

## 1A Low Dropout CMOS Linear Regulators Stable with Ceramic Output Capacitors

### General Description

The LP38690/2 low dropout CMOS linear regulators provide tight output tolerance (2.5% typical), extremely low dropout voltage (450mV @ 1A load current,  $V_{OUT} = 5V$ ), and excellent AC performance utilizing ultra low ESR ceramic output capacitors.

The low thermal resistance of the LLP, SOT-223 and T0-252 packages allow the full operating current to be used even in high ambient temperature environments.

The use of a PMOS power transistor means that no DC base drive current is required to bias it allowing ground pin current to remain below 100  $\mu A$  regardless of load current, input voltage, or operating temperature.

**Dropout Voltage:** 450 mV (typ) @ 1A (typ, 5V out).

**Ground Pin Current:** 55  $\mu A$  (typ) at full load.

**Precision Output Voltage:** 2.5% (25°C) accuracy.

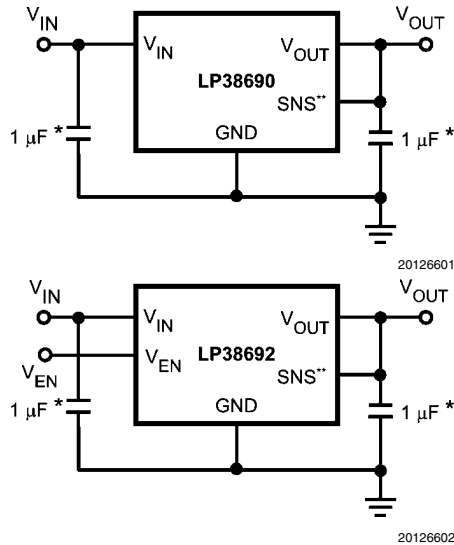
### Features

- 2.5% output accuracy (25°C)
- Low dropout voltage: 450mV @ 1A (typ, 5V out)
- Wide input voltage range (2.7V to 10V)
- Precision (trimmed) bandgap reference
- Guaranteed specs for -40°C to +125°C
- 1 $\mu A$  off-state quiescent current
- Thermal overload protection
- Foldback current limiting
- T0-252, SOT-223 and 6-Lead LLP packages
- Enable pin (LP38692)

### Applications

- Hard Disk Drives
- Notebook Computers
- Battery Powered Devices
- Portable Instrumentation

### Typical Application Circuits



Note: \* Minimum value required for stability.

\*\*LLP package devices only.

## Ordering Information

Order Number	Package Marking	Package Type	Package Drawing	Supplied As
LP38690SD-1.8	L113B	6-Lead LLP	SDE06A	1000 Units Tape and Reel
LP38690SD-2.5	L114B	6-Lead LLP	SDE06A	1000 Units Tape and Reel
LP38690SD-3.3	L115B	6-Lead LLP	SDE06A	1000 Units Tape and Reel
LP38690SD-5.0	L116B	6-Lead LLP	SDE06A	1000 Units Tape and Reel
LP38690DT-1.8	LP38690DT-1.8	TO-252	TD03B	75 Units per Rail
LP38690DT-2.5	LP38690DT-2.5	TO-252	TD03B	75 Units per Rail
LP38690DT-3.3	LP38690DT-3.3	TO-252	TD03B	75 Units per Rail
LP38690DT-5.0	LP38690DT-5.0	TO-252	TD03B	75 Units per Rail
LP38692SD-1.8	L123B	6-Lead LLP	SDE06A	1000 Units Tape and Reel
LP38692SD-2.5	L124B	6-Lead LLP	SDE06A	1000 Units Tape and Reel
LP38692SD-3.3	L125B	6-Lead LLP	SDE06A	1000 Units Tape and Reel
LP38692SD-5.0	L126B	6-Lead LLP	SDE06A	1000 Units Tape and Reel
LP38692MP-1.8	LJPB	SOT-223	MP05A	1000 Units Tape and Reel
LP38692MP-2.5	LJRB	SOT-223	MP05A	1000 Units Tape and Reel
LP38692MP-3.3	LJSB	SOT-223	MP05A	1000 Units Tape and Reel
LP38692MP-5.0	LJTB	SOT-223	MP05A	1000 Units Tape and Reel
LP38690SDX-1.8	L113B	6-Lead LLP	SDE06A	4500 Units Tape and Reel
LP38690SDX-2.5	L114B	6-Lead LLP	SDE06A	4500 Units Tape and Reel
LP38690SDX-3.3	L115B	6-Lead LLP	SDE06A	4500 Units Tape and Reel
LP38690SDX-5.0	L116B	6-Lead LLP	SDE06A	4500 Units Tape and Reel
LP38690DTX-1.8	LP38690DT-1.8	TO-252	TD03B	2500 Units Tape and Reel
LP38690DTX-2.5	LP38690DT-2.5	TO-252	TD03B	2500 Units Tape and Reel
LP38690DTX-3.3	LP38690DT-3.3	TO-252	TD03B	2500 Units Tape and Reel
LP38690DTX-5.0	LP38690DT-5.0	TO-252	TD03B	2500 Units Tape and Reel
LP38692SDX-1.8	L123B	6-Lead LLP	SDE06A	4500 Units Tape and Reel
LP38692SDX-2.5	L124B	6-Lead LLP	SDE06A	4500 Units Tape and Reel
LP38692SDX-3.3	L125B	6-Lead LLP	SDE06A	4500 Units Tape and Reel
LP38692SDX-5.0	L126B	6-Lead LLP	SDE06A	4500 Units Tape and Reel
LP38692MPX-1.8	LJPB	SOT-223	MP05A	2000 Units Tape and Reel
LP38692MPX-2.5	LJRB	SOT-223	MP05A	2000 Units Tape and Reel
LP38692MPX-3.3	LJSB	SOT-223	MP05A	2000 Units Tape and Reel
LP38692MPX-5.0	LJTB	SOT-223	MP05A	2000 Units Tape and Reel

**Absolute Maximum Ratings** (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Storage Temperature Range	-65°C to +150°C
Lead Temp. (Soldering, 5 seconds)	260°C
ESD Rating (Note 3)	2 kV
Power Dissipation (Note 2)	Internally Limited

V(max) All pins (with respect to GND)	-0.3V to 12V
I <sub>OUT</sub>	Internally Limited
Junction Temperature	-40°C to +150°C

**Operating Ratings**

V <sub>IN</sub> Supply Voltage	2.7V to 10V
Operating Junction Temperature Range	-40°C to +125°C

**Electrical Characteristics** Limits in standard typeface are for T<sub>J</sub> = 25°C, and limits in **boldface type** apply over the full operating temperature range. Unless otherwise specified: V<sub>IN</sub> = V<sub>OUT</sub> + 1V, C<sub>IN</sub> = C<sub>OUT</sub> = 10 μF, I<sub>LOAD</sub> = 10mA. Min/Max limits are guaranteed through testing, statistical correlation, or design.

Symbol	Parameter	Conditions	MIN	TYP (Note 4)	MAX	Units
V <sub>O</sub>	Output Voltage Tolerance		-2.5		2.5	%V <sub>OUT</sub>
		100 μA < I <sub>L</sub> < 1A V <sub>O</sub> + 1V ≤ V <sub>IN</sub> ≤ 10V	<b>-5.0</b>		<b>5.0</b>	
ΔV <sub>O</sub> /ΔV <sub>IN</sub>	Output Voltage Line Regulation (Note 6)	V <sub>O</sub> + 0.5V ≤ V <sub>IN</sub> ≤ 10V I <sub>L</sub> = 25mA		0.03	<b>0.1</b>	%/V
ΔV <sub>O</sub> /ΔI <sub>L</sub>	Output Voltage Load Regulation (Note 7)	1 mA < I <sub>L</sub> < 1A V <sub>IN</sub> = V <sub>O</sub> + 1V		1.8	<b>5</b>	%/A
V <sub>IN</sub> - V <sub>OUT</sub>	Dropout Voltage (Note 8)	(V <sub>O</sub> = 1.8V) I <sub>L</sub> = 1A		950	<b>1600</b>	mV
		(V <sub>O</sub> = 2.5V) I <sub>L</sub> = 0.1A I <sub>L</sub> = 1A		80 800	<b>145</b> <b>1300</b>	
		(V <sub>O</sub> = 3.3V) I <sub>L</sub> = 0.1A I <sub>L</sub> = 1A		65 650	<b>110</b> <b>1000</b>	
		(V <sub>O</sub> = 5V) I <sub>L</sub> = 0.1A I <sub>L</sub> = 1A		45 450	<b>100</b> <b>800</b>	
I <sub>Q</sub>	Quiescent Current	V <sub>IN</sub> ≤ 10V, I <sub>L</sub> = 100 μA - 1A		55	<b>100</b>	μA
		V <sub>EN</sub> ≤ 0.4V, (LP38692 Only)		0.001	<b>1</b>	
I <sub>L</sub> (MIN)	Minimum Load Current	V <sub>IN</sub> - V <sub>O</sub> ≤ 4V			<b>100</b>	
I <sub>FB</sub>	Foldback Current Limit	V <sub>IN</sub> - V <sub>O</sub> > 5V		450		mA
		V <sub>IN</sub> - V <sub>O</sub> < 4V		1500		
PSRR	Ripple Rejection	V <sub>IN</sub> = V <sub>O</sub> + 2V(DC), with 1V(p-p) / 120Hz Ripple		55		dB
T <sub>SD</sub>	Thermal Shutdown Activation (Junction Temp)			160		°C
T <sub>SD</sub> (HYST)	Thermal Shutdown Hysteresis (Junction Temp)			10		

Symbol	Parameter	Conditions	MIN	TYP (Note 4)	MAX	Units
$e_n$	Output Noise	BW = 10Hz to 10kHz $V_O = 3.3V$		0.7		$\mu V/\sqrt{Hz}$
$V_O$ (LEAK)	Output Leakage Current	$V_O = V_O(NOM) + 1V @ 10V_{IN}$		0.5	12	$\mu A$
$V_{EN}$	Enable Voltage (LP38692 Only)	Output = OFF			<b>0.4</b>	V
		Output = ON, $V_{IN} = 4V$	<b>1.8</b>			
		Output = ON, $V_{IN} = 6V$	<b>3.0</b>			
		Output = ON, $V_{IN} = 10V$	<b>4.0</b>			
$I_{EN}$	Enable Pin Leakage	$V_{EN} = 0V$ or $10V$ , $V_{IN} = 10V$	-1	0.001	1	$\mu A$

**Note 1:** Absolute maximum ratings indicate limits beyond which damage to the component 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, see Electrical Characteristics. Specifications do not apply when operating the device outside of its rated operating conditions.

**Note 2:** At elevated temperatures, device power dissipation must be derated based on package thermal resistance and heatsink values (if a heatsink is used). The junction-to-ambient thermal resistance ( $\theta_{JA}$ ) for the TO-252 is approximately 90°C/W for a PC board mounting with the device soldered down to minimum copper area (less than 0.1 square inch). If one square inch of copper is used as a heat dissipator for the TO-252, the  $\theta_{JA}$  drops to approximately 50°C/W. The SOT-223 package has a  $\theta_{JA}$  of approximately 125°C/W when soldered down to a minimum sized pattern (less than 0.1 square inch) and approximately 70°C/W when soldered to a copper area of one square inch. The  $\theta_{JA}$  values for the LLP package are also dependent on trace area, copper thickness, and the number of thermal vias used (refer to application note AN-1187). If power dissipation causes the junction temperature to exceed specified limits, the device will go into thermal shutdown.

**Note 3:** ESD is tested using the human body model which is a 100pF capacitor discharged through a 1.5k resistor into each pin.

**Note 4:** Typical numbers represent the most likely parametric norm for 25°C operation.

**Note 5:** If used in a dual-supply system where the regulator load is returned to a negative supply, the output pin must be diode clamped to ground.

**Note 6:** Output voltage line regulation is defined as the change in output voltage from nominal value resulting from a change in input voltage.

**Note 7:** Output voltage load regulation is defined as the change in output voltage from nominal value as the load current increases from 1mA to full load.

**Note 8:** Dropout voltage is defined as the minimum input to output differential required to maintain the output within 100mV of nominal value.

**Physical Dimensions** inches (millimeters) unless otherwise noted

