

5-Volt Regulator

General Description

The LM109 series are complete 5V regulators fabricated on a single silicon chip. They are designed for local regulation on digital logic cards, eliminating the distribution problems associated with single-point regulation. The devices are available in two standard transistor packages. In the solid-kovar TO-5 header, it can deliver output currents in excess of 200 mA, if adequate heat sinking is provided. With the TO-3 power package, the available output current is greater than 1A.

The regulators are essentially blowout proof. Current limiting is included to limit the peak output current to a safe value. In addition, thermal shutdown is provided to keep the IC from overheating. If internal dissipation becomes too great, the regulator will shut down to prevent excessive heating.

Considerable effort was expended to make these devices easy to use and to minimize the number of external components. It is not necessary to bypass the output, although this

does improve transient response somewhat. Input bypassing is needed, however, if the regulator is located very far from the filter capacitor of the power supply. Stability is also achieved by methods that provide very good rejection of load or line transients as are usually seen with TTL logic.

Although designed primarily as a fixed-voltage regulator, the output of the LM109 series can be set to voltages above 5V, as shown. It is also possible to use the circuits as the control element in precision regulators, taking advantage of the good current-handling capability and the thermal overload protection.

Features

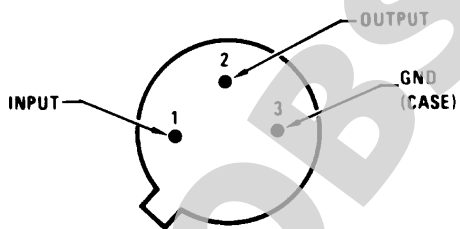
- Specified to be compatible, worst case, with TTL and DTL
- Output current in excess of 1A
- Internal thermal overload protection
- No external components required

Ordering Information

NS Part Number	JAN Part Number	NS Package Number	Package Description
JL109BXA	JM38510/10701BXA	H03A	3LD Metal Can
JL109BYA	JM38510/10701BYA	K02C	2LD TO-3 Metal Can

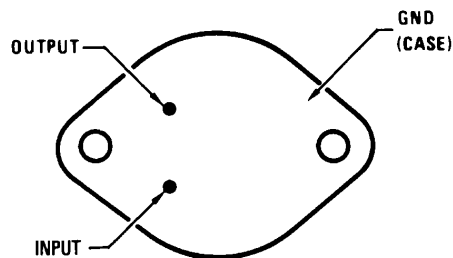
Connection Diagrams

Metal Can Packages



See NS Package Number H03A
Bottom View

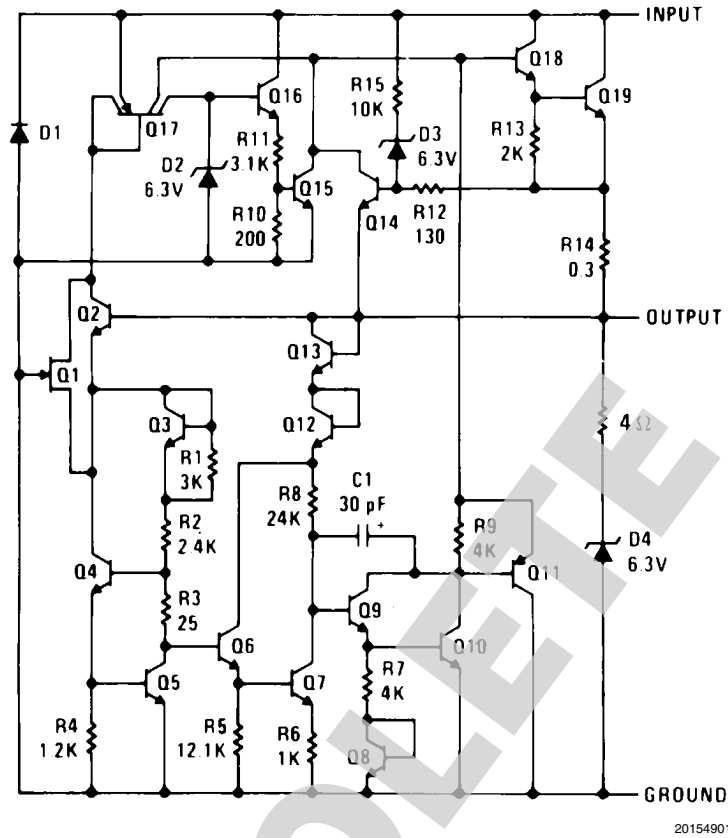
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See NS Package Number K02C
Bottom View

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Schematic Diagram



Absolute Maximum Ratings *(Note 1)*

Input Voltage	35V
Power Dissipation	Internally Limited
Operating Ambient Temperature Range	$-55^{\circ}\text{C} \leq T_A \leq +150^{\circ}\text{C}$
Storage Temperature Range	$-65^{\circ}\text{C} \leq T_A \leq +150^{\circ}\text{C}$
Maximum Junction Temperature	150°C
Thermal Resistance	
θ_{JA}	
H-Pkg (Still Air)	190°C/W
H-Pkg (500LF/Min Air flow)	69°C/W
K-Pkg (Still Air)	39°C/W
K-Pkg (500LF/Min Air flow)	TBD
θ_{JC}	
H-Pkg	25°C/W
K-Pkg	3°C/W
Lead Temperature (Soldering, 10 sec.)	300°C
ESD Tolerance <i>(Note 9)</i>	4000V

Quality Conformance Inspection

Mil-Std-883, Method 5005 - Group A

Subgroup	Description	Temp °C
1	Static tests at	25
2	Static tests at	125
3	Static tests at	-55
4	Dynamic tests at	25
5	Dynamic tests at	125
6	Dynamic tests at	-55
7	Functional tests at	25
8A	Functional tests at	125
8B	Functional tests at	-55
9	Switching tests at	25
10	Switching tests at	125
11	Switching tests at	-55
12	Settling time at	25
13	Settling time at	125
14	Settling time at	-55

JL109H Electrical Characteristics

DC Parameters

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_O	Output Voltage	$V_I = 7V, I_L = -5mA$		4.7	5.4	V	1, 2, 3
		$V_I = 7V, I_L = -0.5A$	(Note 3)	4.7	5.4	V	1, 2, 3
		$V_I = 9V, I_L = -0.5A$		4.7	5.4	V	1, 2, 3
		$V_I = 25V, I_L = -5mA$		4.7	5.4	V	1, 2, 3
		$V_I = 25V, I_L = -100mA$		4.7	5.4	V	1, 2, 3
V_{RLine}	Line Regulation	$7V \leq V_I \leq 25V, I_L = -5mA$		-50	50	mV	1
				-100	100	mV	2, 3
V_{RLoad}	Load Regulation	$V_I = 10V, -0.5A \leq I_L \leq -5mA$		-100	100	mV	1, 2, 3
I_{SCD}	Standby Current Drain	$V_I = 7V, I_L = -5mA$		-10	0.5	mA	1, 2, 3
		$V_I = 25V, I_L = -5mA$		-10	0.5	mA	1, 2, 3
ΔI_{SCD} (Line)	Standby Current Drain vs Line Voltage	$7V \leq V_I \leq 25V, I_L = -5mA$		-0.5	0.5	mA	1, 2, 3
ΔI_{SCD} (Load)	Standby Current Drain vs Load Current	$V_I = 10V, -0.5A \leq I_L \leq -5mA$		-0.8	0.8	mA	1, 2, 3
I_{OS}	Output Short Circuit Current	$V_I = 35V$		-2.0	0.01	A	1, 2, 3
V_{Start}	Minimum Start Up Input Voltage	$R_L = 25\Omega \pm 5\%$	(Note 8)		9.0	V	1, 2, 3
$\Delta V_O / \Delta T$	Average Temperature Coefficient of Output Voltage	$V_I = 7V, I_L = -5mA$	(Note 4)	-2.0	2.0	mV/°C	8A, 8B

AC Parameters

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
N_O	Output Noise Voltage	$V_I = 10V, I_L = -50mA$			125	μV_{RMS}	7
$\Delta V_O / \Delta V_I$	Line Transient Response	$V_I = 10V, V_{Pulse} = 3V, I_L = -5mA$	(Note 5)		45	mV	7
$\Delta V_O / \Delta I_L$	Load Transient Response	$V_I = 10V, I_L = -50mA, \Delta I_L = -200mA$	(Note 7)		400	mV	7
$\Delta V_I / \Delta V_O$	Ripple Rejection	$V_I = 10V, I_L = -125mA, e_i = 1V_{RMS}$ at $f = 2400Hz$		60		dB	4

DC Drift Parameters

Delta calculations performed on JAN S devices at group B, Subgroup 5, only.

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_O	Output Voltage	$V_I = 7V, I_L = -5mA$		-0.025	0.025	V	1
		$V_I = 7V, I_L = -0.5A$		-0.025	0.025	V	1
		$V_I = 9V, I_L = -0.5A$		-0.025	0.025	V	1
		$V_I = 25V, I_L = -5mA$		-0.025	0.025	V	1
		$V_I = 25V, I_L = -100mA$		-0.025	0.025	V	1
V_{RLine}	Line Regulation	$7V \leq V_I \leq 25V, I_L = -5mA$		-10	10	mV	1

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_{RLoad}	Load Regulation	$V_I = 10V, -0.5A \leq I_L \leq -5mA$		-10	10	mV	1
I_{SCD}		$V_I = 7V, I_L = -5mA$		-1.0	1.0	mA	1
		$V_I = 25V, I_L = -5mA$		-1.0	1.0	mA	1

OBSOLETE

JL109K Electrical Characteristics

DC Parameters

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_O	Output Voltage	$V_I = 7V, I_L = -5mA$		4.7	5.4	V	1, 2, 3
		$V_I = 7V, I_L = -1.5A$	(Note 3)	4.7	5.4	V	1, 2, 3
		$V_I = 18V, I_L = -1.5A$		4.7	5.4	V	1, 2, 3
		$V_I = 25V, I_L = -5mA$		4.7	5.4	V	1, 2, 3
		$V_I = 25V, I_L = -1A$		4.7	5.4	V	1, 2, 3
V_{RLine}	Line Regulation	$7V \leq V_I \leq 25V, I_L = -5mA$		-50	50	mV	1
				-100	100	mV	2, 3
V_{RLoad}	Load Regulation	$V_I = 10V, -1.5A \leq I_L \leq -5mA$		-100	100	mV	1, 2, 3
I_{SCD}	Standby Current Drain	$7V \leq V_I \leq 25V, I_L = -5mA$		-10	0.5	mA	1, 2, 3
ΔI_{SCD} (Line)	Standby Current Drain vs Line Voltage	$7V \leq V_I \leq 25V, I_L = -5mA$		-0.5	0.5	mA	1, 2, 3
ΔI_{SCD} (Load)	Standby Current Drain vs Load Current	$V_I = 10V, -1.5A \leq I_L \leq -5mA$		-0.8	0.8	mA	1, 2, 3
I_{OS}	Output Short Circuit Current	$V_I = 35V$		-2.8	0.01	A	1, 2, 3
V_{Start}	Minimum Start Up Input Voltage	$R_L = 5\Omega \pm 5\%$	(Note 8)		9.0	V	1, 2, 3
$\Delta V_O / \Delta T$	Average Temperature Coefficient of Output Voltage	$V_I = 7V, I_L = -5mA$	(Note 4)	-2.0	2.0	mV/°C	8A, 8B

AC Parameters

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
N_O	Output Noise Voltage	$V_I = 10V, I_L = -100mA$			125	μV_{RMS}	7
$\Delta V_O / \Delta V_I$	Line Transient Response	$V_I = 10V, V_{Pulse} = 3V, I_L = -5mA$	(Note 5)		45	mV	7
$\Delta V_O / \Delta I_L$	Load Transient Response	$V_I = 10V, I_L = -100mA, \Delta I_L = -400mA$	(Note 6)		800	mV	7
$\Delta V_I / \Delta V_O$	Ripple Rejection	$V_I = 10V, I_L = -350mA, e_i = 1V_{RMS}$ at $f = 2400Hz$		60		dB	4

DC Drift Parameters

Delta calculations performed on JAN S devices at group B, Subgroup 5, only.

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_O	Output Voltage	$V_I = 7V, I_L = -5mA$		-0.025	0.025	V	1
		$V_I = 7V, I_L = -1.5A$		-0.025	0.025	V	1
		$V_I = 18V, I_L = -1.5A$		-0.025	0.025	V	1
		$V_I = 25V, I_L = -5mA$		-0.025	0.025	V	1
		$V_I = 25V, I_L = -1A$		-0.025	0.025	V	1
V_{RLine}	Line Regulation	$7V \leq V_I \leq 25V, I_L = -5mA$		-10	10	mV	1

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_{RLoad}	Load Regulation	$V_I = 10V, -1.5A \leq I_L \leq -5mA$		-10	10	mV	1
I_{SCD}	Standby Current Drain	$7V \leq V_I \leq 25V, I_L = -5mA$		-1.0	1.0	mA	1

OBSOLETE

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

Note 2: This test is performed by shifting the input voltage in 50mV increments until output reaches 4.706V.

Note 3: $V_I = 8V$ at $-55^\circ C$.

Note 4: Calculated parameter.

Note 5: Slash Sheet limit of 15 mV/V is equivalent to 45mV

Note 6: Slash Sheet limit of 2mV/mA is equivalent to 800mV

Note 7: Slash Sheet limit of 2mV/mA is equivalent to 400mV

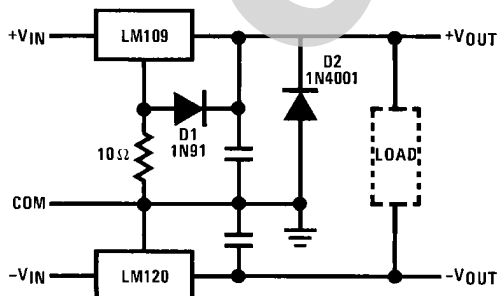
Note 8: Parameter tested go-no-go, only.

Note 9: Human body model, 1.5k Ω in series with 100pF.

Application Hints

1. **Bypass the input** of the LM109 to ground with $\geq 0.2 \mu F$ ceramic or solid tantalum capacitor if main filter capacitor is more than 4 inches away.
2. **Avoid insertion of regulator into "live" socket** if input voltage is greater than 10V. The output will rise to within 2V of the unregulated input if the ground pin does not make contact, possibly damaging the load. The LM109 may also be damaged if a large output capacitor is charged up, then discharged through the internal clamp zener when the ground pin makes contact.
3. **The output clamp zener** is designed to absorb transients only. It will not clamp the output effectively if a failure occurs in the internal power transistor structure. Zener dynamic impedance is $\approx 4\Omega$. Continuous RMS current into the zener should not exceed 0.5A.
4. **Paralleling of LM109s** for higher output current is not recommended. Current sharing will be almost nonexistent, leading to a current limit mode operation for devices with the highest initial output voltage. The current limit devices may also heat up to the thermal shutdown point ($\approx 175^\circ C$). Long term reliability cannot be guaranteed under these conditions.
5. **Preventing latchoff** for loads connected to negative voltage:

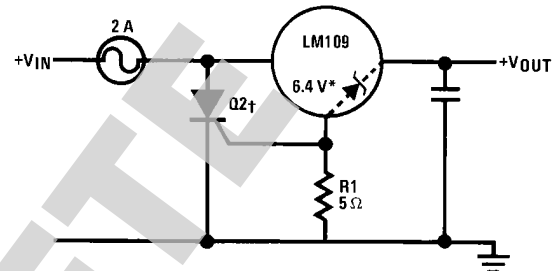
If the output of the LM109 is pulled negative by a high current supply so that the output pin is more than 0.5V negative with respect to the ground pin, the LM109 can latch off. This can be prevented by clamping the ground pin to the output pin with a germanium or Schottky diode as shown. A silicon diode (1N4001) at the output is also needed to keep the positive output from being pulled too far negative. The 10 Ω resistor will raise $+V_{OUT}$ by $\approx 0.05V$.



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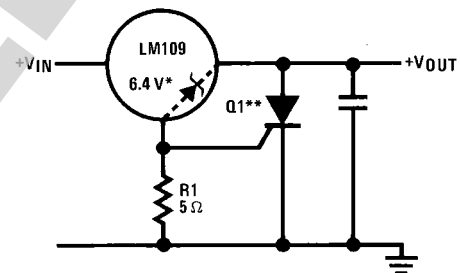
Crowbar Overvoltage Protection

Input Crowbar



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Output Crowbar



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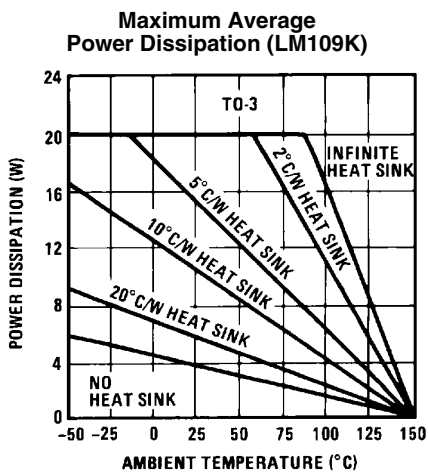
*Zener is internal to LM109.

**Q1 must be able to withstand 7A continuous current if fusing is not used at regulator input. LM109 bond wires will fuse at currents above 7A.

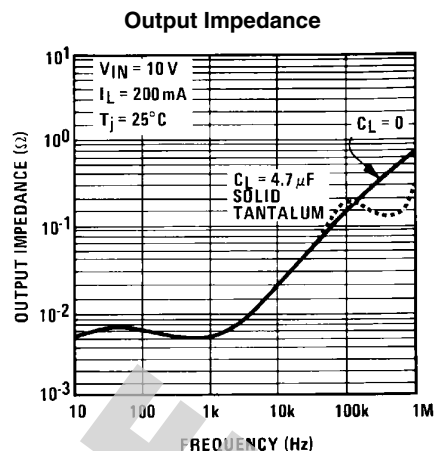
†Q2 is selected for surge capability. Consideration must be given to filter capacitor size, transformer impedance, and fuse blowing time.

††Trip point is $\approx 7.5V$.

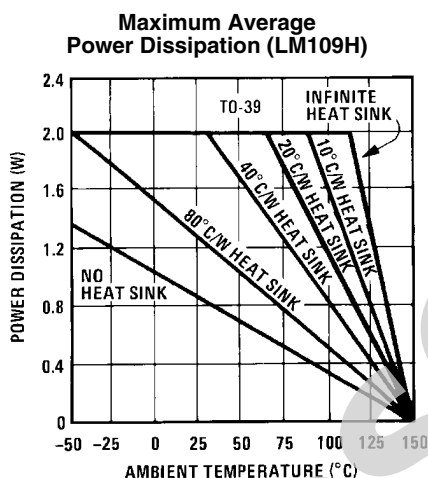
Typical Performance Characteristics



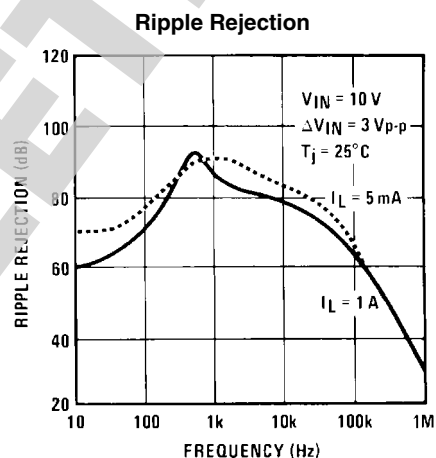
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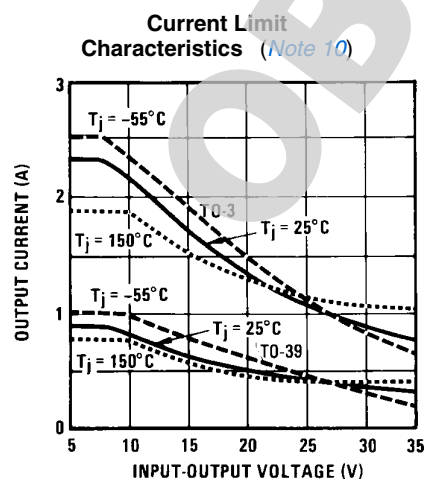
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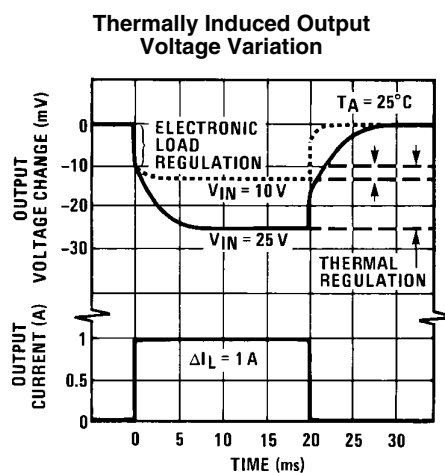
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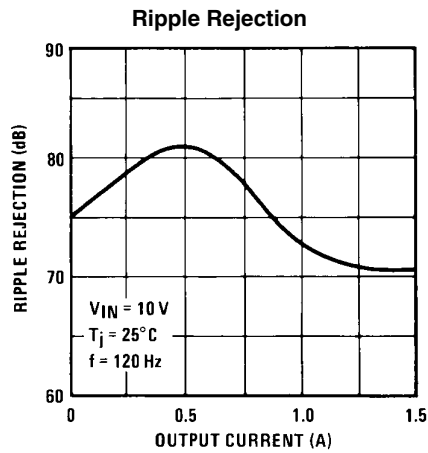
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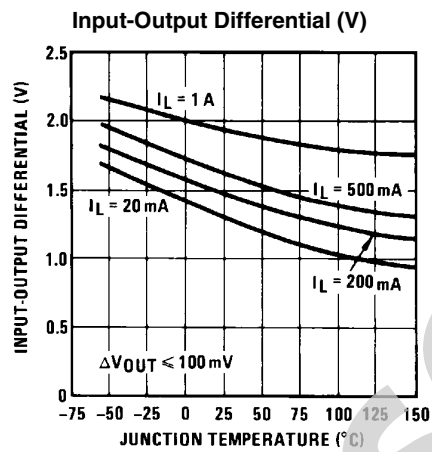


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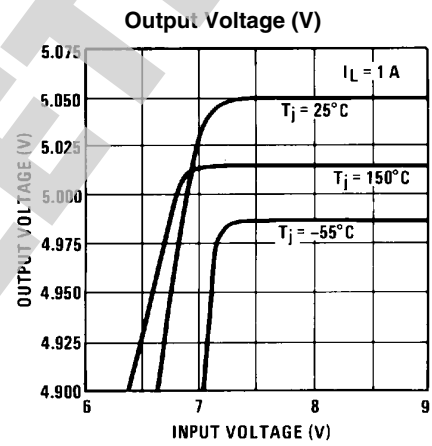


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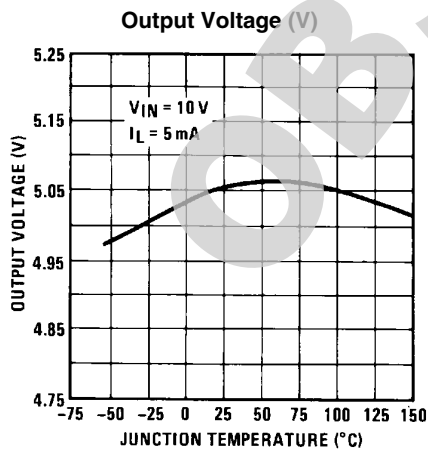
Note 10: Current limiting foldback characteristics are determined by input output differential, not by output voltage.



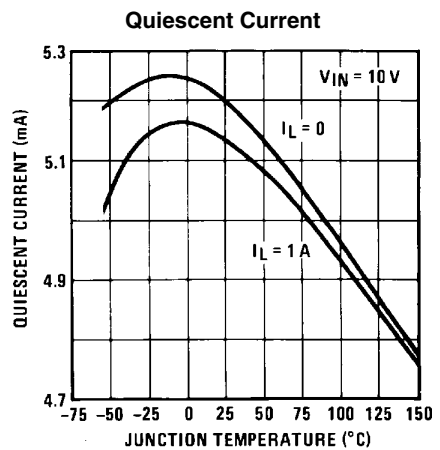
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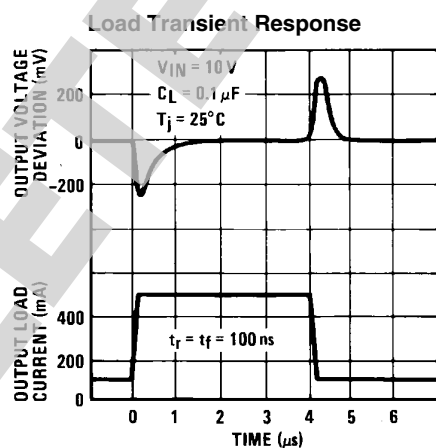
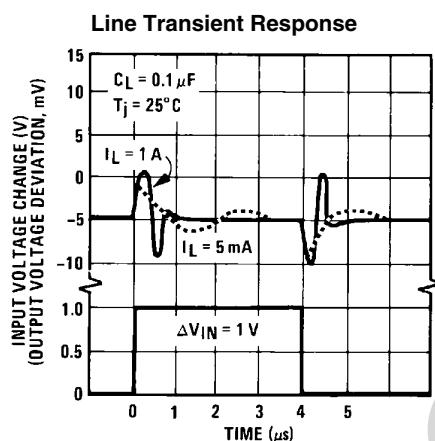
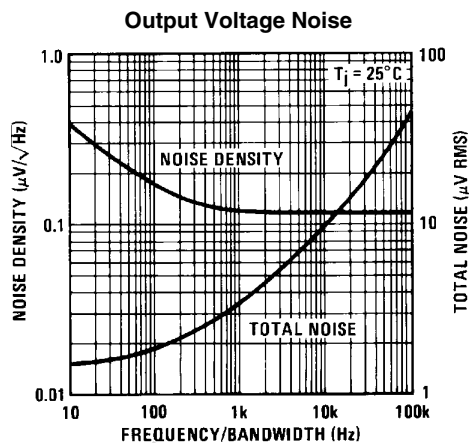
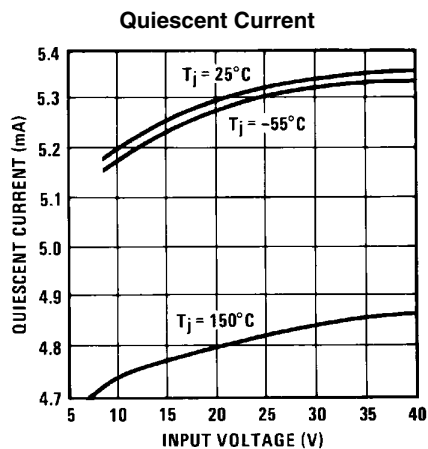
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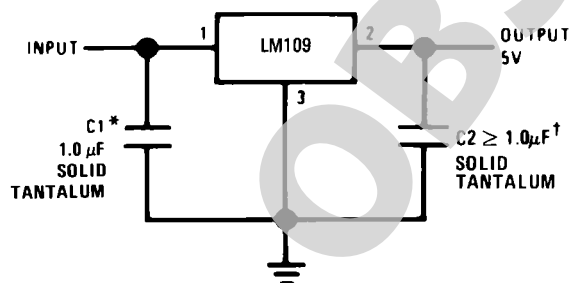


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Typical Applications

Fixed 5V Regulator



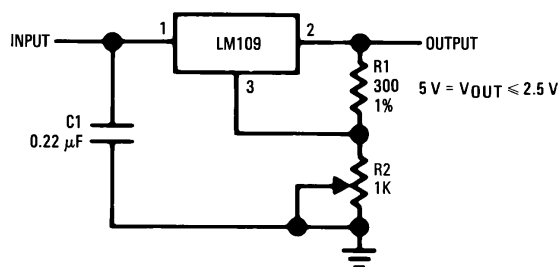
*Required if regulator is located more than 4" from power supply filter capacitor.

†Although no output capacitor is needed for stability, it does improve transient response.

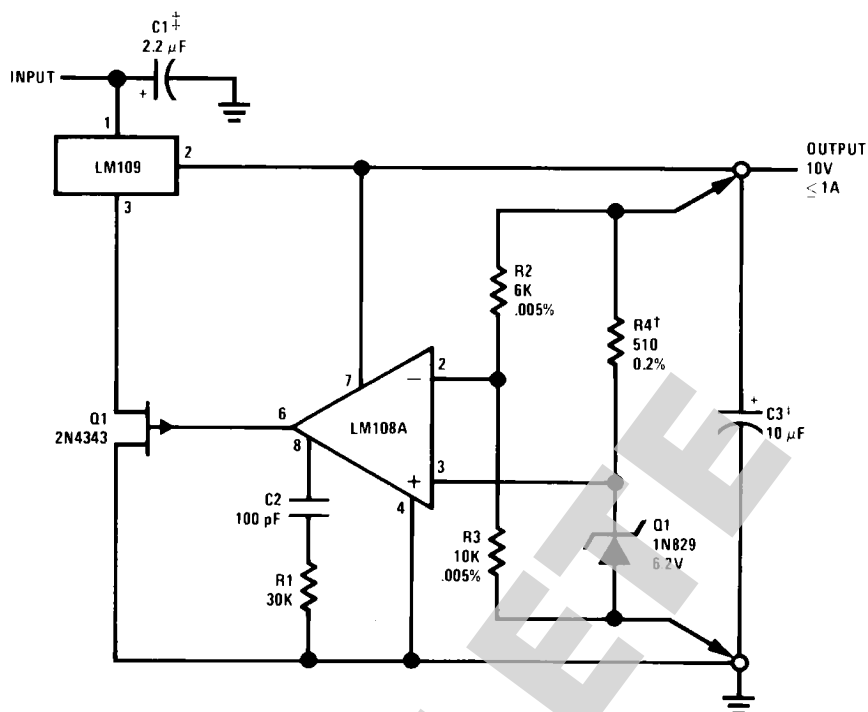
C2 should be used whenever long wires are used to connect to the load, or when transient response is critical.

Note: Pin 3 electrically connected to case.

Adjustable Output Regulator



High Stability Regulator*



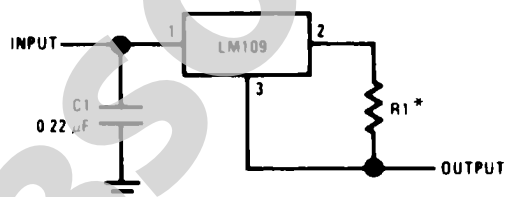
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*Regulation better than 0.01%, load, line and temperature, can be obtained.

†Determines zener current. May be adjusted to minimize thermal drift.

‡Solid tantalum.

Current Regulator



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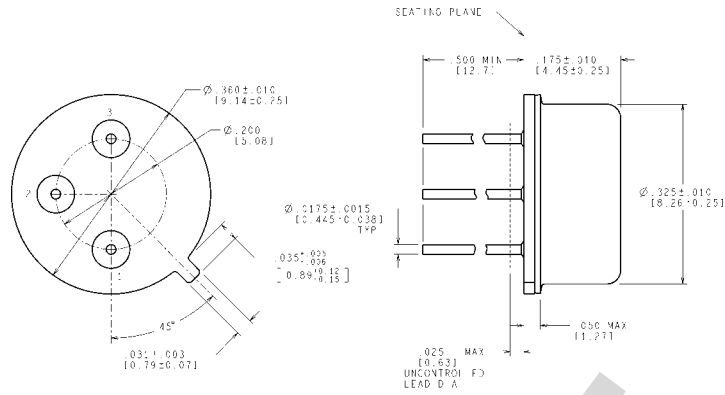
*Determines output current. If wirewound resistor is used, bypass with 0.1 μF.

Revision History

Date Released	Revision	Section	Changes
11/08/05	A	New release to corporate format	2 MDS datasheets converted into one datasheet in the corporate format. MJLM109-K Rev 0BL & MJLM109-H Rev 0AL will be archived.
9/24/10	B	End Of Life on Product/NSID	Revision B, End of Life on Product/NSID Dec. 2008/09 Obsolete Data Sheet

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Physical Dimensions inches (millimeters) unless otherwise noted

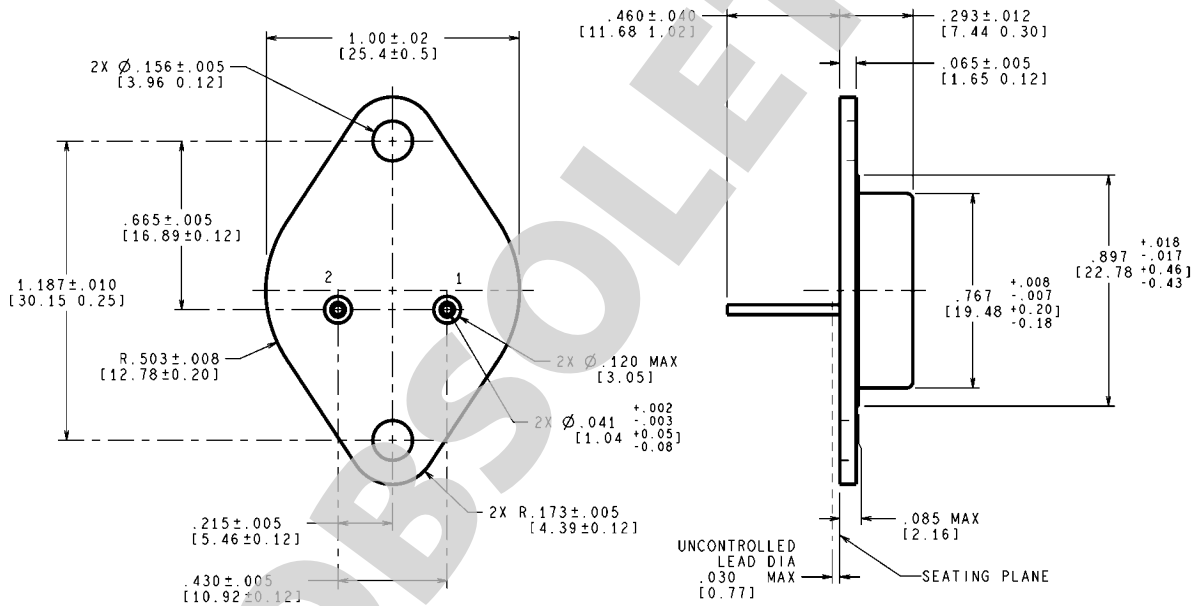


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VALUES IN [] ARE MILLIMETERS

MIL-PRF-38535
CONFIGURATION CONTROL

H03A (Rev D)

Metal Can Package (H) NS Package Number H03A



CONTROLLING DIMENSION IS INCH
VALUES IN [] ARE MILLIMETERS

MIL-PRF-38535
CONFIGURATION CONTROL

K02C (Rev E)

Metal Can Package (K) NS Package Number K02C

Notes

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Notes

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Data Converters	www.national.com/adc	Samples	www.national.com/samples
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Switching Regulators	www.national.com/switchers	Distributors	www.national.com/contacts
LDOs	www.national.com/ldo	Quality and Reliability	www.national.com/quality
LED Lighting	www.national.com/led	Feedback/Support	www.national.com/feedback
Voltage References	www.national.com/vref	Design Made Easy	www.national.com/easy
PowerWise® Solutions	www.national.com/powerwise	Applications & Markets	www.national.com/solutions
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