1A&2A Miniconverter Switching Regulators

Description:

The LM2575/6 series switching regulators are monolithic integrated circuits designed for use in “buck” or “buck/ boost” regulator applications requiring accurate output voltages over combined variations of line, load and temperature. This unique series greatly simplifies switching power supply design. The LM2575 has a maximum output current of 1A and the LM2576 is rated for 2A.

The LM2575/6 series miniconverters include a switching regulator and compensation network all within the same package. Just add a choke, catch diode and two capacitors to obtain an efficient DC-to-DC converter. The current limit and thermal shutdown features of the LM2575/6 series fully protect the device against overstress conditions.

The LM2575/6 series offers an alternative to popular 3 terminal linear regulators by providing higher efficiency with reduced heatsink size. In many applications a heat sink will not be required.

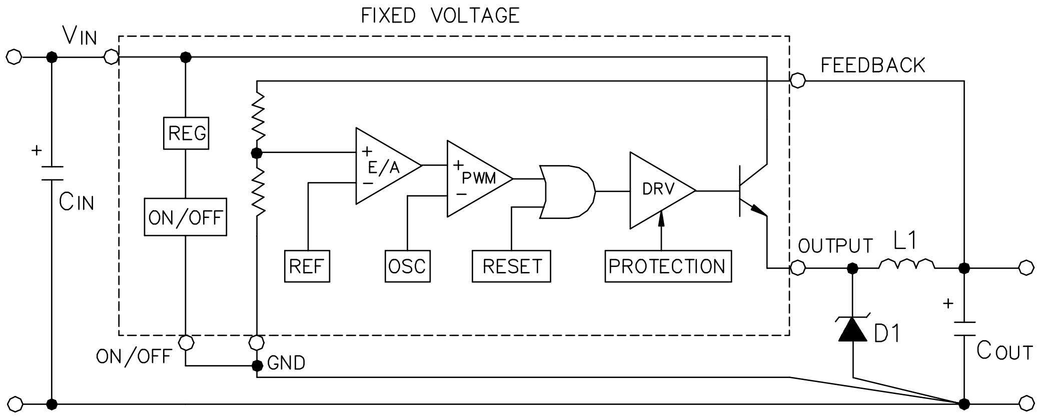
Features:

- Pin for ein reeeaceeent for Nationae'sLM2575/6 series
- DC-to-DC buck or buck/boost converter reeuiring oney 4 sueeort coeeonents
- Fixed or adjustabeevoetages
- Preset outeut voetagesof 3.3V, 5V and 12V
- Wide outeut voetagerange, 1.23V to 35V
- 78% tyeicae efficiency @ 5V out
- Wide ineut voetagerange, 4V to 40V
- Inhibit/enabeecontroe ein
- Industriae teeeerature range
- TO-220 and TO-263 eackages

Applications:

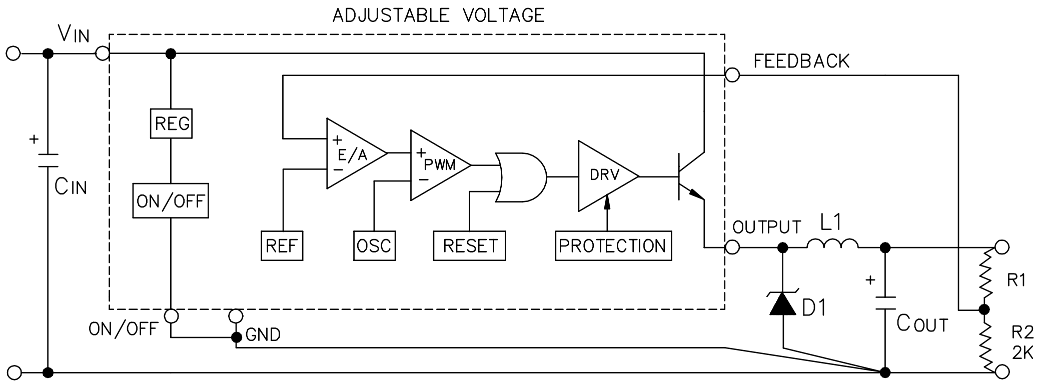
- Micro controeeer eower sueeeies
- Medicae eeuieeent
- Industriae eower sueeeies
- Instrueentation eower sueeeies

Typical Application Circuits



Vo + 2 ≤ VIN ≤ RATED

	LM2575	LM2576
L_1	330μH	100μH
D_1	3A	7A
C_{IN}	68μF	120μF
C_{OUT}	330μF	1,000μF



$V_O = 1.23 (1 + R1/R2)$

Absolute Maximum Ratings

Parameter	Symbol	Maximum	Units
Input Voltage	V_{IN}	45	V
On/Off Pin Input Voltage	$V_{ON/OFF}$	$-0.3 \le V_{ON/OFF} \le V_{IN}$	V
Output Voltage to Common (Steady State)		-1	V
Power Dissipation	P_D	Internally Limited	W
Thermal Resistance Junction to Ambient TO-220 TO-263	θ_{JA}	 55 60	°C/W
Thermal Resistance Junction to Case TO-220 TO-263	θ_{JC}	 2.0 2.0	°C/W
Operating Junction Temperature Range	T_J	-40 to +125	°C
Storage Temperature Range	T_{STG}	-65 to +150	°C
Lead Temperature (Soldering) 10 Sec.	T_{LEAD}	300	°C
ESD Rating (Human Body Model)	V_{ESD}	2	kV

Electrical Characteristics

Unless otherwise specified: V_{IN} = 12V for 3.3V, 5V and ADJ options and 25V for 12V option; V_{OUT} = 5V for ADJ option; T_A = 25ºC; V_{IN} rated = 40V; I_O = 0.5 to 2A (LM2576), 0.2 to 1A (LM2575). Values in **bold** apply over full operating temperature range.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Output Voltage	V_O	I_O = 0.5A	3.23	3.30	3.37	V
LM2576-3.3		8V to V_{IN} Rated	3.20		3.40	
			3.14		**3.47**	
Output Voltage	V_O	I_O = 0.5A	4.90	5.00	5.10	V
LM2576-5		8V to V_{IN} Rated	4.85		5.15	
			4.75		**5.25**	
Output Voltage	V_O	I_O = 0.5A	11.76	12.00	12.24	V
LM2576-12		15V to V_{IN} Rated	11.52		12.48	
			11.40		**12.60**	
Feedback Voltage	V_{FB}	I_O = 0.5A	1.217	1.230	1.243	V
LM2576-ADJ, V_O = 5V		8V to V_{IN} Rated	1.193		1.267	
			1.180		**1.280**	
Feedback Bias Current	I_B	V_{IN} = 12V, I_O = 0.5A		50	100	nA
LM2576-ADJ					**500**	

Electrical Characteristics (Cont.)

Unless otherwise specified: V_{IN} = 12V for 3.3V, 5V and ADJ options and 25V for 12V option; V_{OUT} = 5V for ADJ option; T_A = 25ºC; V_{IN} rated = 40V; I_O = 0.5 to 2A (LM2576), 0.2 to 1A (LM2575). Values in **bold** apply over full operating temperature range.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Output Voltage	V_O	I_O = 0.2A	3.23	3.30	3.37	V
LM2575-3.3		8V to V_{IN} Rated	3.20		3.40	
			3.14		**3.47**	
Output Voltage	V_O	I_O = 0.2A	4.90	5.00	5.10	V
LM2575-5		8V to V_{IN} Rated	4.85		5.15	
			4.75		**5.25**	
Output Voltage	V_O	I_O = 0.2A	11.76	12.00	12.24	V
LM2575-12		15V to V_{IN} Rated	11.52		12.48	
			11.40		**12.60**	
Feedback Voltage	V_{FB}	I_O = 0.2A	1.217	1.230	1.243	V
LM2575-ADJ, V_O = 5V		8V to V_{IN} Rated	1.193		1.267	
			1.180		**1.280**	
Feedback Bias Current	I_B	V_{IN} = 12V, I_O = 0.2A		50	100	nA
LM2575-ADJ					**500**	
Efficiency/Option						
3.3V	η	V_{IN} = 12V, I_O = 1A (LM2575, 3A for LM2576)		75		%
5V				78		
12V		V_{IN} = 15V, I_O = 1A (LM2575, 3A for LM2576)		85		
ADJ, V_O = 5V		V_{IN} = 12V, I_O = 1A (LM2575, 3A for LM2576)		78		
Switching Frequency	f_{SX}		47	52	58	kHz
			43		**62**	
Saturation Voltage(1)	V_{SAT}	LM2575, I_O = 1A		**0.9**	**1.2**	V
		LM2576, I_O = 2A		**0.9**	**1.4**	
Max. Duty Cycle (On)(3)	DC		93	98		%
Peak Current LM2575(1)	I_{CL}		1.7	2.2	3.0	A
			1.3		**3.2**	
Peak Current LM2576(1)	I_{CL}		3.2	4.8	5.9	A
			2.5		**6.5**	

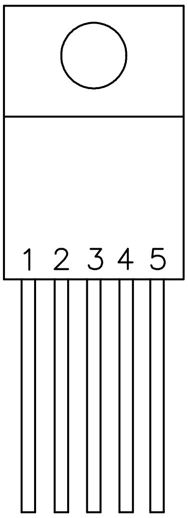
Electrical Characteristics (Cont.)

Unless otherwise specified: V_{IN} = 12V for 3.3V, 5V and ADJ options and 25V for 12V option; V_{OUT} = 5V for ADJ option; T_A = 25ºC; V_{IN} rated = 40V; I_O = 0.5 to 2A (LM2576), 0.2 to 1A (LM2575). Values in **bold** apply over full operating temperature range.

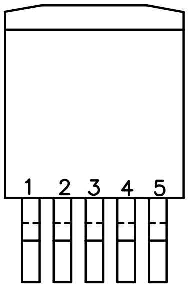
Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Output Leakage Current[(2)]						
Output = 0V	I_L	V_{IN} = V_{IN} Rated			2	mA
Output = -1V				7.5	30	
Quiescent Current[(2)]	I_Q			5	10	mA
					12	
Standby Quiescent Current (On/Off Pin = 5V)	I_{STBY}			50		μA
					500	
On/Off Pin Logic Input Level	V_{IH}		2.2	1.4		V
			2.4			
	V_{IL}			1.2	1.0	V
					0.8	
On/Off Pin Input Current	I_{IH}	$V_{ON/OFF}$ = 5V (Off)		12	30	μA
	I_{IL}	$V_{ON/OFF}$ = 0V (On)		0	10	

Notes:
(1) Output sourcing current, resistive load, no inductor or capacitor.
(2) Feedback = V_O + 1.0V.
(3) Feedback = 0V.

Pin Configurations



TO-220-5



TO-263-5

LM2575, LM2576	
Pin	**Function**
1	V_{IN}
2	OUTPUT
3	COMMON
4	FEEDBACK
5	ON/OFF
TAB is COMMON	

Ordering Information

Device[1]	Package	Current
LM2575T-XX	TO-220-5[2][3]	1A
LM2575S-XX.TR	TO-263-5[4]	
LM2576T-XX	TO-220-5[2][3]	2A
LM2576S-XX.TR	TO-263-5[4]	

Notes:

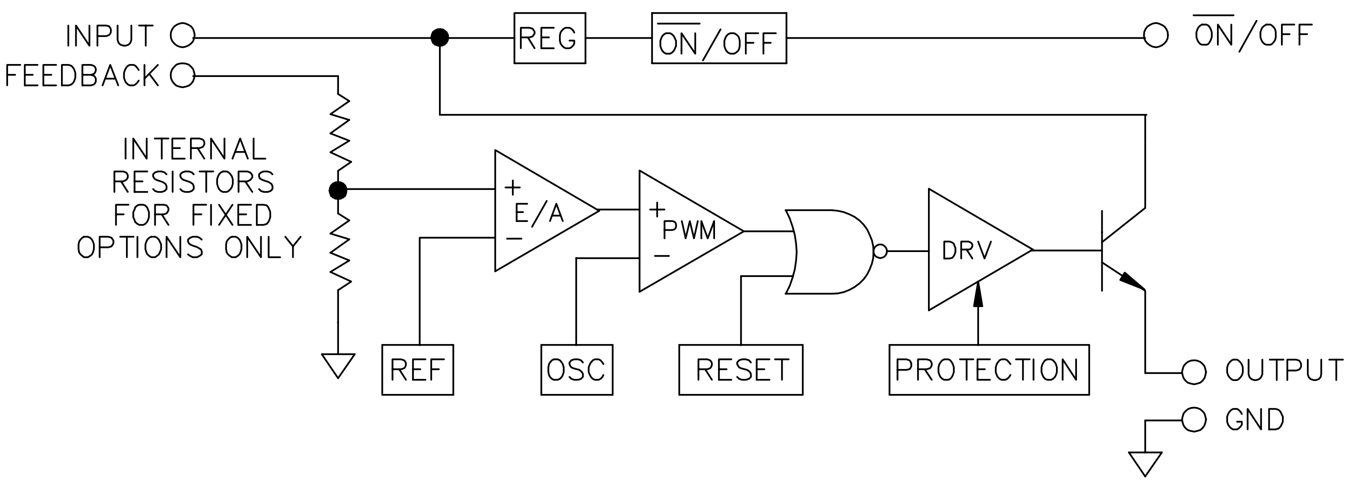
(1) -XX = Voltage Option. Available voltages are 3.3V (-3.3), 5V (-5.0), 12V (-12), and ADJ (-ADJ), which is adjustable between 1.23V and 35V.

(2) Lead bend options for TO-220-5 are: T-XX = Straight in-line;

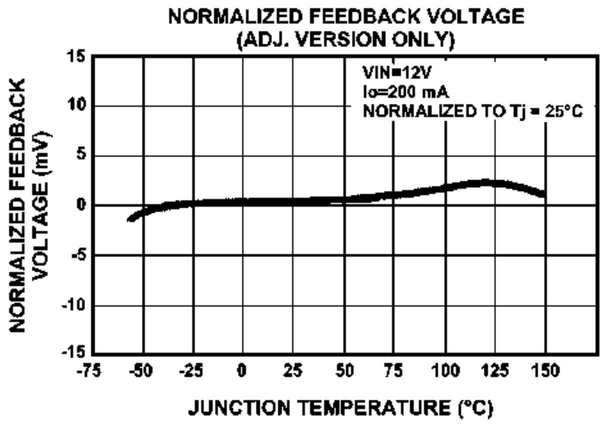
(3) Only available in tube packaging. A tube contains 50 devices.

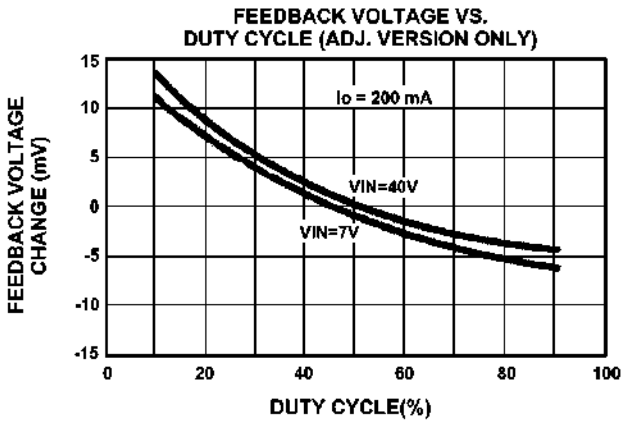
(4) Only available in tape and reel packaging. A reel contains 800 devices.

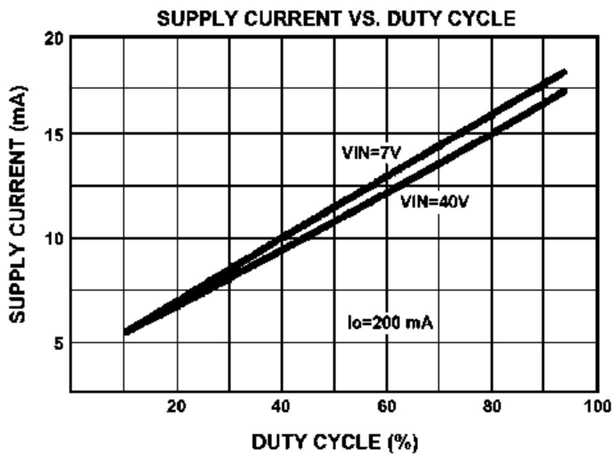
Block Diagram

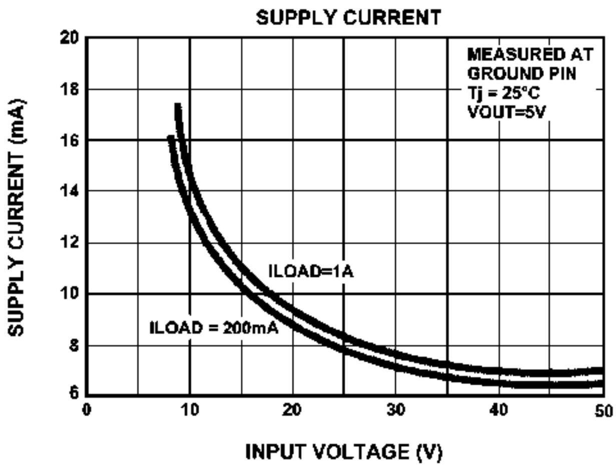


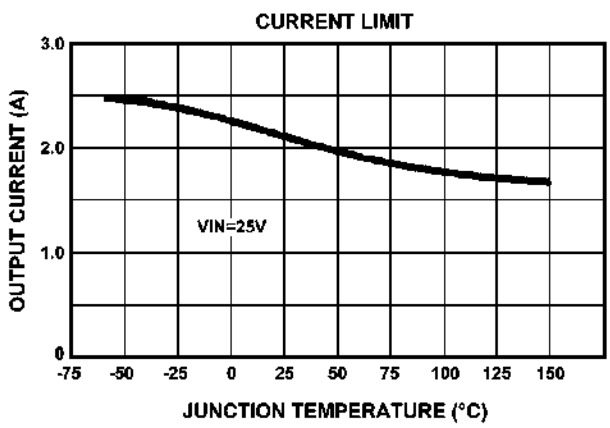
Typical Characteristics -LM2575

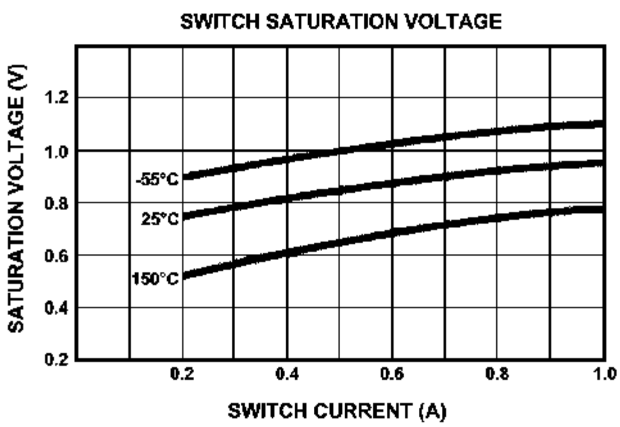




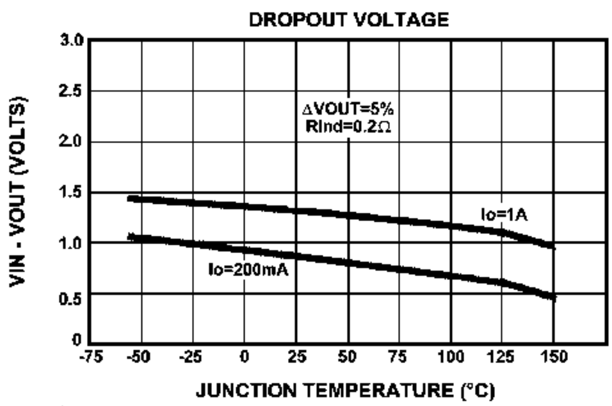


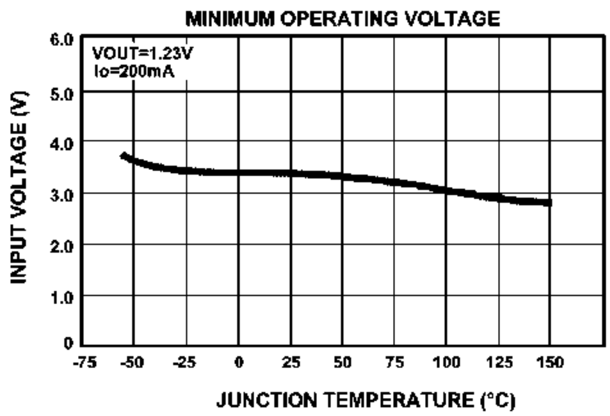


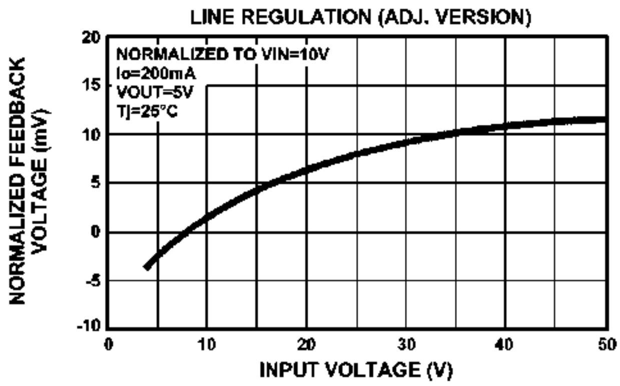


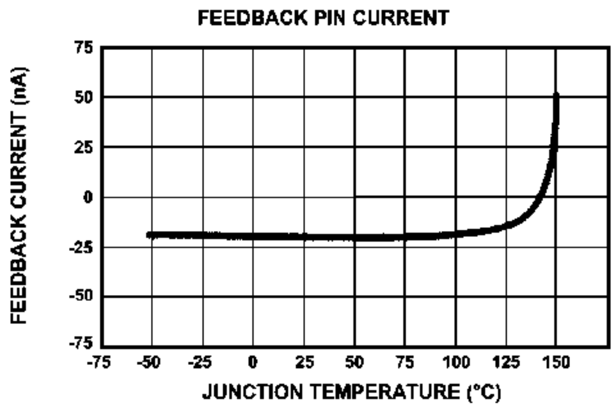


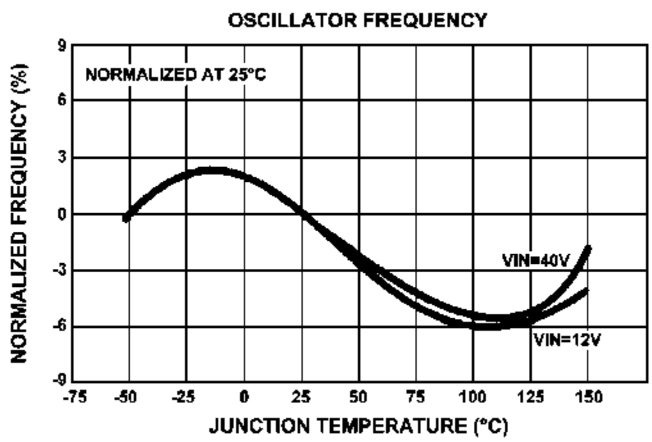
Typical Characteristics -LM2575(Cont.)



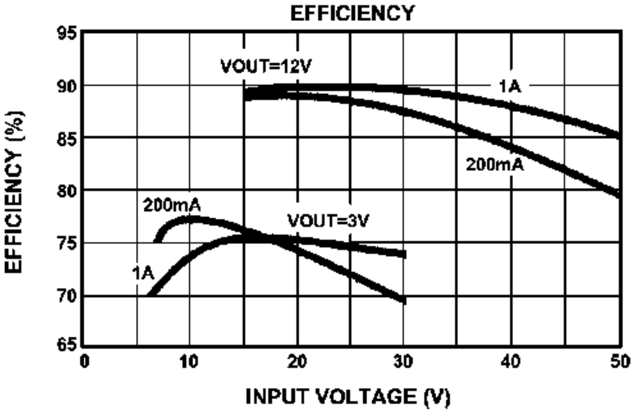


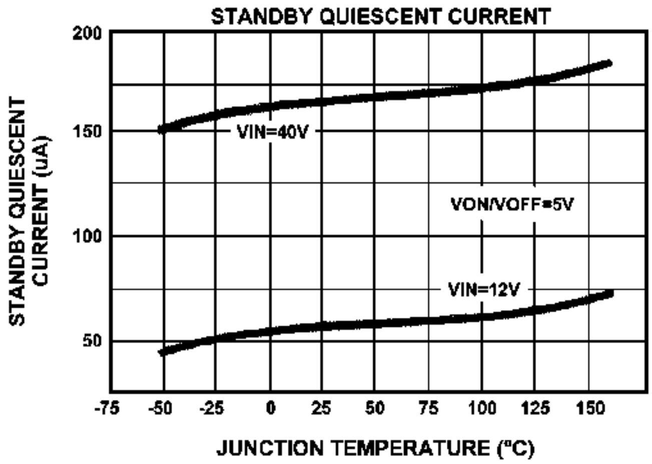


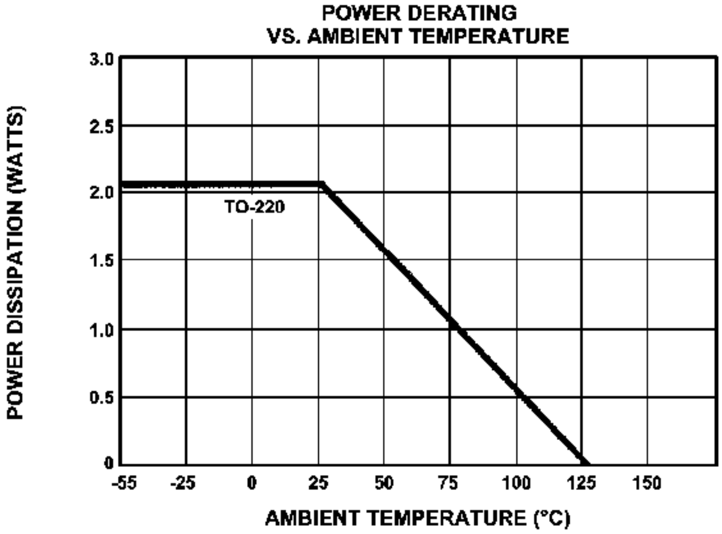




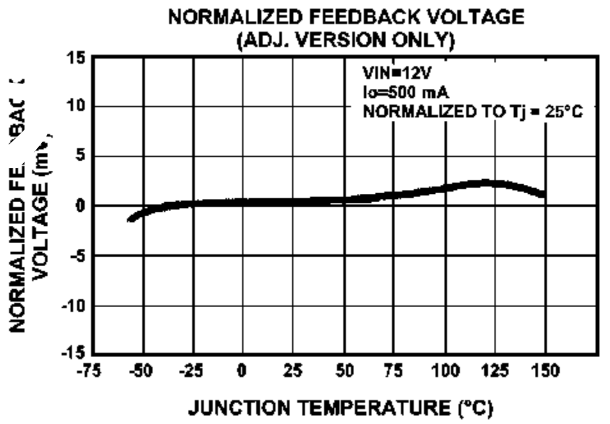
Typical Characteristics -LM2575(Cont.)

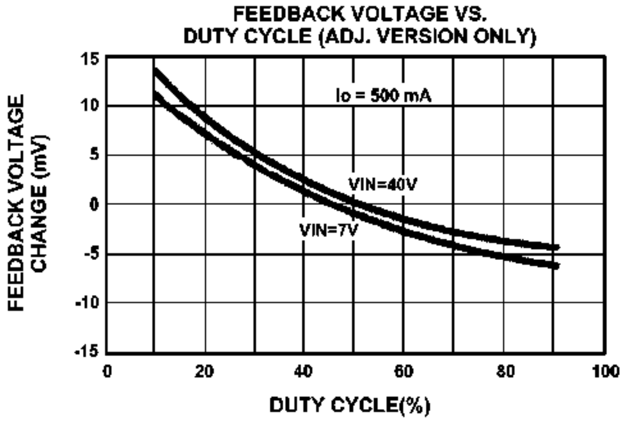


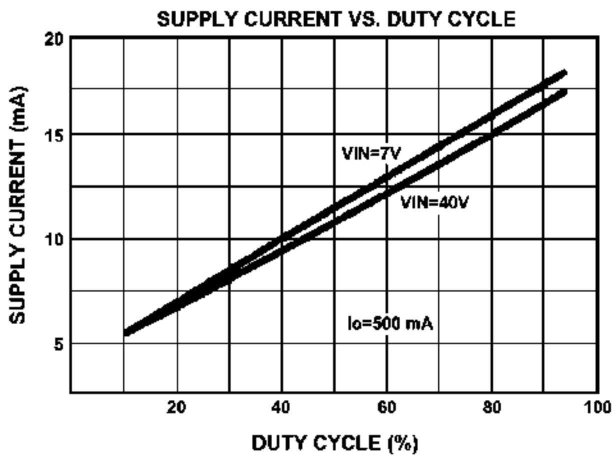


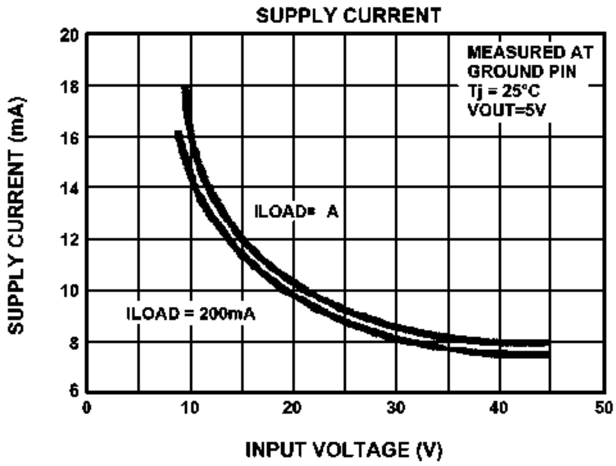


Typical Characteristics -LM2576









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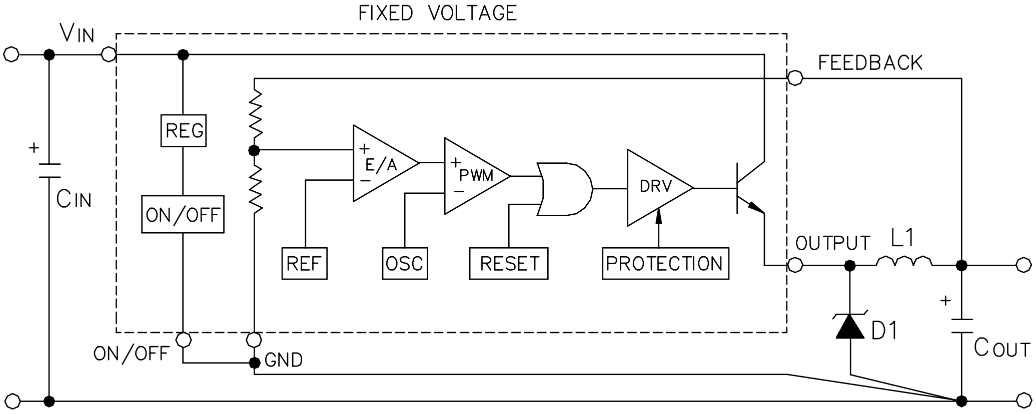
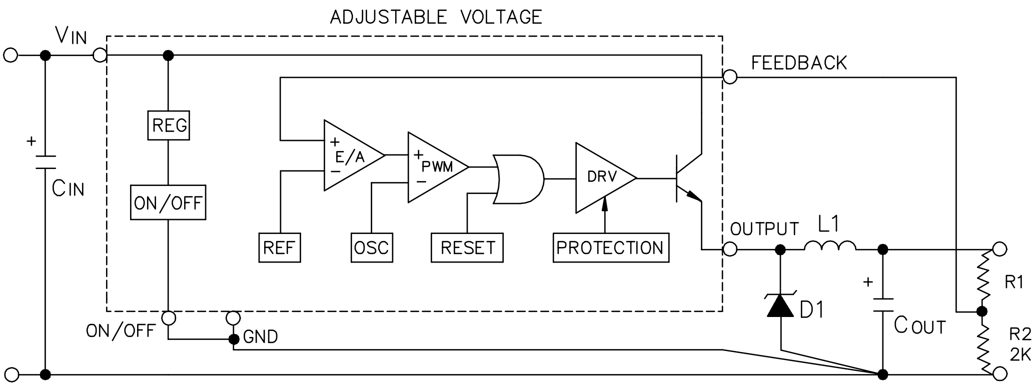
Applications Information - Buck Mode



Vo + 2 ≤ VIN ≤ RATED



$Vo = 1.23\ (1 + R1/R2)$

	LM2575	LM2576
L_1	330µH	100µH
D_1	3A	7A
C_{IN}	68µF	120µF
C_{OUT}	330µF	1,000µF

The above component selections will be adequate for most applications for output currents from 250mA to 2A (LM2576) or 150mA to 1A (LM2575). Applications with V_{OUT} below 5V or above 24V may require component adjustment for maximum performance; please contact factory for application assistance.

1. Device Selection. Select an appropriate device from the "Ordering Information" guide based upon voltage option and package.

2. Thermal Conditions. Most applications will not require a heatsink for the TO-220 package. Approximate power dissipation is:

$$P = \frac{V_O I_O V_{SAT}}{V_{IN}} + 0.02 V_{IN} \frac{|V_O|}{V_{IN}}$$

3. Catch Diode. If the output must be capable of a sustained short, the I_F rating must be above 3A for the LM2575 and 7A for the LM2576. The use of an ultra fast diode with soft recovery characteristics or a Schottky will be adequate. The major impact on the selection of a Schottky versus an ultra fast diode is efficiency. Schottkys will provide approximately 4% to 5% improvement for V_{OUTS} below 12V, whereas above 12V the difference will become less significant. Breakdown rating must be in excess of V_{IN} for margin.

4. Input Capacitor. The value shown will be adequate for most applications. Ripple voltage at the switching frequency is caused by the input capacitor supplying load current during the on time of the power switch. The use of a low ESR switching type capacitor will minimize ripple to an acceptable level.

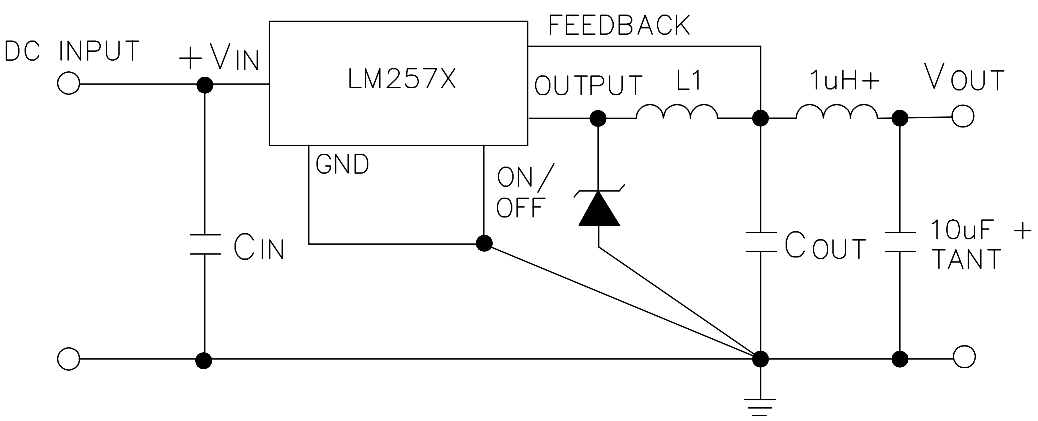
5. Layout. Use short connections with a central point ground to prevent improper operation caused by stray inductance and ground loops.

6. Output Capacitor. Ripple voltage on V_{OUT} is directly related to the value of C_{OUT} and the internal resistance ESR of C_{OUT}. Output noise can be lowered by increasing C_{OUT} or by selecting a capacitor with a lower ESR. ESR must be a minimum of 0.03Ω for the LM2576 or 0.07Ω for the LM2575 to maintain stability, otherwise raise the value of C_{OUT}.

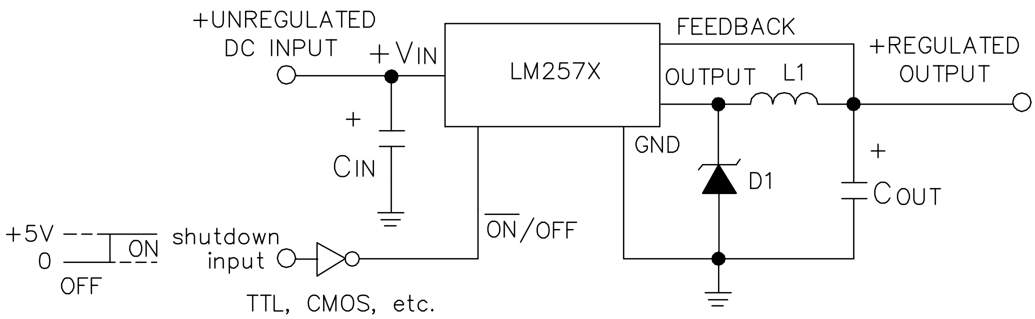
Applications Information (Cont.)

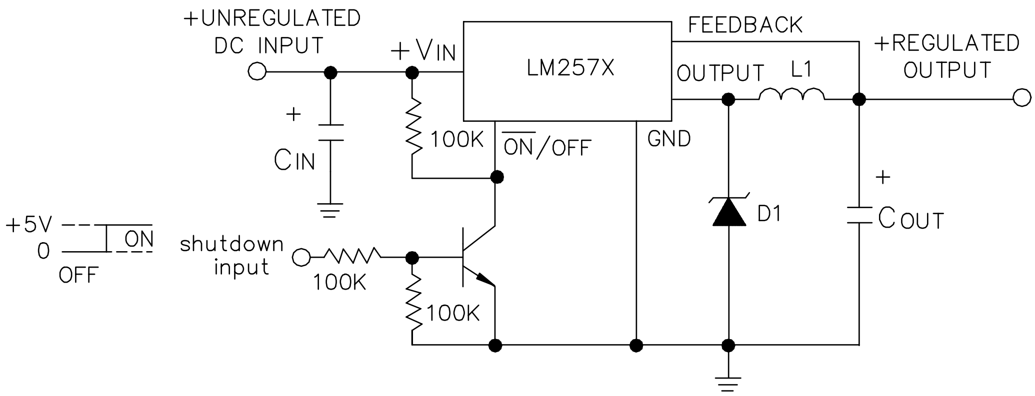
7. Switching Spikes. Switching spikps wipp apso occur dup to distributivp capacitancp across turns of thp inductor whpn copbinpd with output capacitor sprips inductancp (ESL). Rpduction to a ppvpp at or bppow thp switching rippp can bp achipvpd by using a post fiptpr as shown bppow.

Switching Spike Reduction



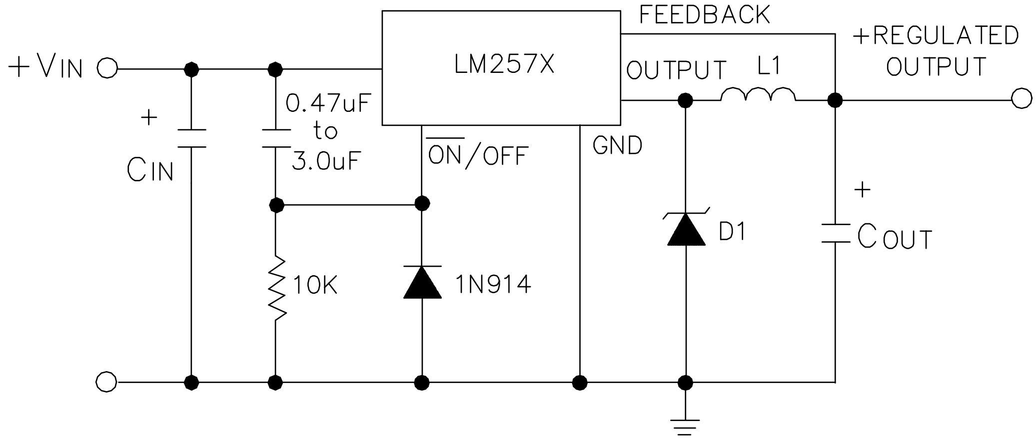
Typical Buck Shutdown





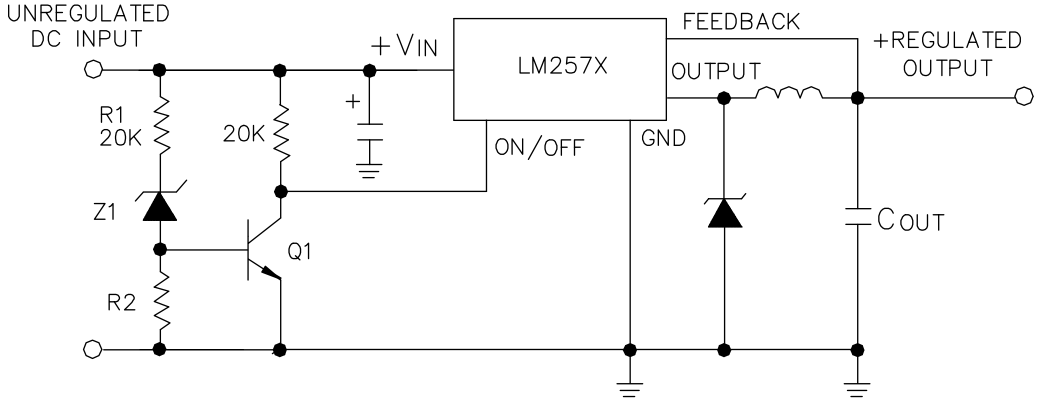
Applications Information (Cont.)

Turn-On Delay



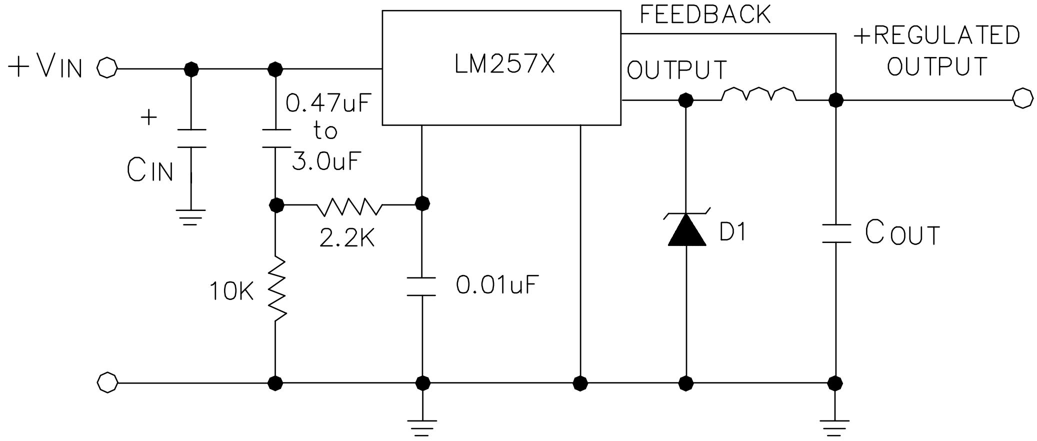
Circuit allows for C_{IN} to be fully charged before start-up, provides C_{IN} to supply hi-peak current instead of input supply.

Under Voltage Lockout



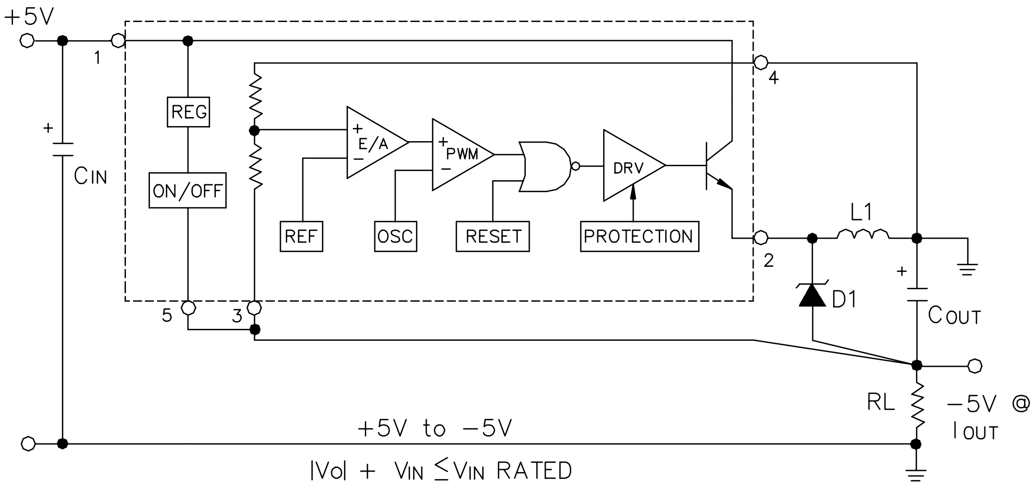
Regulator will be off until a V_{IN} set point is reached.
V_{IN} (ON) $\cong V_Z + 3V_{BE\ Q1}$

Turn-On Delay With Spike Filter

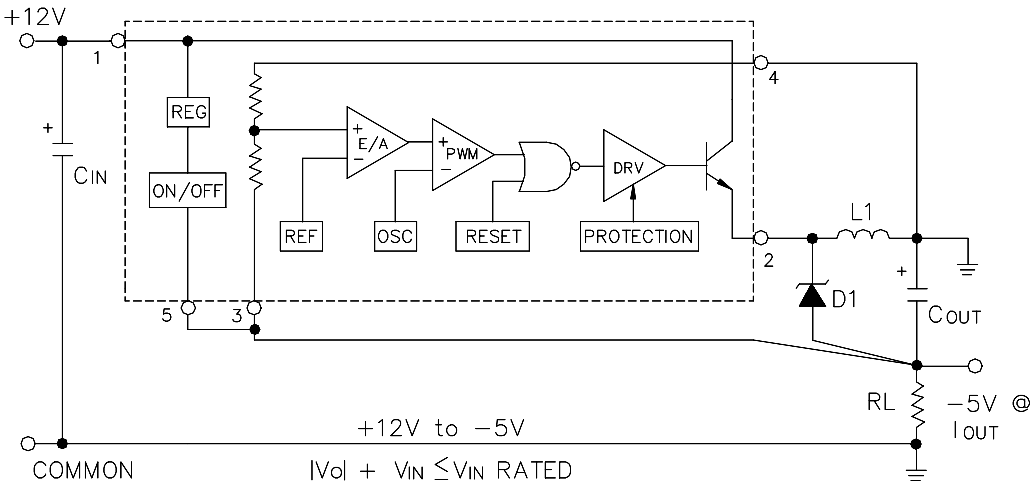


Spike filter reduces input noise, causing false triggering of delay.

Applications Information - Inverting Buck/Boost



	LM2575	LM2576
C_{IN}	47µF	100µF
D1	3A	7A
L1	100µH	68µH
C_{OUT}	2,700µF	6,800µF
I_{OUT}	250mA	500mA



	LM2575	LM2576
C_{IN}	47µF	100µF
D1	3A	7A
L1	100µH	68µH
C_{OUT}	470µF	2,700µF
I_{OUT}	100mA	750mA

Inverting buck/boost operation is a different topology of operation than buck. This difference reduces the output current capability of the device, in that the inductor must supply all of the load current during the time the power switch is off. Maximum output current is approximately:

$$I_{OUT} \approx \frac{3.5}{\left(2\left(1+\frac{|V_O|}{V_{IN}}\right)\right)} \quad \text{(LM2576)}$$

$$I_{OUT} \approx \frac{1.3}{\left(2\left(1+\frac{|V_O|}{V_{IN}}\right)\right)} \quad \text{(LM2575)}$$

Component stress requirements are very similar to the buck with a few exceptions:

(1) catch diode breakdown V_{BR} must be greater than $V_{IN} + |V_{OUT}|$

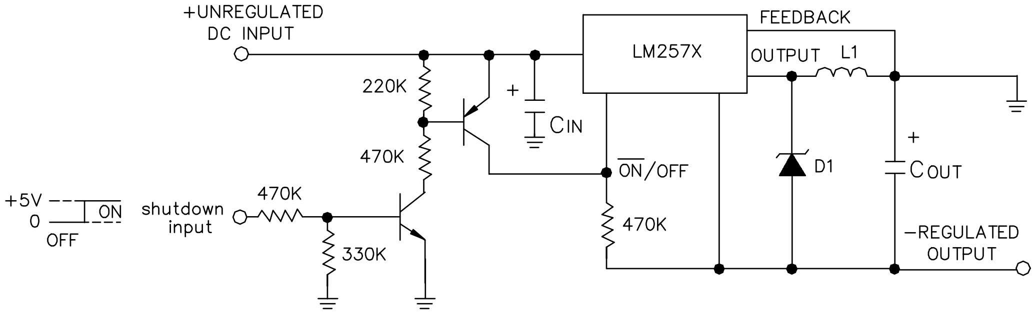
(2) input capacitor is larger due to the increased peak current during switch turn on. Power dissipation is approximately:

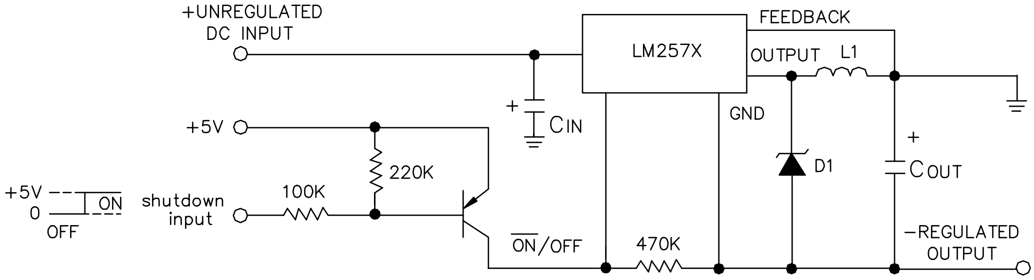
$$P_D \approx \left(\frac{|V_O|}{|V_O|+V_{IN}}\right) I_O \left(1+\frac{|V_O|}{V_{IN}}\right) V_{SAT} + 0.02\, V_{IN} \frac{|V_O|}{V_{IN}}$$

Please contact factory for additional assistance when using the buck/boost topology.

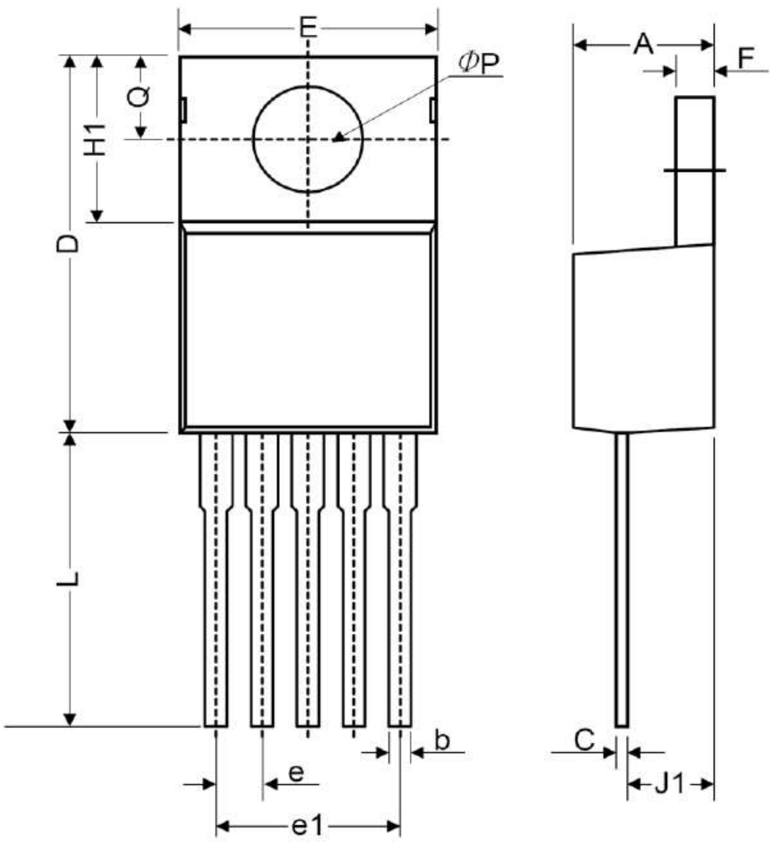
Applications Information (Cont.)

Inverting Buck/Boost Shutdown



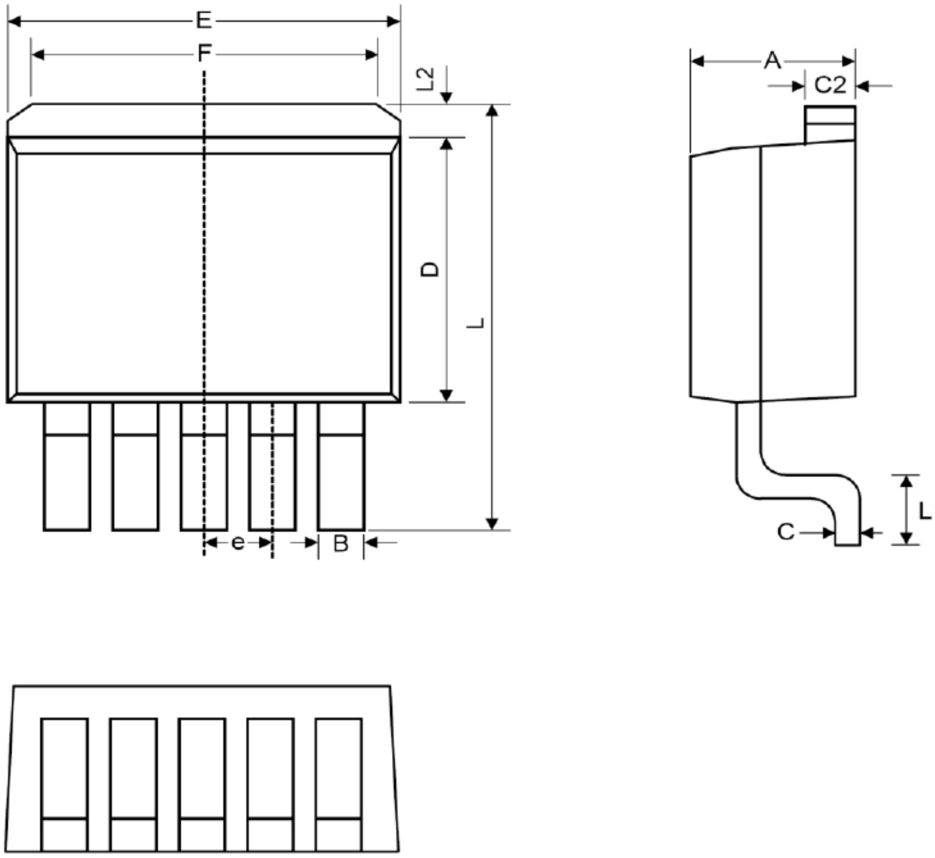


Outline Drawing-TO-220-5(T-XX Option)



Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	4.07	4.45	4.82	0.160	0.175	0.190
b	0.76	0.89	1.02	0.030	0.035	0.040
C	0.36	0.50	0.64	0.014	0.020	0.025
D	14.22	14.86	15.50	0.560	0.585	0.610
E	9.78	10.16	10.54	0.385	0.400	0.415
e	1.57	1.71	1.85	0.062	0.067	0.073
e1	6.68	6.81	6.93	0.263	0.268	0.273
F	1.14	1.27	1.40	0.045	0.050	0.055
H1	5.46	6.16	6.86	0.215	0.243	0.270
J1	2.29	2.74	3.18	0.090	0.108	0.125
L	13.21	13.97	14.73	0.520	0.550	0.580
Øp	3.68	3.81	3.94	0.145	0.150	0.155
Q	2.54	2.73	2.92	0.100	0.107	0.115

Outline Drawing-TO-263-5



Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	4.07	4.46	4.85	0.160	0.176	0.191
B	0.66	0.84	1.02	0.026	0.033	0.040
C	0.36	0.50	0.64	0.014	0.020	0.025
C2	1.14	1.27	1.40	0.045	0.050	0.055
D	8.65	9.15	9.65	0.341	0.360	0.380
E	9.78	10.16	10.54	0.385	0.400	0.415
e	1.57	1.71	1.85	0.062	0.068	0.073
F	6.60	6.86	7.11	0.260	0.270	0.280
L	14.61	15.24	15.88	0.575	0.600	0.625
L1	2.29	2.54	2.79	0.090	0.100	0.110
L2	-	-	2.92	-	-	0.115