LM109JAN 5-Volt Regulator

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**

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 association with single-point regulation. The devices are available in two standard transistor packages. In the solid-kovar TO header, it can deliver output currents in excess of 200 mA, if adequate heat sinking is provided. With the TO 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.

Connection Diagrams

Metal Can Packages

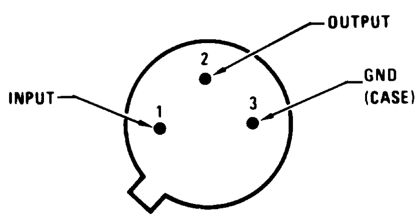


Figure 1. See Package Number NDT0003A
Bottom View

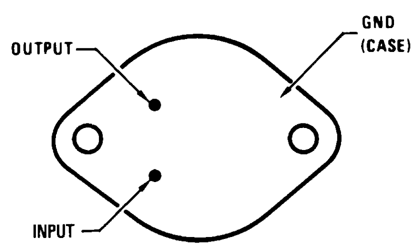
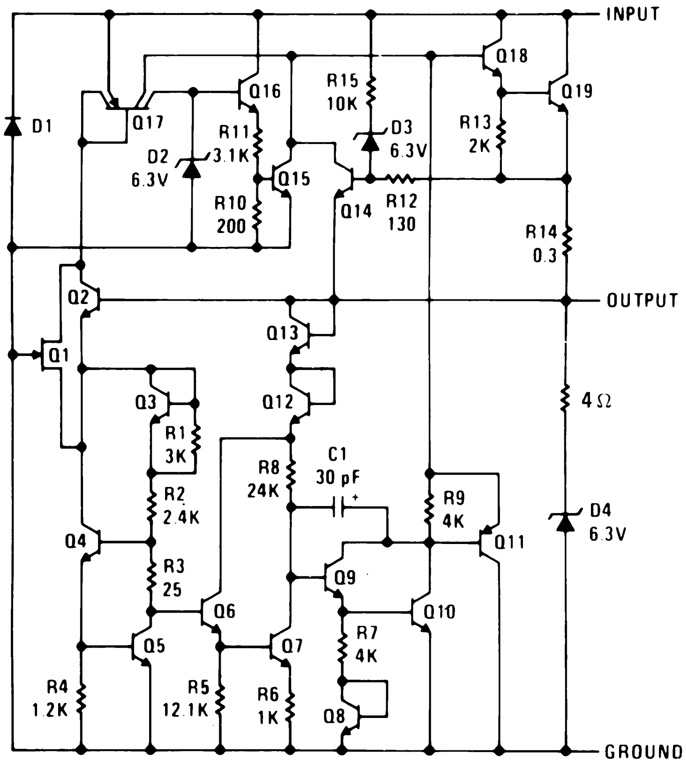


Figure 2. See Package Number K0002C
Bottom View

Schematic Diagram



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Absolute Maximum Ratings [1]

Input Voltage		35V
Power Dissipation		Internally Limited
Operating Ambient Temperature Range		−55°C ≤ TA ≤ +150°C
Storage Temperature Range		−65°C ≤ TA ≤ +150°C
Maximum Junction Temperature		150°C
Thermal Resistance		
θ_{JA}	NDT0003A-Pkg (Still Air)	190°C/W
	NDT0003A-Pkg (500LF/Min Air flow)	69°C/W
	K0002C-Pkg (Still Air)	39°C/W
	K0002C-Pkg (500LF/Min Air flow)	TBD
θ_{JC}	NDT0003A-Pkg	25°C/W
	K0002C-Pkg	3°C/W
Lead Temperature (Soldering, 10 sec.)		300°C
ESD Tolerance [2]		4000V

(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 ensure specific performance limits. For ensured specifications and test conditions, see the Electrical Characteristics. The ensured specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.
(2) Human body model, 1.5kΩ in series with 100pF.

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	(1)	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 ≤ V_I ≤ 25V, I_L = -5mA		-50	50	mV	1
				-100	100	mV	2, 3
V_{RLoad}	Load Regulation	V_I = 10V, -0.5A ≤ I_L ≤ -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 ≤ V_I ≤ 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 ≤ I_L ≤ -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 = 25Ω ±5%			(2)(3) 9.0	V	1, 2, 3
ΔV_O / ΔT	Average Temperature Coefficient of Output Voltage	V_I = 7V, I_L = -5mA	(4)	-2.0	2.0	mV/°C	8A, 8B

(1) V_I = 8V at −55°C.
(2) This test is performed by shifting the input voltage in 50mV increments until output reaches 4.706V.
(3) Parameter tested go-no-go, only.
(4) Calculated parameter.

JL109H Electrical Characteristics 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
ΔV_O / ΔV_I	Line Transient Response	V_I = 10V, V_{Pulse} = 3V, I_L = -5mA	(1)		45	mV	7
ΔV_O / ΔI_L	Load Transient Response	V_I = 10V, I_L = -50mA, ΔI_L = -200mA	(2)		400	mV	7
ΔV_I / ΔV_O	Ripple Rejection	V_I = 10V, I_L = -125mA, e_I = 1V_{RMS} at f = 2400Hz		60		dB	4

(1) Slash Sheet limit of 15 mV/V is equivalent to 45mV
(2) Slash Sheet limit of 2mV/mA is equivalent to 400mV

JL109H Electrical Characteristics 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 ≤ V_I ≤ 25V, I_L = -5mA		-10	10	mV	1
V_{RLoad}	Load Regulation	V_I = 10V, -0.5A ≤ I_L ≤ -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

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	(1)	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 ≤ V_I ≤ 25V, I_L = -5mA		-50	50	mV	1
				-100	100	mV	2, 3
V_{RLoad}	Load Regulation	V_I = 10V, -1.5A ≤ I_L ≤ -5mA		-100	100	mV	1, 2, 3
I_{SCD}	Standby Current Drain	7V ≤ V_I ≤ 25V, I_L = -5mA		-10	0.5	mA	1, 2, 3
ΔI_{SCD} (Line)	Standby Current Drain vs Line Voltage	7V ≤ V_I ≤ 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 ≤ I_L ≤ -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 = 5Ω ±5%	(2)(3)		9.0	V	1, 2, 3
ΔV_O / ΔT	Average Temperature Coefficient of Output Voltage	V_I = 7V, I_L = -5mA	(4)	-2.0	2.0	mV/°C	8A, 8B

(1) V_I = 8V at −55°C.
(2) This test is performed by shifting the input voltage in 50mV increments until output reaches 4.706V.
(3) Parameter tested go-no-go, only.
(4) Calculated parameter.

JL109K Electrical Characteristics 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	(1)		45	mV	7
$\Delta V_O / \Delta I_L$	Load Transient Response	V_I = 10V, I_L = -100mA, ΔI_L = -400mA	(2)		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

(1) Slash Sheet limit of 15 mV/V is equivalent to 45mV
(2) Slash Sheet limit of 2mV/mA is equivalent to 800mV

JL109K Electrical Characteristics DC Drift Parameters

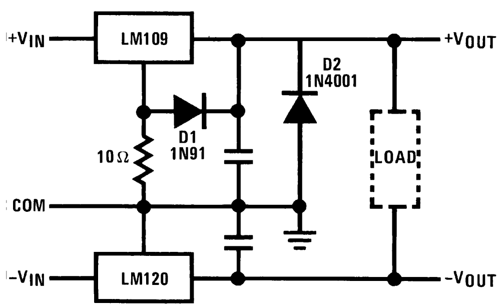
Delta calculations performed on JAN S devices at group B, Subgroup 5, only.

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 ≤ V_I ≤ 25V, I_L = -5mA		-10	10	mV	1
V_{RLoad}	Load Regulation	V_I = 10V, -1.5A ≤ I_L ≤ -5mA		-10	10	mV	1
I_{SCD}	Standby Current Drain	7V ≤ V_I ≤ 25V, I_L = -5mA		-1.0	1.0	mA	1

Application Hints

1. **Bypass the input** of the LM109 to ground with ≥ 0.2 μF 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 ≈ 4Ω. 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 (≈ 175°C). Long term reliability cannot be ensured 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 10Ω resistor will raise $+V_{OUT}$ by ≈ 0.05V.



Crowbar Overvoltage Protection

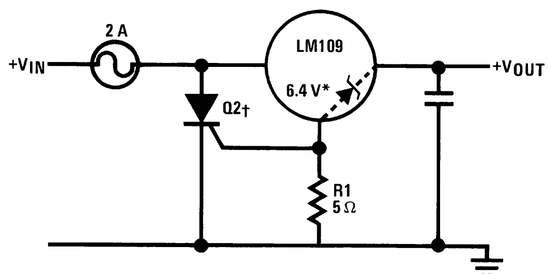
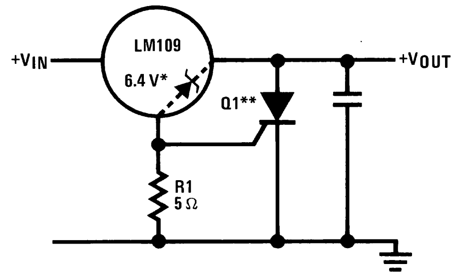


Figure 3. Input Crowbar



*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 ≈ 7.5V.

Figure 4. Output Crowbar

Typical Performance Characteristics

Maximum Average Power Dissipation (LM109K)

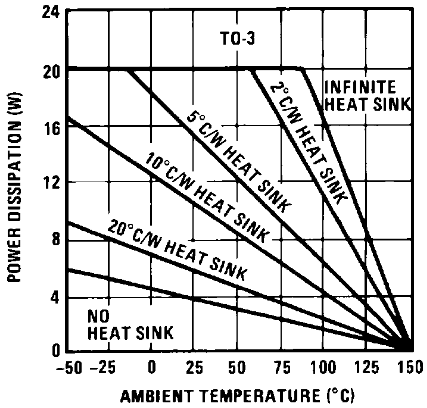


Figure 5.

Output Impedance

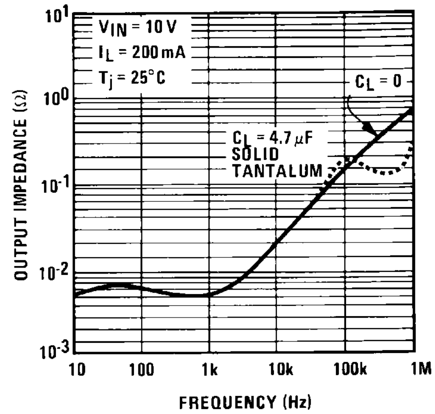


Figure 6.

Maximum Average Power Dissipation (LM109H)

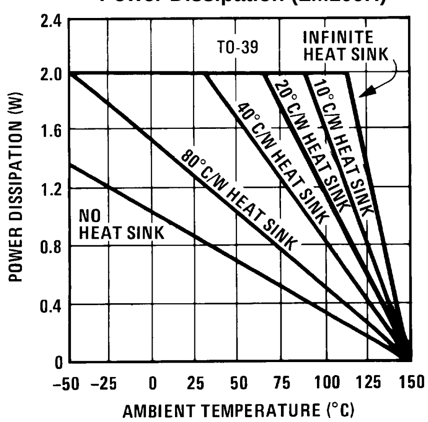


Figure 7.

Ripple Rejection

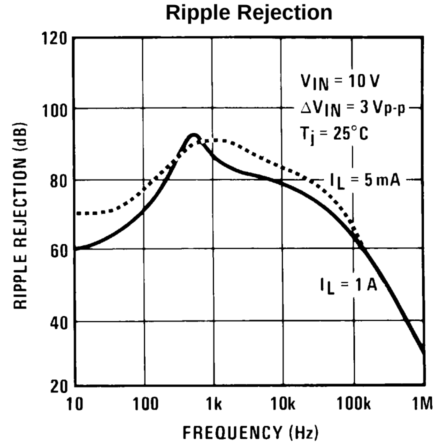
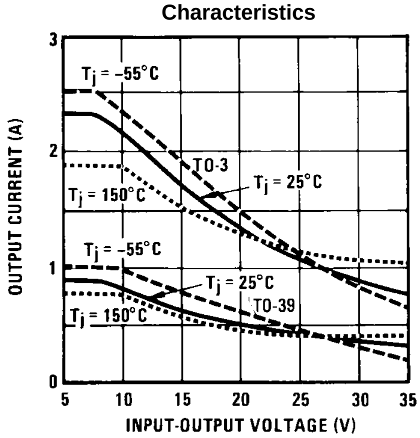


Figure 8.

Current Limit Characteristics



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

Figure 9.

Thermally Induced Output Voltage Variation

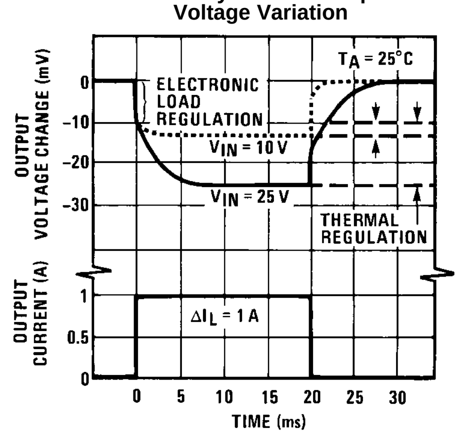


Figure 10.

Typical Performance Characteristics (continued)

Ripple Rejection

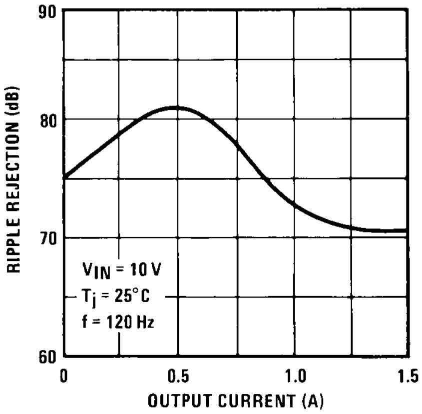


Figure 11.

Input-Output Differential (V)

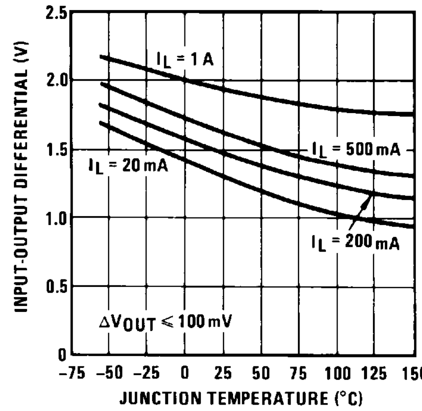


Figure 12.

Output Voltage (V)

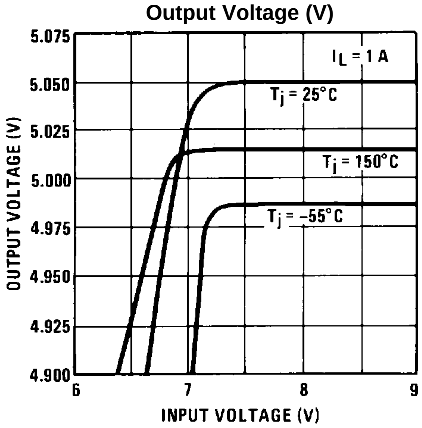


Figure 13.

Output Voltage (V)

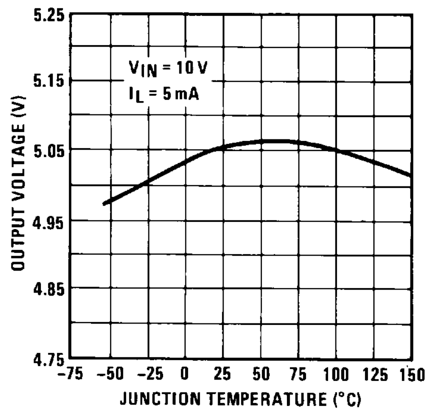


Figure 14.

Quiescent Current

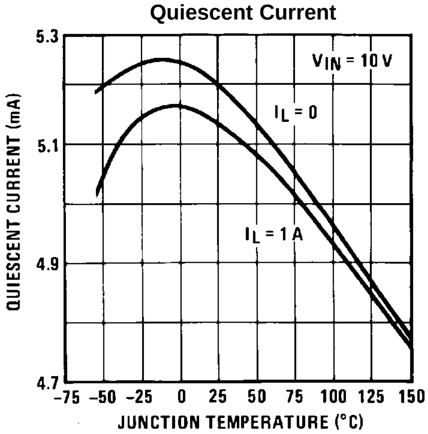


Figure 15.

Quiescent Current

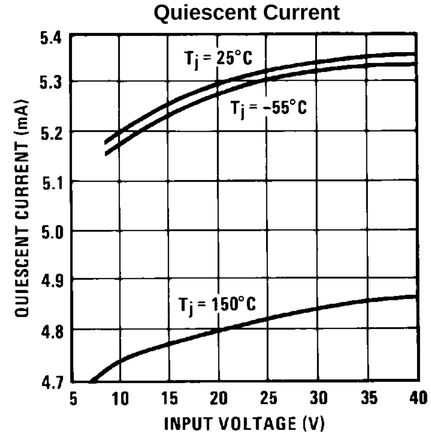


Figure 16.

Typical Performance Characteristics (continued)

Output Voltage Noise

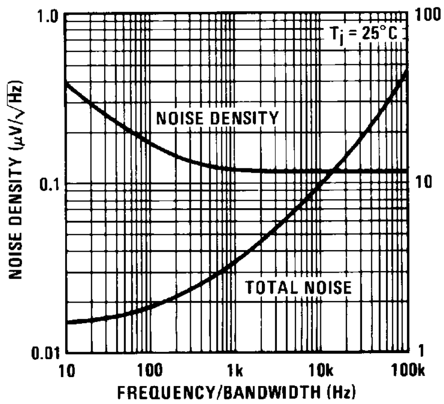


Figure 17.

Line Transient Response

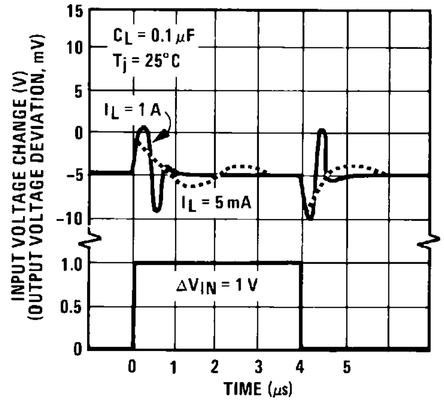


Figure 18.

Load Transient Response

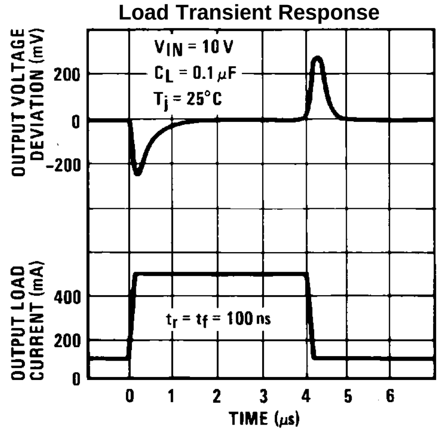
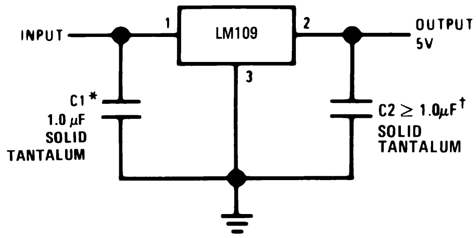


Figure 19.

TYPICAL APPLICATIONS



*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.

Figure 20. Fixed 5V Regulator

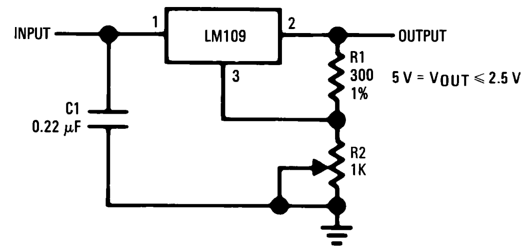
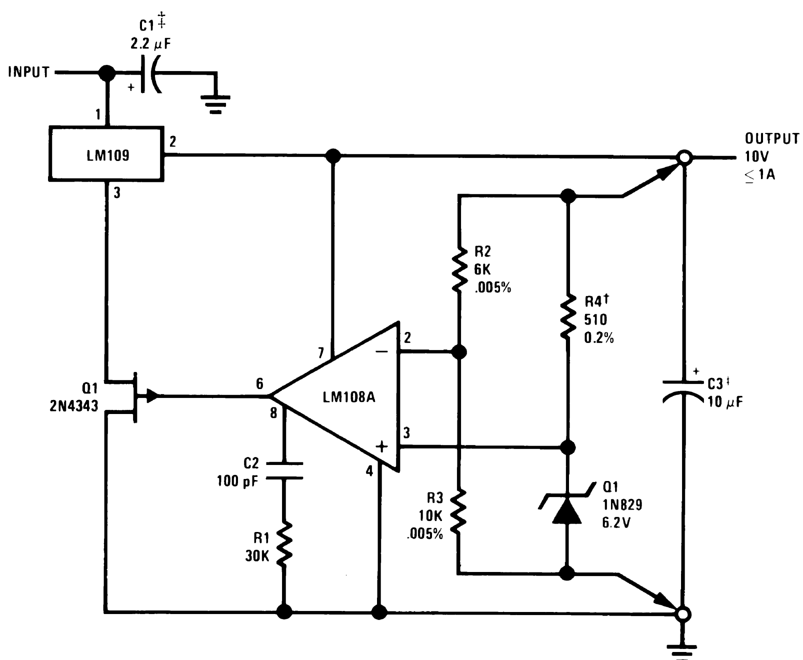


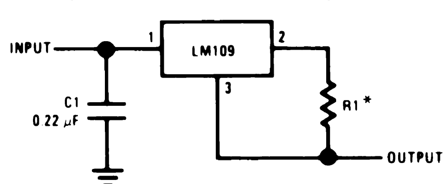
Figure 21. Adjustable Output Regulator



*Regulation better than 0.01%, load, line and temperature, can be obtained.
†Determines zener current. May be adjusted to minimize thermal drift.
‡Solid tantalum.

Figure 22. High Stability Regulator*

Figure 23. Current Regulator



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

Table 1. 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
3/21/2013	B	All Sections	Changed layout of National Data Sheet to TI format

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