SM72238

SM72238 SolarMagic Micropower Voltage Regulator

Literature Number: SNVS694B

SM72238

SolarMagic Micropower Voltage Regulator

General Description

The SM72238 is a micropower voltage regulator with very low quiescent current (75µA typ.) and very low dropout voltage (typ. 40mV at light loads and 380mV at 100mA). It is ideally suited for use in battery-powered systems. Furthermore, the quiescent current of the SM72238 increases only slightly in dropout, prolonging battery life.

The SM72238 is available in the surface-mount D-Pak package.

Careful design of the SM72238 has minimized all contributions to the error budget. This includes a tight initial tolerance (.5% typ.), extremely good load and line regulation (.05% typ.) and a very low output voltage temperature coefficient, making the part useful as a low-power voltage reference.

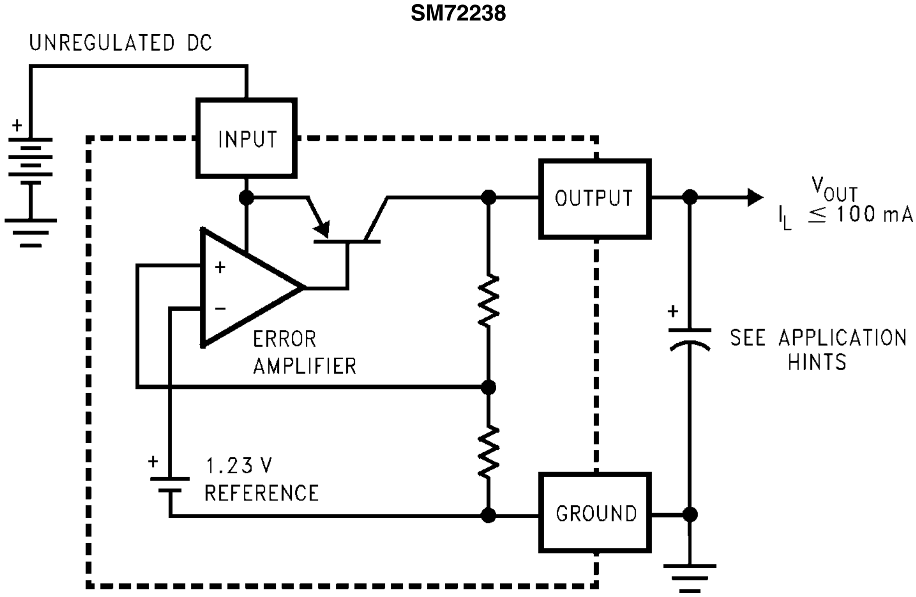
Features

- Renewable Energy Grade
- High accuracy output voltage
- Guaranteed 100mA output current
- Extremely low quiescent current
- Low dropout voltage
- Extremely tight load and line regulation
- Very low temperature coefficient
- Use as Regulator or Reference
- Needs minimum capacitance for stability
- Current and Thermal Limiting
- Stable with low-ESR output capacitors (10mΩ to 6Ω)

SolarMagic by National Semiconductor

Block Diagram and Typical Applications

SM72238



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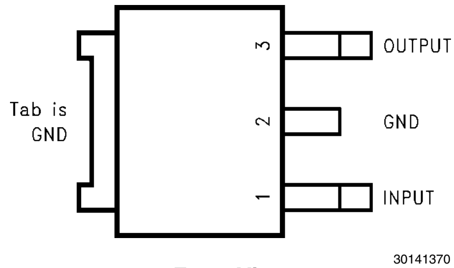
Connection Diagrams

TO-252 (D-Pak)



Front View

Ordering Information

Package	Temperature Range	V_{OUT}	Part Number	Package Marking	Transport Media	NSC Drawing
TO-252 (DPAK)	$-40<T_J<125$	3.0	SM72238TD-3.0	S72238–3.0	75 Units in Rail	TD03B
			SM72238TDE-3.0		250 Units in Tape and Reel	
			SM72238TDX-3.0		2500 Units in Tape and Reel	
TO-252 (DPAK)	$-40<T_J<125$	3.3	SM72238TD-3.3	S72238–3.3	75 Units in Rail	TD03B
			SM72238TDE-3.3		250 Units in Tape and Reel	
			SM72238TDX-3.3		2500 Units in Tape and Reel	
TO-252 (DPAK)	$-40<T_J<125$	5.0	SM72238TD-5.0	S72238	75 Units in Rail	TD03B
			SM72238TDE-5.0		250 Units in Tape and Reel	
			SM72238TDX-5.0		2500 Units in 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.

Input Supply Voltage	−0.3 to +30V
Power Dissipation	Internally Limited
Junction Temperature (T_J)	+150°C
Ambient Storage Temperature	−65° to +150°C
Soldering Dwell Time, Temperature	
Wave	4 seconds, 260°C
Infrared	10 seconds, 240°C
Vapor Phase	75 seconds, 219°C
ESD Rating	
Human Body Model(Note 11)	2500V

Operating Ratings (Note 1)

Maximum Input Supply Voltage	30V
Junction Temperature Range (T_J) (Note 6)	−40° to +125°C

Electrical Characteristics (Note 2)

Parameter	Conditions (Note 2)	Typ	Tested Limit (Note 3)	Design Limit (Note 4)	Units
3V Versions					
Output Voltage	T_J = 25°C	3.0	3.030 2.970		V max V min
	−25°C ≤ T_J ≤ 85°C	3.0		3.045 2.955	V max V min
	Full Operating Temperature Range	3.0		**3.060** **2.940**	V max V min
Output Voltage	100µA ≤ I_L ≤ 100mA T_J ≤ T_{JMAX}	3.0		**3.072** **2.928**	V max V min
3.3V Versions					
Output Voltage	T_J = 25°C	3.3	3.333 3.267		V max V min
	−25°C ≤ T_J ≤ 85°C	3.3		3.350 3.251	V max V min
	Full Operating Temperature Range	3.3		**3.366** **3.234**	V max V min
Output Voltage	100µA ≤ I_L ≤ 100mA T_J ≤ T_{JMAX}	3.3		**3.379** **3.221**	V max V min
5.0V Versions					
Output Voltage	T_J = 25°C	5.0	5.05 4.95		V max V min
	−25°C ≤ T_J ≤ 85°C	5.0		5.075 4.925	V max V min
	Full Operating Temperature Range	5.0		**5.1** **4.9**	V max V min
Output Voltage	100µA ≤ I_L ≤ 100mA T_J ≤ T_{JMAX}	5.0		**5.12** **4.88**	V max V min
All Voltage Options					
Output Voltage Temperature Coefficient	(Note 7)	**50**		**150**	ppm/°C
Line Regulation (Note 9)	(V_ONOM + 1)V ≤ V_{in} ≤ 30V (Note 10)	0.04	0.2	 **0.4**	% max % max
Load Regulation (Note 9)	100µA ≤ I_L ≤ 100mA	0.1	0.2	 **0.3**	% max % max

Parameter	Conditions (Note 2)	Typ	Tested Limit (Note 3)	Design Limit (Note 4)	Units
Dropout Voltage (Note 5)	I_L = 100µA		80		mV max
		50		**150**	mV max
	I_L = 100mA		450		mV max
		380		**600**	mV max
Ground Current	I_L = 100µA	75	120		µA max
				140	µA max
	I_L = 100mA	8	12		mA max
				14	mA max
Dropout Ground Current	$V_{in} = (V_O NOM – 0.5)V$	110	170		µA max
	I_L = 100µA			**200**	µA max
Current Limit	$V_{out} = 0$	160	200		mA max
				220	mA max
Thermal Regulation	(Note 8)	0.05	0.2		%/W max
Output Noise, 10 Hz to 100 kHz	C_L = 1µF (5V Only)	430			µV rms
	C_L = 200µF	160			µV rms
	C_L = 3.3µF (Bypass = 0.01µF)	100			µV rms

Note 1: Absolute Maximum Ratings are limits beyond which damage to the device may occur. Operating Ratings are conditions under which operation of the device is guaranteed. Operating Ratings do not imply guaranteed performance limits. For guaranteed performance limits and associated test conditions, see the Electrical Characteristics tables.

Note 2: Unless otherwise specified all limits guaranteed for $V_{IN} = (V_{ONOM} + 1)V$, I_L = 100µA and C_L = 1µF. Limits appearing in **boldface** type apply over the entire junction temperature range for operation. Limits appearing in normal type apply for $T_A = T_J$ = 25°C.

Note 3: Guaranteed and 100% production tested.

Note 4: Guaranteed but not 100% production tested. These limits are not used to calculate outgoing AQL levels.

Note 5: Dropout Voltage is defined as the input to output differential at which the output voltage drops 100 mV below its nominal value measured at 1V differential. At very low values of programmed output voltage, the minimum input supply voltage of 2V (2.3V over temperature) must be taken into account.

Note 6: Junction-to-case thermal resistance for the TO-252 package is 5.4°C/W.

Note 7: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

Note 8: Thermal regulation is defined as the change in output voltage at a time T after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 50mA load pulse at V_{IN} = 30V (1.25W pulse) for T = 10ms.

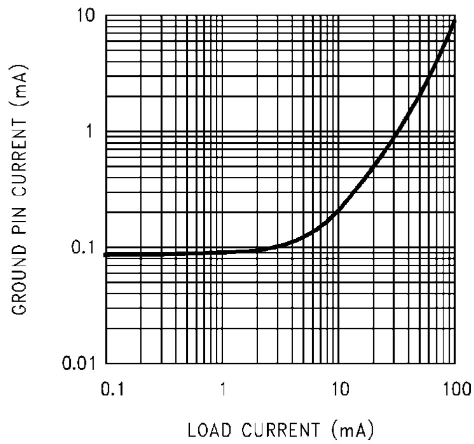
Note 9: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

Note 10: For I_L = 100µA and T_J = 125°C, line regulation is guaranteed by design to 0.2%. See Typical Performance Characteristics for line regulation versus temperature and load current.

Note 11: Human Body Model 1.5kΩ in series with 100pF.

Typical Performance Characteristics

Quiescent Current



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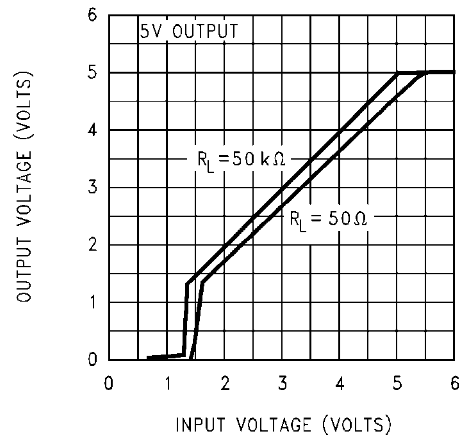
Dropout Characteristics



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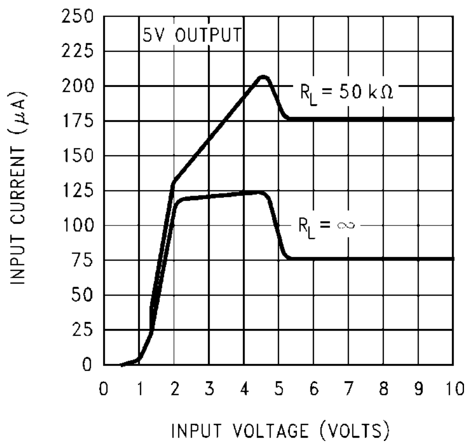
Input Current



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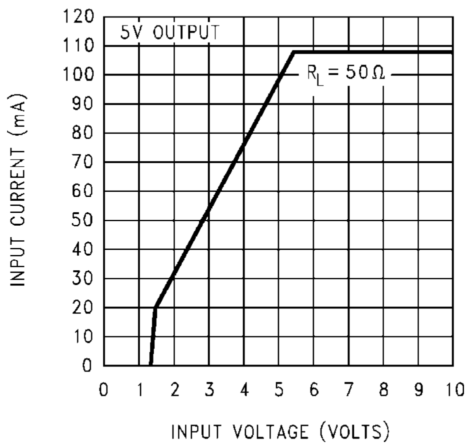
Input Current



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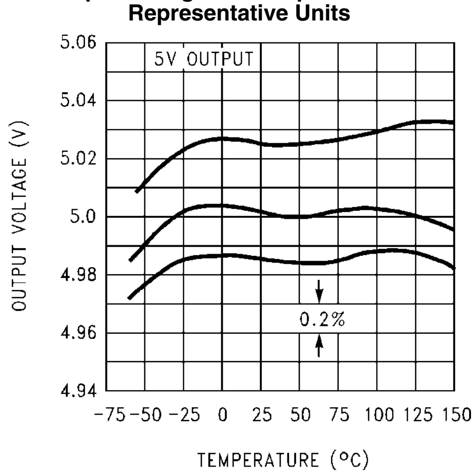
Output Voltage vs. Temperature of 3 Representative Units



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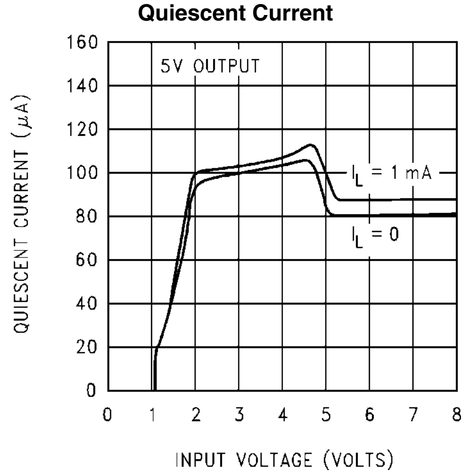
Quiescent Current



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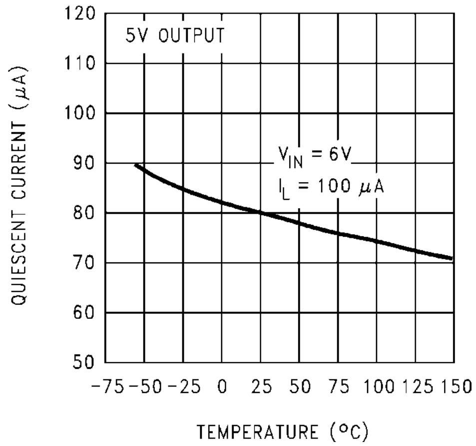
Quiescent Current



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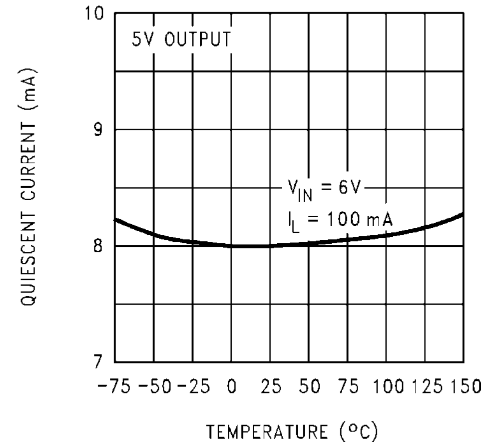
Quiescent Current



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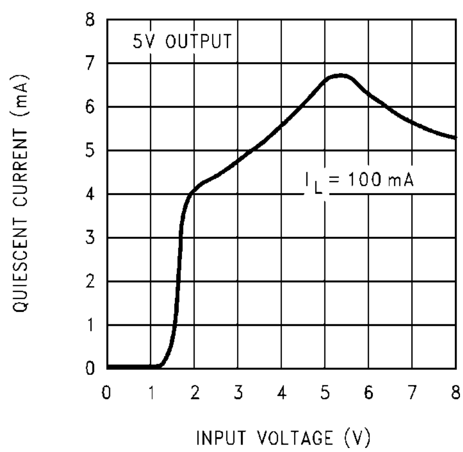
Quiescent Current



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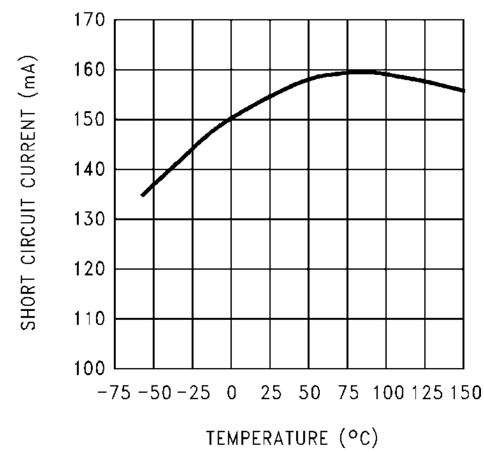
Short Circuit Current



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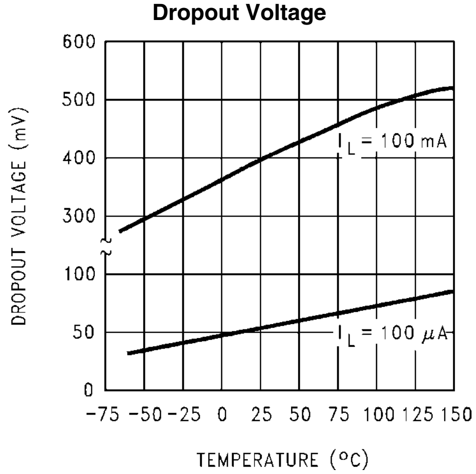
Dropout Voltage



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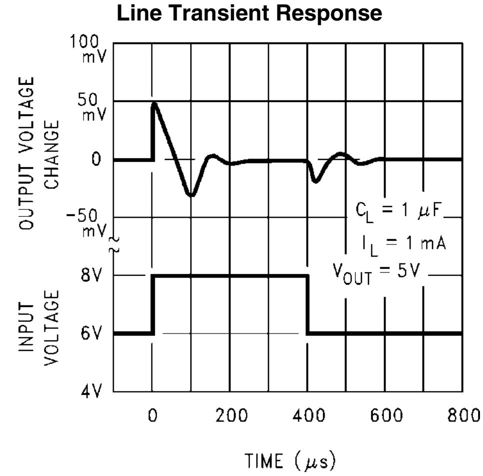
Line Transient Response



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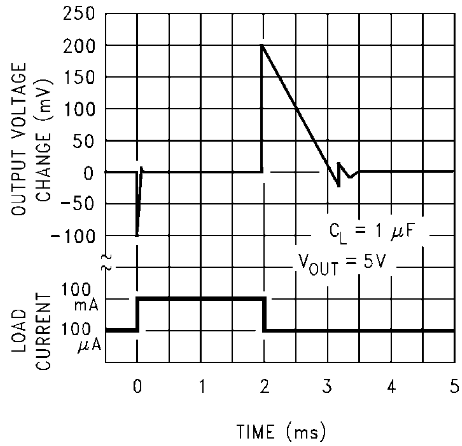
Load Transient Response



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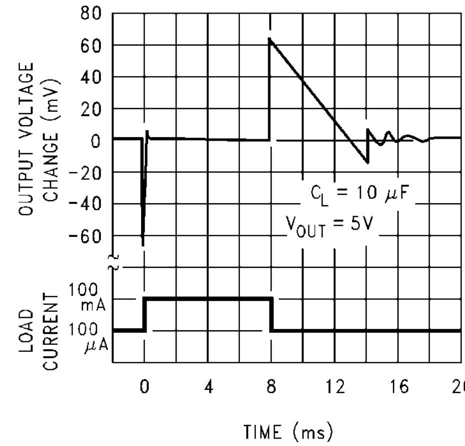
Load Transient Response



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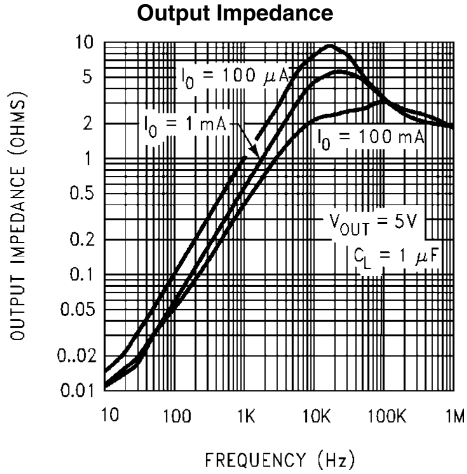
Output Impedance



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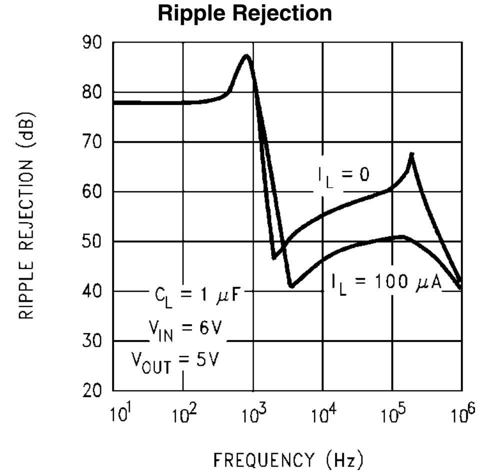
Ripple Rejection



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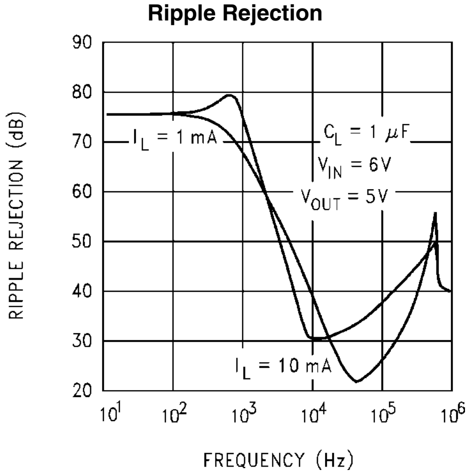
Ripple Rejection



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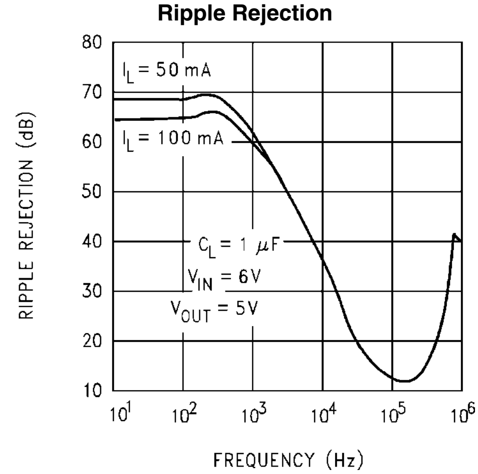
Ripple Rejection



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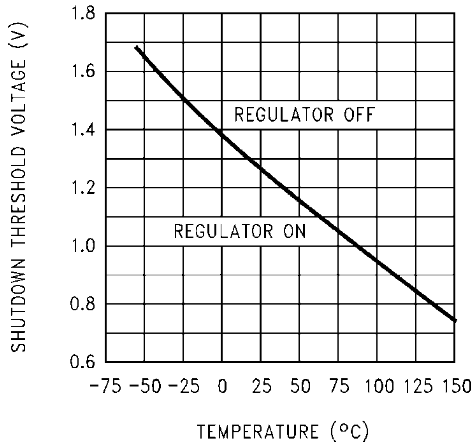
Shutdown Threshold Voltage



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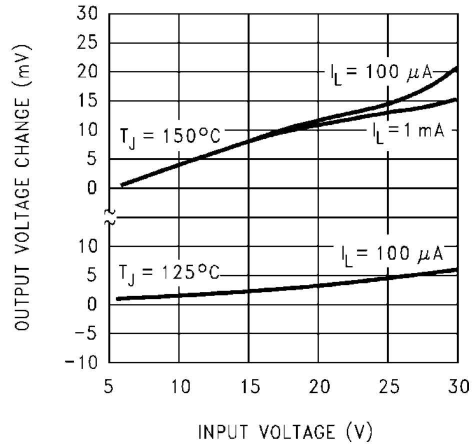
Line Regulation



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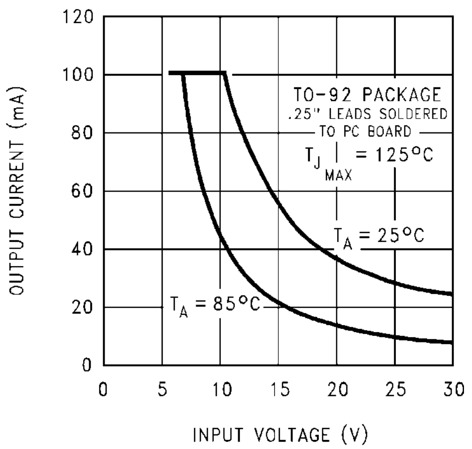
Maximum Rated Output Current



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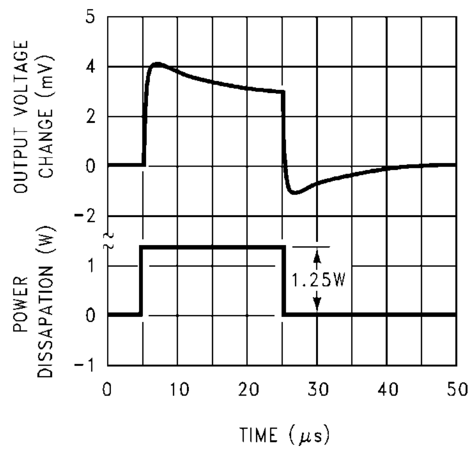
Thermal Response



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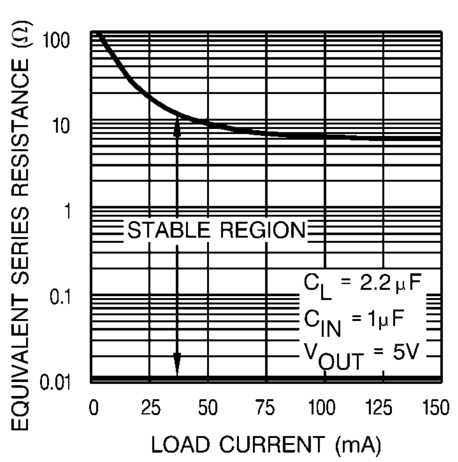
Output Capacitor ESR Range



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Application Hints

EXTERNAL CAPACITORS

A 1.0μF (or greater) capacitor is required between the output and ground for stability. Without this capacitor the part will oscillate. Most types of tantalum or aluminum electrolytics work fine here; even film types work but are not recommended for reasons of cost. Many aluminum electrolytics have electrolytes that freeze at about −30°C, so solid tantalums are recommended for operation below −25°C. The important parameters of the capacitor are an ESR of about 5Ω or less and a resonant frequency above 500kHz. The value of this capacitor may be increased without limit.

Ceramic capacitors whose value is greater than 1000pF should not be connected directly from the SM72238 output to ground. Ceramic capacitors typically have ESR values in the range of 5 to 10mΩ, a value below the lower limit for stable operation (see curve Output Capacitor ESR Range).

The reason for the lower ESR limit is that the loop compensation of the part relies on the ESR of the output capacitor to provide the zero that gives added phase lead. The ESR of ceramic capacitors is so low that this phase lead does not occur, significantly reducing phase margin. A ceramic output capacitor can be used if a series resistance is added (recommended value of resistance about 0.1Ω to 2Ω).

At lower values of output current, less output capacitance is required for stability. The capacitor can be reduced to 0.33μF for currents below 10mA or 0.1μF for currents below 1mA.

Unlike many other regulators, the SM72238 will remain stable and in regulation with no load in addition to the internal voltage divider. This is especially important in CMOS RAM keep-alive applications.

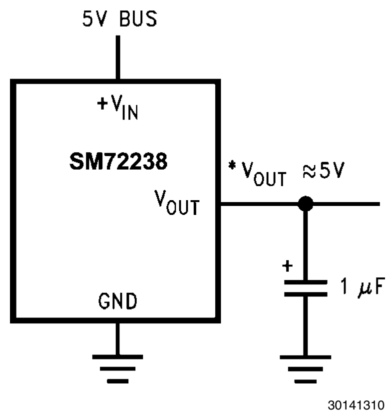
A 1μF tantalum, ceramic or aluminum electrolytic capacitor should be placed from the SM72238 input to ground if there is more than 10 inches of wire between the input and the AC filter capacitor or if a battery is used as the input.

REDUCING OUTPUT NOISE

In reference applications it may be advantageous to reduce the AC noise present at the output. One method is to reduce the regulator bandwidth by increasing the size of the output capacitor. This is the only way noise can be reduced but is relatively inefficient, as increasing the capacitor from 1μF to 220μF only decreases the noise from 430μV to 160μV rms for a 100kHz bandwidth at 5V output.

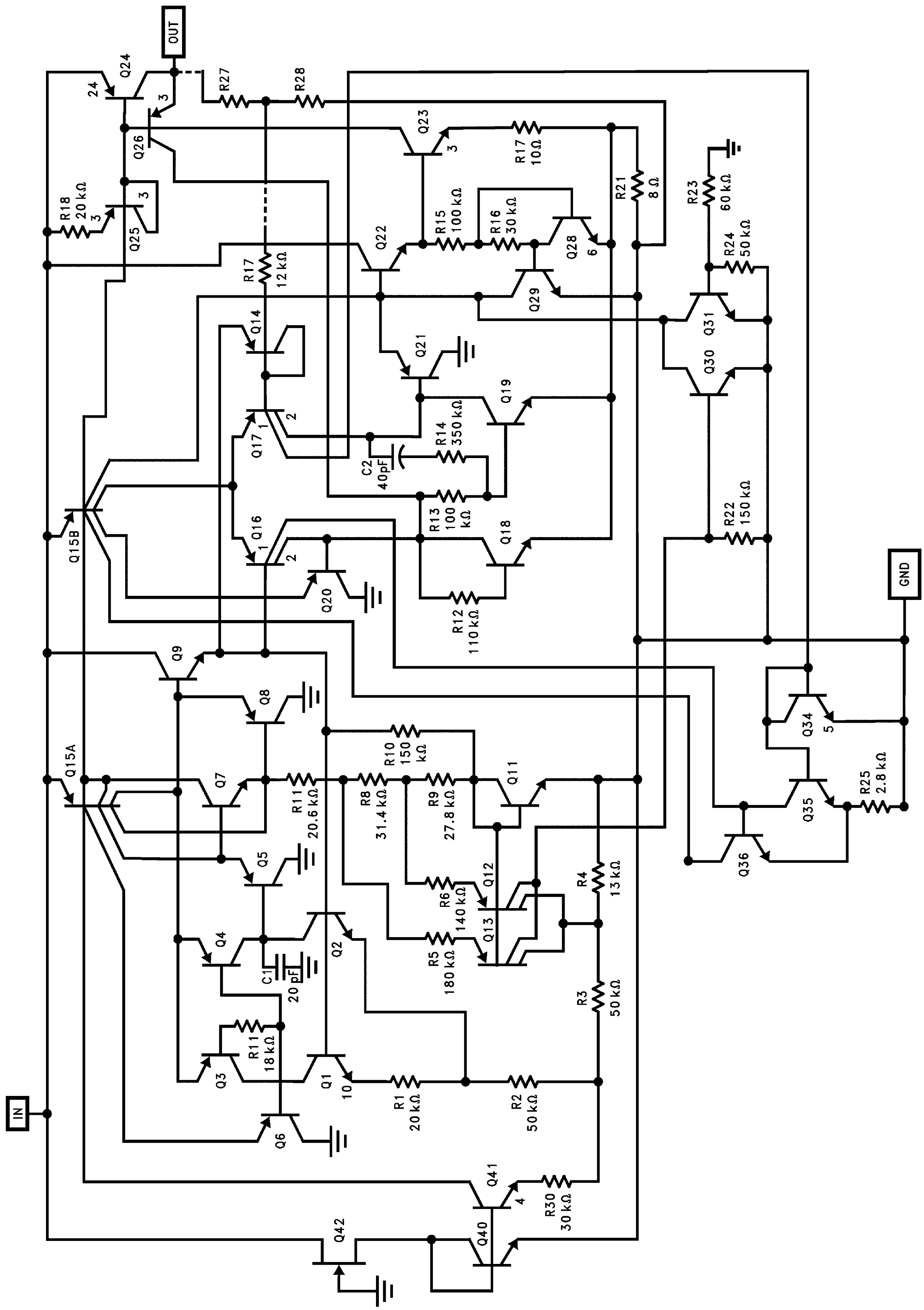
Typical Applications

5 Volt Current Limiter



*Minimum input-output voltage ranges from 40mV to 400mV, depending on load current. Current limit is typically 160mA.

Schematic Diagram



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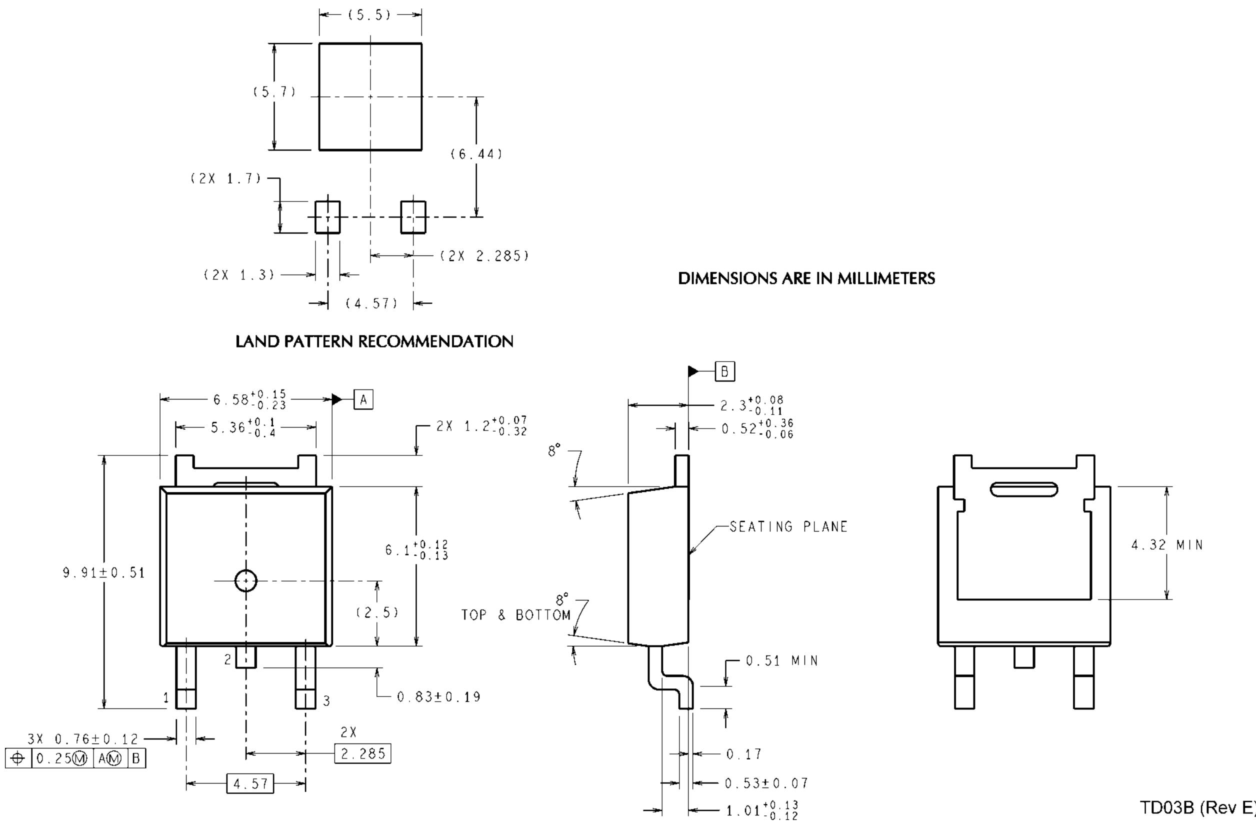
Physical Dimensions inches (millimeters) unless otherwise noted



D-Pak Package
NS Package Number TD03B

Notes

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