MOTOROLA

# L4949

*Advanced Information*

# Multifunction Very Low Dropout Voltage Regulator

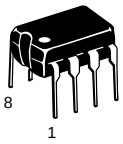
The L4949 is a monolithic integrated 5.0 V voltage regulator with a very low dropout and additional functions such as power–on reset and input voltage sense.

It is designed for supplying the micro–computer controlled systems especially in automotive applications.

- Operating DC Supply Voltage Range 5.0 V to 28 V
- Transient Supply Voltage Up to 40 V
- Extremely Low Quiescent Current in Standby Mode
- High Precision Standby Output Voltage 5.0 V ±1%
- Output Current Capability Up to 100 mA
- Very Low Dropout Voltage Less Than 0.4 V
- Reset Circuit Sensing The Output Voltage
- Programmable Reset Pulse Delay With External Capacitor
- Voltage Sense Comparator
- Thermal Shutdown and Short Circuit Protections

**MULTIFUNCTION VERY LOW DROPOUT VOLTAGE REGULATOR**

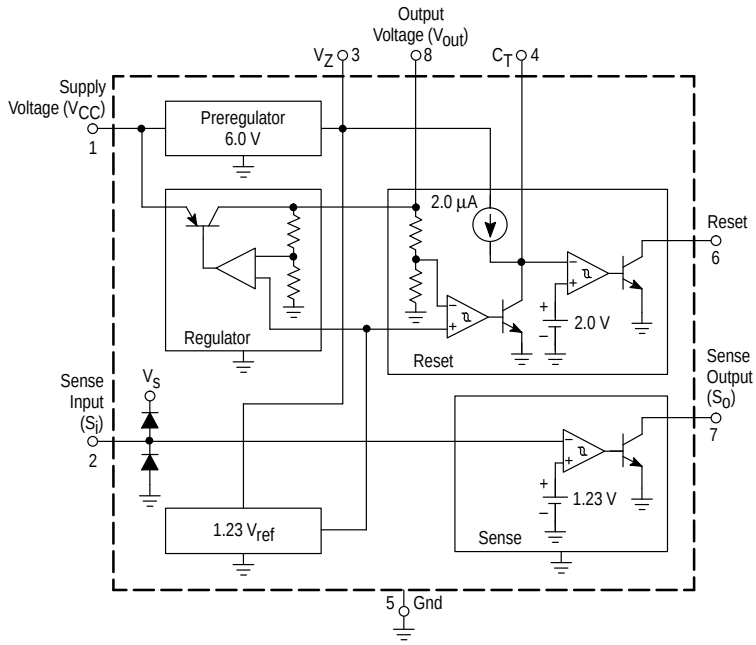
**SILICON MONOLITHIC INTEGRATED CIRCUIT**



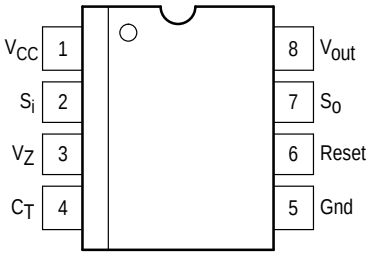

**N SUFFIX**
PLASTIC PACKAGE
CASE 626


**D SUFFIX**
PLASTIC PACKAGE
CASE 751

**Representative Block Diagram**




**PIN CONNECTIONS**




(Top View)

**ORDERING INFORMATION**

| Device | Operating Temperature Range | Package |
|---|---|---|
| L4949N | $T_J$ = –40° to +125°C | DIP–8 |
| L4949D | | SO–8 |

This document contains information on a new product. Specifications and information herein are subject to change without notice.

**ABSOLUTE MAXIMUM RATINGS** (Absolute Maximum Ratings indicate limits beyond which damage to the device may occur.)

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| DC Operating Supply Voltage | $V_{CC}$ | 28 | V |
| Transient Supply Voltage (t < 1.0 s) | $V_{CC\ TR}$ | 40 | V |
| Output Current | $I_{out}$ | Internally Limited | – |
| Output Voltage | $V_{out}$ | 20 | V |
| Sense Input Current | $I_{SI}$ | ±1.0 | mA |
| Sense Input Voltage | $V_{SI}$ | $V_{CC}$ | – |
| Output Voltages<br>Reset Output<br>Sense Output | <br>$V_{Reset}$<br>$V_{SO}$ | <br>20<br>20 | V |
| Output Currents<br>Reset Output<br>Sense Output | <br>$I_{Reset}$<br>$I_{SO}$ | <br>5.0<br>5.0 | mA |
| Preregulator Output Voltage | $V_Z$ | 7.0 | V |
| Preregulator Output Current | $I_Z$ | 5.0 | mA |
| ESD Protection at any pin<br>Human Body Model<br>Machine Model | <br>–<br>– | <br>2000<br>400 | V |
| Thermal Resistance, Junction–to–Air<br>P Suffix, DIP–8 Plastic Package, Case 626<br>D Suffix, SO–8 Plastic Package, Case 751 | $R_{\theta JA}$ | <br>100<br>200 | °C/W |
| Maximim Junction Temperature | $T_J$ | 150 | °C |
| Storage Temperature Range | $T_{stg}$ | –65 to +150 | °C |

**NOTE:** ESD data available upon request.

**ELECTRICAL CHARACTERISTICS** ($V_{CC}$ = 14 V, –40°C < $T_J$ < 125°C, unless otherwise specified.)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Output Voltage ($T_J$ = 25°C, $I_{out}$ = 1.0 mA) | $V_{out}$ | 4.95 | 5.0 | 5.05 | V |
| Output Voltage (6.0 V < $V_{CC}$ < 28 V, 1.0 mA < $I_{out}$ < 50 mA) | $V_{out}$ | 4.9 | 5.0 | 5.1 | V |
| Output Voltage ($V_{CC}$ = 35 V, t < 1.0 s, 1.0 mA < $I_{out}$ < 50 mA) | $V_{out}$ | 4.9 | 5.0 | 5.1 | V |
| Dropout Voltage<br>$I_{out}$ = 10 mA<br>$I_{out}$ = 50 mA<br>$I_{out}$ = 100 mA | $V_{drop}$ | <br>–<br>–<br>– | <br>0.1<br>0.2<br>0.3 | <br>0.25<br>0.40<br>0.50 | V |
| Input to Output Voltage Difference in Undervoltage Condition ($V_{CC}$ = 4.0 V, $I_{out}$ = 35 mA) | $V_{IO}$ | – | 0.2 | 0.4 | V |
| Line Regulation (6.0 V < $V_{CC}$ < 28 V, $I_{out}$ = 1.0 mA) | $Reg_{line}$ | – | 1.0 | 20 | mV |
| Load Regulation (1.0 mA < $I_{out}$ < 100 mA) | $Reg_{load}$ | – | 8.0 | 30 | mV |
| Current Limit<br>$V_{out}$ = 4.5 V<br>$V_{out}$ = 0 V | $I_{Lim}$ | <br>105<br>– | <br>200<br>100 | <br>400<br>– | mA |
| Quiescent Current ($I_{out}$ = 0.3 mA, $T_J$ < 100°C) | $I_{QSE}$ | – | 150 | 260 | µA |
| Quiescent Current ($I_{out}$ = 100 mA) | $I_Q$ | – | – | 5.0 | mA |

**ELECTRICAL CHARACTERISTICS (continued)** ($V_{CC}$ = 14 V, –40°C < $T_J$ < 125°C, unless otherwise specified.)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **RESET** | | | | | |
| Reset Threshold Voltage | $V_{Resth}$ | – | $V_{out}$ – 0.5 | – | V |
| Reset Threshold Hysteresis<br>@ $T_J$ = 25°C<br>@ $T_J$ = –40 to +125°C | $V_{Resth,hys}$ | <br>50<br>50 | <br>100<br>– | <br>200<br>300 | mV |
| Reset Pulse Delay ($C_T$ = 100 nF, $t_R \geq$ 100 µs) | $t_{ResD}$ | 55 | 100 | 180 | ms |
| Reset Reaction Time ($C_T$ = 100 nF) | $t_{ResR}$ | – | 5.0 | 30 | µs |
| Reset Output Low Voltage ($R_{Reset}$ = 10 kΩ to $V_{out}$, $V_{CC} \geq$ 3.0 V) | $V_{ResL}$ | – | – | 0.4 | V |
| Reset Output High Leakage Current ($V_{Reset}$ = 5.0 V) | $I_{ResH}$ | – | – | 1.0 | µA |
| Delay Comparator Threshold | $V_{CTth}$ | – | 2.0 | – | V |
| Delay Comparator Threshold Hysteresis | $V_{CTth, hys}$ | – | 100 | – | mV |
| **SENSE** | | | | | |
| Sense Low Threshold ($V_{SI}$ Decreasing = 1.5 V to 1.0 V) | $V_{SOth}$ | 1.16 | 1.23 | 1.35 | V |
| Sense Threshold Hysteresis | $V_{SOth,hys}$ | 20 | 100 | 200 | mV |
| Sense Output Low Voltage<br>($V_{SI} \leq$ 1.16 V, $V_{CC} \geq$ 3.0 V, $R_{SO}$ = 10 kΩ to $V_{out}$) | $V_{SOL}$ | – | – | 0.4 | V |
| Sense Output Leakage ($V_{SO}$ = 5.0 V, $V_{SI} \geq$ 1.5 V) | $I_{SOH}$ | – | – | 1.0 | µA |
| Sense Input Current | $I_{SI}$ | –1.0 | 0.1 | 1.0 | µA |
| **PREREGULATOR** | | | | | |
| Preregulator Output Voltage ($I_Z$ = 10 µA) | $V_Z$ | – | 6.3 | – | V |

## PIN FUNCTION DESCRIPTION

| Pin | Symbol | Description |
|---|---|---|
| 1 | $V_{CC}$ | Supply Voltage |
| 2 | $S_i$ | Input of Sense Comparator |
| 3 | $V_Z$ | Output of Preregulator |
| 4 | $C_T$ | Reset Delay Capacitor |
| 5 | Gnd | Ground |
| 6 | Reset | Output of Reset Comparator |
| 7 | $S_O$ | Output of Sense Comparator |
| 8 | $V_{out}$ | Main Regulator Output |

## TYPICAL CHARACTERIZATION CURVES

**Figure 1. Output Voltage versus Junction Temperature**

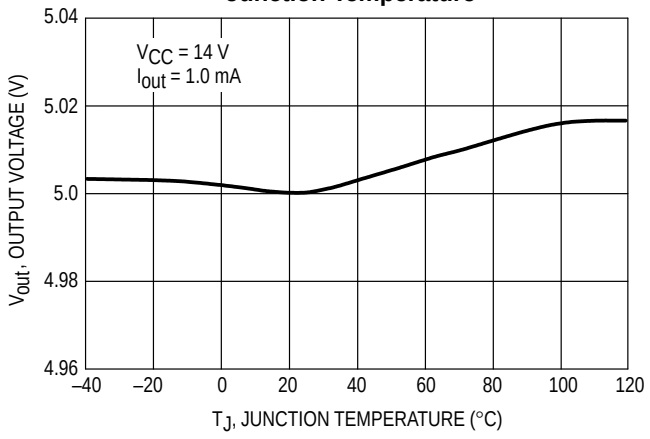
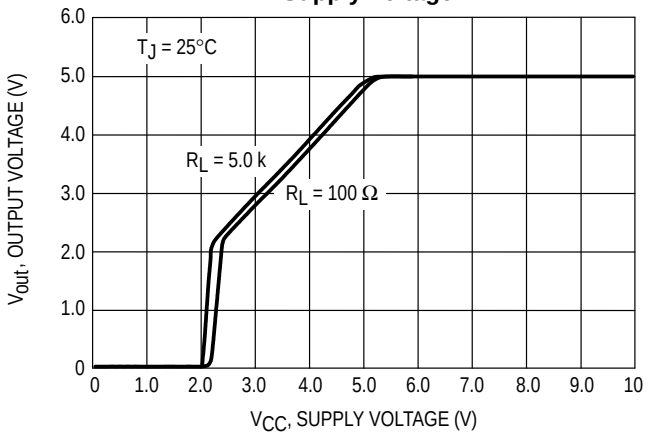



**Figure 2. Output Voltage versus Supply Voltage**



## TYPICAL CHARACTERIZATION CURVES (continued)

**Figure 3. Dropout Voltage versus Output Current**

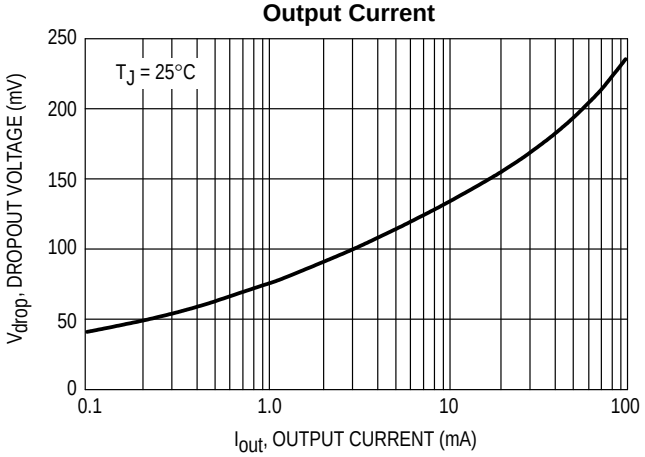



**Figure 4. Dropout Voltage versus Junction Temperature**

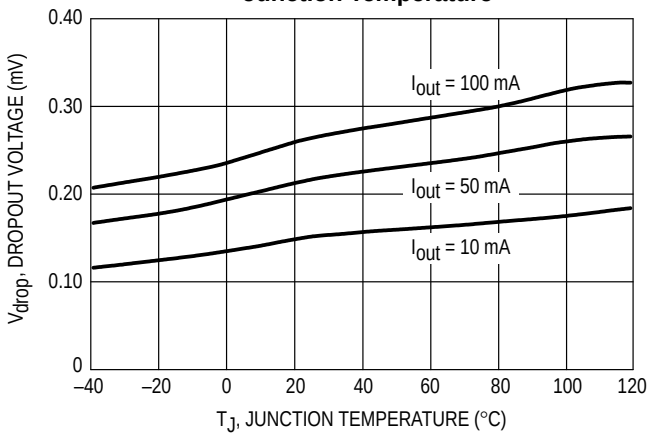



**Figure 5. Quiescent Current versus Output Current**

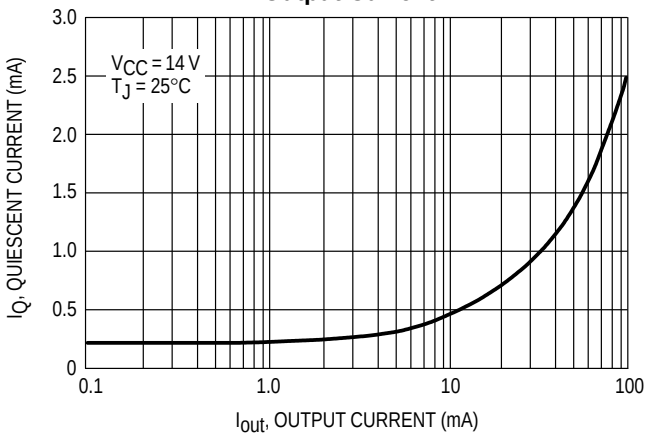



**Figure 6. Quiescent Current versus Supply Voltage**

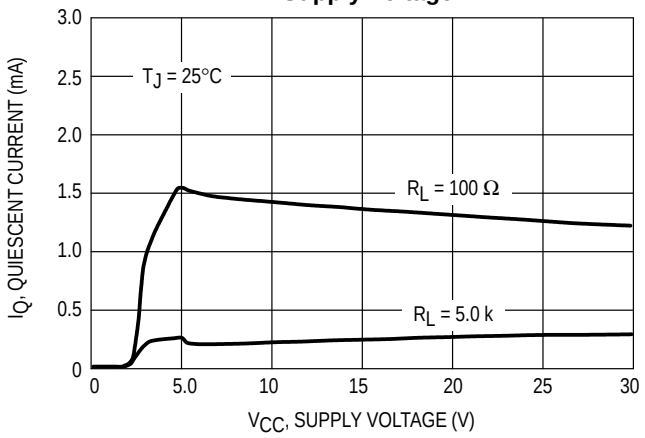



**Figure 7. Reset Output versus Regulator Output Voltage**

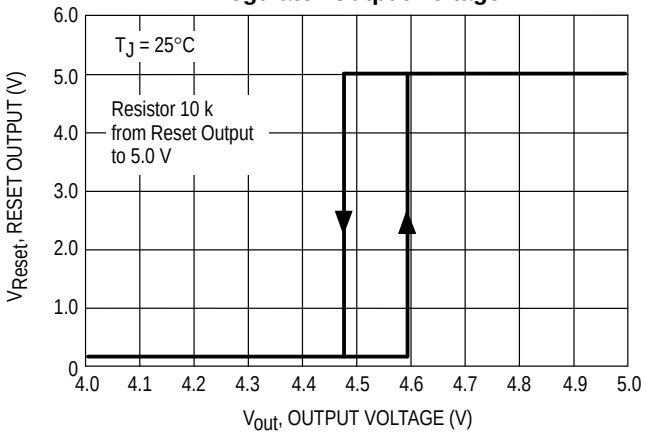
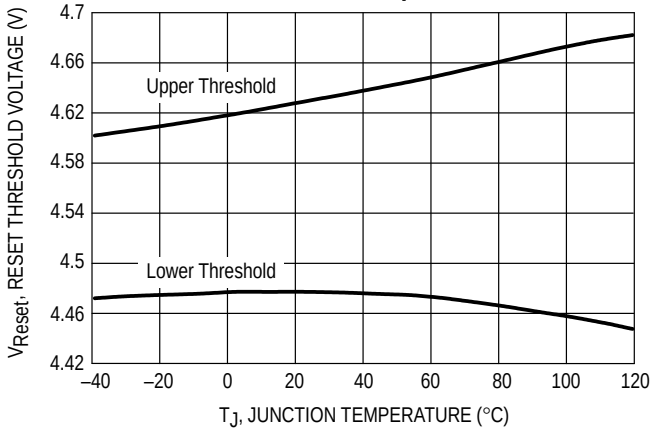



**Figure 8. Reset Thresholds versus Junction Temperature**



## TYPICAL CHARACTERIZATION CURVES (continued)

**Figure 9. Sense Output versus Sense Input Voltage**

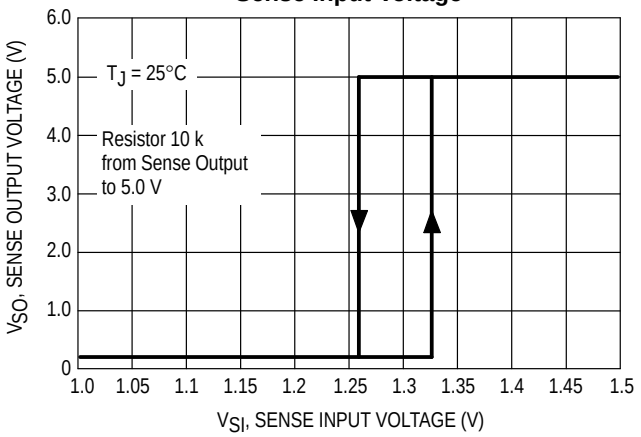
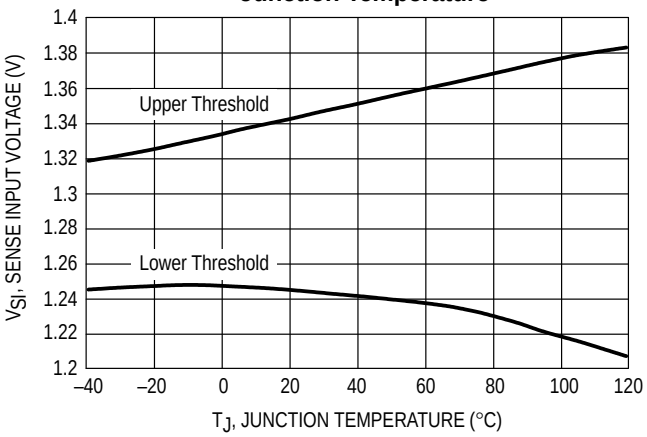



**Figure 10. Sense Thresholds versus Junction Temperature**

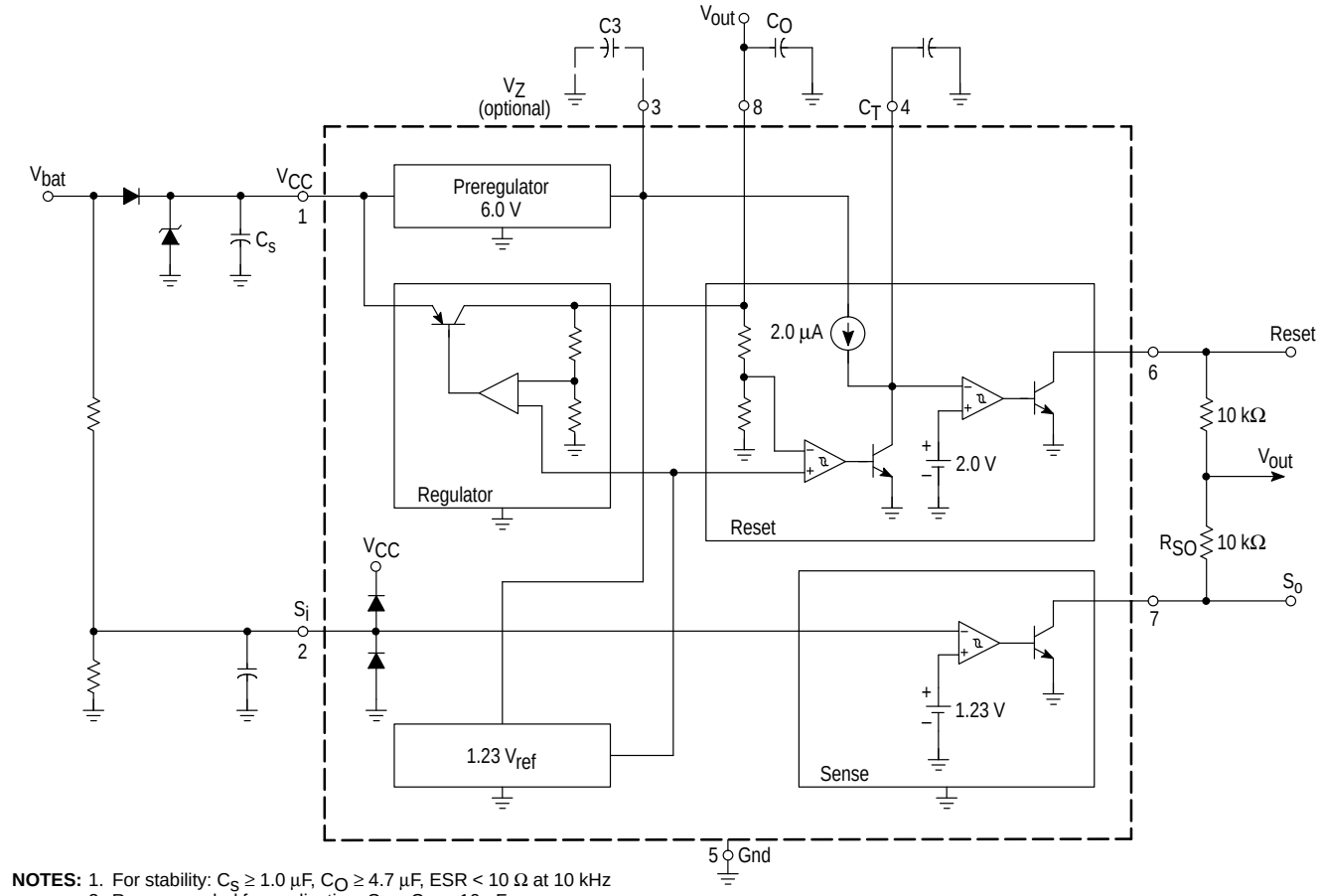



## APPLICATION INFORMATION

### Supply Voltage Transient

High supply voltage transients can cause a reset output signal perturbation. For supply voltages greater than 8.0 V the circuit shows a high immunity of the reset output against supply transients of more than 100 V/µs. For supply voltages less than 8.0 V supply transients of more than 0.4 V/µs can cause a reset signal perturbation. To improve the transient behavior for supply voltages less than 8.0 V a capacitor at Pin 3 can be used. A capacitor at Pin 3 (C3 ≤ 1.0 µF) reduces also the output noise.

**Figure 11. Application Schematic**




**NOTES:** 1. For stability: $C_S \geq 1.0\ \mu F$, $C_O \geq 4.7\ \mu F$, ESR < 10 Ω at 10 kHz
2. Recommended for application: $C_S = C_O = 10\ \mu F$

## OPERATING DESCRIPTION

The L4949 is a monolithic integrated low dropout voltage regulator. Several outstanding features and auxiliary functions are implemented to meet the requirements of supplying microprocessor systems in automotive applications. Nevertheless, it is suitable also in other applications where the present functions are required. The modular approach of this device allows the use of other features and functions independently when required.

### Voltage Regulator

The voltage regulator uses an isolated Collector Vertical PNP transistor as a regulating element. With this structure, very low dropout voltage at currents up to 100 mA is obtained. The dropout operation of the standby regulator is maintained down to 3.0 V input supply voltage. The output voltage is regulated up to the transient input supply voltage of 35 V. With this feature no functional interruption due to overvoltage pulses is generated.

The typical curve showing the standby output voltage as a function of the input supply voltage is shown in Figure 13.

The current consumption of the device (quiescent current) is less than 200 μA.

To reduce the quiescent current peak in the undervoltage region and to improve the transient response in this region, the dropout voltage is controlled. The quiescent current as a function of the supply input voltage is shown in Figure 14.

*Short Circuit Protection:*

The maximum output current is internally limited. In case of short circuit, the output current is foldback current limited as described in Figure 12.

**Figure 12. Foldback Characteristic of $V_{out}$**

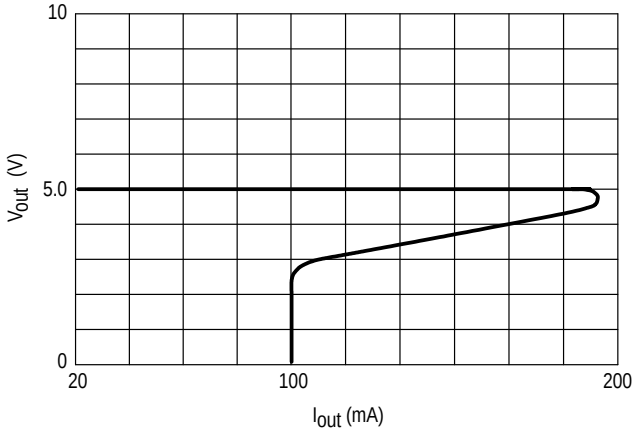



**Figure 13. Output Voltage versus Supply Voltage**

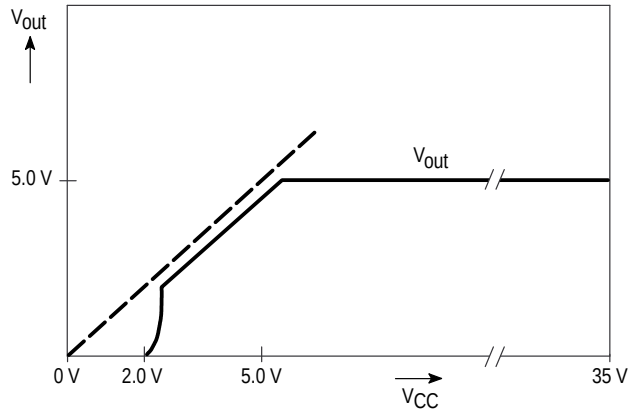
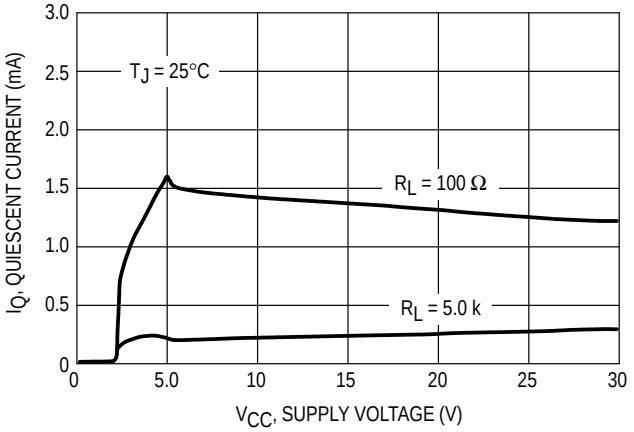



**Figure 14. Quiescent Current versus Supply Voltage**




### Preregulator

To improve the transient immunity a preregulator stabilizes the internal supply voltage to 6.0 V. This internal voltage is present at Pin 3 ($V_Z$). This voltage should not be used as an output because the output capability is very small (≤ 100 μA).

This output may be used as an option when better transient behavior for supply voltages less than 8.0 V is required. In this case a capacitor (100 nF – 1.0 μF) must be connected between Pin 3 and Gnd. If this feature is not used Pin 3 must be left open.

**Reset Circuit**

The block circuit diagram of the reset circuit is shown in Figure 15.

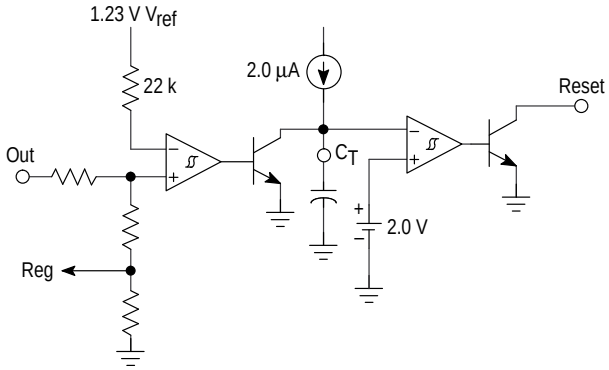
The reset circuit supervises the output voltage. The reset thereshold of 4.5 V is defined with the internal reference voltage and standby output drivider.

The reset pulse delay time $t_{RD}$, is defined with the charge time of an external capacitor $C_T$:

$$t_{RD} = \frac{C_T \text{ x } 2.0 \text{ V}}{2.0\ \mu\text{A}}$$

The reaction time of the reset circuit originates from the discharge time limitation of the reset capacitor $C_T$ and is proportional to the value of $C_T$. The reaction time of the reset circuit increases the noise immunity.

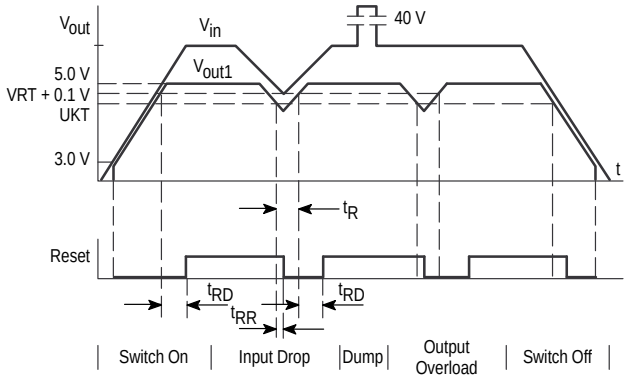
**Figure 15. Reset Circuit**




Standby output voltage drops below the reset threshold only a bit longer than the reaction time results in a shorter reset delay time.

The nominal reset delay time will be generated for standby output voltage drops longer than approximately 50 µs. The typical reset output waveforms are shown in Figure 16.

**Figure 16. Typical Reset Output Waveforms**



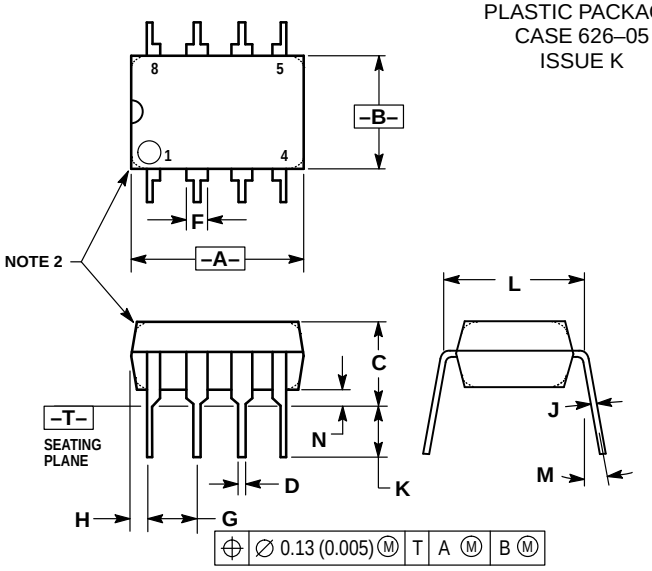

**Sense Comparator**

The sense comparator compares an input signal with an internal voltage reference of typical 1.23 V. The use of an external voltage divider makes this comparator very flexible in the application.

It can be used to supervise the input voltage either before or after the protection diode and to give additional information to the microprocessor like low voltage warnings.

## OUTLINE DIMENSIONS

**N SUFFIX**
PLASTIC PACKAGE
CASE 626–05
ISSUE K

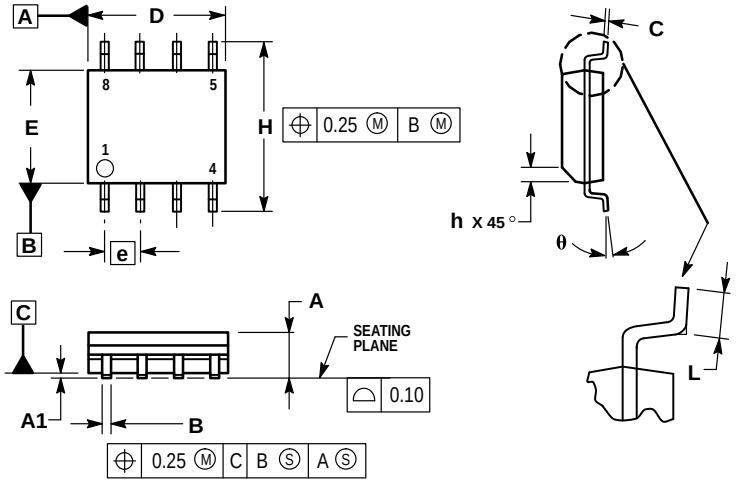



NOTES:
1. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
2. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 9.40 | 10.16 | 0.370 | 0.400 |
| B | 6.10 | 6.60 | 0.240 | 0.260 |
| C | 3.94 | 4.45 | 0.155 | 0.175 |
| D | 0.38 | 0.51 | 0.015 | 0.020 |
| F | 1.02 | 1.78 | 0.040 | 0.070 |
| G | 2.54 BSC | | 0.100 BSC | |
| H | 0.76 | 1.27 | 0.030 | 0.050 |
| J | 0.20 | 0.30 | 0.008 | 0.012 |
| K | 2.92 | 3.43 | 0.115 | 0.135 |
| L | 7.62 BSC | | 0.300 BSC | |
| M | — | 10° | — | 10° |
| N | 0.76 | 1.01 | 0.030 | 0.040 |

STYLE 1:
PIN 1. AC IN
2. DC + IN
3. DC – IN
4. AC IN
5. GROUND
6. OUTPUT
7. AUXILIARY
8. $V_{CC}$

**D SUFFIX**
PLASTIC PACKAGE
CASE 751–05
ISSUE S




NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. DIMENSIONS ARE IN MILLIMETERS.
3. DIMENSION D AND E DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
5. DIMENSION B DOES NOT INCLUDE MOLD PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 TOTAL IN EXCESS OF THE B DIMENSION AT MAXIMUM MATERIAL CONDITION.

| | MILLIMETERS | |
|---|---|---|
| DIM | MIN | MAX |
| A | 1.35 | 1.75 |
| A1 | 0.10 | 0.25 |
| B | 0.35 | 0.49 |
| C | 0.18 | 0.25 |
| D | 4.80 | 5.00 |
| E | 3.80 | 4.00 |
| e | 1.27 BSC | |
| H | 5.80 | 6.20 |
| h | 0.25 | 0.50 |
| L | 0.40 | 1.25 |
| θ | 0° | 7° |



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**JAPAN**: Nippon Motorola Ltd.: SPD, Strategic Planning Office, 4–32–1,
Nishi–Gotanda, Shinagawa–ku, Tokyo 141, Japan. 81–3–5487–8488

**ASIA / PACIFIC**: Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,
51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852–26629298