

April 7, 1998

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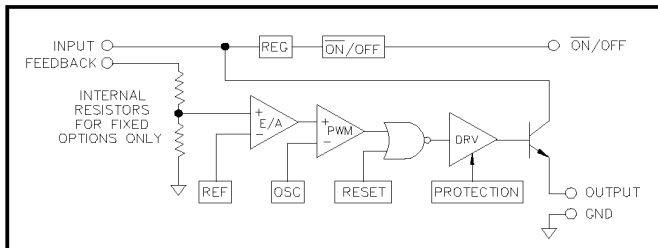
## DESCRIPTION

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 3A.

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. 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.

## BLOCK DIAGRAM



## ORDERING INFORMATION

DEVICE <sup>(1)</sup>	PACKAGE	CURRENT
LM2575T-XX	TO-220 <sup>(2)</sup>	1A
LM2575S-XX	TO-263 <sup>(3)</sup>	
LM2576T-XX	TO-220 <sup>(2)</sup>	3A
LM2576S-XX	TO-263 <sup>(3)</sup>	

### Notes:

(1) XX = Voltage Option 3.3, 5.0, 12, and ADJ (1.23V to 35V).

(2) T-XX = Straight in-line; T-XX-V = Vertical Staggered; T-XX-H = Horizontal Staggered.

(3) Add suffix 'TR' for tape and reel (TO-263).

## FEATURES

- Pin for pin interchangeable with National's LM2575/LM2576 series
- DC-to-DC buck or buck/boost converter requiring only 4 support components
- Fixed or adjustable voltages
- Preset output voltages of 3.3, 5 and 12V
- Wide output voltage range, 1.23 to 35V
- 82% typical efficiency @ 5V
- Wide input voltage range, 4V to 40V
- Inhibit/enable control pin

## ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Maximum	Units
Input Voltage	$V_{IN}$	45	V
On/Off Pin Input Voltage		$-0.3 \leq V \leq V_{IN}$	V
Output Voltage to Common (Steady State)		-1	V
Power Dissipation	$P_D$	Internally Limited	W
Thermal Resistance Junction to Case TO-220 TO-263	$\theta_{JC}$	2.0 2.0	°C/W
Thermal Resistance Junction to Ambient TO-220 TO-263	$\theta_{JA}$	55 60	°C/W
Operating Junction Temperature Range	$T_J$	-40 to 125	°C
Storage Temperature Range	$T_{STG}$	-40 to 125	°C
Lead Temperature (Soldering) 10 Sec	$T_{LEAD}$	260	°C
ESD Class		2	

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**ELECTRICAL CHARACTERISTICS**

 Unless otherwise specified,  $V_{IN} = 12V$  for 3.3V, 5V and ADJ options; 25V for 12V;  $V_{OUT} = 5V$  for ADJ,  $T_J = 25^\circ C$ .  
 $V_{IN}$  rated = 40V;  $I_O = 0.5$  to 3A (LM2576), 0.2 to 1A (LM2575).

Parameter	Symbol	Test Conditions			Test Limits			Units
		$V_{IN}$	$I_O$	$T_J^{(4)}$	Min	Typ	Max	
Output Voltage LM2576-3.3	$V_O$		0.5A		3.23	3.30	3.37	V
		8V to $V_{IN}$ Rated		O.T.	3.14	3.30	3.47	
					3.20	3.30	3.40	
LM2576-5	$V_O$		0.5A		4.90	5.00	5.10	V
		8V to $V_{IN}$ Rated		O.T.	4.76	5.00	5.25	
					4.85	5.00	5.15	
LM2576-12	$V_O$		0.5A		11.76	12.00	12.24	V
		15V to $V_{IN}$ Rated		O.T.	11.40	12.00	12.60	
					11.52	12.00	12.48	
Feedback Voltage $V_{OUT} = 5V$ LM2576-ADJ	$I_{FB}$		0.5A		1.217	1.230	1.243	V
		8V to $V_{IN}$ Rated		O.T.	1.180	1.230	1.280	
					1.193	1.230	1.267	
Feedback Bias Current LM2576-ADJ	$I_B$	12V	0.5A			50	100	nA
				O.T.		500		
Output Voltage LM2575-3.3	$V_O$		0.2A		3.23	3.30	3.37	V
		8V to $V_{IN}$ Rated		O.T.	3.14	3.30	3.47	
					3.20	3.30	3.40	
LM2575-5	$V_O$		0.2A		4.90	5.00	5.10	V
		8V to $V_{IN}$ Rated		O.T.	4.75	5.00	5.25	
					4.85	5.00	5.15	
LM2575-12	$V_O$		0.2A		11.76	12.00	12.24	V
		15V to $V_{IN}$ Rated		O.T.	11.40	12.00	12.60	
					11.52	12.00	12.48	
Feedback Voltage $V_{OUT} = 5V$ LM2575-ADJ	$I_{FB}$		0.2A		1.217	1.230	1.243	V
		8V to $V_{IN}$ Rated		O.T.	1.180	1.230	1.280	
					1.193	1.230	1.267	
Feedback Bias Current LM2575-ADJ	$I_B$	12V	0.2A	O.T.			500	nA

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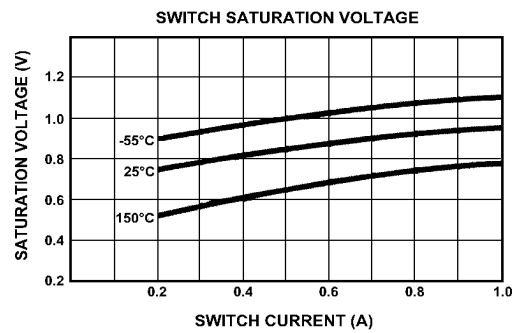
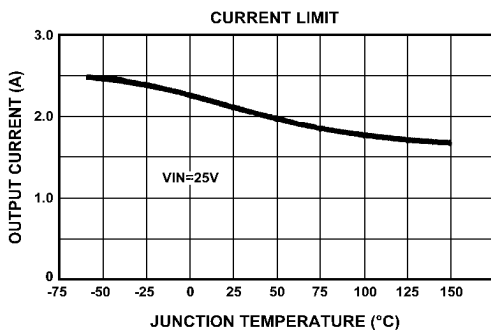
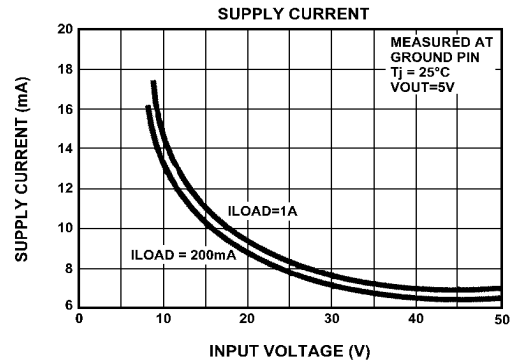
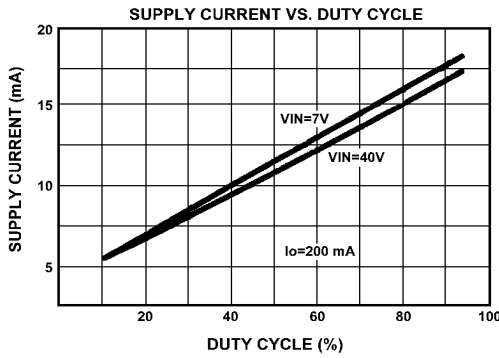
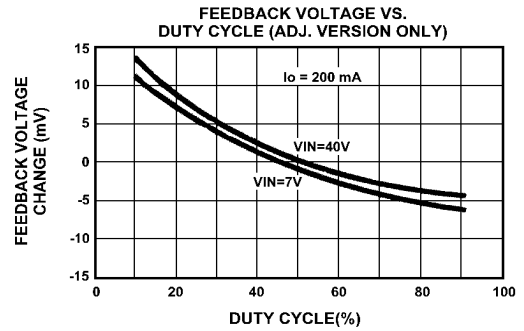
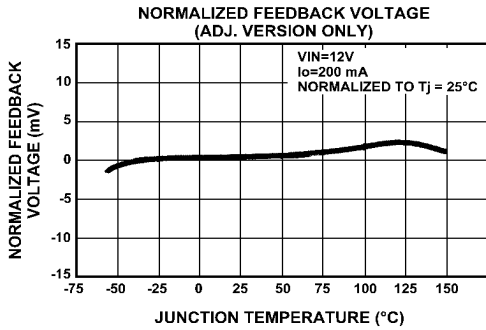
**ELECTRICAL CHARACTERISTICS (cont.)**

Parameter	Symbol	Test Conditions			Test Limits			Units
		V <sub>IN</sub>	I <sub>O</sub>	T <sub>J</sub> <sup>(4)</sup>	Min	Typ	Max	
Efficiency/Option	η	12V	LM2575-1A			77		%
3.3			LM2576-3A			82		
5		15V	88					
12		12V	82					
ADJ V <sub>O</sub> = 5V								
Switching Frequency	F <sub>SW</sub>				47	52	58	kHz
				O.T.	43	52	62	
Saturation Voltage <sup>(1)</sup>	V <sub>SAT</sub>		LM2575-1A	O.T.		0.9	1.2	V
			LM2576-3A	O.T.		0.9	1.4	
Max Duty Cycle (On) <sup>(3)</sup>	DC				93	98		%
Current Limit <sup>(1)</sup>	I <sub>CL</sub>				4.2	5.8	6.9	A
Peak Current LM2576				O.T.	3.5		7.5	
Peak Current LM2575	I <sub>CL</sub>				1.7	2.2	3.0	A
				O.T.	1.3		3.2	
Output Leakage Current <sup>(2)</sup>	I <sub>L</sub>	V <sub>IN</sub> RATED					2	mA
Output = 0V								
Output = -1V						7.5	30	
Quiescent Current <sup>(2)</sup>	I <sub>Q</sub>					5	10	mA
				O.T.			12	
Standby Quiescent Current (On/Off Pin = 5V)	I <sub>STBY</sub>					50		μA
				O.T.		50	500	
On/Off Pin Logic Input Level	V <sub>IH</sub>				2.2	1.4		V
V <sub>OUT</sub> = 0V					O.T.	2.4	1.4	
V <sub>OUT</sub> = Option	V <sub>IL</sub>					1.2	1.0	V
					O.T.		1.2	
On/Off Input Current								
On/Off = 5V (Off)	I <sub>IH</sub>		0.5A			12	30	μA
On/Off = 0V (On)	I <sub>IL</sub>		0.5A			0	10	

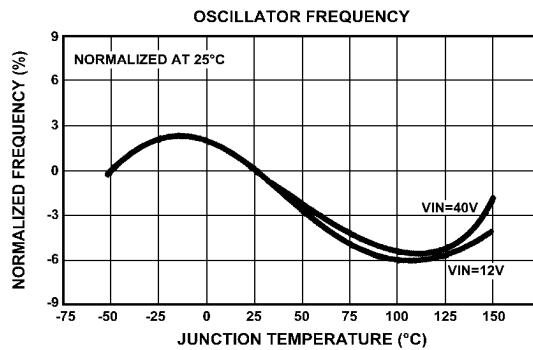
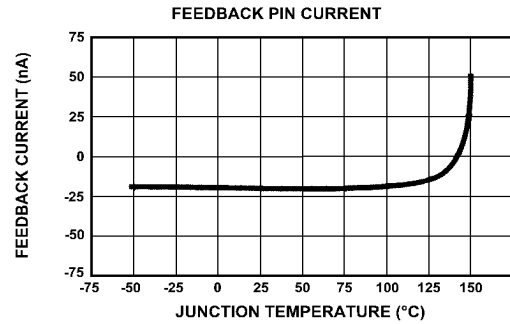
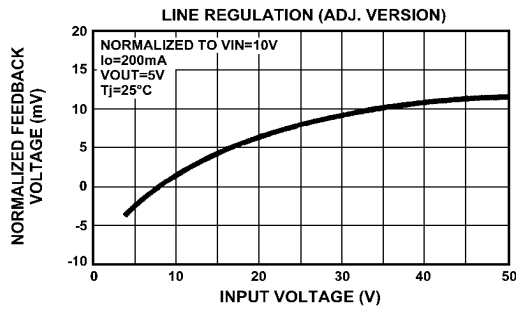
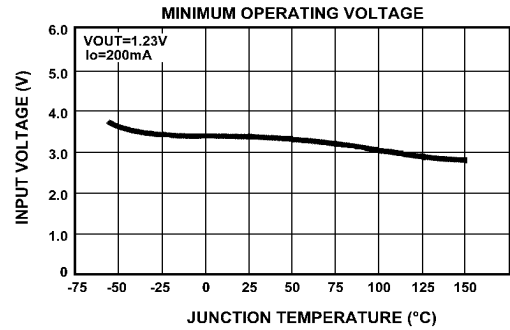
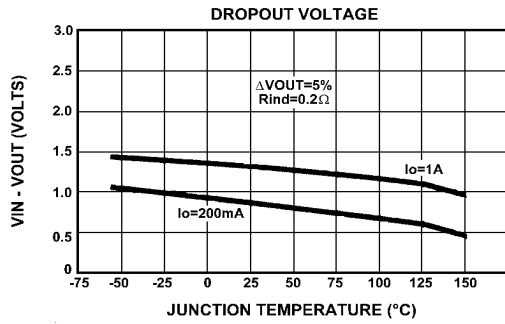
**NOTES:**

- (1) Output sourcing current-resistive load, no inductor or capacitor.
- (2) Feedback = V<sub>O</sub> + 1.0V.
- (3) Feedback = 0V.
- (4) Over Temp. (O.T.) = over specified operating junction temperature range.

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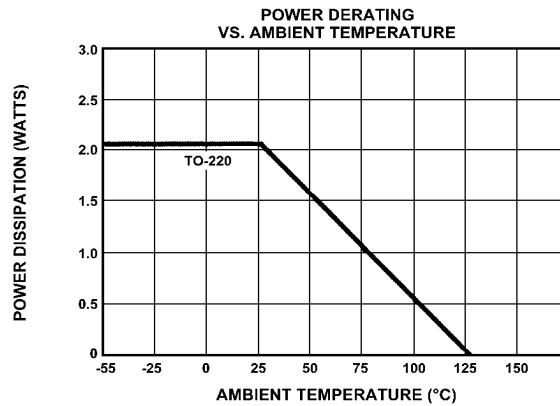
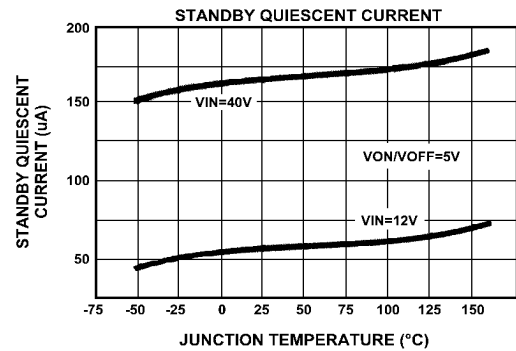
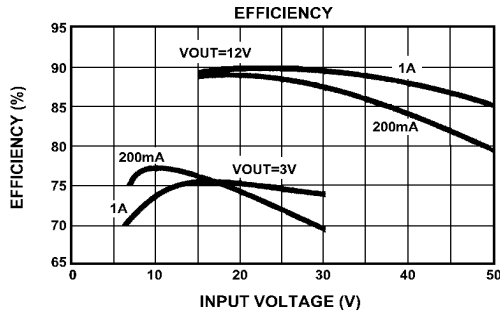
**LM2575 - OPERATIONAL DATA**


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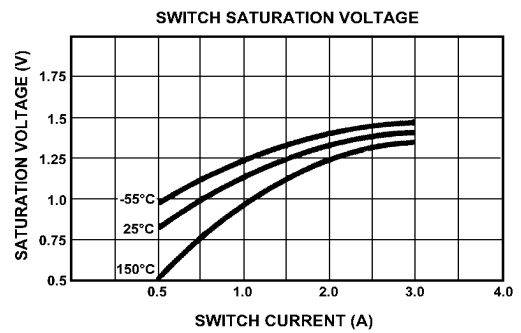
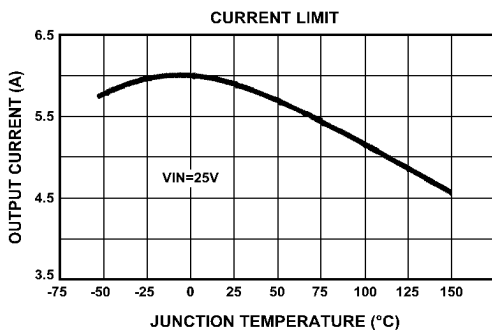
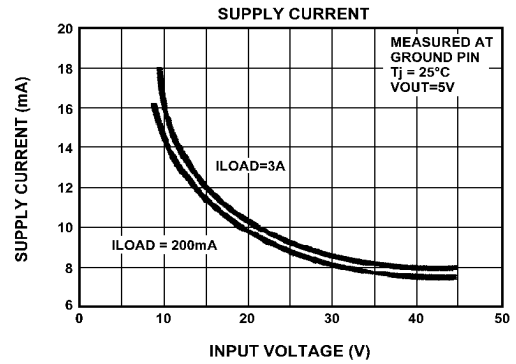
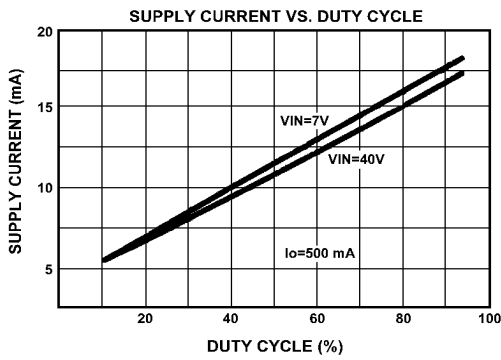
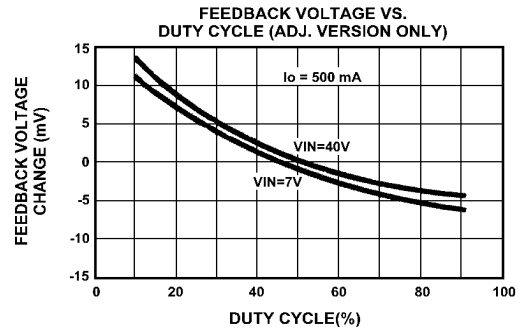
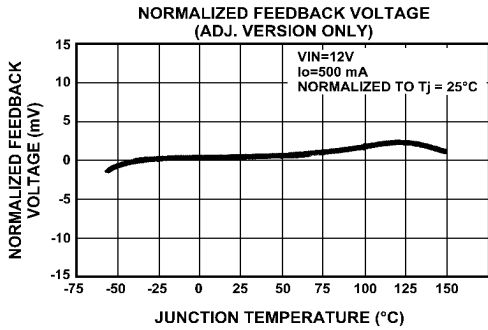
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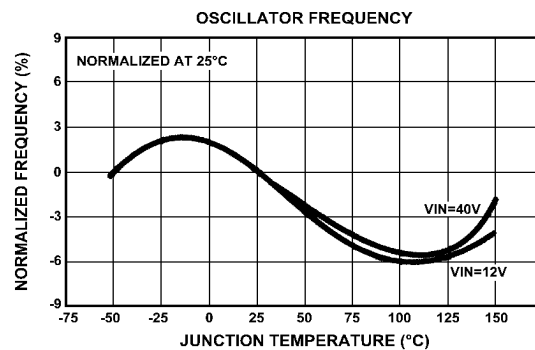
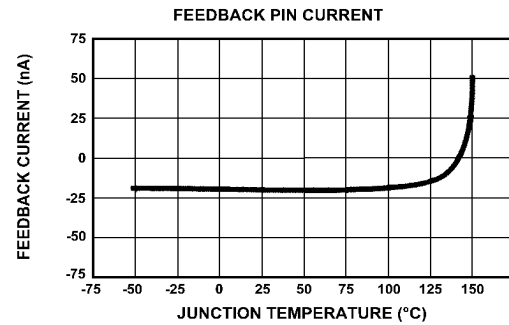
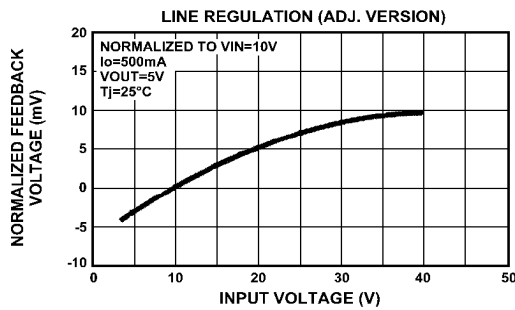
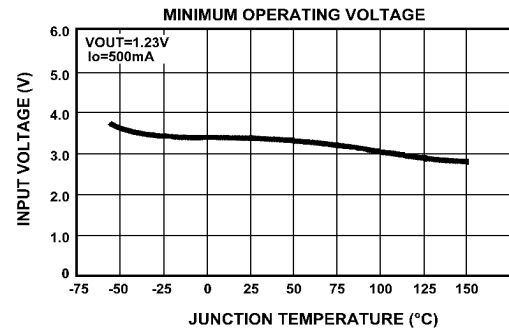
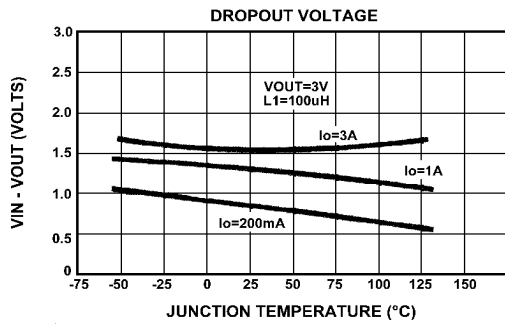
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**LM2576 - OPERATIONAL DATA**


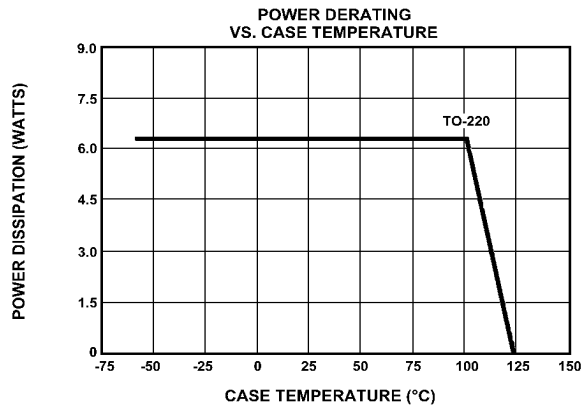
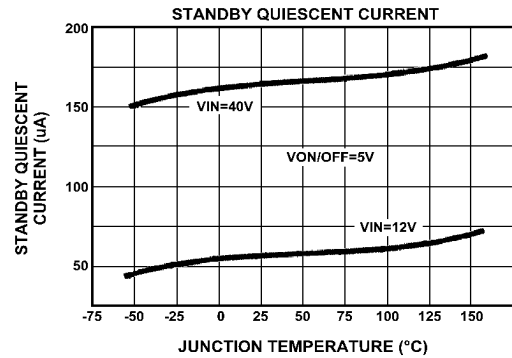
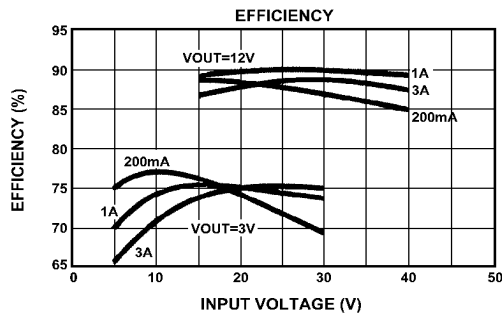
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**LM2576 - OPERATIONAL DATA**


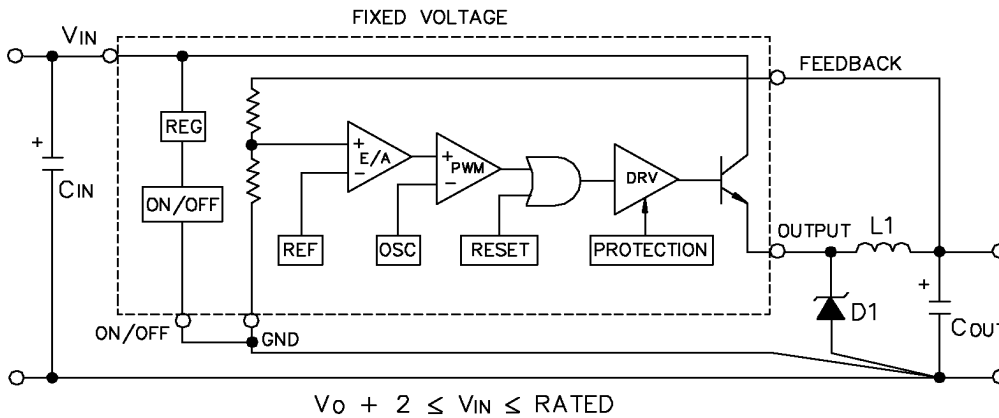


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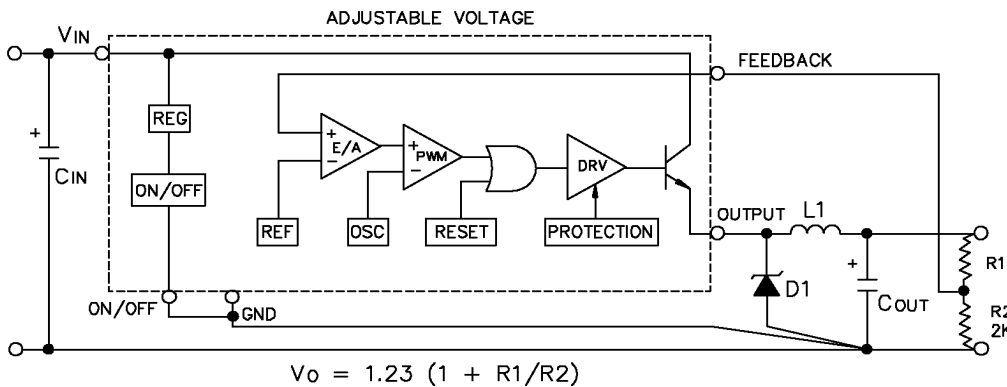
LM2576 - OPERATIONAL DATA



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**TYPICAL APPLICATION - BUCK MODE**


	LM2575	LM2576
$L_1$	330 $\mu$ H	100 $\mu$ H
$D_1$	3A	7A
$C_{IN}$	68 $\mu$ F	120 $\mu$ F
$C_{OUT}$	330 $\mu$ F	1,000 $\mu$ F



	LM2575	LM2576
$L_1$	330 $\mu$ H	100 $\mu$ H
$D_1$	3A	7A
$C_{IN}$	68 $\mu$ F	120 $\mu$ F
$C_{OUT}$	330 $\mu$ F	1,000 $\mu$ F

The above component selections will be adequate for most applications for output currents from 250mA to 3.0A (LM2576) or 150mA to 1.0A (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 Schottky versus an ultra fast 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.

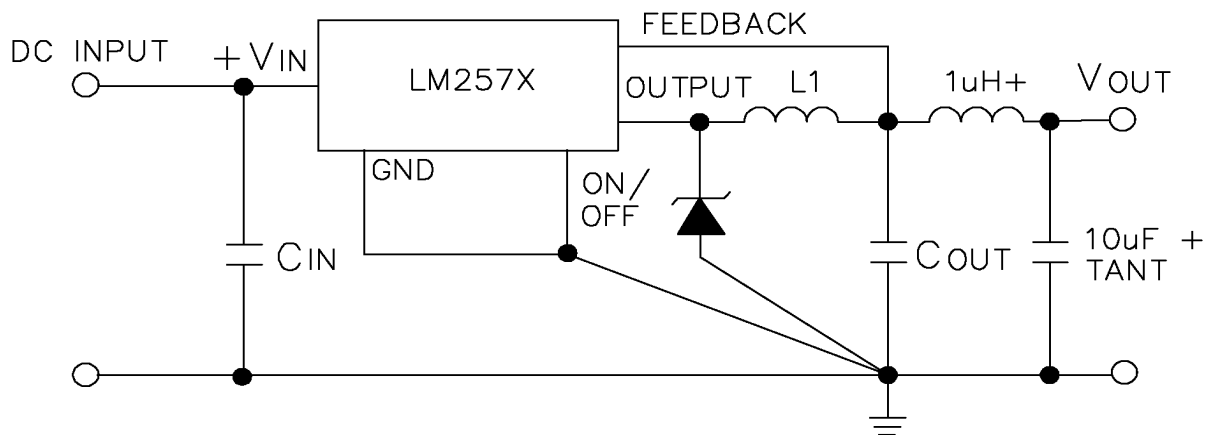
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**5. LAYOUT.** Use short connections with a central point ground to prevent improper operation caused by stray inductance and ground loops.

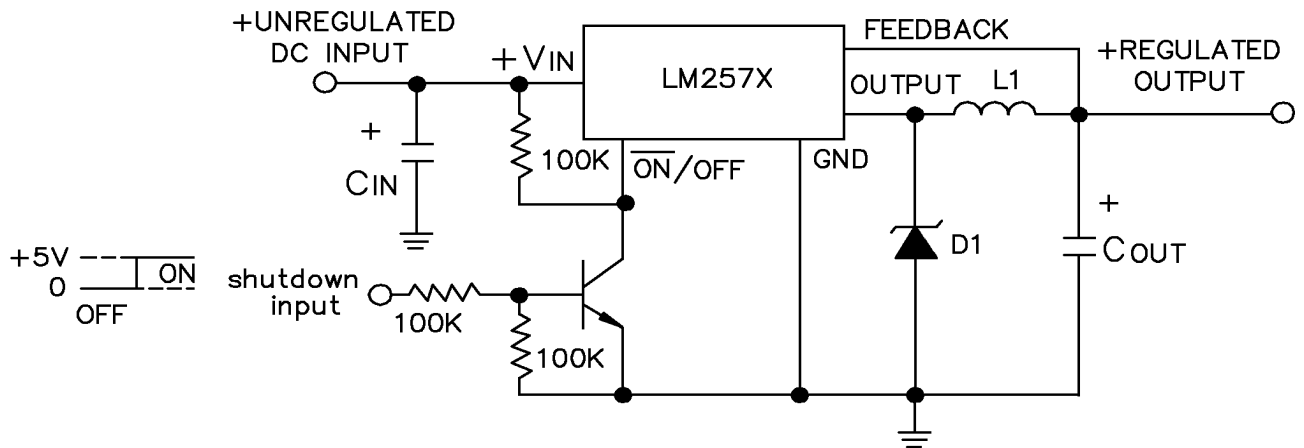
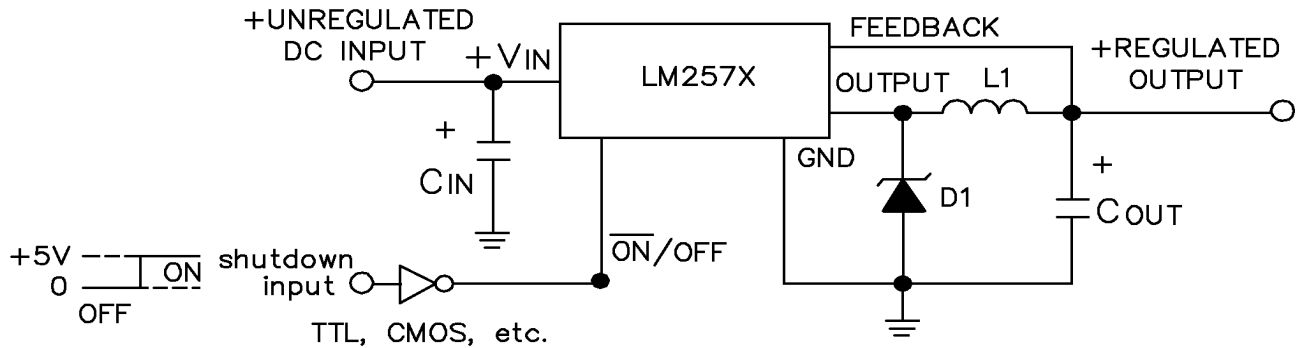
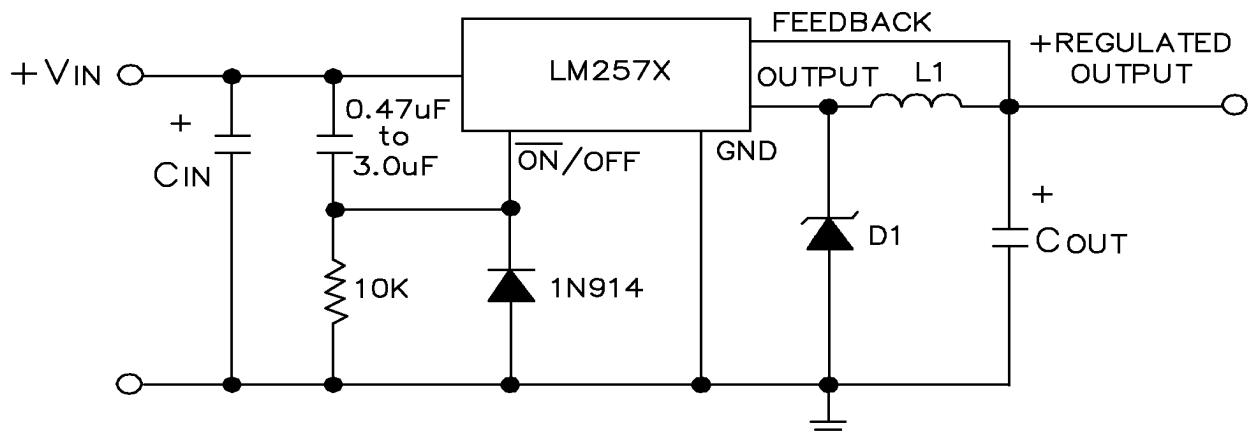
**6. OUTPUT CAPACITOR.** Ripple voltage on  $V_{OUT}$  is directly related to the value of  $C_{OUT}$  and the internal resistance ESR of  $C_{OUT}$ . Output noise can be lowered by increasing  $C_{OUT}$  or by selecting a capacitor with a lower ESR. ESR must be approximately  $0.03\Omega$  for the LM2576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

**7. SWITCHING SPIKES.** Switching spikes will also occur due to distributive capacitance across turns of the inductor when combined with output capacitor series inductance (ESL). Reduction to a level at or below the switching ripple can be achieved by using a post filter as shown.

### SWITCHING SPIKE REDUCTION

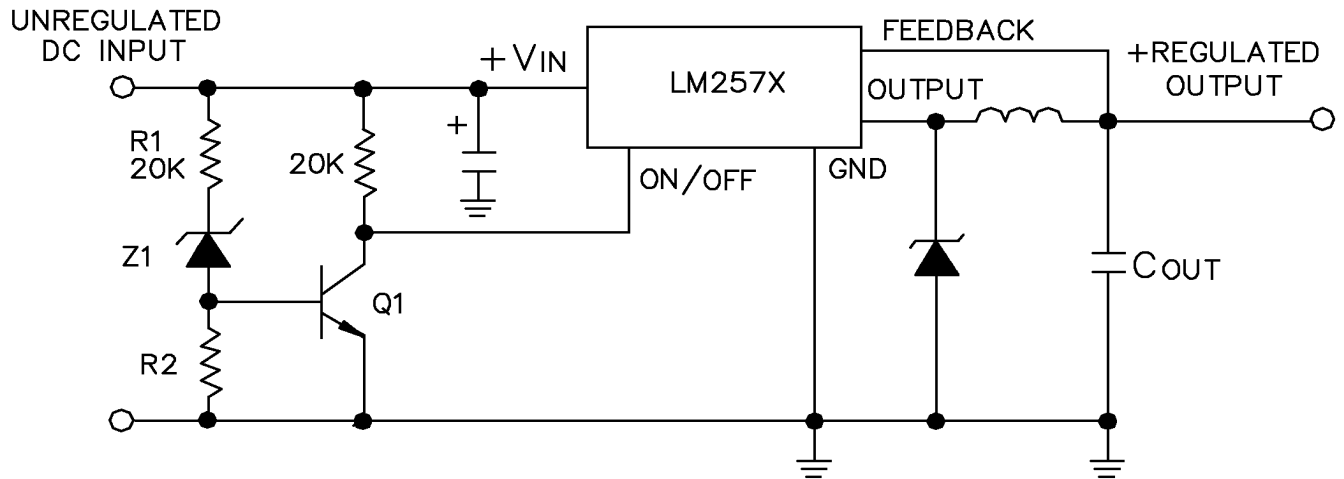


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**TYPICAL BUCK SHUTDOWN**

**TURN-ON DELAY**


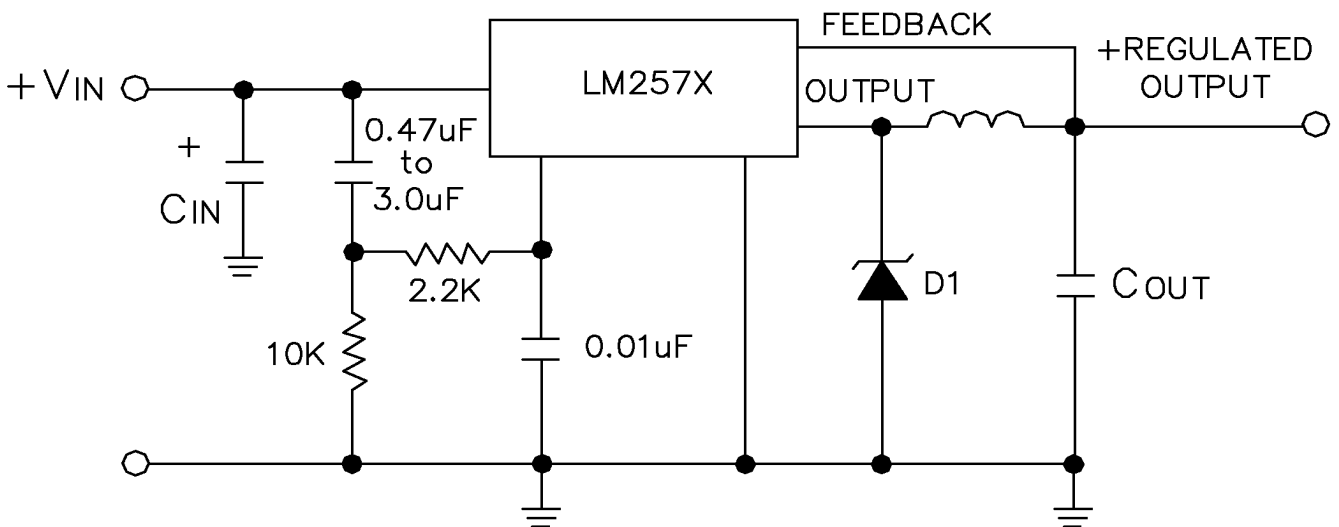
Circuit allows for  $C_{IN}$  to be fully charged before start-up,  
 provides  $C_{IN}$  to supply hi-peak current instead of input supply.

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**UNDER VOLTAGE LOCKOUT**


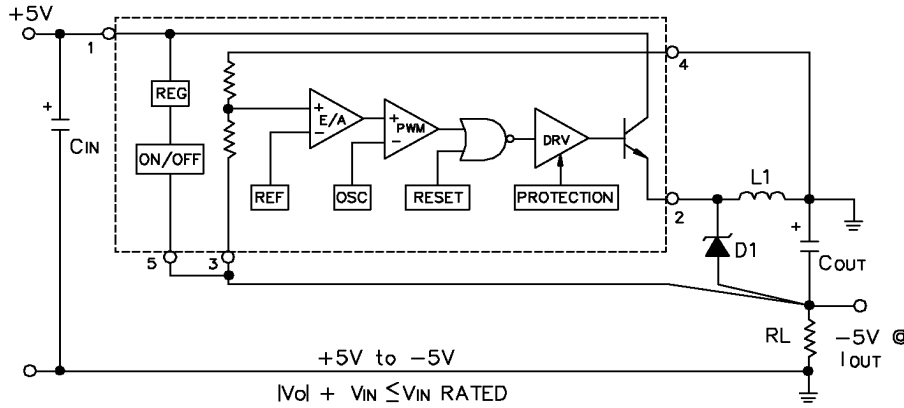
Regulator will be off until a  $V_{IN}$  set point is reached.

$$V_{IN} (ON) \cong V_Z + 3V_{BE Q1}$$

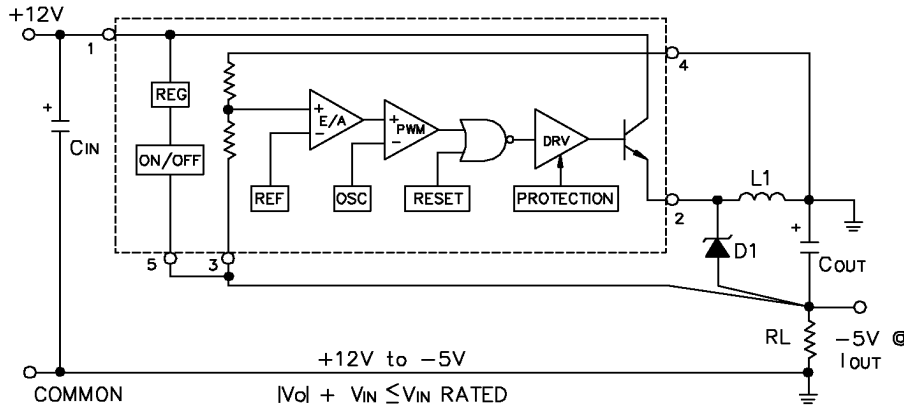
**TURN-ON DELAY WITH SPIKE FILTER**


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

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**TYPICAL APPLICATION - INVERTING BUCK/BOOST**


	LM2575	LM2576
$C_{IN}$	47 $\mu$ F	100 $\mu$ F
D1	3A	7A
L1	100 $\mu$ H	68 $\mu$ H
$C_{OUT}$	2,700 $\mu$ F	6,800 $\mu$ F
$I_{OUT}$	250mA	500mA



	LM2575	LM2576
$C_{IN}$	47 $\mu$ F	100 $\mu$ F
D1	3A	7A
L1	100 $\mu$ H	68 $\mu$ H
$C_{OUT}$	470 $\mu$ F	2,700 $\mu$ F
$I_{OUT}$	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:

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

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

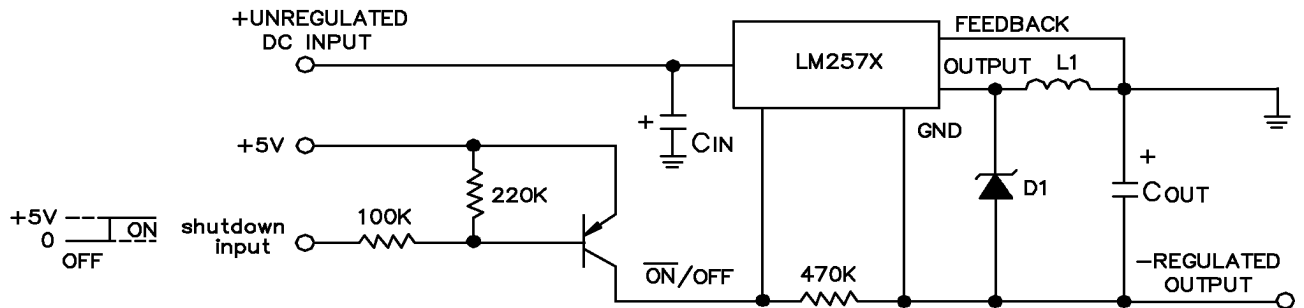
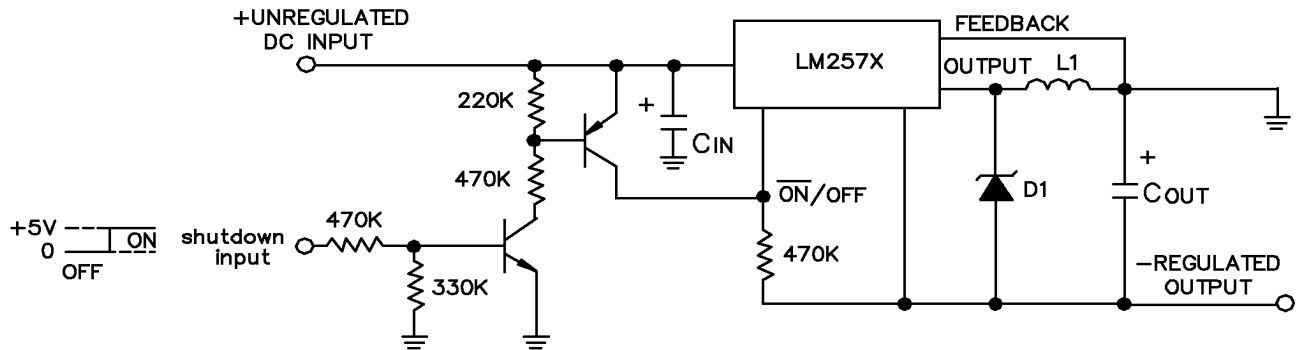
Component stress requirement is very similar to the buck with a few exceptions:

- catch diode breakdown  $V_{BR}$  must be greater than  $V_{IN} + |V_{OUT}|$
- 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.

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**INVERTING BUCK/BOOST SHUTDOWN**




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**SUPPORT COMPONENTS INFORMATION**

**PRE-WOUND INDUCTORS:**

Hurricane Electronics Lab  
P.O. Box 1280  
Hurricane Industrial Park  
Hurricane, UT 84737  
(801) 635-2003

**CORE SOURCE:**

Micro Metals, Inc.  
1190 N. Hawk Circle  
Anaheim, CA 92807  
(714) 630-7420

**CAPACITORS:**

VPR Series  
Mallory Capacitor Co.  
4760 Kentucky Avenue  
Indianapolis, IN 46241  
(317) 856-3731

511D & 673 Series  
Sprague Electric Co.  
North Adams, MA  
(413) 664-4411

HFQ, HFZ Series  
Panasonic Industrial Co.  
2 Panasonic Way  
Secaucus, NJ 07094  
(201) 392-6142

PF, PL Series  
Nichicon Corp.  
927 E. State Pkwy.  
Schaumburg, IL 60195  
(708) 843-7600

**LXF Series**

United Chemi-con  
9801 West Higgins Road  
Rosemont, IL 60018  
(708) 696-2000

**HEAT SINKS:**

AAVID Engineering Co.  
P.O.Box 400  
One Kool Path  
Laconia, NH 03247  
(603) 528-3400

Thermalloy, Inc.  
2021 W. Valley View Lane  
Dallas, TX 76381  
(214) 243-4321

**DIODES - CATCH:**

Ultra Fast/Soft Recovery  
Semtech Corporation  
652 Mitchell Road  
Newbury Park, CA 91320  
(805) 498-2111

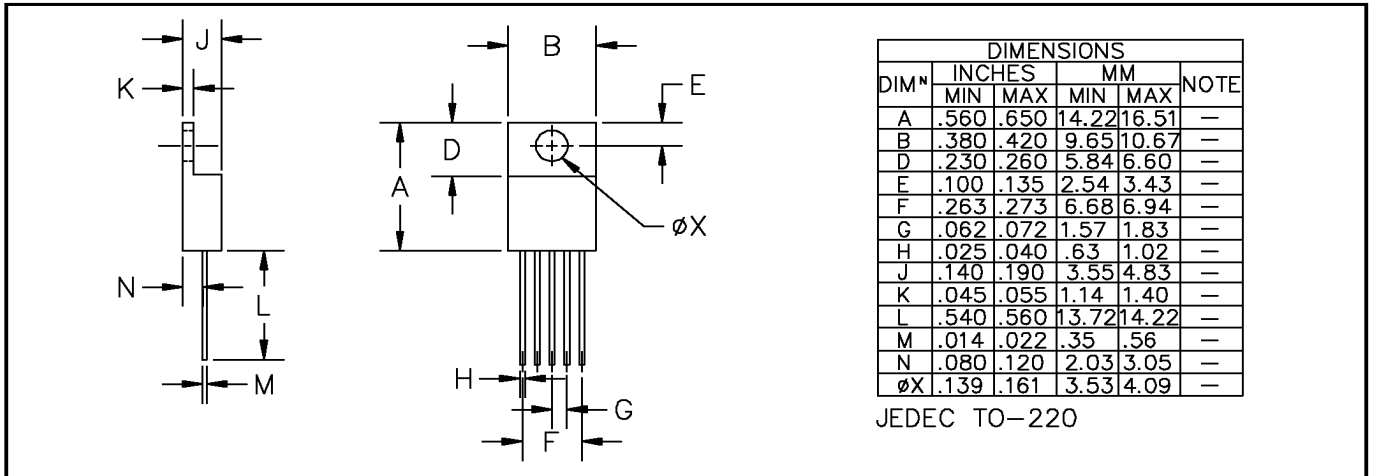
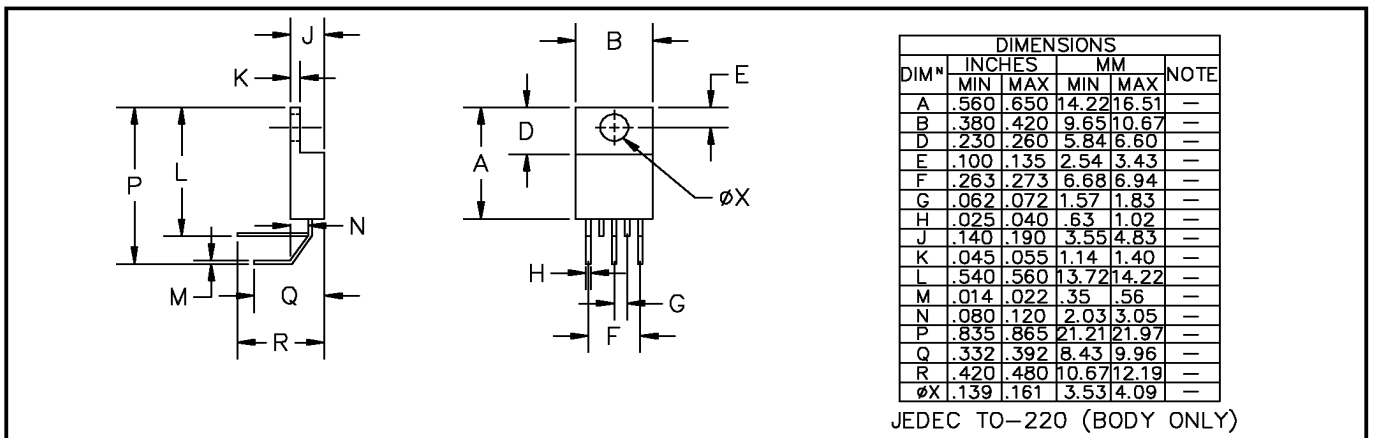
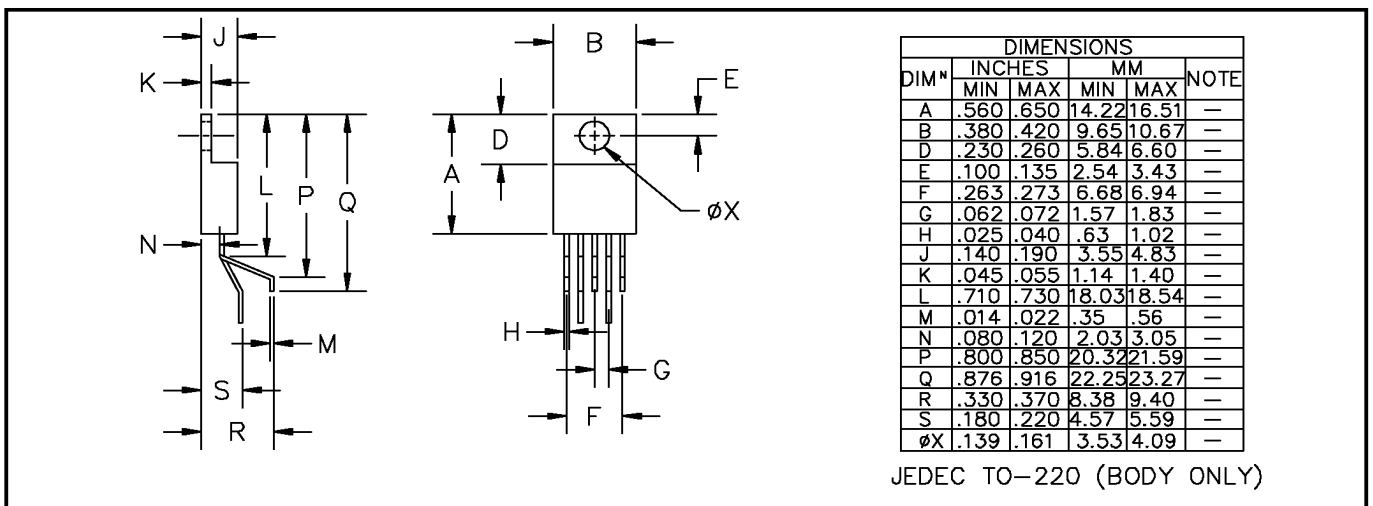
**DIODES - SCHOTTKY:**

Fuji/Collmer Semiconductor  
14368 Proton Road  
Dallas, TX 76244  
(800) 527-0521

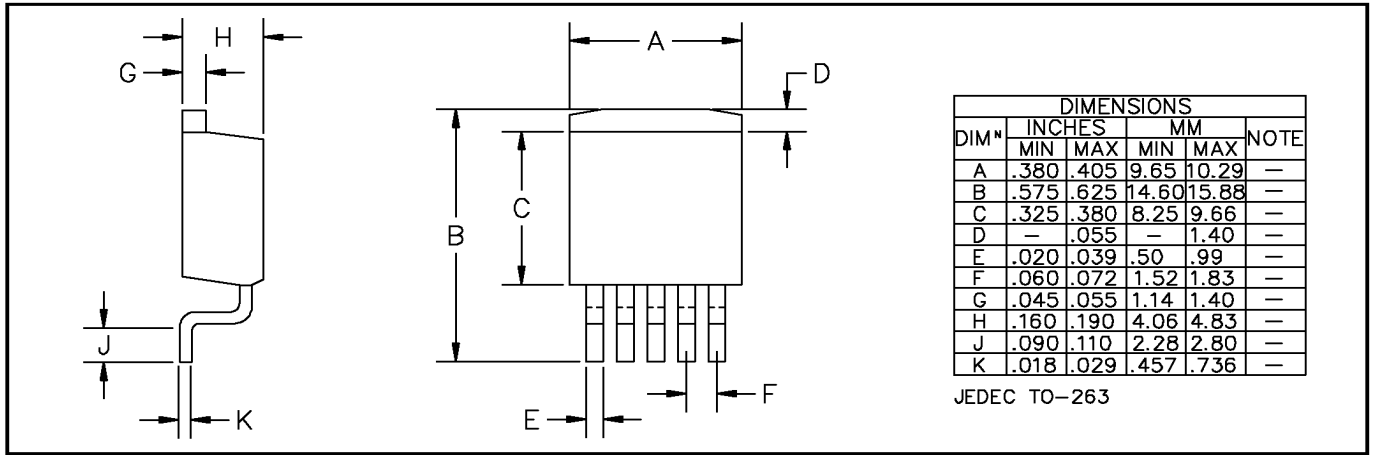
Micro Quality  
1000 N. Shiloh  
Garland, TX 76046  
(214) 272-7811



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**OUTLINE - TO-220 (T-XX Option)**

**OUTLINE - TO-220 (T-XX-H Option)**

**OUTLINE - TO-220 (T-XX-V Option)**


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**OUTLINE - TO-263**

**PIN CONFIGURATIONS**
