LM109QML 5-Volt Regulator

Check for Samples: LM109QML

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 PFM 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

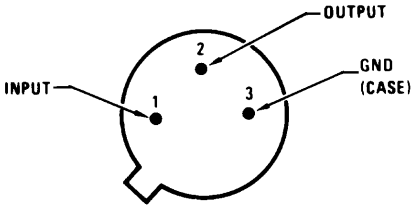


Figure 1. 3-Pin PFM
Bottom View
See NDT003A Package

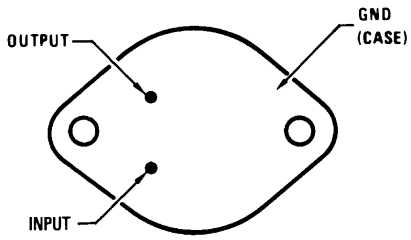
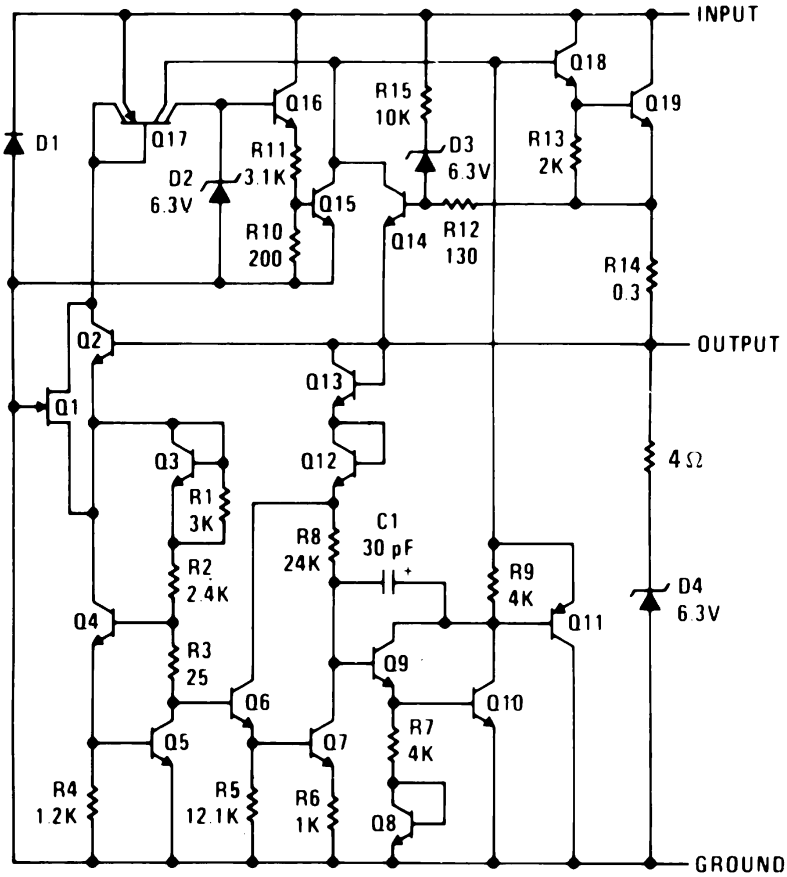


Figure 2. 2-Pin TO
Bottom View
See K Package

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			$-55°C \le T_A \le +150°C$
Storage Temperature Range			$-65°C \le T_A \le +150°C$
Maximum Junction Temperature			150°C
Thermal Resistance	θ_{JA}	PFM-Pkg (Still Air)	190°C/W
		PFM-Pkg (500LF/Min Air flow)	69°C/W
		TO-Pkg (Still Air)	39°C/W
		TO-Pkg (500LF/Min Air flow)	TBD
	θ_{JC}	PFM-Pkg	25°C/W
		TO-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 100_PF.

Table 1. 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

LM109H ELECTRICAL CHARACTERISTICS DC/AC PARAMETERS

The following conditions apply to all the following parameters, unless otherwise specified.
AC / DC: I_L = 5mA

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_{Start}	Start Up Input Voltage	$V_O \geq 4.706V$, $R_L = 25\Omega$	(1)		9.0	V	1
I_Q	Quiescent Current	V_I = 7V		-10		mA	1, 2, 3
		V_I = 7.2V, I_L = 500mA	(2)	-10		mA	1, 2, 3
		V_I = 25V		-10		mA	1, 2, 3
		V_I = 25V, I_L = 500mA	(2)	-10		mA	1, 2, 3
		V_I = 35V		-10		mA	1
Δ_{IQ}	Quiescent Current Change	7V ≤ V_I ≤ 25 V		-0.5	0.5	mA	1, 2, 3
		V_I = 7.2V, 5mA ≤ I_L ≤ 500mA	(2)	-0.8	0.8	mA	1, 2, 3
V_{RLine}	Line Regulation	7V ≤ V_I ≤ 25V		-50	50	mV	1
				-100	100	mV	2, 3
V_{RLoad}	Load Regulation	V_I = 7.2V, 5mA ≤ I_L ≤ 500mA		-50	50	mV	1
			(2)	-100	100	mV	2, 3
		V_I = 10V, 5mA ≤ I_L ≤ 500mA		-50	50	mV	1
			(2)	-100	100	mV	2, 3
		V_I = 25V, 20mA ≤ I_L ≤ 500mA		-150	150	mV	1
		V_I = 25V, t_{PW} ≤ 10ms, 500mA ≥ I_L ≥ 20mA,	(2)	-50	50	mV	1
V_O	Output Voltage	V_I = 7V, P_1 ≤ 2W		4.6	5.4	V	1, 2, 3
		V_I = 7.2V, I_L = 500mA, P ≤ 2W	(2)	4.6	5.4	V	1, 2, 3
		V_I = 10V, I_L = 100mA, P ≤ 2W		4.7	5.3	V	1
		V_I = 25V, I_L = 20mA, P ≤ 2W		4.6	5.4	V	1
		V_I = 25V, I_L = 500mA, P ≤ 2W, t_{PW} ≤ 10mS	(2)	4.6	5.4	V	1, 2, 3
		V_I = 25V, P ≤ 2W		4.6	5.4	V	1, 2, 3
I_{OS}	Short Circuit Current	V_I = 35V			2.0	A	1
RR	Ripple Rejection *f*	*f* ≤ 120Hz, $e_I = 1V_{RMS}$, I_L = 125mA		50		dB	4

(1) This test is performed by shifting the input voltage in 50mV increments until output reaches 4.706V.
(2) At −55°C & 125°C, I_L = 200mA rather than 500mA.

LM109K ELECTRICAL CHARACTERISTICS DC/AC PARAMETERS

The following conditions apply to all the following parameters, unless otherwise specified.
AC / DC: I_L = 5mA (1)

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_{Start}	Start Up Input Voltage	$V_O \geq 4.706V$, $R_L = 5\Omega$	(2)		9.0	V	1
I_Q	Quiescent Current	V_I = 7V		-10		mA	1, 2, 3
		V_I = 7.2V, I_L = 1.5A	(3)	-10		mA	1, 2, 3
		V_I = 25V		-10		mA	1, 2, 3
		V_I = 25V, I_L = 1.5A $t_{PW} \leq 10ms$	(3)	-10		mA	1, 2, 3
		V_I = 35V		-10		mA	1
Δ_{IQ}	Quiescent Current Change	$7V \leq V_I \leq 25$ V		-0.5	0.5	mA	1, 2, 3
		V_I = 7.2V, $5mA \leq I_L \leq 1.5A$	(3)	-0.8	0.8	mA	1, 2, 3
V_{RLine}	Line Regulation	$7V \leq V_I \leq 25V$		-50	50	mV	1
				-100	100	mV	2, 3
V_{RLoad}	Load Regulation	V_I = 7.2V, $5mA \leq I_L \leq 1.5A$		-100	100	mV	1
			(3)	-200	200	mV	2, 3
		V_I = 10V, $1.5A \geq I_L \geq 5mA$		-100	100	mV	1
			(3)	-200	200	mV	2, 3
		V_I = 25V, t_{PW} < 10ms, $1A \geq I_L \geq 20mA$,		-50	50	mV	1
V_O	Output Voltage	V_I = 7V, $P_1 \leq 20W$		4.6	5.4	V	1, 2, 3
		V_I = 7.2V, I_L = 1.5A, $P \leq 20W$	(3)	4.6	5.4	V	1, 2, 3
		V_I = 10V, I_L = 500mA, $P \leq 20W$		4.7	5.3	V	1
		V_I = 25V, I_L = 20mA, $P \leq 20W$		4.6	5.4	V	1
		V_I = 25V, I_L = 1A, $P \leq 20W$, $t_{PW} \leq 10mS$		4.6	5.4	V	1, 2, 3
		V_I = 25V, $P \leq 20W$		4.6	5.4	V	1, 2, 3
I_{OS}	Short Circuit Current	V_I = 35V			2.8	A	1
RR	Ripple Rejection	$f \leq 120Hz$, $e_I = 1V_{RMS}$, I_L = 500mA		50		dB	4

(1) Human body model, 1.5kΩ in series with 100pF.
(2) This test is performed by shifting the input voltage in 50mV increments until output reaches 4.706V.
(3) At −55°C & 125°C, I_L = 1A rather than 1.5A.

LM109K ELECTRICAL CHARACTERISTICS DC PARAMETERS

The following conditions apply to all the following parameters, unless otherwise specified.
DC: I_L = 5mA (1)

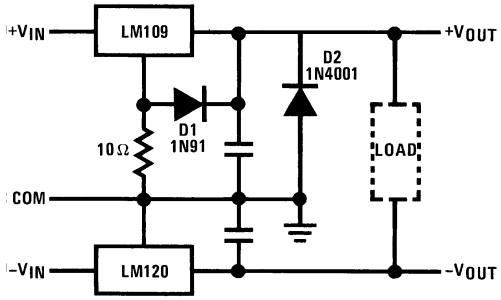
Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_N	Output Noise Voltage	$10Hz \leq f \leq 100KHz$	(2)		200	µV	7
$\Delta V_O / \Delta T$	Long Term Stability		(2)		10	mV	8

(1) Human body model, 1.5kΩ in series with 100pF.
(2) Specified parameter, not tested.

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 specified 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

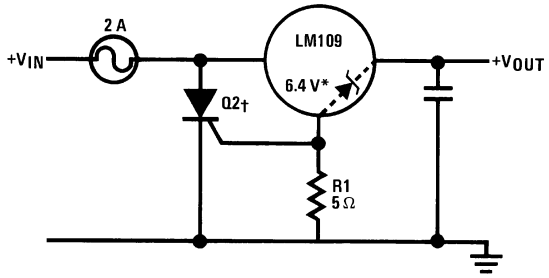
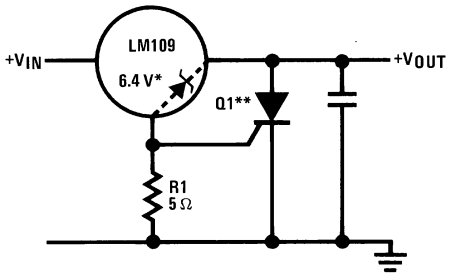


Figure 4. Output Crowbar



*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.

TYPICAL PERFORMANCE CHARACTERISTICS

Maximum Average Power Dissipation (LM109K)

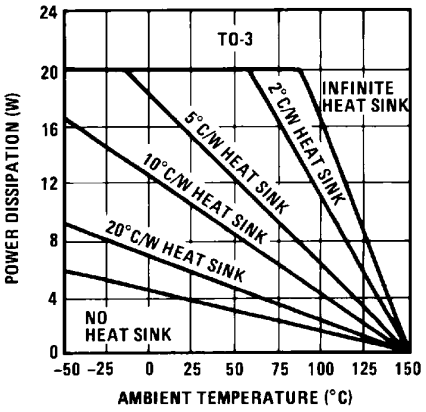


Figure 5.

Output Impedance

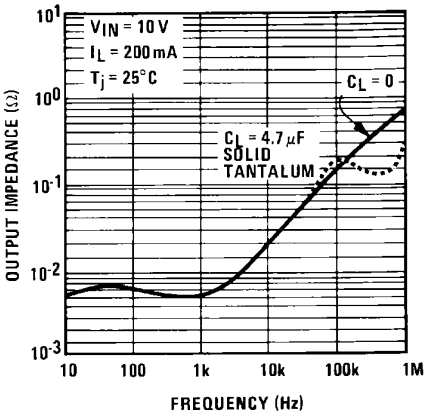


Figure 6.

Maximum Average Power Dissipation (LM109H)

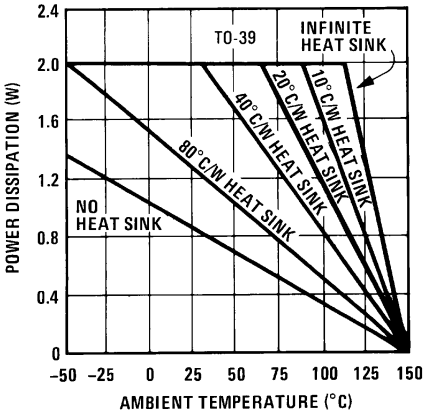


Figure 7.

Ripple Rejection

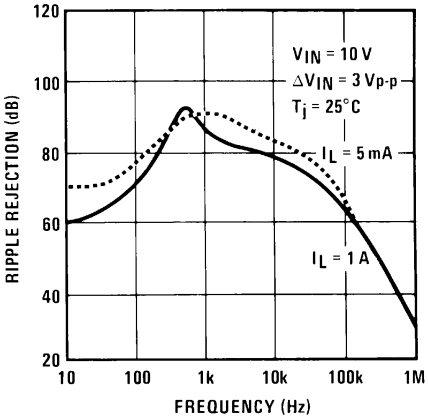
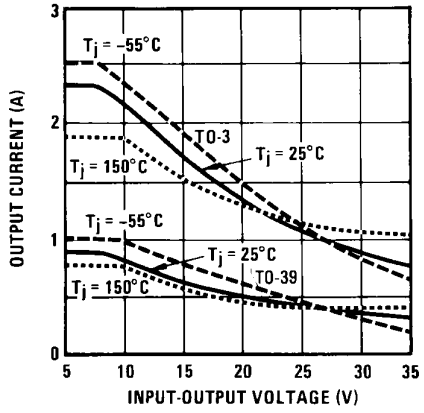


Figure 8.

Current Limit
Characteristics docato-extra-info-title Current limiting foldback characteristics are determined by input output differential, not by output voltage.



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

Figure 9.

Thermally Induced Output Voltage Variation

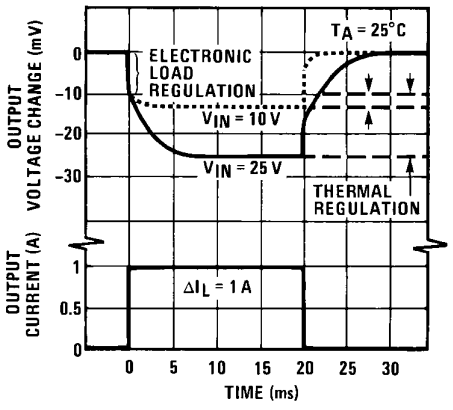


Figure 10.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Ripple Rejection

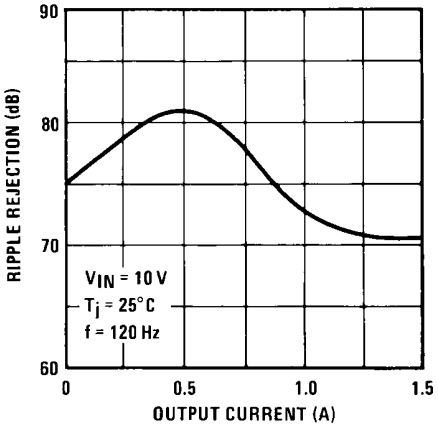


Figure 11.

Input-Output Differential (V)

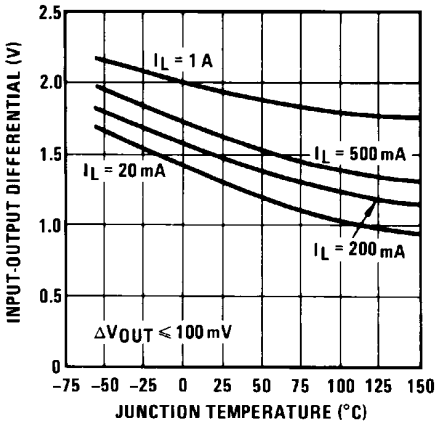


Figure 12.

Output Voltage (V)

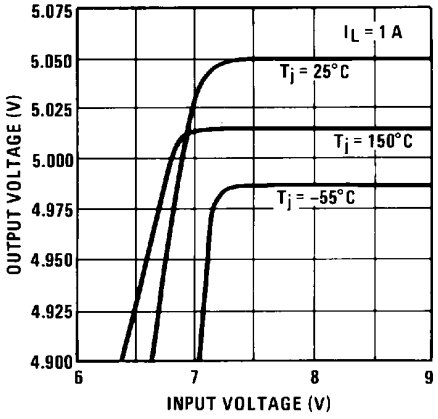


Figure 13.

Output Voltage (V)

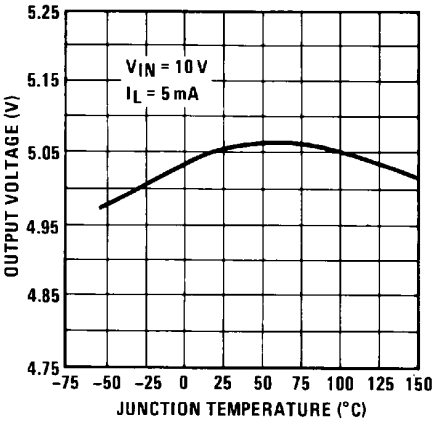


Figure 14.

Quiescent Current

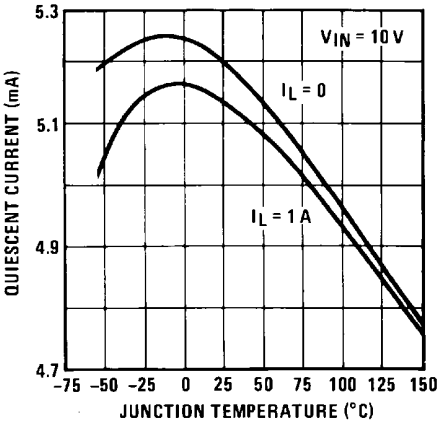


Figure 15.

Quiescent Current

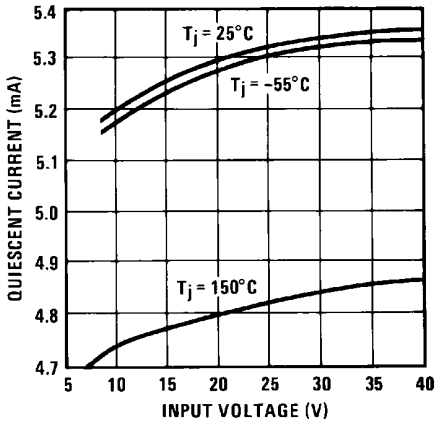


Figure 16.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Output Voltage Noise

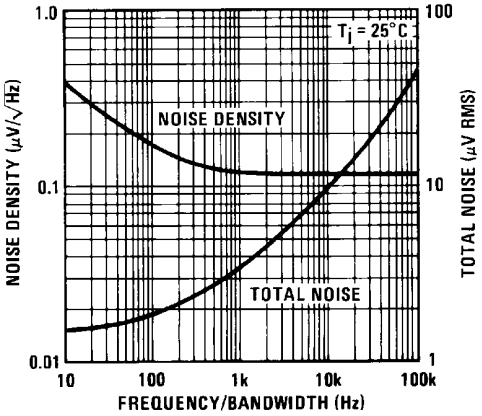


Figure 17.

Line Transient Response

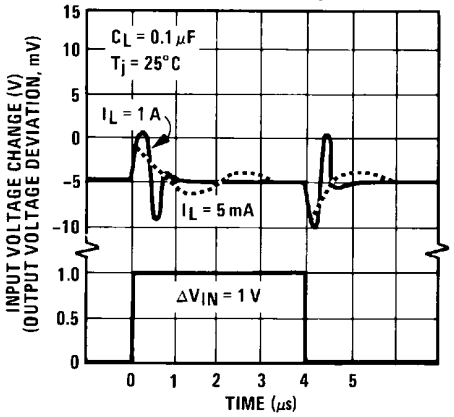


Figure 18.

Load Transient Response

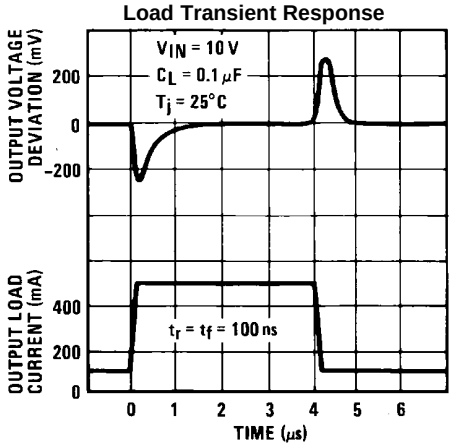
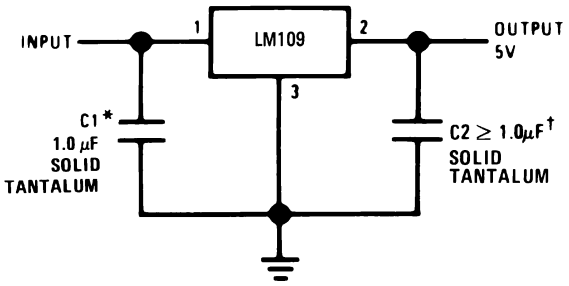


Figure 19.

TYPICAL APPLICATIONS

Figure 20. 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.

Figure 21. Adjustable Output Regulator

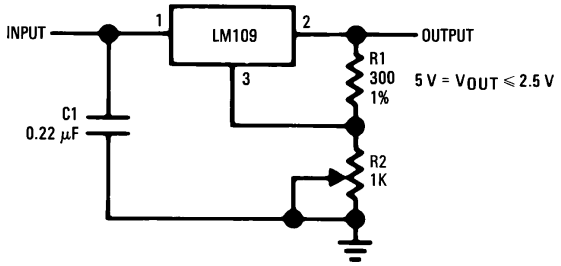
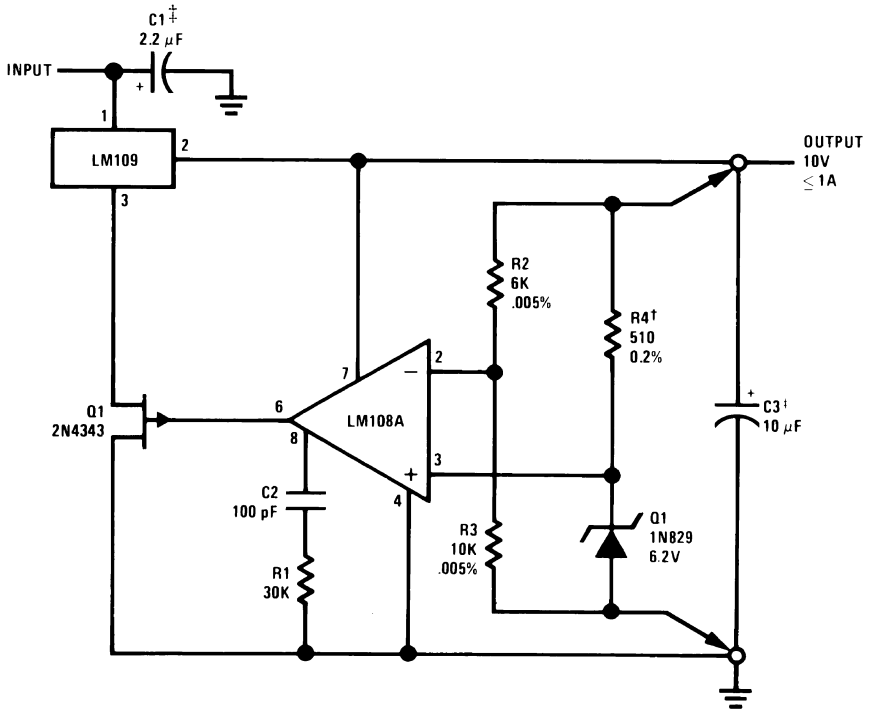
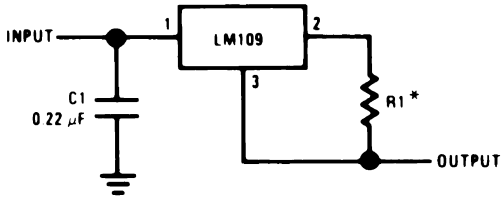


Figure 22. High Stability Regulator*



*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 23. Current Regulator



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

REVISION HISTORY

Date Released	Revision	Section	Originator	Changes
11/08/05	A	New release to corporate format	L. Lytle	2 MDS datasheets converted into one datasheet in the corporate format. Deleted note 5 & corrected V_{RLoad} of LM109K to ≥ . MNLM109-K Rev 0AL & MNLM109-H Rev 0AL will be archived.
4/22/2013	A	All		Changed layout of National Data Sheet to TI format.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
LM109H/883	ACTIVE	TO	NDT	3	20	TBD	Call TI	Call TI	-55 to 150	LM109H/883 Q ACO LM109H/883 Q >T	Samples
LM109K/883	ACTIVE	TO	K	2	50	TBD	Call TI	Call TI	-55 to 150	LM109K /883 Q ACO /883 Q >T	Samples

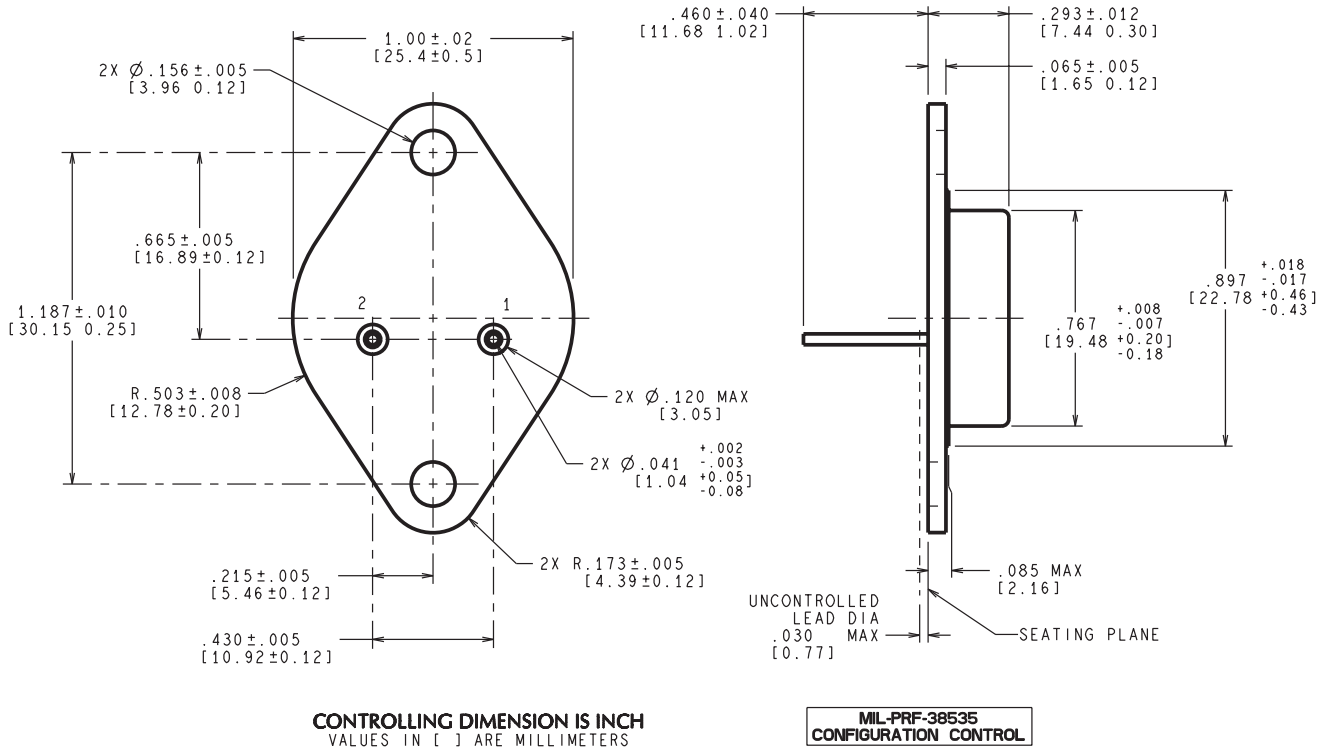
(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

K0002C



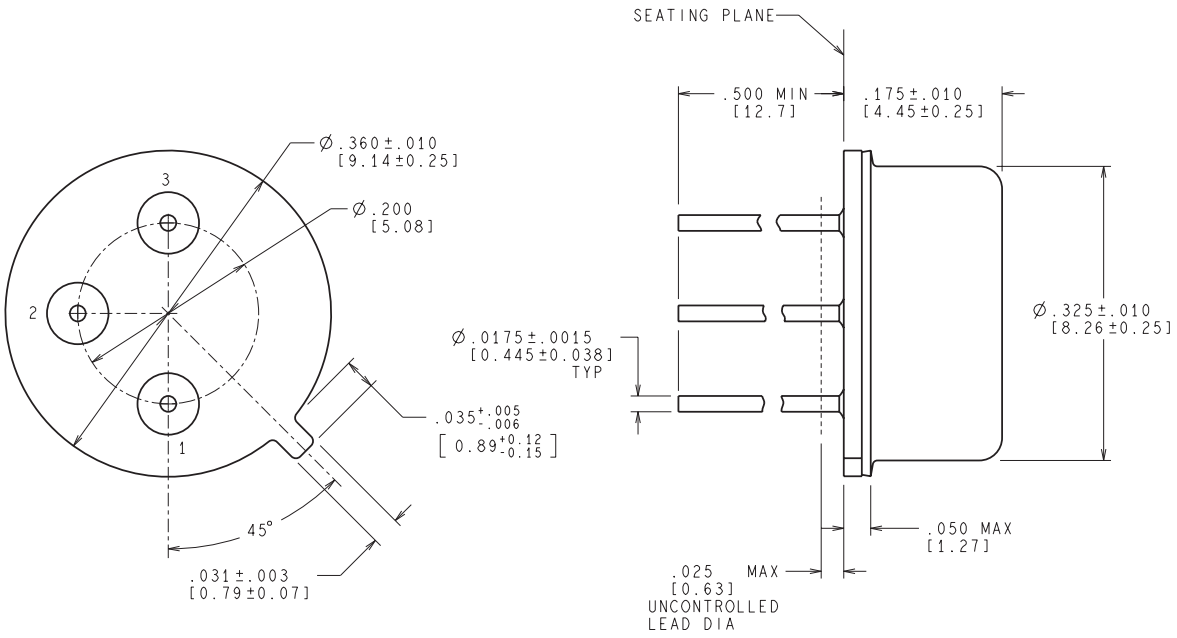
NOTES:

1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.

2. This drawing is subject to change without notice.

3. Leads not to be bent greater than 15º

NDT0003A



CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE MILLIMETERS

MIL-PRF-38535
CONFIGURATION CONTROL

H03A (Rev D)

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265