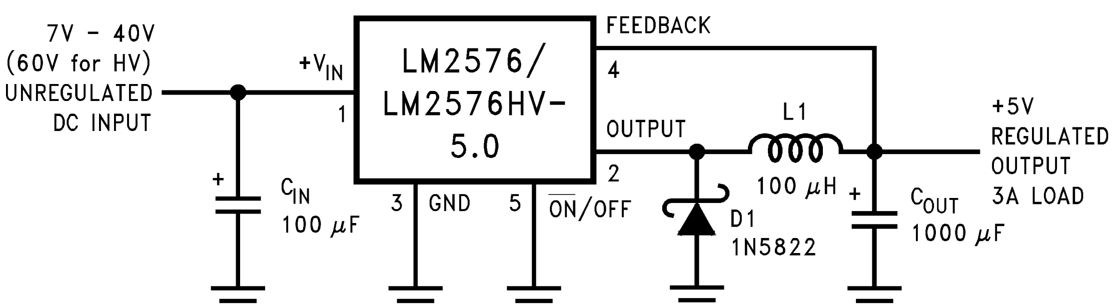
Other features include a ±4% tolerance on output voltage within specified input voltages and output load conditions, and ±10% on the oscillator frequency. External shutdown is included, featuring 50-μA (typical) standby current. The output switch includes cycle-by-cycle current limiting, as well as thermal shutdown for full protection under fault conditions.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
LM2576 LM2576HV	TO-220 (5)	10.16 mm × 8.51 mm
	DDPAK/TO-263 (5)	10.16 mm × 8.42 mm

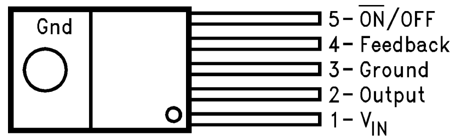
(1) For all available packages, see the orderable addendum at the end of the data sheet.

Fixed Output Voltage Version Typical Application Diagram

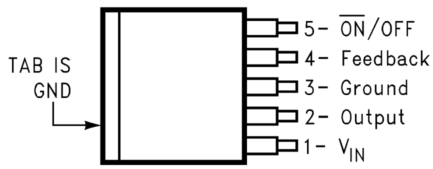


5 Pin Configuration and Functions

KC Package
5-Pin TO-220
Top View

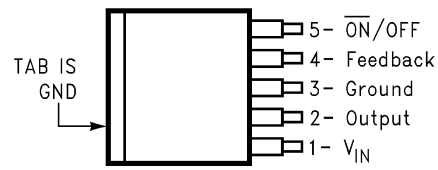


KTT Package
5-PIN DDPAK/TO-263
Top View



Side View

DDPAK/TO-263 (S) Package
5-Lead Surface-Mount Package
Top View



Side View

Pin Functions

PIN		I/O[1]	DESCRIPTION
NO.	NAME		
1	V_{IN}	I	Supply input pin to collector pin of high-side transistor. Connect to power supply and input bypass capacitors CIN. Path from V_{IN} pin to high frequency bypass C_{IN} and GND must be as short as possible.
2	OUTPUT	O	Emitter pin of the power transistor. This is a switching node. Attached this pin to an inductor and the cathode of the external diode.
3	GROUND	—	Ground pin. Path to C_{IN} must be as short as possible.
4	FEEDBACK	I	Feedback sense input pin. Connect to the midpoint of feedback divider to set VOUT for ADJ version or connect this pin directly to the output capacitor for a fixed output version.
5	$\overline{ON}$/OFF	I	Enable input to the voltage regulator. High = OFF and low = ON. Connect to GND to enable the voltage regulator. Do not leave this pin float.
—	TAB	—	Connected to GND. Attached to heatsink for thermal relief for TO-220 package or put a copper plane connected to this pin as a thermal relief for DDPAK package.

(1) I = INPUT, O = OUTPUT

6 Specifications

6.1 Absolute Maximum Ratings

over the recommended operating junction temperature range of -40°C to 125°C (unless otherwise noted)(1)(2)

		MIN	MAX	UNIT
Maximum supply voltage	LM2576		45	V
	LM2576HV		63	
$\overline{ON}$ /OFF pin input voltage		−0.3V ≤ V ≤ +V_{IN}		V
Output voltage to ground	(Steady-state)	−1		V
Power dissipation		Internally Limited		
Maximum junction temperature, T_J			150	°C
Storage temperature, T_{stg}		−65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) If Military/Aerospace specified devices are required, please contact the TI Sales Office/ Distributors for availability and specifications.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±2000	V

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

over the recommended operating junction temperature range of -40°C to 125°C (unless otherwise noted)

		MIN	MAX	UNIT
Temperature	LM2576, LM2576HV	−40	125	°C
Supply voltage	LM2576		40	V
	LM2576HV		60	

6.4 Thermal Information

THERMAL METRIC(1)(2)(3)		LM2576, LM2576HV		UNIT
		KTT (TO-263)	KC (TO-220)	
		5 PINS	5 PINS	
$R_{θJA}$	Junction-to-ambient thermal resistance	42.6	32.4	°C/W
$R_{θJC(top)}$	Junction-to-case (top) thermal resistance	43.3	41.2	°C/W
$R_{θJB}$	Junction-to-board thermal resistance	22.4	17.6	°C/W
$ψ_{JT}$	Junction-to-top characterization parameter	10.7	7.8	°C/W
$ψ_{JB}$	Junction-to-board characterization parameter	21.3	17	°C/W
$R_{θJC(bot)}$	Junction-to-case (bottom) thermal resistance	0.4	0.4	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, SPRA953 and the *Using New Thermal Metrics* applications report, SBVA025.
(2) The package thermal impedance is calculated in accordance with JESD 51-7
(3) Thermal Resistances were simulated on a 4-layer, JEDEC board.

6.5 Electrical Characteristics: 3.3 V

Specifications are for T_J = 25°C (unless otherwise noted).

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
SYSTEM PARAMETERS TEST CIRCUIT Figure 26 and Figure 32[(1)]							
V_{OUT}	Output Voltage	V_{IN} = 12 V, I_{LOAD} = 0.5 A Circuit of Figure 26 and Figure 32		3.234	3.3	3.366	V
	Output Voltage: LM2576	6 V ≤ V_{IN} ≤ 40 V, 0.5 A ≤ I_{LOAD} ≤ 3 A Circuit of Figure 26 and Figure 32	T_J = 25°C	3.168	3.3	3.432	V
			Applies over full operating temperature range	3.135		3.465	
	Output Voltage: LM2576HV	6 V ≤ V_{IN} ≤ 60 V, 0.5 A ≤ I_{LOAD} ≤ 3 A Circuit of Figure 26 and Figure 32	T_J = 25°C	3.168	3.3	3.45	V
			Applies over full operating temperature range	3.135		3.482	
η	Efficiency	V_{IN} = 12 V, I_{LOAD} = 3 A			75%		

(1) External components such as the catch diode, inductor, input and output capacitors can affect switching regulator system performance. When the LM2576/LM2576HV is used as shown in Figure 26 and Figure 32, system performance is as shown in *Electrical Characteristics: All Output Voltage Versions*.

6.6 Electrical Characteristics: 5 V

Specifications are for T_J = 25°C for the Figure 26 and Figure 32 (unless otherwise noted).

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
SYSTEM PARAMETERS TEST CIRCUIT Figure 26 and Figure 32[(1)]							
V_{OUT}	Output Voltage	V_{IN} = 12 V, I_{LOAD} = 0.5 A Circuit of Figure 26 and Figure 32		4.9	5	5.1	V
V_{OUT}	Output Voltage LM2576	0.5 A ≤ I_{LOAD} ≤ 3 A, 8 V ≤ V_{IN} ≤ 40 V Circuit of Figure 26 and Figure 32	T_J = 25°C	4.8	5	5.2	V
			Applies over full operating temperature range	4.75		5.25	
V_{OUT}	Output Voltage LM2576HV	0.5 A ≤ I_{LOAD} ≤ 3 A, 8 V ≤ V_{IN} ≤ 60 V Circuit of Figure 26 and Figure 32	T_J = 25°C	4.8	5	4.75	V
			Applies over full operating temperature range	5.225		5.275	
η	Efficiency	V_{IN} = 12 V, I_{LOAD} = 3 A			77%		

(1) External components such as the catch diode, inductor, input and output capacitors can affect switching regulator system performance. When the LM2576/LM2576HV is used as shown in Figure 26 and Figure 32, system performance is as shown in *Electrical Characteristics: All Output Voltage Versions*.

6.7 Electrical Characteristics: 12 V

Specifications are for T_J = 25°C (unless otherwise noted).

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
SYSTEM PARAMETERS TEST CIRCUIT Figure 26 and Figure 32[(1)]							
V_{OUT}	Output Voltage	V_{IN} = 25 V, I_{LOAD} = 0.5 A Circuit of Figure 26 and Figure 32		11.76	12	12.24	V
V_{OUT}	Output Voltage LM2576	0.5 A ≤ I_{LOAD} ≤ 3 A, 15 V ≤ V_{IN} ≤ 40 V Circuit of Figure 26 and Figure 32 and	T_J = 25°C	11.52	12	12.48	V
			Applies over full operating temperature range	11.4		12.6	
V_{OUT}	Output Voltage LM2576HV	0.5 A ≤ I_{LOAD} ≤ 3 A, 15 V ≤ V_{IN} ≤ 60 V Circuit of Figure 26 and Figure 32	T_J = 25°C	11.52	12	12.54	V
			Applies over full operating temperature range	11.4		12.66	
η	Efficiency	V_{IN} = 15 V, I_{LOAD} = 3 A			88%		

(1) External components such as the catch diode, inductor, input and output capacitors can affect switching regulator system performance. When the LM2576/LM2576HV is used as shown in Figure 26 and Figure 32, system performance is as shown in *Electrical Characteristics: All Output Voltage Versions*.

6.8 Electrical Characteristics: 15 V

over operating free-air temperature range (unless otherwise noted).

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
SYSTEM PARAMETERS TEST CIRCUIT Figure 26 and Figure 32(1)							
V_{OUT}	Output Voltage	V_{IN} = 25 V, I_{LOAD} = 0.5 A Circuit of Figure 26 and Figure 32		14.7	15	15.3	V
V_{OUT}	Output Voltage LM2576	0.5 A ≤ I_{LOAD} ≤ 3 A, 18 V ≤ V_{IN} ≤ 40 V Circuit of Figure 26 and Figure 32	T_J = 25°C	14.4	15	15.6	V
			Applies over full operating temperature range	14.25		15.75	
V_{OUT}	Output Voltage LM2576HV	0.5 A ≤ I_{LOAD} ≤ 3 A, 18 V ≤ V_{IN} ≤ 60 V Circuit of Figure 26 and Figure 32	T_J = 25°C	14.4	15	14.25	V
			Applies over full operating temperature range	15.68		15.83	
η	Efficiency	V_{IN} = 18 V, I_{LOAD} = 3 A			88%		

(1) External components such as the catch diode, inductor, input and output capacitors can affect switching regulator system performance. When the LM2576/LM2576HV is used as shown in Figure 26 and Figure 32, system performance is as shown in *Electrical Characteristics: All Output Voltage Versions*.

6.9 Electrical Characteristics: Adjustable Output Voltage

over operating free-air temperature range (unless otherwise noted).

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
SYSTEM PARAMETERS TEST CIRCUIT Figure 26 and Figure 32(1)							
V_{OUT}	Feedback voltage	V_{IN} = 12 V, I_{LOAD} = 0.5 A V_{OUT} = 5 V, Circuit of Figure 26 and Figure 32		1.217	1.23	1.243	V
V_{OUT}	Feedback Voltage LM2576	0.5 A ≤ I_{LOAD} ≤ 3 A, 8 V ≤ V_{IN} ≤ 40 V V_{OUT} = 5 V, Circuit of Figure 26 and Figure 32	T_J = 25°C	1.193	1.23	1.267	V
			Applies over full operating temperature range	1.18		1.28	
V_{OUT}	Feedback Voltage LM2576HV	0.5 A ≤ I_{LOAD} ≤ 3 A, 8 V ≤ V_{IN} ≤ 60 V V_{OUT} = 5 V, Circuit of Figure 26 and Figure 32	T_J = 25°C	1.193	1.23	1.273	V
			Applies over full operating temperature range	1.18		1.286	
η	Efficiency	V_{IN} = 12 V, I_{LOAD} = 3 A, V_{OUT} = 5 V			77%		

(1) External components such as the catch diode, inductor, input and output capacitors can affect switching regulator system performance. When the LM2576/LM2576HV is used as shown in Figure 26 and Figure 32, system performance is as shown in *Electrical Characteristics: All Output Voltage Versions*.

6.10 Electrical Characteristics: All Output Voltage Versions

over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP(1)	MAX	UNIT
SYSTEM PARAMETERS TEST CIRCUIT Figure 26 and Figure 32(2)							
I_b	Feedback Bias Current	V_{OUT} = 5 V (Adjustable Version Only)	T_J = 25°C	100	50		nA
			Applies over full operating temperature range	500			
f_O	Oscillator Frequency(3)	T_J = 25°C		47	52	58	kHz
		Applies over full operating temperature range		42		63	

(1) All limits specified at room temperature (25°C) unless otherwise noted. All room temperature limits are 100% production tested. All limits at temperature extremes are specified through correlation using standard Statistical Quality Control (SQC) methods.
(2) External components such as the catch diode, inductor, input and output capacitors can affect switching regulator system performance. When the LM2576/LM2576HV is used as shown in Figure 26 and Figure 32, system performance is as shown in *Electrical Characteristics: All Output Voltage Versions*.
(3) The oscillator frequency reduces to approximately 11 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 power dissipation of the IC by lowering the minimum duty cycle from 5% down to approximately 2%.

Electrical Characteristics: All Output Voltage Versions (continued)

over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP[1]	MAX	UNIT
V_{SAT}	Saturation Voltage	I_{OUT} = 3 A [4]	T_J = 25°C		1.4	1.8	V
			Applies over full operating temperature range			2	
DC	Max Duty Cycle (ON)[5]			93%	98%		
I_{CL}	Current Limit[4][3]	T_J = 25°C		4.2	5.8	6.9	A
		Applies over full operating temperature range		3.5		7.5	
I_L	Output Leakage Current	Output = 0 V Output = −1 V Output = −1 V [6][7]		2	7.5	30	mA
I_Q	Quiescent Current[6]				5	10	mA
I_{STBY}	Standby Quiescent Current	$\overline{ON}$ /OFF Pin = 5 V (OFF)			50	200	μA
$\overline{ON}$ /OFF CONTROL TEST CIRCUIT Figure 26 and Figure 32							
V_{IH}	$\overline{ON}$ /OFF Pin Logic Input Level	V_{OUT} = 0 V	T_J = 25°C	2.2	1.4		V
			Applies over full operating temperature range	2.4			
V_{IL}		V_{OUT} = Nominal Output Voltage	T_J = 25°C		1.2	1	V
			Applies over full operating temperature range			0.8	
I_{IH}	$\overline{ON}$ /OFF Pin Input Current	$\overline{ON}$ /OFF Pin = 5 V (OFF)			12	30	μA
I_{IL}		$\overline{ON}$ /OFF Pin = 0 V (ON)			0	10	μA

(4) Output pin sourcing current. No diode, inductor or capacitor connected to output.
(5) Feedback pin removed from output and connected to 0V.
(6) Feedback pin removed from output and connected to +12 V for the Adjustable, 3.3-V, and 5-V versions, and +25 V for the 12-V and 15-V versions, to force the output transistor OFF.
(7) V_{IN} = 40 V (60 V for high voltage version).

6.11 Typical Characteristics

(Circuit of Figure 26 and Figure 32)

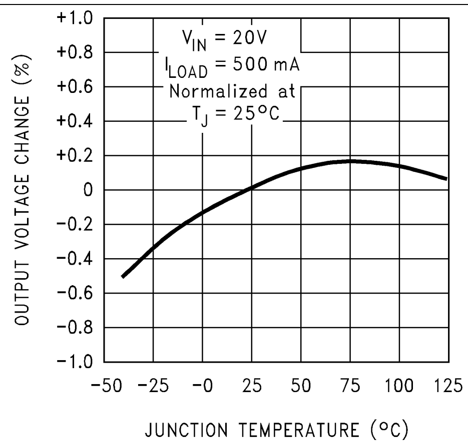


Figure 1. Normalized Output Voltage

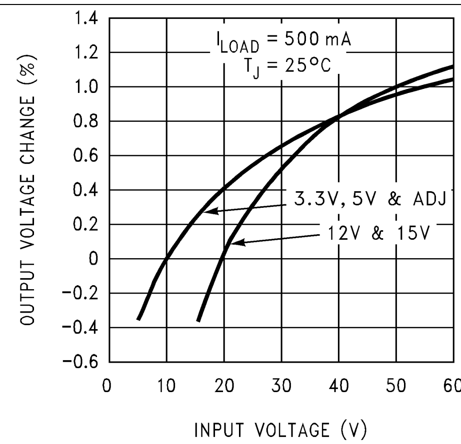


Figure 2. Line Regulation

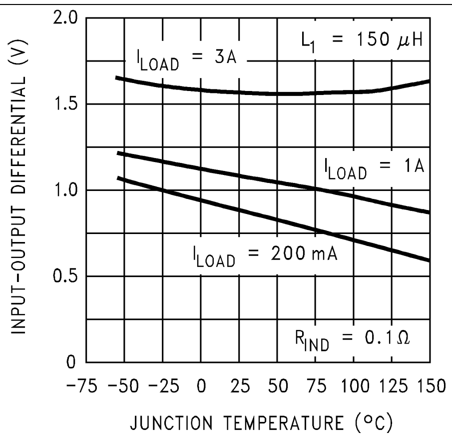


Figure 3. Dropout Voltage

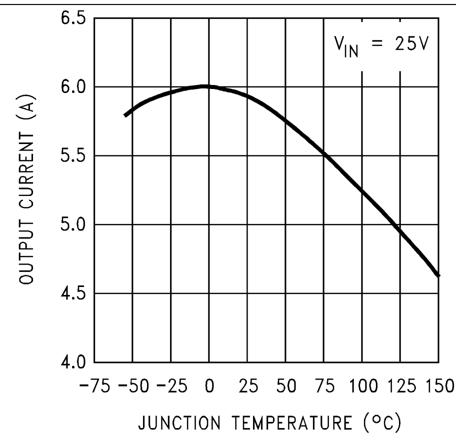


Figure 4. Current Limit

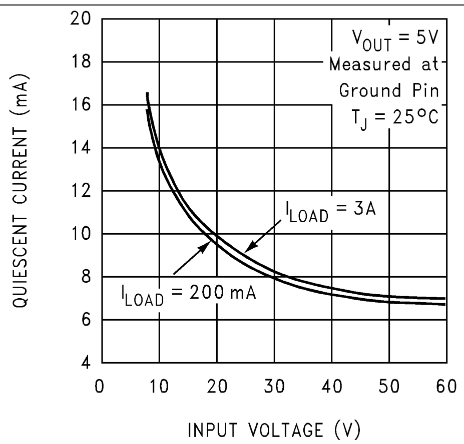


Figure 5. Quiescent Current

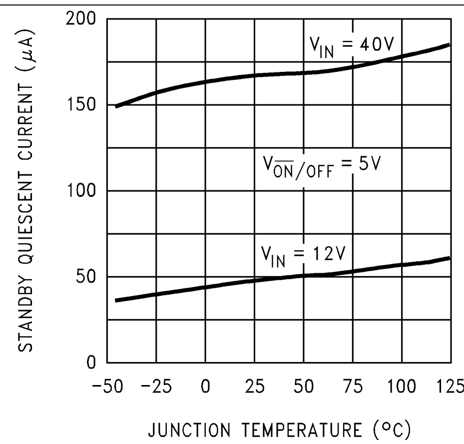


Figure 6. Standby Quiescent Current

Typical Characteristics (continued)

(Circuit of Figure 26 and Figure 32)

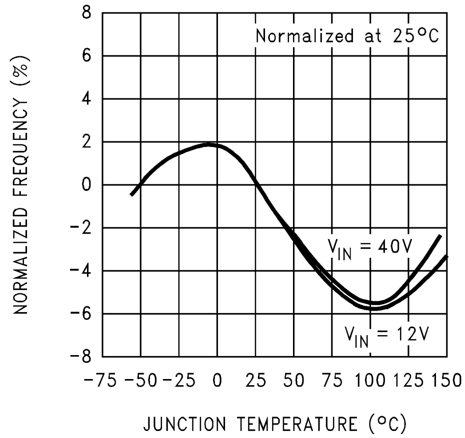


Figure 7. Oscillator Frequency

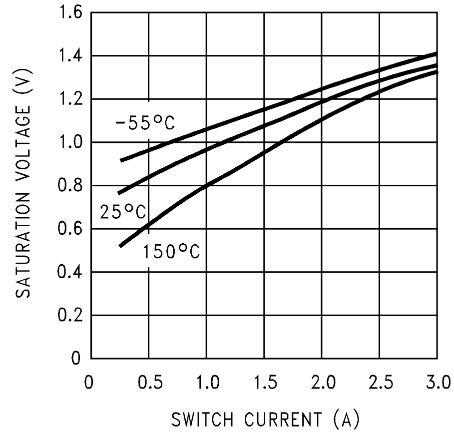


Figure 8. Switch Saturation Voltage

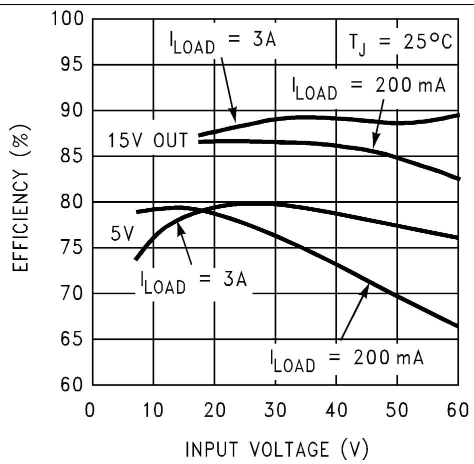


Figure 9. Efficiency

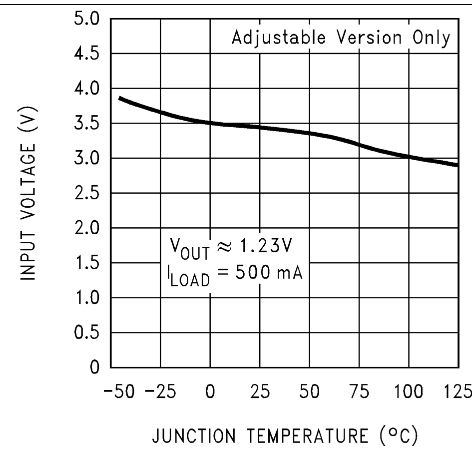


Figure 10. Minimum Operating Voltage

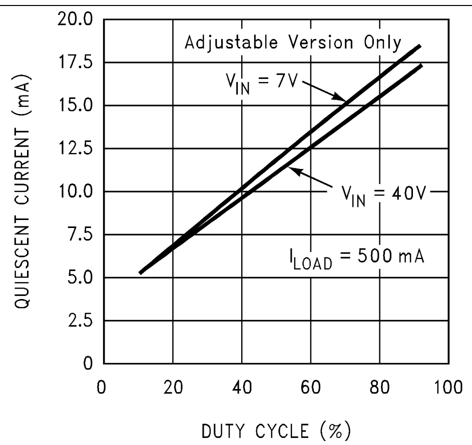


Figure 11. Quiescent Current vs Duty Cycle

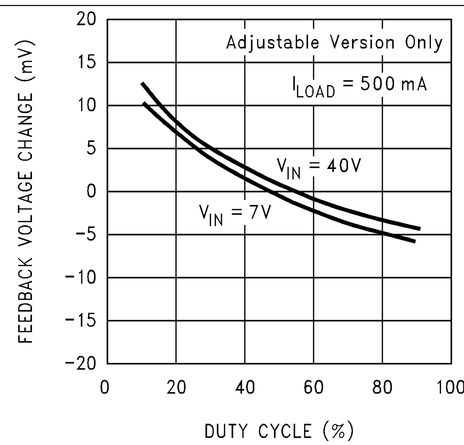


Figure 12. Feedback Voltage vs Duty Cycle

Typical Characteristics (continued)

(Circuit of Figure 26 and Figure 32)

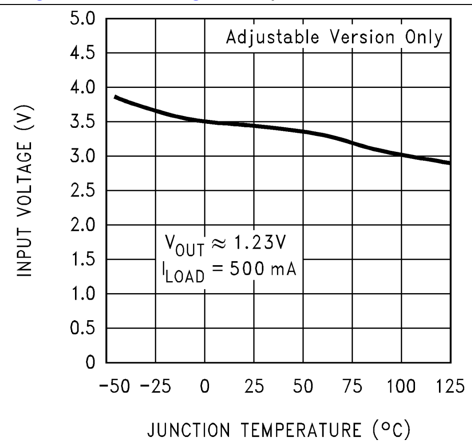


Figure 13. Minimum Operating Voltage

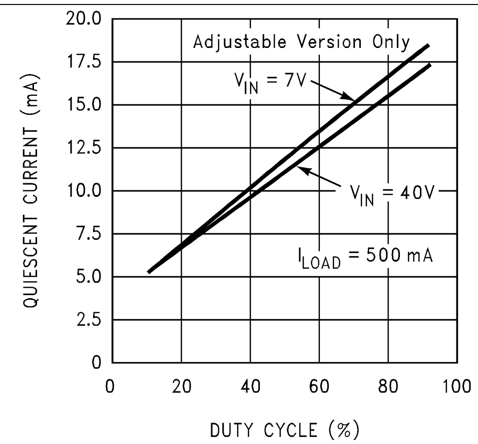


Figure 14. Quiescent Current vs Duty Cycle

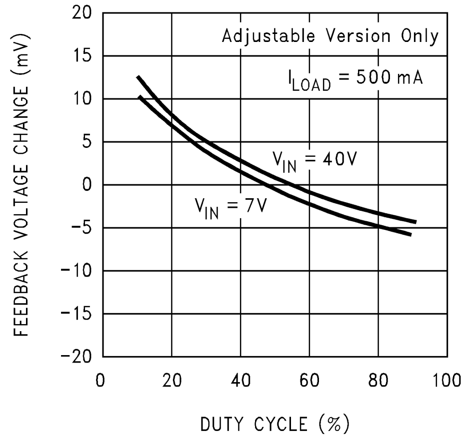


Figure 15. Feedback Voltage vs Duty Cycle

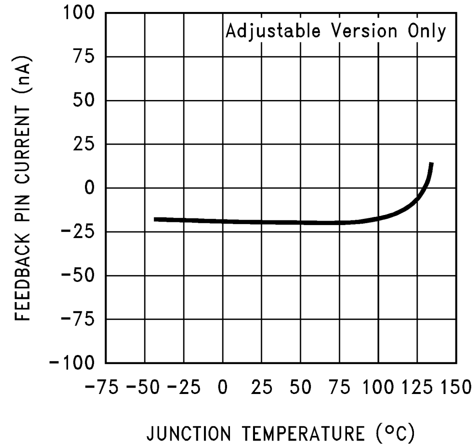
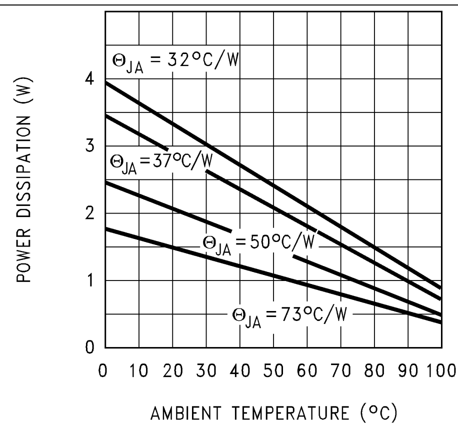
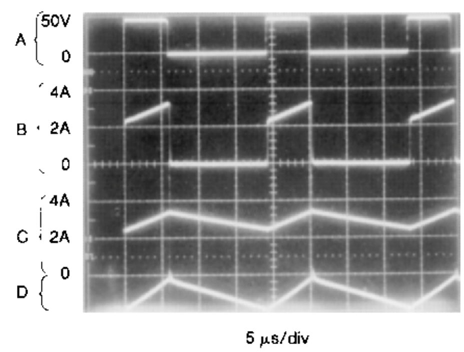


Figure 16. Feedback Pin Current



If the DDPAK/TO-263 package is used, the thermal resistance can be reduced by increasing the PCB copper area thermally connected to the package. Using 0.5 square inches of copper area, θ_{JA} is 50°C/W, with 1 square inch of copper area, θ_{JA} is 37°C/W, and with 1.6 or more square inches of copper area, θ_{JA} is 32°C/W.

Figure 17. Maximum Power Dissipation (DDPAK/TO-263)



V_{OUT} = 15 V
A: Output Pin Voltage, 50 V/div
B: Output Pin Current, 2 A/div
C: Inductor Current, 2 A/div
D: Output Ripple Voltage, 50 mV/div, AC-Coupled
Horizontal Time Base: 5 µs/div

Figure 18. Switching Waveforms

Typical Characteristics (continued)

(Circuit of Figure 26 and Figure 32)

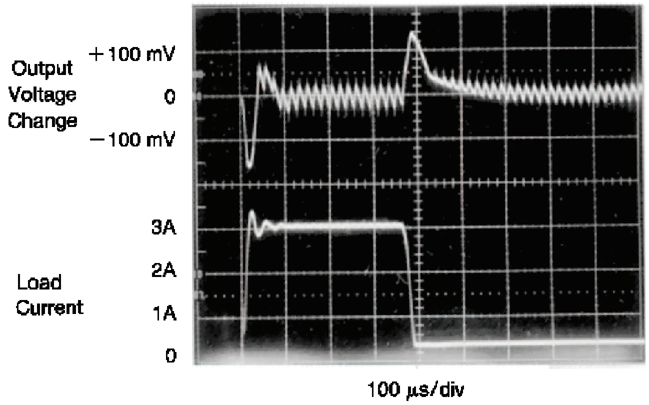


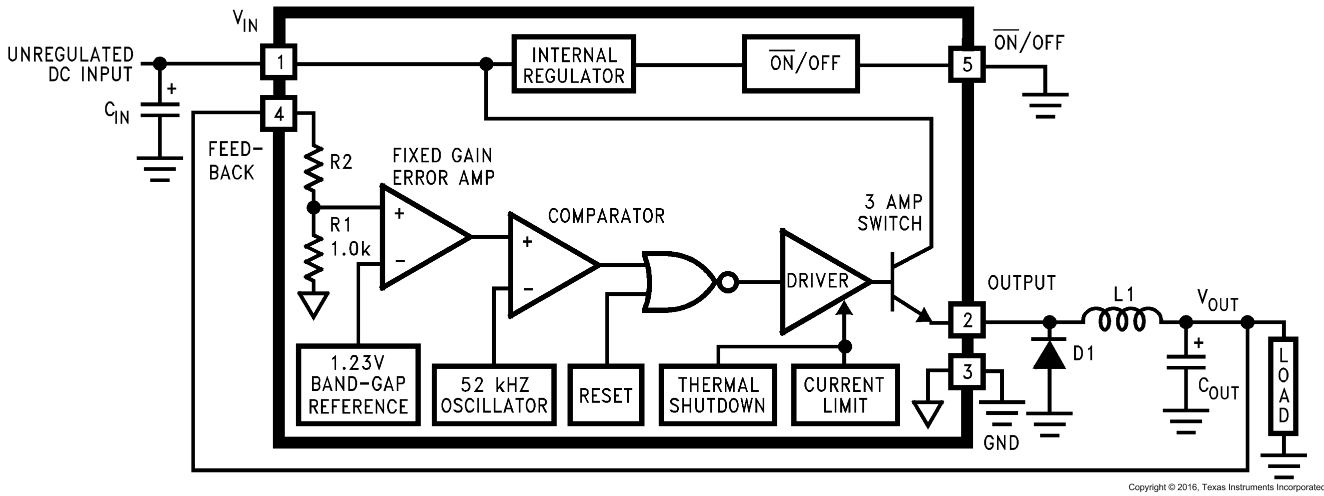
Figure 19. Load Transient Response

7 Detailed Description

7.1 Overview

The LM2576 SIMPLE SWITCHER® regulator is an easy-to-use, non-synchronous step-down DC-DC converter with a wide input voltage range from 40 V to up to 60 V for a HV version. It is capable of delivering up to 3-A DC load current with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, 15 V, and an adjustable output version. The family requires few external components, and the pin arrangement was designed for simple, optimum PCB layout.

7.2 Functional Block Diagram



3.3 V R2 = 1.7 k
5 V, R2 = 3.1 k
12 V, R2 = 8.84 k
15 V, R2 = 11.3 k
For ADJ. Version
R1 = Open, R2 = 0 Ω
Patent Pending

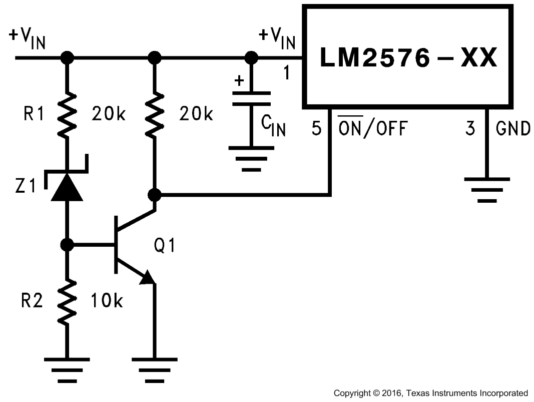
7.3 Feature Description

7.3.1 Undervoltage Lockout

In some applications it is desirable to keep the regulator off until the input voltage reaches a certain threshold. Figure 20 shows an undervoltage lockout circuit that accomplishes this task, while Figure 21 shows the same circuit applied to a buck-boost configuration. These circuits keep the regulator off until the input voltage reaches a predetermined level.

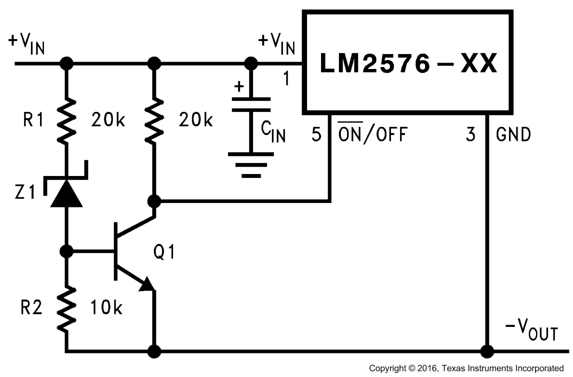
$$V_{TH} \approx V_{Z1} + 2V_{BE}(Q1) \quad (1)$$

Feature Description (continued)



Complete circuit not shown.

Figure 20. Undervoltage Lockout for Buck Circuit



Complete circuit not shown (see Figure 24).

Figure 21. Undervoltage Lockout for Buck-Boost Circuit

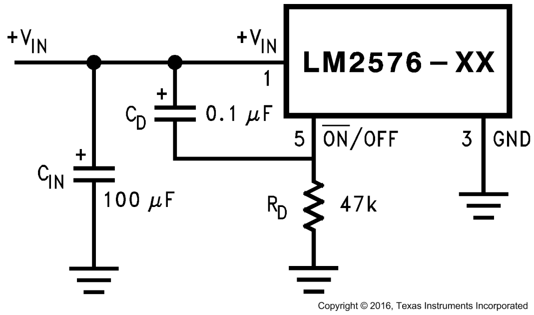
7.3.2 Delayed Start-Up

The $\overline{ON}$ /OFF pin can be used to provide a delayed start-up feature as shown in Figure 22. With an input voltage of 20 V and for the part values shown, the circuit provides approximately 10 ms of delay time before the circuit begins switching. Increasing the RC time constant can provide longer delay times. But excessively large RC time constants can cause problems with input voltages that are high in 60-Hz or 120-Hz ripple, by coupling the ripple into the $\overline{ON}$ /OFF pin.

7.3.3 Adjustable Output, Low-Ripple Power Supply

Figure 23 shows a 3-A power supply that features an adjustable output voltage. An additional LC filter that reduces the output ripple by a factor of 10 or more is included in this circuit.

Feature Description (continued)



Complete circuit not shown.

Figure 22. Delayed Start-Up

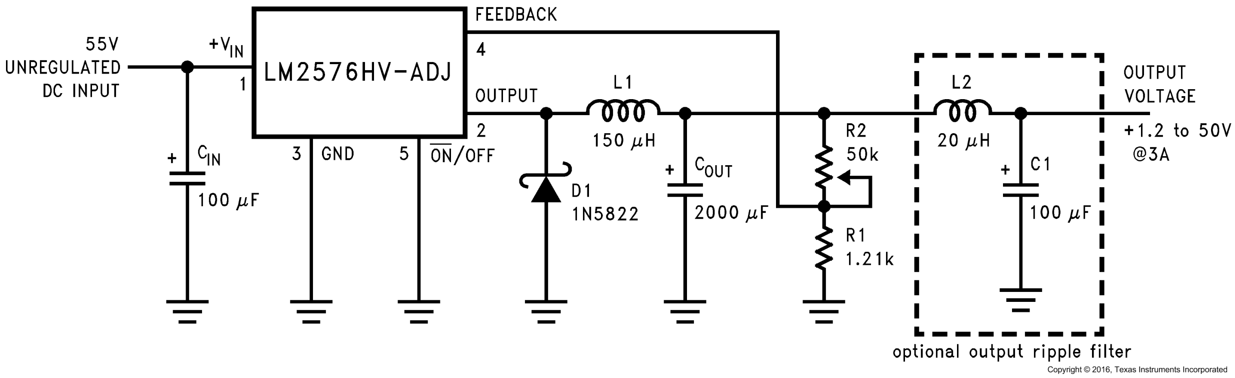


Figure 23. 1.2-V to 55-V Adjustable 3-A Power Supply With Low Output Ripple

7.4 Device Functional Modes

7.4.1 Shutdown Mode

The $\overline{\text{ON}}$/OFF pin provides electrical ON and OFF control for the LM2576. When the voltage of this pin is higher than 1.4 V, the device is in shutdown mode. The typical standby current in this mode is 50 µA.

7.4.2 Active Mode

When the voltage of the $\overline{\text{ON}}$/OFF pin is below 1.2 V, the device starts switching, and the output voltage rises until it reaches the normal regulation voltage.

7.4.3 Current Limit

The LM2576 device has current limiting to prevent the switch current from exceeding safe values during an accidental overload on the output. This current limit value can be found in *Electrical Characteristics: All Output Voltage Versions* under the heading of I_{CL}.

The LM2576 uses cycle-by-cycle peak current limit for overload protection. This helps to prevent damage to the device and external components. The regulator operates in current limit mode whenever the inductor current exceeds the value of I_{CL} given in *Electrical Characteristics: All Output Voltage Versions*. This occurs if the load current is greater than 3 A, or the converter is starting up. Keep in mind that the maximum available load current depends on the input voltage, output voltage, and inductor value. The regulator also incorporates short-circuit protection to prevent inductor current run-away. When the voltage on the FB pin (ADJ) falls below about 0.58 V the switching frequency is dropped to about 11 kHz. This allows the inductor current to ramp down sufficiently during the switch OFF-time to prevent saturation.

Application Information (continued)

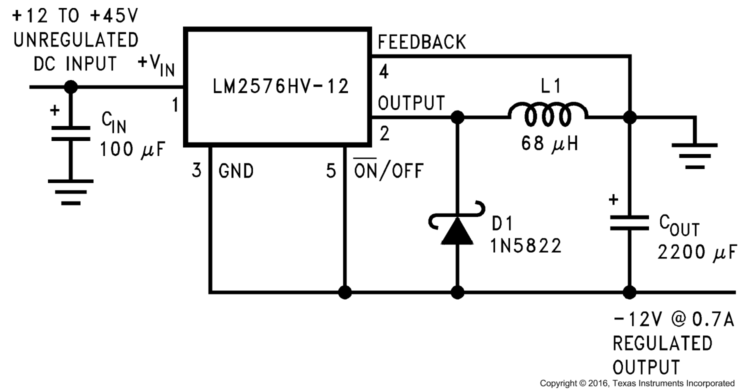
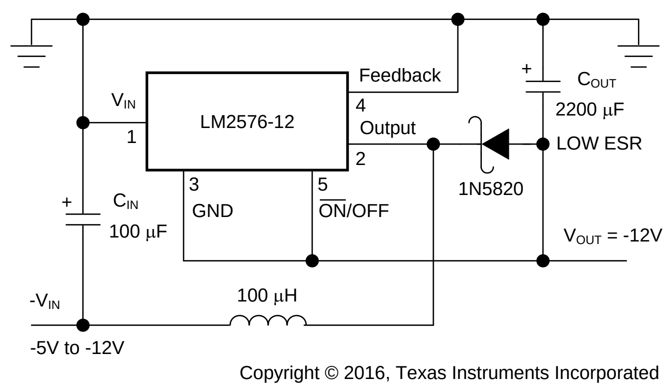


Figure 24. Inverting Buck-Boost Develops −12 V

Also, the maximum voltage appearing across the regulator is the absolute sum of the input and output voltage. For a −12-V output, the maximum input voltage for the LM2576 is +28 V, or +48 V for the LM2576HV.

8.1.10 Negative Boost Regulator

Another variation on the buck-boost topology is the negative boost configuration. The circuit in Figure 25 accepts an input voltage ranging from −5 V to −12 V and provides a regulated −12-V output. Input voltages greater than −12 V causes the output to rise above −12 V, but does not damage the regulator.



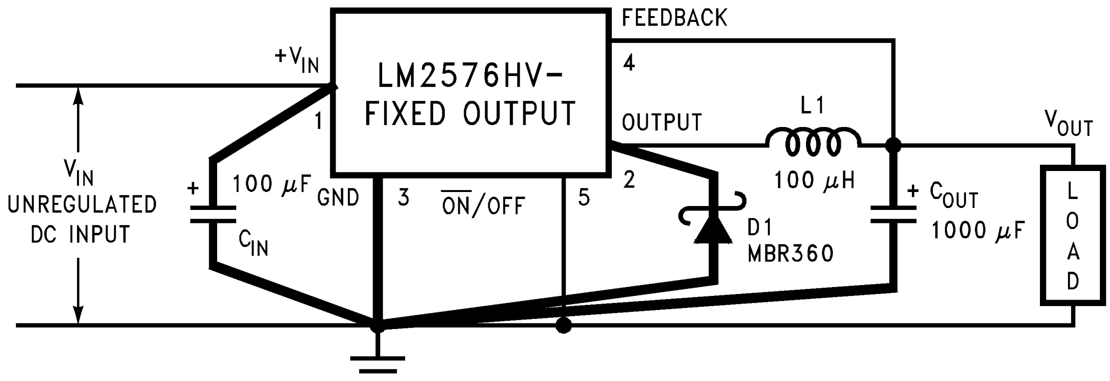
Typical Load Current
400 mA for V_{IN} = −5.2 V
750 mA for V_{IN} = −7 V
Heat sink may be required.

Figure 25. Negative Boost

Because of the boosting function of this type of regulator, the switch current is relatively high, especially at low input voltages. Output load current limitations are a result of the maximum current rating of the switch. Also, boost regulators can not provide current-limiting load protection in the event of a shorted load, so some other means (such as a fuse) may be necessary.

8.2 Typical Applications

8.2.1 Fixed Output Voltage Version



C_{IN} — 100-µF, 75-V, Aluminum Electrolytic
C_{OUT} — 1000-µF, 25-V, Aluminum Electrolytic
D_1 — Schottky, MBR360
L_1 — 100 µH, Pulse Eng. PE-92108
R_1 — 2 k, 0.1%
R_2 — 6.12 k, 0.1%

Figure 26. Fixed Output Voltage Versions

8.2.1.1 Design Requirements

Table 1 lists the design parameters of this example.

Table 1. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
Regulated Output Voltage (3.3 V, 5 V, 12 V, or 15 V), V_{OUT}	5 V
Maximum Input Voltage, V_{IN}(Max)	15 V
Maximum Load Current, I_{LOAD}(Max)	3 A

8.2.1.2 Detailed Design Procedure

8.2.1.2.1 Inductor Selection (L1)

1. Select the correct Inductor value selection guide from Figure 27, Figure 28, Figure 29, or Figure 30. (Output voltages of 3.3 V, 5 V, 12 V or 15 V respectively). For other output voltages, see the design procedure for the adjustable version. Use the selection guide shown in Figure 28.
2. From the inductor value selection guide, identify the inductance region intersected by V_{IN}(Max) and I_{LOAD}(Max), and note the inductor code for that region. From the selection guide, the inductance area intersected by the 15-V line and 3-A line is L100.
3. Identify the inductor value from the inductor code, and select an appropriate inductor from the table shown in Figure 27. Part numbers are listed for three inductor manufacturers. The inductor chosen must be rated for operation at the LM2576 switching frequency (52 kHz) and for a current rating of 1.15 × I_{LOAD}. For additional inductor information, see *Inductor Selection*. Inductor value required is 100 µH from the table in Figure 27. Choose AIE 415-0930, Pulse Engineering PE92108, or Renco RL2444.

8.2.1.2.2 Output Capacitor Selection (C_{OUT})

1. The value of the output capacitor together with the inductor defines the dominate pole-pair of the switching regulator loop. For stable operation and an acceptable output ripple voltage, (approximately 1% of the output voltage) TI recommends a value between 100 µF and 470 µF. We choose C_{OUT} = 680-µF to 2000-µF standard aluminum electrolytic.

2. The voltage rating of the capacitor must be at least 1.5 times greater than the output voltage. For a 5-V regulator, a rating of at least 8 V is appropriate, and a 10-V or 15-V rating is recommended. Capacitor voltage rating = 20 V. Higher voltage electrolytic capacitors generally have lower ESR numbers, and for this reason it may be necessary to select a capacitor rated for a higher voltage than would normally be needed.

8.2.1.2.3 Catch Diode Selection (D1)

1. The catch-diode current rating must be at least 1.2 times greater than the maximum load current. Also, if the power supply design must withstand a continuous output short, the diode should have a current rating equal to the maximum current limit of the LM2576. The most stressful condition for this diode is an overload or shorted output condition. For this example, a 3-A current rating is adequate.
2. The reverse voltage rating of the diode should be at least 1.25 times the maximum input voltage. Use a 20-V 1N5823 or SR302 Schottky diode, or any of the suggested fast-recovery diodes shown in Table 3.

8.2.1.2.4 Input Capacitor (C_{IN})

An aluminum or tantalum electrolytic bypass capacitor located close to the regulator is needed for stable operation. A 100-μF, 25-V aluminum electrolytic capacitor located near the input and ground pins provides sufficient bypassing.

8.2.1.3 Application Curves

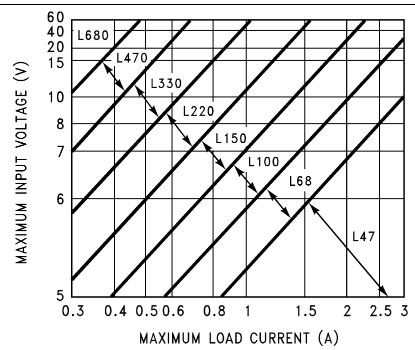


Figure 27. LM2576(HV)-3.3

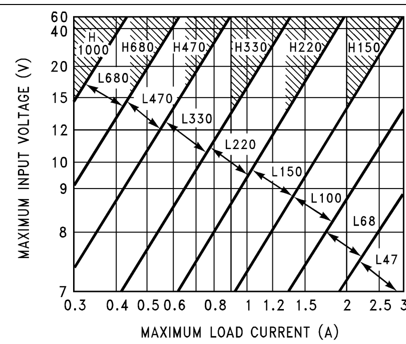


Figure 28. LM2576(HV)-5.0

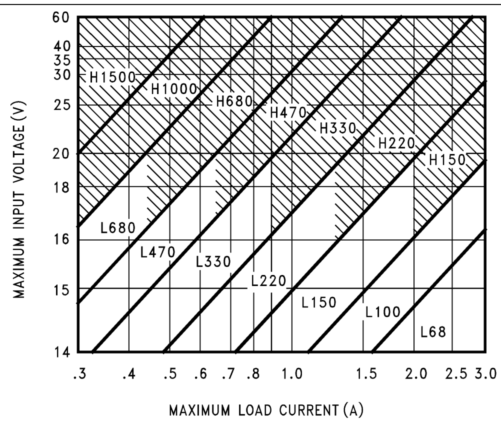


Figure 29. LM2576(HV)-12

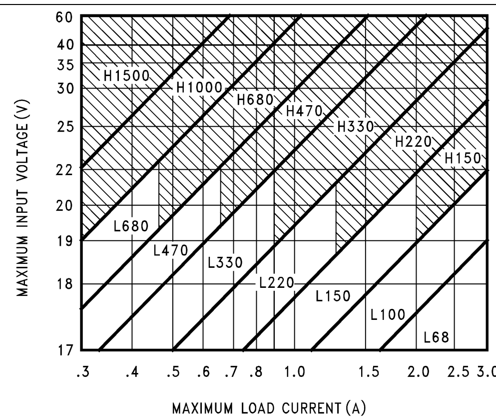


Figure 30. LM2576(HV)-15

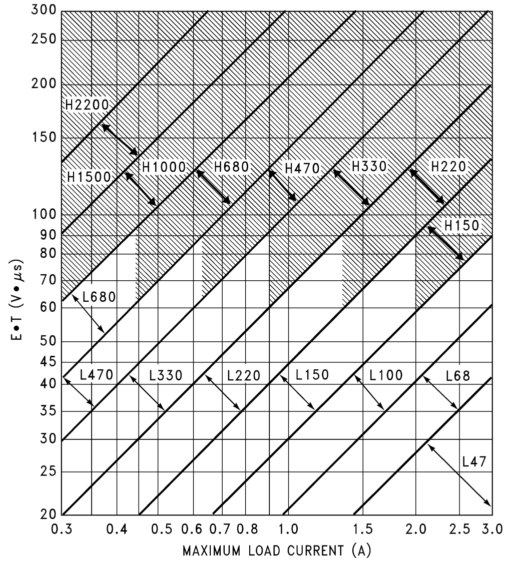
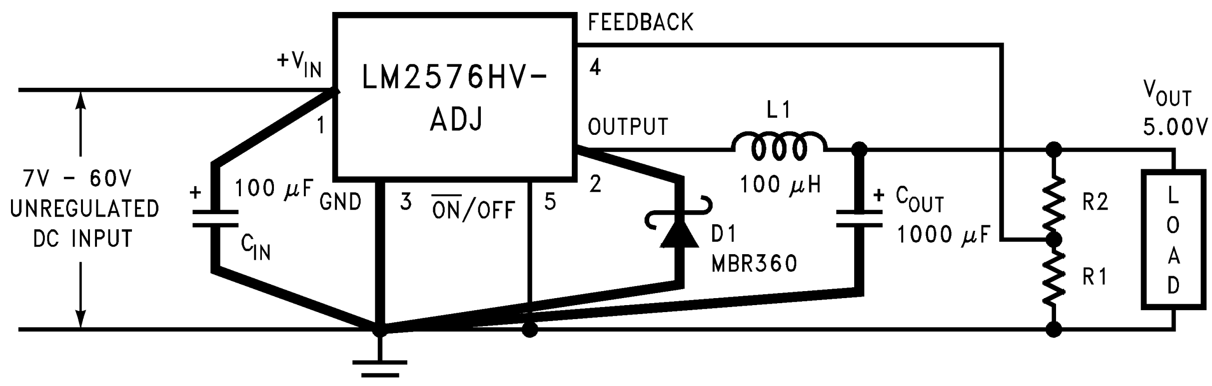


Figure 31. LM2576(HV)-ADJ

8.2.2 Adjusted Output Voltage Version



$$V_{OUT} = V_{REF}\left(1 + \frac{R_2}{R_1}\right)$$

$$R_2 = R_1\left(\frac{V_{OUT}}{V_{REF}} - 1\right)$$

where

V_{REF} = 1.23 V, R1 between 1 k and 5 k

Figure 32. Adjustable Output Voltage Version

8.2.2.1 Design Requirements

Table 2 lists the design parameters of this example.

Table 2. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
Regulated Output Voltage, V_{OUT}	10 V
Maximum Input Voltage, V_{IN}(Max)	25 V
Maximum Load Current, I_{LOAD}(Max)	3 A
Switching Frequency, F	Fixed at 52 kHz