

1.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 3A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3V, 5V, 12V, 15V, and an adjustable output versions. Requiring a minimum number of external components, these regulators are simple to use and include internal frequency compensation 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 guaranteed $\pm 4\%$ tolerance on output voltage within specified input voltages and output load conditions, and $\pm 10\%$ on the oscillator frequency. External shutdown is included, featuring 50 μ A (typical) standby current. The output switch includes cycle-by-cycle current limiting, as well as thermal shutdown for full protection under fault conditions. Note: The LM2576HV is not produced yet.

2.Features

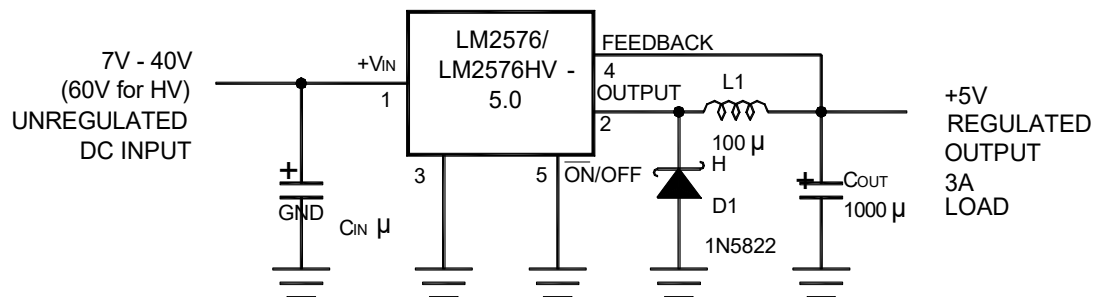
- 3.3V, 5V, 12V, 15V, and adjustable output versions
- Adjustable version output voltage range
- 1.23V to 37V (57V for HV version) $\pm 4\%$ max over line and load conditions
- Guaranteed 3A output current
- Wide input voltage range, 40V up to 60V for HV version
- Requires only 4 external components
- 52 kHz fixed frequency oscillator
- TTL shutdown capability, low power standby mode
- High efficiency
- Uses readily available standard inductors
- Thermal shutdown and current limit protection

3.Applications

- Simple high-efficiency step-down (buck) regulator
- Efficient pre-regulator for linear regulators
- On-card switching regulators
- Positive to negative converter (Buck-Boost)



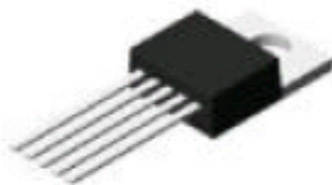
4. Typical Application (Fixed Output Voltage Versions)



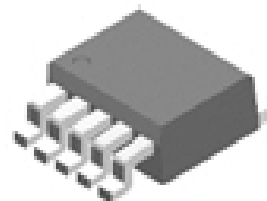
5. Package Types



TO-220B



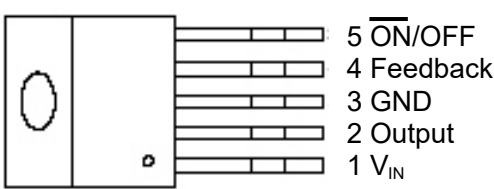
TO-220



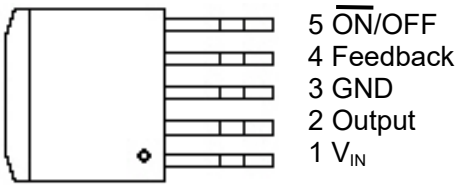
TO-263



6.Pinning information



TO-220B/TO-220

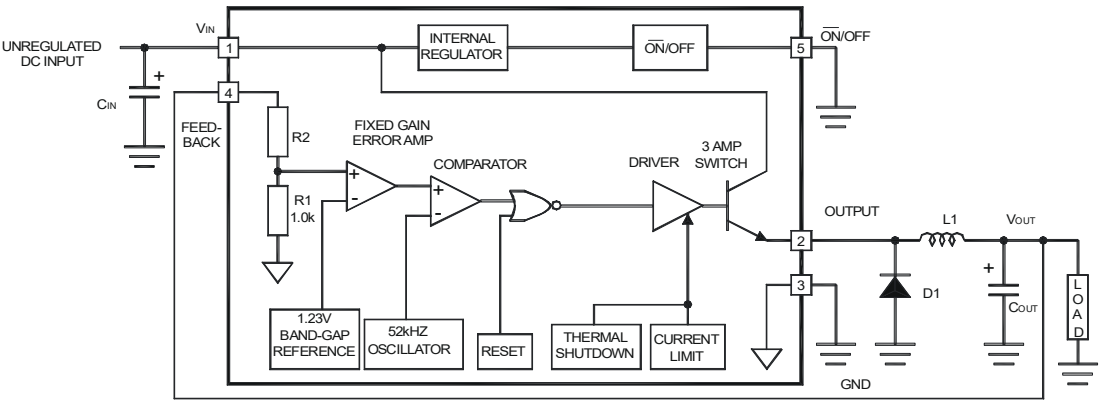


TO-263

Pin Descriptions

Name	Description
V _{IN}	Input supply voltage
Output	Switching output
GND	Ground
Feedback	Output voltage feedback
ON/OFF	ON/OFF shutdown Active is “Low” or floating

7.Block Diagram



3.3V, R2 = 1.7K 15V, R2 = 11.3K
5V, R2 = 3.1K For ADJ, Version
12V, R2 = 8.84K R1 = Open, R2 = 0Ω



8. Absolute Maximum Ratings (Note 1)

Parameter	Rating	Units
Maximum Supply Voltage		V
LM2576	45	V
LM2576HV	63	V
ON/OFF Pin Input Voltage	$-0.3 \leq V \leq +V_{IN}$	V
Output Voltage to Ground (Steady State)	-1V	V
Power Dissipation	Internally limited	W
Storage Temperature Range	-65°C to +150	°C
Maximum Junction Temperature	150	°C
Minimum ESD Rating (C=100pF, R=1.5kΩ)	2	kV
Lead Temperature (Soldering, 10 Seconds)	260	°C

9. Operating Ratings

Parameter	Rating
Temperature Range (LM2576/LM2576HV)	$-40^{\circ}\text{C} \leq T_J \leq +125^{\circ}\text{C}$
Supply Voltage, LM2576	4.5V ~ 40V
LM2576HV	4.5V ~ 60V



10.1 Electrical Characteristics

Specifications with standard type face are for $T_J=25^{\circ}\text{C}$, and those with boldface type apply over full Operating Temperature Range

Parameter	Symbol	Conditions	Typ	Limit(Note 2)	Units
System Parameters (Note 3) Test Circuit Figure 2 (LM2576 3.3, LM2576HV-3.3)					
Output Voltage	V_{OUT}	$V_{IN}=12\text{V}$, $I_{LOAD}=0.5\text{A}$ Circuit of Figure 2	3.3		V
				3.234	V(min)
				3.366	V(max)
Output Voltage (LM2576)	V_{OUT}	$6\text{V}\leq V_{IN}\leq 40\text{V}$, $0.5\text{A}\leq I_{LOAD}\leq 3\text{A}$ Circuit of Figure 2	3.3		V
				3.168/3.135	V(min)
				3.432/3.465	V(max)
Output Voltage (LM2576HV)	V_{OUT}	$6\text{V}\leq V_{IN}\leq 60\text{V}$, $0.5\text{A}\leq I_{LOAD}\leq 3\text{A}$ Circuit of Figure 2	3.3		V
				3.168/3.135	V(min)
				3.450/3.482	V(max)
Efficiency	η	$V_{IN}=12\text{V}$, $I_{LOAD}=3\text{A}$	75		%
System Parameters (Note 3) Test Circuit Figure 2 (LM2576 - 5.0, LM2576HV - 5.0)					
Output Voltage	V_{OUT}	$V_{IN}=12\text{V}$, $I_{LOAD}=0.5\text{A}$ Circuit of Figure 2	5		V
				4.900	V(min)
				5.100	V(max)
Output Voltage (LM2576)	V_{OUT}	$8\text{V}\leq V_{IN}\leq 40\text{V}$, $0.5\text{A}\leq I_{LOAD}\leq 3\text{A}$ Circuit of Figure 2	5		V
				4.800/4.750	V(min)
				5.200/5.250	V(max)
Output Voltage (LM2576HV)	V_{OUT}	$8\text{V}\leq V_{IN}\leq 60\text{V}$, $0.5\text{A}\leq I_{LOAD}\leq 3\text{A}$ Circuit of Figure 2	5		V
				4.800/4.750	V(min)
				5.225/5.275	V(max)
Efficiency	η	$V_{IN}=12\text{V}$, $I_{LOAD}=3\text{A}$	77		%



Parameter	Symbol	Conditions	Typ	Limit(Note 2)	Units
System Parameters (Note 3) Test Circuit Figure 2 (LM2576 -12, LM2576HV -12)					
Output Voltage	V_{OUT}	$V_{IN}=25V, I_{LOAD}=0.5A$ Circuit of Figure 2	12		V
				11.76	V(min)
				12.24	V(max)
Output Voltage (LM2576)	V_{OUT}	$15V \leq V_{IN} \leq 40V, 0.5A \leq I_{LOAD} \leq 3A$ Circuit of Figure 2	12		V
				11.52/11.40	V(min)
				12.48/12.60	V(max)
Output Voltage (LM2576HV)	V_{OUT}	$15V \leq V_{IN} \leq 60V, 0.5A \leq I_{LOAD} \leq 3A$ Circuit of Figure 2	12		V
				11.52/11.40	V(min)
				12.54/12.66	V(max)
Efficiency	η	$V_{IN}=15V, I_{LOAD}=3A$	88		%
System Parameters (Note 3) Test Circuit Figure 2 (LM2576 15, LM2576HV - 15)					
Output Voltage	V_{OUT}	$V_{IN}=25V, I_{LOAD}=0.5A$ Circuit of Figure 2	15		V
				14.70	V(min)
				15.30	V(max)
Output Voltage (LM2576)	V_{OUT}	$18V \leq V_{IN} \leq 40V, 0.5A \leq I_{LOAD} \leq 3A$ Circuit of Figure 2	15		V
				14.40/14.25	V(min)
				15.60/15.75	V(max)
Output Voltage (LM2576HV)	V_{OUT}	$18V \leq V_{IN} \leq 60V, 0.5A \leq I_{LOAD} \leq 3A$ Circuit of Figure 2	15		V
				14.40/14.25	V(min)
				15.68/15.83	V(max)
Efficiency	η	$V_{IN}=18V, I_{LOAD}=3A$	88		%



Parameter	Symbol	Conditions	Typ	Limit(Note 2)	Units
System Parameters (Note 3) Test Circuit Figure 2 (LM2576-ADJ, LM2576HV -ADJ)					
Output Voltage	V_{OUT}	$V_{IN}=12V, I_{LOAD}=0.5A, V_{OUT}=5V$ Circuit of Figure 2	1.230		V
				1.217	V(min)
				1.243	V(max)
Output Voltage (LM2576)	V_{OUT}	$8V \leq V_{IN} \leq 40V, 0.5A \leq I_{LOAD} \leq 3A$ Circuit of Figure 2	1.230		V
				1.193/1.180	V(min)
				1.267/1.280	V(max)
Output Voltage (LM2576HV)	V_{OUT}	$8V \leq V_{IN} \leq 60V, 0.5A \leq I_{LOAD} \leq 3A$ Circuit of Figure 2	1.230		V
				1.193/1.180	V(min)
				1.273/1.286	V(max)
Efficiency	η	$V_{IN}=12V, I_{LOAD}=3A, V_{OUT}=5V$	77		%



10.2 Electrical Characteristics (All Output Voltage Versions)

Specifications with standard type face are for $T_J=25^{\circ}\text{C}$, and those with boldface type apply over full Operating Temperature Range, Unless otherwise specified, $V_{IN}=12\text{V}$ for the 3.3V, 5V, and Adjustable version, $V_{IN}=25\text{V}$ for the 12V version, and $V_{IN}=30\text{V}$ for the 15V version, $I_{LOAD}=500\text{mA}$.

Parameter	Symbol	Conditions	Typ	Limit(Note 2)	Units
Device Parameters					
Feedback Bias Current	I_B	$V_{OUT}=5\text{V}$ (Adjustable Version Only)	50	100/500	nA
Oscillator Frequency	f_o	(Note 8)	52		kHz
			47	42	kHz(min)
			58	63	kHz(max)
Saturation Voltage	V_{SAT}	$I_{OUT}=3\text{A}$ (Note 4)	1.4		V
				1.8/2.0	V(max)
Max Duty Cycle (ON)	DC	(Note 5)	98		%
				93	%(min)
Current Limit	I_{CL}	(Notes 4, 8)	5.8		A
				4.2/3.5	A(min)
				6.9/7.5	A(max)
Output Leakage Current	I_L	(Notes 6, 7)		2	mA(min)
		Output = -1V	7.5		mA
				30	mA(max)
Quiescent Current	I_Q	(Note 6)	5		mA
				10	mA(max)
Standby Quiescent Current	I_{STBY}	$\overline{\text{ON/OFF}}$ pin=5V (OFF)	50		μA
				200	$\mu\text{A(max)}$



Parameter	Symbol	Conditions	Typ	Limit(Note 2)	Units
ON/OFF Control					
ON/OFF Pin Logic Input Level	V_{IH}	$V_{OUT}=0V$	1.4	2.2/2.4	V(min)
	V_{IL}	V_{OUT} =Nominal Output Voltage	1.2	1.0/0.8	V(max)
ON/OFF Pin Input Current	I_{IH}	ON/OFF Pin=5V(OFF)	12		μA
				30	$\mu A(max)$
	I_{IL}	ON/OFF Pin=0V(ON)	0		μA
				10	$\mu A(max)$

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.

Note 2: All limits guaranteed at room temperature (standard type face) and at temperature extremes (bold type face).

Note 3: 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 the Figure 2 test circuit, system performance will be as shown in system parameters section of Electrical Characteristics.

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

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

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

Note 7: V_{IN} =40V (60V for high voltage version).

Note 8: 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 protections feature lowers the average power dissipation of the IC by lowering the minimum duty cycle from 5% down to approximately 2%.



11.1 Typical Characteristic (Circuit of Figure 2)

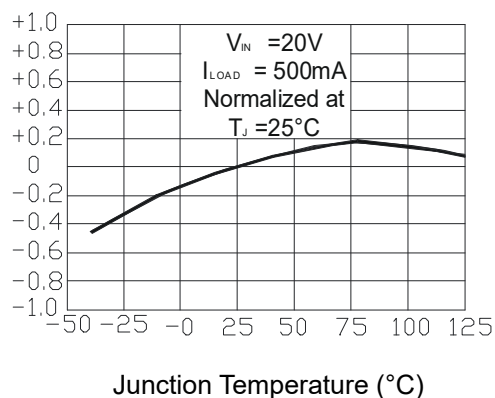


Figure 1: Normalized Output Voltage

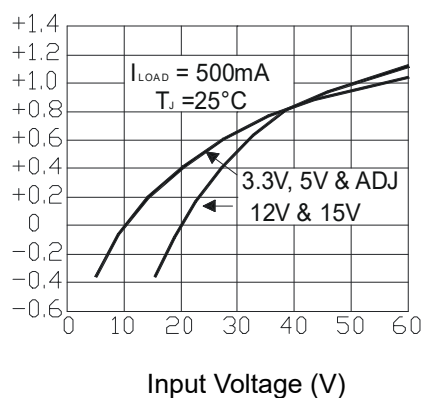


Figure 2: Line Regulation

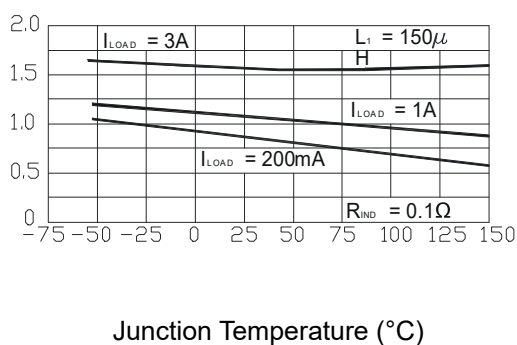


Figure 3: Dropout Voltage

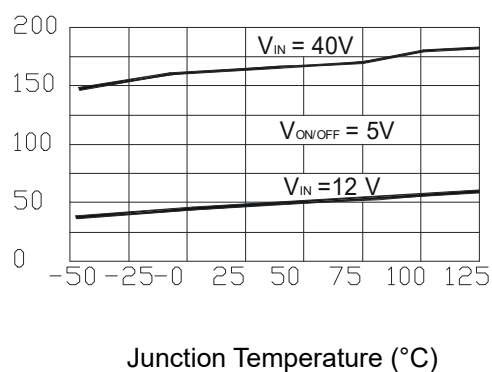


Figure 4: Standby Quiescent Current

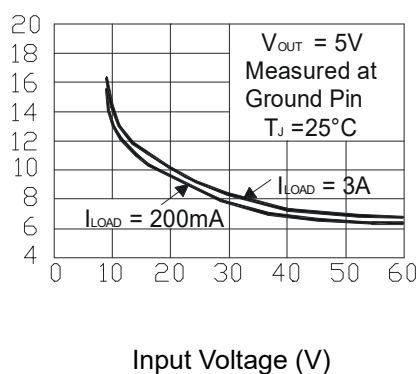


Figure 5: Quiescent Current

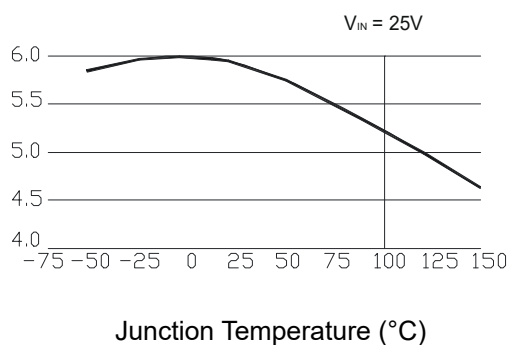


Figure 6: Current Limit



11.2 Typical Characteristic

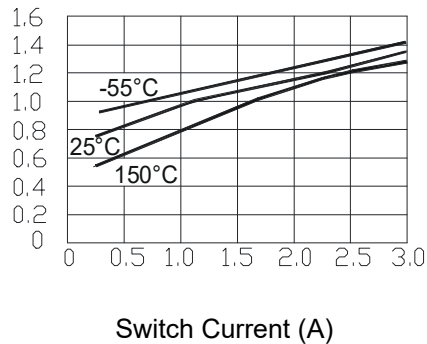


Figure 7: Switch Saturation Voltage

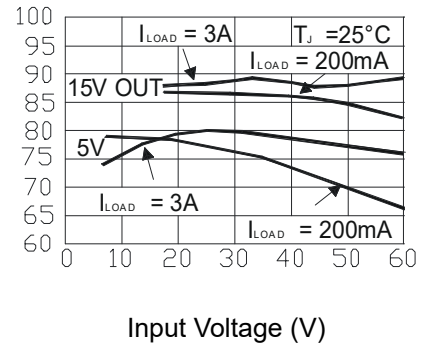


Figure 8: Efficiency

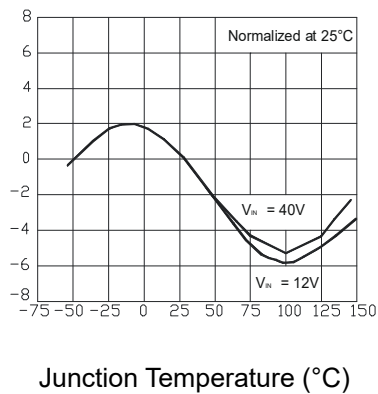


Figure 9: Oscillator Frequency

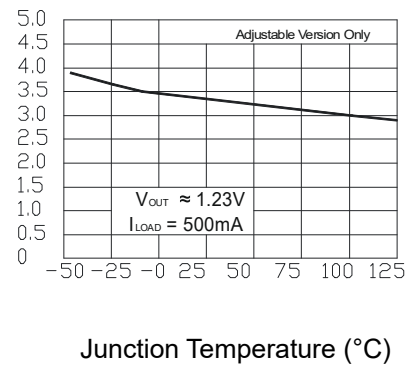


Figure 10: Minimum Operating Voltage

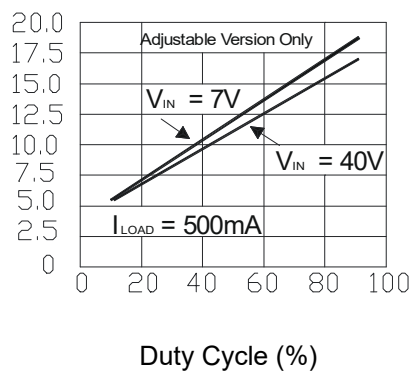


Figure 11: Quiescent Current vs Duty Cycle

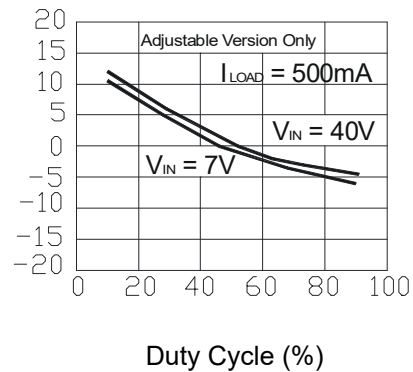
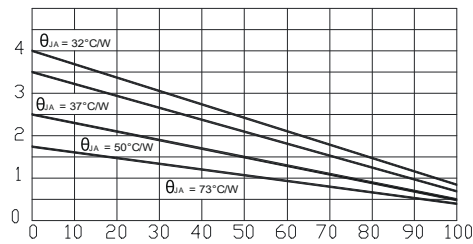


Figure 12: Feedback Voltage vs Duty Cycle

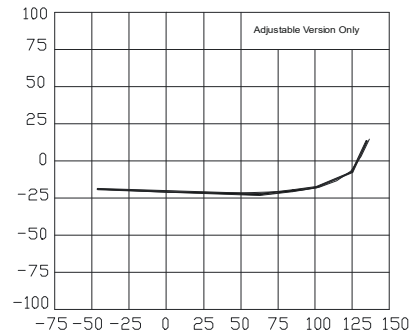


11.3 Typical Characteristic



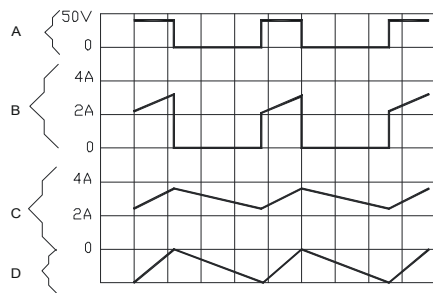
Ambient Temperature (°C)

Figure 13: Maximum Power Dissipation (TO-263)



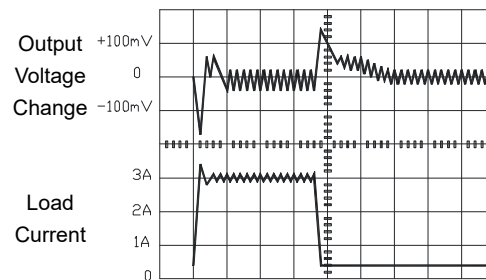
Junction Temperature (°C)

Figure 14: Feedback Pin Current



5μs/div

Figure 15: Switching Waveforms



100μ

Figure 16: Load Transient

$V_{OUT} = 15V$

A: Output Pin Voltage, 50V/div

B: Output Pin Current, 2A/div

C: Inductor Current, 2A/div

D: Output Ripple Voltage, 50mV/div,

AC-Coupled

Horizontal Time Base: 5μs/div

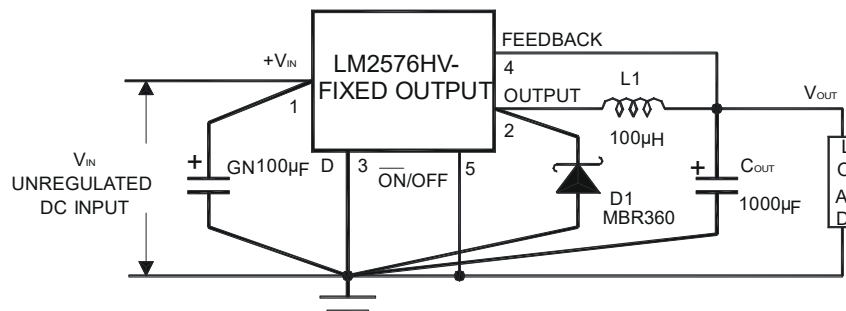


12. Test Circuit and Layout Guidelines

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 length of the leads indicated by heavy lines should be kept as short as possible.

Single-point grounding (as indicated) or ground plane construction should be used for best results. When using the Adjustable version, physically locate the programming resistors near the regulator, to keep the sensitive feedback wiring short

Fixed Output Voltage Versions (Figure 2a)



C_{IN} — 100µF, 75V, Aluminum Electrolytic

C_{OUT} — 1000µF, 25V, Aluminum Electrolytic

D1 — Schottky, MBR360

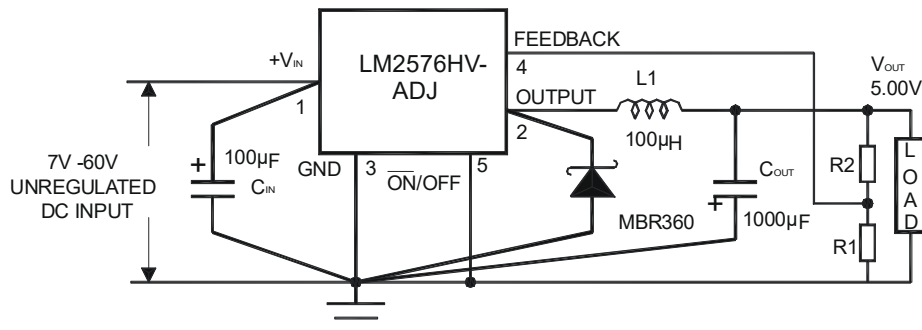
L_1 — 100µH, Pulse Eng. PE-92108

R_1 — 2k, 0.1%

R_2 — 6.12k, 0.1%



Adjustable Output Voltage Version (Figure 2b)



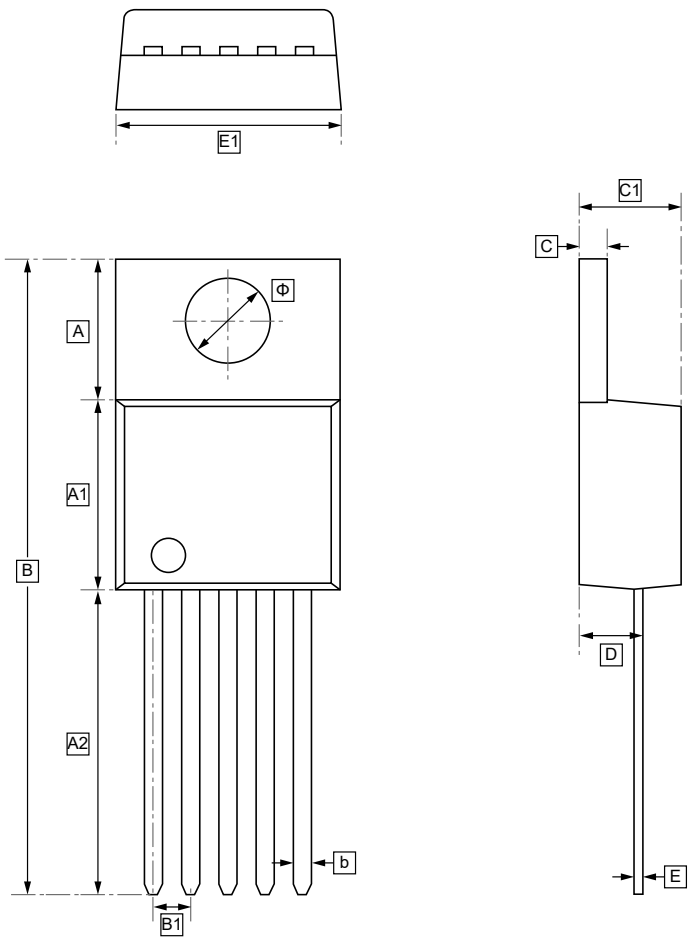
$$V_{OUT} = V_{REF} (1 + R_2/R_1)$$

$$R_2 = R_1 (V_{OUT}/V_{REF} - 1)$$

where $V_{REF} = 1.23V$, R_1 between 1k and 5k



13.1 TO-220 Package Outline Dimensions

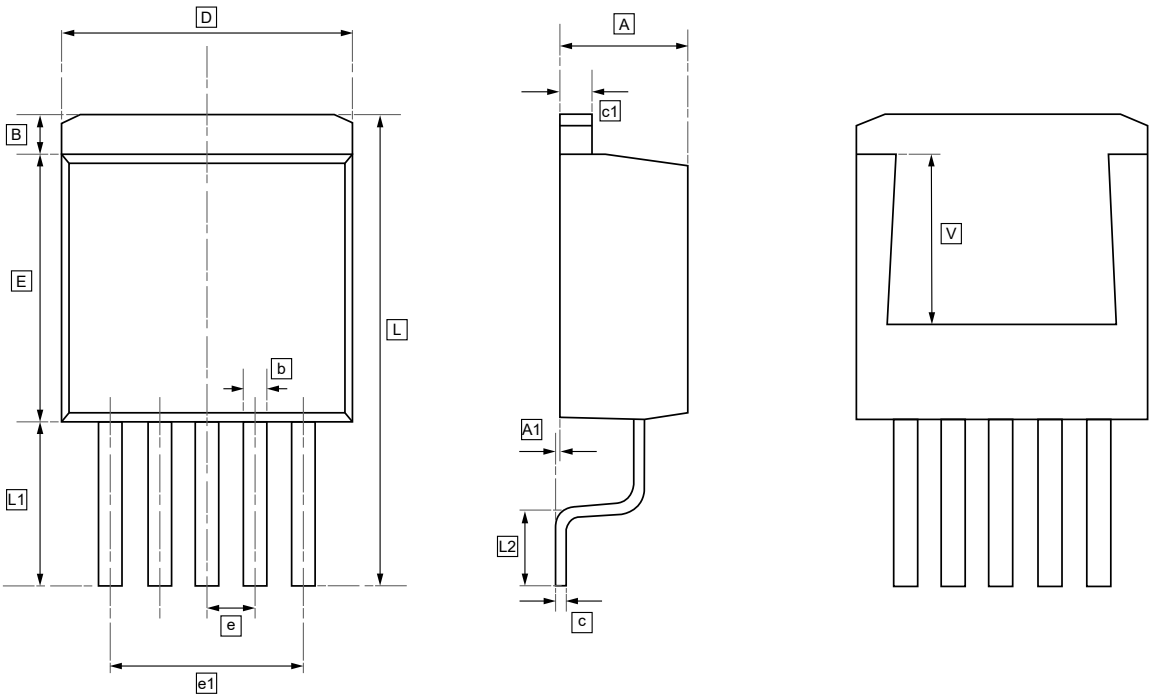


DIMENSIONS (mm are the original dimensions)

Symbol	A	A1	A2	B	B1	b	C	C1	D	E	E1	Φ
Min	6.3	8.48	13.67	28.55	1.70	0.75	1.20	0.45	2.38	0.33	10.00	3.80
Max	6.4	8.68	13.97	28.95		0.85	1.30	0.65	2.58	0.43	10.20	3.90



13.2 TO-263 Package Outline Dimensions



DIMENSIONS (mm are the original dimensions)

Symbol	A	A1	B	b	c	c1	D	E	e	e1	L	L1
Min	4.470	0.000	1.560	0.710	0.310	1.170	9.880	8.200	1.700	6.700	15.140	5.080
Max	4.670	0.150	1.760	0.910	0.530	1.370	10.180	8.600	TYP	6.900	15.540	5.480

Symbol	L2	V
Min	2.340	5.600
Max	2.740	REF



14.Ordering Information

UMW yyww
LM2576S
-12 P+
○

yy: Year Code
ww: Week Code

Order Code	Marking	Package	Base QTY	Delivery Mode
UMW LM2576S-xx	LM2576S-xx	TO-263	800	Tape and reel
UMW LM2576T-xx	LM2576T-xx	TO-220	1000	Tape and box
UMW LM2576HVT-xx	LM2576HVT-xx	TO-220	1000	Tape and box
UMW LM2576T-xx	LM2576T-xx	TO-220	1000	Tape and box



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