

# LP2950, LP2951, NCV2951

## 100 mA, Low Power Low Dropout Voltage Regulator

The LP2950 and LP2951 are micropower voltage regulators that are specifically designed to maintain proper regulation with an extremely low input-to-output voltage differential. These devices feature a very low quiescent bias current of 75  $\mu$ A and are capable of supplying output currents in excess of 100 mA. Internal current and thermal limiting protection is provided.

The LP2951 has three additional features. The first is the  $\overline{\text{Error}}$  Output that can be used to signal external circuitry of an out of regulation condition, or as a microprocessor power-on reset. The second feature allows the output voltage to be preset to 5.0 V, 3.3 V or 3.0 V output (depending on the version) or programmed from 1.25 V to 29 V. It consists of a pinned out resistor divider along with direct access to the Error Amplifier feedback input. The third feature is a Shutdown input that allows a logic level signal to turn-off or turn-on the regulator output.

Due to the low input-to-output voltage differential and bias current specifications, these devices are ideally suited for battery powered computer, consumer, and industrial equipment where an extension of useful battery life is desirable. The LP2950 is available in the three pin case 29 and DPAK packages, and the LP2951 is available in the eight pin dual-in-line, SOIC-8 and Micro8 surface mount packages. The 'A' suffix devices feature an initial output voltage tolerance  $\pm 0.5\%$ .

### Features

- Pb-Free Packages are Available
- Low Quiescent Bias Current of 75  $\mu$ A
- Low Input-to-Output Voltage Differential of 50 mV at 100  $\mu$ A and 380 mV at 100 mA
- 5.0 V, 3.3 V or 3.0 V  $\pm 0.5\%$  Allows Use as a Regulator or Reference
- Extremely Tight Line and Load Regulation
- Requires Only a 1.0  $\mu$ F Output Capacitor for Stability
- Internal Current and Thermal Limiting
- NCV Prefix for Automotive and Other Applications Requiring Site and Control Changes

### LP2951 Additional Features

- $\overline{\text{Error}}$  Output Signals an Out of Regulation Condition
- Output Programmable from 1.25 V to 29 V
- Logic Level Shutdown Input

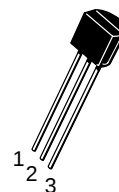
(See Following Page for Device Information.)



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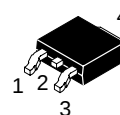
<http://onsemi.com>

TO-92  
Z SUFFIX  
CASE 29

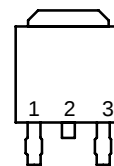


Pin: 1. Output  
2. Ground  
3. Input

DPAK  
DT SUFFIX  
CASE 369C



### PIN CONNECTIONS



Pin: 1. Input  
2. Ground  
3. Output

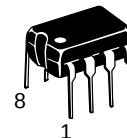
(Top View)

Heatsink surface (shown as terminal 4 in case outline drawing) is connected to Pin 2.

SOIC-8  
D SUFFIX  
CASE 751



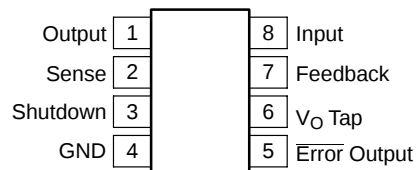
PDIP-8  
N SUFFIX  
CASE 626



Micro8™  
DM SUFFIX  
CASE 846A



### PIN CONNECTIONS



(Top View)

### ORDERING & MARKING INFORMATION

See detailed ordering and shipping information in the package dimensions section on pages 14 and 16 of this data sheet. See general marking information in the device marking section on page 18 of this data sheet.

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## DEVICE INFORMATION

| Package                           | Output Voltage                  |                                 |                                 |                         | Operating Ambient Temperature Range               |
|-----------------------------------|---------------------------------|---------------------------------|---------------------------------|-------------------------|---------------------------------------------------|
|                                   | 3.0 V                           | 3.3 V                           | 5.0 V                           | Adjustable              |                                                   |
| <b>TO-92</b><br><b>Suffix Z</b>   | LP2950CZ-3.0<br>LP2950ACZ-3.0   | LP2950CZ-3.3<br>LP2950ACZ-3.3   | LP2950CZ-5.0<br>LP2950ACZ-5.0   | Not Available           | $T_A = -40^\circ \text{ to } +125^\circ \text{C}$ |
| <b>DPAK</b><br><b>Suffix DT</b>   | LP2950CDT-3.0<br>LP2950ACDT-3.0 | LP2950CDT-3.3<br>LP2950ACDT-3.3 | LP2950CDT-5.0<br>LP2950ACDT-5.0 | Not Available           | $T_A = -40^\circ \text{ to } +125^\circ \text{C}$ |
| <b>SOIC-8</b>                     | —                               | NCV2951ACD-3.3R2                | NCV2951ACDR2                    | NCV2951CDR2             | $T_A = -40^\circ \text{ to } +125^\circ \text{C}$ |
| <b>SOIC-8</b><br><b>Suffix D</b>  | LP2951CD-3.0<br>LP2951ACD-3.0   | LP2951CD-3.3<br>LP2951ACD-3.3   | LP2951CD<br>LP2951ACD           | LP2951CD<br>LP2951ACD   | $T_A = -40^\circ \text{ to } +125^\circ \text{C}$ |
| <b>Micro8</b><br><b>Suffix DM</b> | LP2951CDM-3.0<br>LP2951ACDM-3.0 | LP2951CDM-3.3<br>LP2951ACDM-3.3 | LP2951CDM<br>LP2951ACDM         | LP2951CDM<br>LP2951ACDM | $T_A = -40^\circ \text{ to } +125^\circ \text{C}$ |
| <b>DIP-8</b><br><b>Suffix N</b>   | LP2951CN-3.0<br>LP2951ACN-3.0   | LP2951CN-3.3<br>LP2951ACN-3.3   | LP2951CN<br>LP2951ACN           | LP2951CN<br>LP2951ACN   | $T_A = -40^\circ \text{ to } +125^\circ \text{C}$ |

LP2950Cx-xx / LP2951Cxx-xx 1% Output Voltage Precision at  $T_A = 25^\circ \text{C}$   
 LP2950ACx-xx / LP2951ACxx-xx 0.5% Output Voltage Precision at  $T_A = 25^\circ \text{C}$

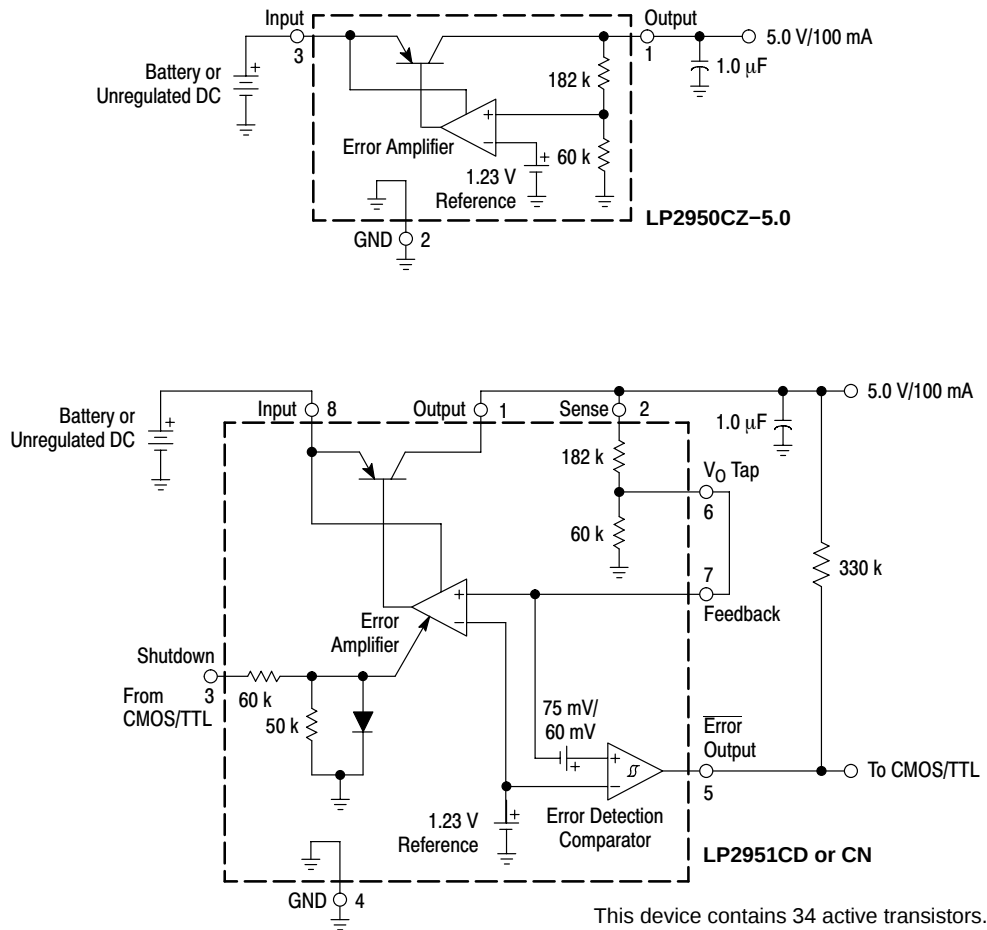


Figure 1. Representative Block Diagrams

# LP2950, LP2951, NCV2951

**MAXIMUM RATINGS** ( $T_A = 25^\circ\text{C}$ , unless otherwise noted.)

| Rating                                        | Symbol          | Value              | Unit               |
|-----------------------------------------------|-----------------|--------------------|--------------------|
| Input Voltage                                 | $V_{CC}$        | 30                 | Vdc                |
| Peak Transient Input Voltage ( $t < 20$ ms)   | $V_{CC}$        | 32                 | Vdc                |
| Power Dissipation and Thermal Characteristics |                 |                    |                    |
| Maximum Power Dissipation                     | $P_D$           | Internally Limited | W                  |
| Case 751(SOIC-8) D Suffix                     |                 |                    |                    |
| Thermal Resistance, Junction-to-Ambient       | $R_{\theta JA}$ | 180                | $^\circ\text{C/W}$ |
| Thermal Resistance, Junction-to-Case          | $R_{\theta JC}$ | 45                 | $^\circ\text{C/W}$ |
| Case 369A (DPAK) DT Suffix (Note 1)           |                 |                    |                    |
| Thermal Resistance, Junction-to-Ambient       | $R_{\theta JA}$ | 92                 | $^\circ\text{C/W}$ |
| Thermal Resistance, Junction-to-Case          | $R_{\theta JC}$ | 6.0                | $^\circ\text{C/W}$ |
| Case 29 (TO-226AA/TO-92) Z Suffix             |                 |                    |                    |
| Thermal Resistance, Junction-to-Ambient       | $R_{\theta JA}$ | 160                | $^\circ\text{C/W}$ |
| Thermal Resistance, Junction-to-Case          | $R_{\theta JC}$ | 83                 | $^\circ\text{C/W}$ |
| Case 626 N Suffix                             |                 |                    |                    |
| Thermal Resistance, Junction-to-Ambient       | $R_{\theta JA}$ | 105                | $^\circ\text{C/W}$ |
| Case 846A (Micro8) DM Suffix                  |                 |                    |                    |
| Thermal Resistance, Junction-to-Ambient       | $R_{\theta JA}$ | 240                | $^\circ\text{C/W}$ |
| Feedback Input Voltage                        | $V_{fb}$        | -1.5 to +30        | Vdc                |
| Shutdown Input Voltage                        | $V_{sd}$        | -0.3 to +30        | Vdc                |
| Error Comparator Output Voltage               | $V_{err}$       | -0.3 to +30        | Vdc                |
| Operating Ambient Temperature Range           | $T_A$           | -40 to +125        | $^\circ\text{C}$   |
| Maximum Die Junction Temperature Range        | $T_J$           | +150               | $^\circ\text{C}$   |
| Storage Temperature Range                     | $T_{stg}$       | -65 to +150        | $^\circ\text{C}$   |

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

# LP2950, LP2951, NCV2951

**ELECTRICAL CHARACTERISTICS** ( $V_{in} = V_O + 1.0\text{ V}$ ,  $I_O = 100\text{ }\mu\text{A}$ ,  $C_O = 1.0\text{ }\mu\text{F}$ ,  $T_A = 25^\circ\text{C}$  [Note 3], unless otherwise noted.)

| Characteristic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Symbol | Min                                                        | Typ                                        | Max                                                        | Unit |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------------------------------------------------------|--------------------------------------------|------------------------------------------------------------|------|
| Output Voltage, 5.0 V Versions<br>$V_{in} = 6.0\text{ V}$ , $I_O = 100\text{ }\mu\text{A}$ , $T_A = 25^\circ\text{C}$<br>LP2950C-5.0/LP2951C/NCV2951C*<br>LP2950AC-5.0/LP2951AC/NCV2951AC*<br>$T_A = -40\text{ to }+125^\circ\text{C}$<br>LP2950C-5.0/LP2951C/NCV2951C*<br>LP2950AC-5.0/LP2951AC/NCV2951AC*<br>$V_{in} = 6.0\text{ to }30\text{ V}$ , $I_O = 100\text{ }\mu\text{A to }100\text{ mA}$ , $T_A = -40\text{ to }+125^\circ\text{C}$<br>LP2950C-5.0/LP2951C/NCV2951C*<br>LP2950AC-5.0/LP2951AC/NCV2951AC*       | $V_O$  | 4.950<br>4.975<br><br>4.900<br>4.940<br><br>4.880<br>4.925 | 5.000<br>5.000<br><br>–<br>–<br><br>–<br>– | 5.050<br>5.025<br><br>5.100<br>5.060<br><br>5.120<br>5.075 | V    |
| Output Voltage, 3.3 V Versions<br>$V_{in} = 4.3\text{ V}$ , $I_O = 100\text{ }\mu\text{A}$ , $T_A = 25^\circ\text{C}$<br>LP2950C-3.3/LP2951C-3.3<br>LP2950AC-3.3/LP2951AC-3.3/NCV2951AC-3.3*<br>$T_A = -40\text{ to }+125^\circ\text{C}$<br>LP2950C-3.3/LP2951C-3.3<br>LP2950AC-3.3/LP2951AC-3.3/NCV2951AC-3.3*<br>$V_{in} = 4.3\text{ to }30\text{ V}$ , $I_O = 100\text{ }\mu\text{A to }100\text{ mA}$ , $T_A = -40\text{ to }+125^\circ\text{C}$<br>LP2950C-3.3/LP2951C-3.3<br>LP2950AC-3.3/LP2951AC-3.3/NCV2951AC-3.3* | $V_O$  | 3.267<br>3.284<br><br>3.234<br>3.260<br><br>3.221<br>3.254 | 3.300<br>3.300<br><br>–<br>–<br><br>–<br>– | 3.333<br>3.317<br><br>3.366<br>3.340<br><br>3.379<br>3.346 | V    |
| Output Voltage, 3.0 V Versions<br>$V_{in} = 4.0\text{ V}$ , $I_O = 100\text{ }\mu\text{A}$ , $T_A = 25^\circ\text{C}$<br>LP2950C-3.0/LP2951C-3.0<br>LP2950AC-3.0/LP2951AC-3.0<br>$T_A = -40\text{ to }+125^\circ\text{C}$<br>LP2950C-3.0/LP2951C-3.0<br>LP2950AC-3.0/LP2951AC-3.0<br>$V_{in} = 4.0\text{ to }30\text{ V}$ , $I_O = 100\text{ }\mu\text{A to }100\text{ mA}$ , $T_A = -40\text{ to }+125^\circ\text{C}$<br>LP2950C-3.0/LP2951C-3.0<br>LP2950AC-3.0/LP2951AC-3.0                                              | $V_O$  | 2.970<br>2.985<br><br>2.940<br>2.964<br><br>2.928<br>2.958 | 3.000<br>3.000<br><br>–<br>–<br><br>–<br>– | 3.030<br>3.015<br><br>3.060<br>3.036<br><br>3.072<br>3.042 | V    |

1. The Junction-to-Ambient Thermal Resistance is determined by PCB copper area per Figure 28.
  2. ESD data available upon request.
  3. Low duty pulse techniques are used during test to maintain junction temperature as close to ambient as possible.
  4.  $V_{O(nom)}$  is the part number voltage option.
  5. Noise tests on the LP2951 are made with a  $0.01\text{ }\mu\text{F}$  capacitor connected across Pins 7 and 1.
- \*NCV prefix is for automotive and other applications requiring site and change control.

# LP2950, LP2951, NCV2951

**ELECTRICAL CHARACTERISTICS (continued)** ( $V_{in} = V_O + 1.0\text{ V}$ ,  $I_O = 100\text{ }\mu\text{A}$ ,  $C_O = 1.0\text{ }\mu\text{F}$ ,  $T_A = 25^\circ\text{C}$  [Note 8], unless otherwise noted.)

| Characteristic                                                                                                                                                               | Symbol                 | Min    | Typ          | Max          | Unit                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|--------|--------------|--------------|---------------------|
| Line Regulation ( $V_{in} = V_{O(nom)} + 1.0\text{ V}$ to $30\text{ V}$ ) (Note 9)<br>LP2950C-XX/LP2951C/LP2951C-XX/NCV2951C*<br>LP2950AC-XX/LP2951AC/LP2951AC-XX/NCV2951AC* | $Reg_{line}$           | –<br>– | 0.08<br>0.04 | 0.20<br>0.10 | %                   |
| Load Regulation ( $I_O = 100\text{ }\mu\text{A}$ to $100\text{ mA}$ )<br>LP2950C-XX/LP2951C/LP2951C-XX/NCV2951C*<br>LP2950AC-XX/LP2951AC/LP2951AC-XX/NCV2951AC*              | $Reg_{load}$           | –<br>– | 0.13<br>0.05 | 0.20<br>0.10 | %                   |
| Dropout Voltage<br>$I_O = 100\text{ }\mu\text{A}$<br>$I_O = 100\text{ mA}$                                                                                                   | $V_I - V_O$            | –<br>– | 30<br>350    | 80<br>450    | mV                  |
| Supply Bias Current<br>$I_O = 100\text{ }\mu\text{A}$<br>$I_O = 100\text{ mA}$                                                                                               | $I_{CC}$               | –<br>– | 93<br>4.0    | 120<br>12    | $\mu\text{A}$<br>mA |
| Dropout Supply Bias Current ( $V_{in} = V_{O(nom)} - 0.5\text{ V}$ , $I_O = 100\text{ }\mu\text{A}$ ) (Note 9)                                                               | $I_{CC\text{dropout}}$ | –      | 110          | 170          | $\mu\text{A}$       |
| Current Limit ( $V_O$ Shorted to Ground)                                                                                                                                     | $I_{Limit}$            | –      | 220          | 300          | mA                  |
| Thermal Regulation                                                                                                                                                           | $Reg_{thermal}$        | –      | 0.05         | 0.20         | %/W                 |
| Output Noise Voltage (10 Hz to 100 kHz) (Note 10)<br>$C_L = 1.0\text{ }\mu\text{F}$<br>$C_L = 100\text{ }\mu\text{F}$                                                        | $V_n$                  | –<br>– | 126<br>56    | –<br>–       | $\mu\text{V}_{rms}$ |

## LP2951A/LP2951AC Only

|                                                                                                                                                                                                                    |           |                |                |                |    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|----------------|----------------|----------------|----|
| Reference Voltage ( $T_A = 25^\circ\text{C}$ )<br>LP2951C/LP2951C-XX/NCV2951C*<br>LP2951AC/LP2951AC-XX/NCV2951AC*                                                                                                  | $V_{ref}$ | 1.210<br>1.220 | 1.235<br>1.235 | 1.260<br>1.250 | V  |
| Reference Voltage ( $T_A = -40$ to $+125^\circ\text{C}$ )<br>LP2951C/LP2951C-XX/NCV2951C*<br>LP2951AC/LP2951AC-XX/NCV2951AC*                                                                                       | $V_{ref}$ | 1.200<br>1.200 | –<br>–         | 1.270<br>1.260 | V  |
| Reference Voltage ( $T_A = -40$ to $+125^\circ\text{C}$ )<br>$I_O = 100\text{ }\mu\text{A}$ to $100\text{ mA}$ , $V_{in} = 23$ to $30\text{ V}$<br>LP2951C/LP2951C-XX/NCV2951C*<br>LP2951AC/LP2951AC-XX/NCV2951AC* | $V_{ref}$ | 1.185<br>1.190 | –<br>–         | 1.285<br>1.270 | V  |
| Feedback Pin Bias Current                                                                                                                                                                                          | $I_{FB}$  | –              | 15             | 40             | nA |

## Error Comparator

|                                                                                    |           |    |      |     |               |
|------------------------------------------------------------------------------------|-----------|----|------|-----|---------------|
| Output Leakage Current ( $V_{OH} = 30\text{ V}$ )                                  | $I_{lkg}$ | –  | 0.01 | 1.0 | $\mu\text{A}$ |
| Output Low Voltage ( $V_{in} = 4.5\text{ V}$ , $I_{OL} = 400\text{ }\mu\text{A}$ ) | $V_{OL}$  | –  | 150  | 250 | mV            |
| Upper Threshold Voltage ( $V_{in} = 6.0\text{ V}$ )                                | $V_{thu}$ | 40 | 45   | –   | mV            |
| Lower Threshold Voltage ( $V_{in} = 6.0\text{ V}$ )                                | $V_{thl}$ | –  | 60   | 95  | mV            |
| Hysteresis ( $V_{in} = 6.0\text{ V}$ )                                             | $V_{hy}$  | –  | 15   | –   | mV            |

## Shutdown Input

|                                                                                                                                            |             |          |           |           |               |
|--------------------------------------------------------------------------------------------------------------------------------------------|-------------|----------|-----------|-----------|---------------|
| Input Logic Voltage<br>Logic "0" (Regulator "On")<br>Logic "1" (Regulator "Off")                                                           | $V_{shtdn}$ | 0<br>2.0 | –<br>–    | 0.7<br>30 | V             |
| Shutdown Pin Input Current<br>$V_{shtdn} = 2.4\text{ V}$<br>$V_{shtdn} = 30\text{ V}$                                                      | $I_{shtdn}$ | –<br>–   | 35<br>450 | 50<br>600 | $\mu\text{A}$ |
| Regulator Output Current in Shutdown Mode<br>( $V_{in} = 30\text{ V}$ , $V_{shtdn} = 2.0\text{ V}$ , $V_O = 0$ , Pin 6 Connected to Pin 7) | $I_{off}$   | –        | 3.0       | 10        | $\mu\text{A}$ |

6. The Junction-to-Ambient Thermal Resistance is determined by PCB copper area per Figure 28.

7. ESD data available upon request.

8. Low duty pulse techniques are used during test to maintain junction temperature as close to ambient as possible.

9.  $V_{O(nom)}$  is the part number voltage option.

10. Noise tests on the LP2951 are made with a  $0.01\text{ }\mu\text{F}$  capacitor connected across Pins 7 and 1.

\*NCV prefix is for automotive and other applications requiring site and change control.

## DEFINITIONS

**Dropout Voltage** – The input/output voltage differential at which the regulator output no longer maintains regulation against further reductions in input voltage. Measured when the output drops 100 mV below its nominal value (which is measured at 1.0 V differential), dropout voltage is affected by junction temperature, load current and minimum input supply requirements.

**Line Regulation** – The change in output voltage for a change in input voltage. The measurement is made under conditions of low dissipation or by using pulse techniques such that average chip temperature is not significantly affected.

**Load Regulation** – The change in output voltage for a change in load current at constant chip temperature.

**Maximum Power Dissipation** – The maximum total device dissipation for which the regulator will operate within specifications.

**Bias Current** – Current which is used to operate the regulator chip and is not delivered to the load.

**Output Noise Voltage** – The RMS ac voltage at the output, with constant load and no input ripple, measured over a specified frequency range.

**Leakage Current** – Current drawn through a bipolar transistor collector–base junction, under a specified collector voltage, when the transistor is “off”.

**Upper Threshold Voltage** – Voltage applied to the comparator input terminal, below the reference voltage which is applied to the other comparator input terminal, which causes the comparator output to change state from a logic “0” to “1”.

**Lower Threshold Voltage** – Voltage applied to the comparator input terminal, below the reference voltage which is applied to the other comparator input terminal, which causes the comparator output to change state from a logic “1” to “0”.

**Hysteresis** – The difference between Lower Threshold voltage and Upper Threshold voltage.

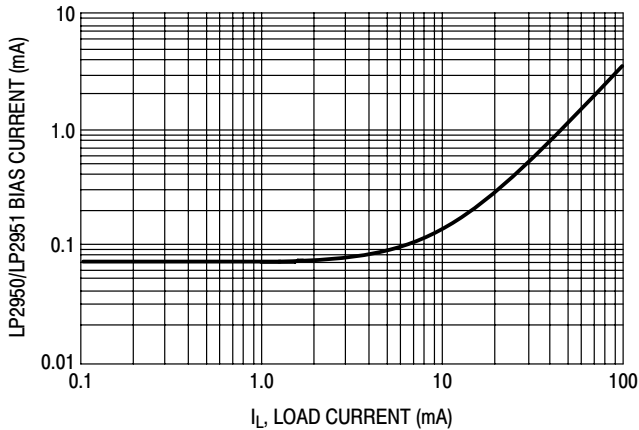


Figure 2. Quiescent Current

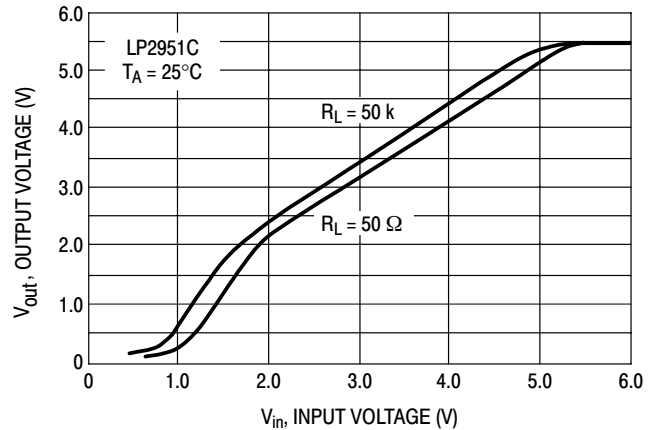


Figure 3. Dropout Characteristics

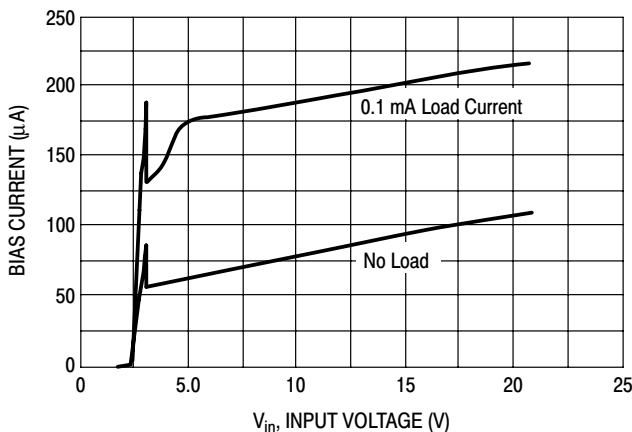


Figure 4. Input Current

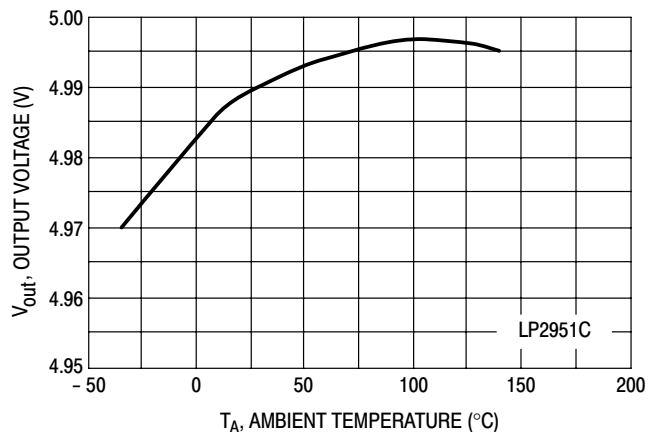


Figure 5. Output Voltage versus Temperature

# LP2950, LP2951, NCV2951

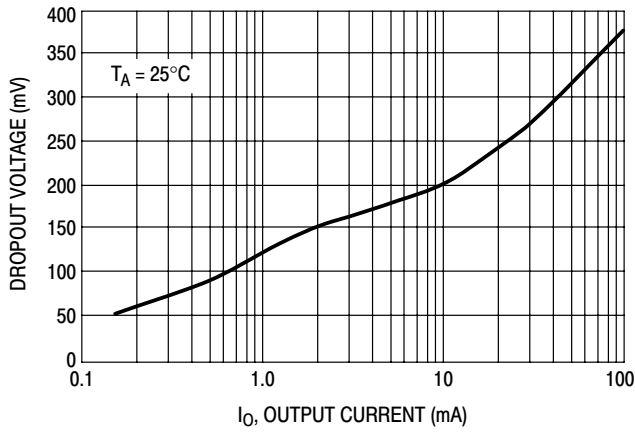


Figure 6. Dropout Voltage versus Output Current

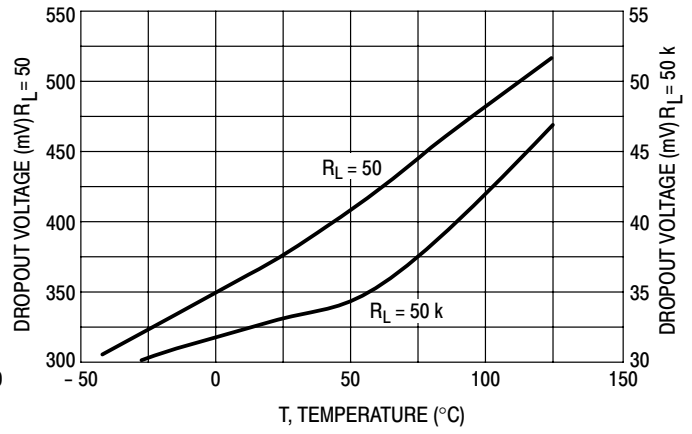


Figure 7. Dropout Voltage versus Temperature

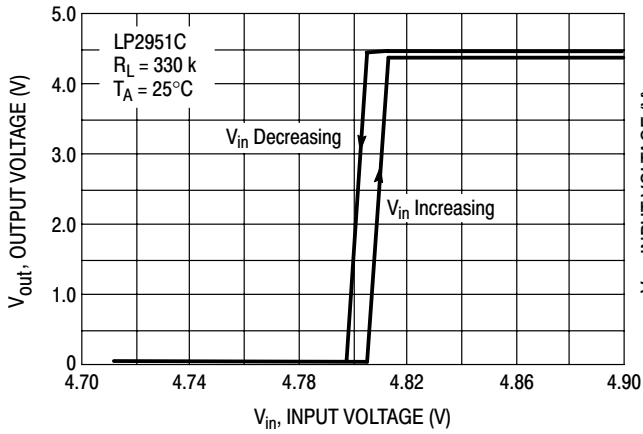


Figure 8. Error Comparator Output

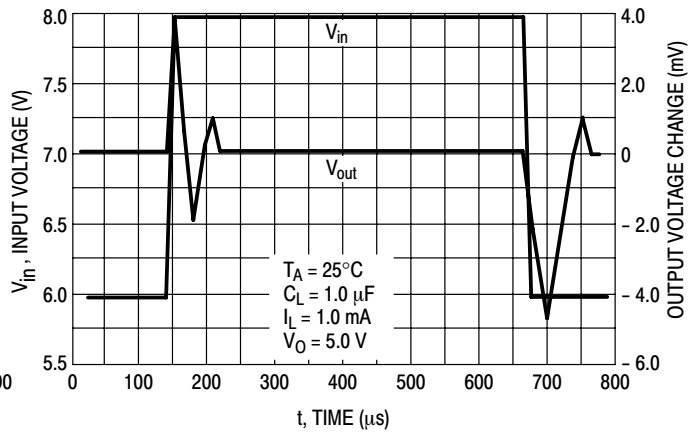


Figure 9. Line Transient Response

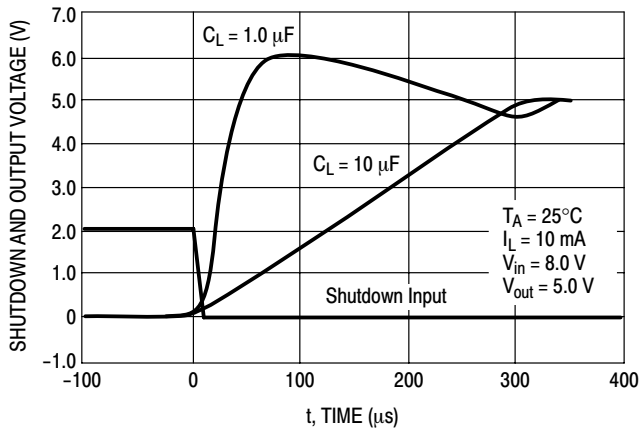


Figure 10. LP2951 Enable Transient

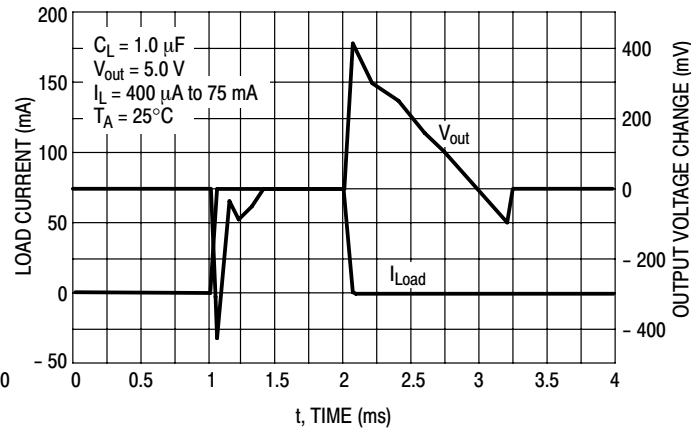


Figure 11. Load Transient Response

# LP2950, LP2951, NCV2951

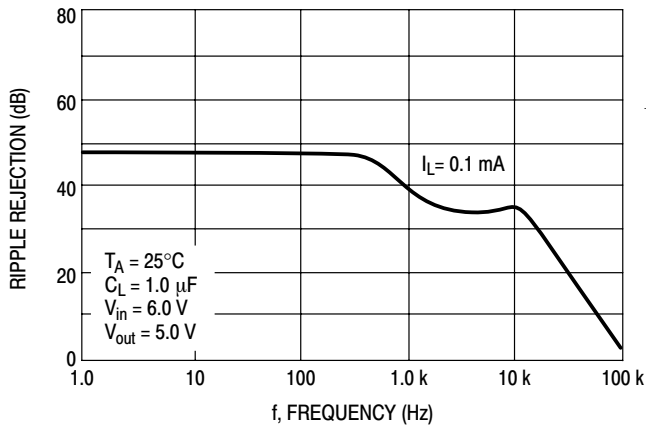


Figure 12. Ripple Rejection

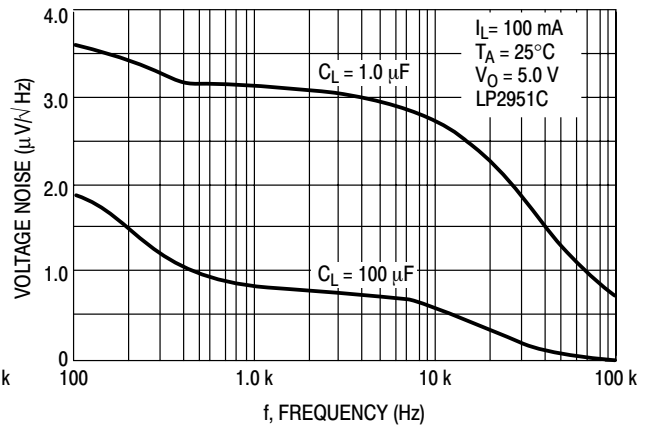


Figure 13. Output Noise

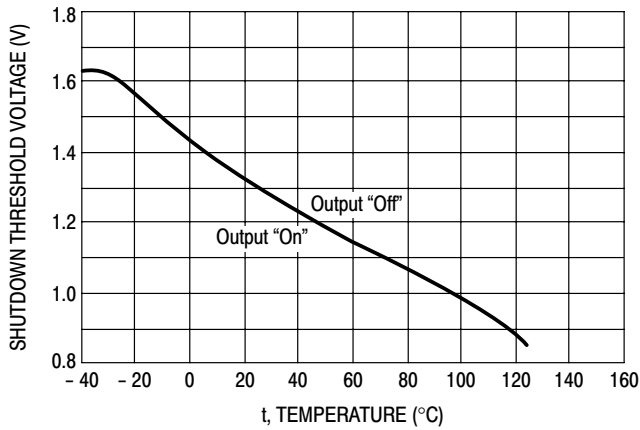


Figure 14. Shutdown Threshold Voltage versus Temperature

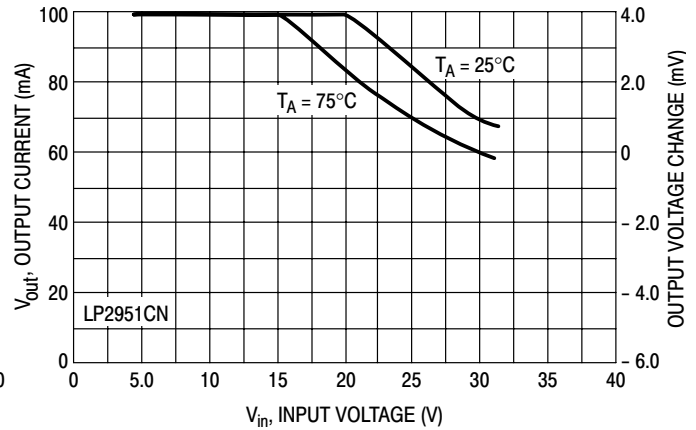


Figure 15. Maximum Rated Output Current

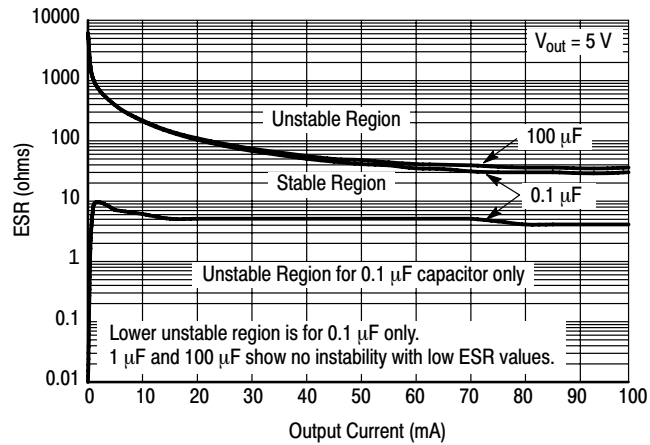


Figure 16. Output Stability versus Output Capacitor Change

## APPLICATIONS INFORMATION

### Introduction

The LP2950/LP2951 regulators are designed with internal current limiting and thermal shutdown making them user-friendly. Typical application circuits for the LP2950 and LP2951 are shown in Figures 19 through 27.

These regulators are not internally compensated and thus require a 1.0  $\mu\text{F}$  (or greater) capacitance between the LP2950/LP2951 output terminal and ground for stability. Most types of aluminum, tantalum or multilayer ceramic will perform adequately. Solid tantalums or appropriate multilayer ceramic capacitors are recommended for operation below 25°C.

At lower values of output current, less output capacitance is required for output stability. The capacitor can be reduced to 0.33  $\mu\text{F}$  for currents less than 10 mA, or 0.1  $\mu\text{F}$  for currents below 1.0 mA. Using the 8 pin versions at voltages less than 5.0 V operates the error amplifier at lower values of gain, so that more output capacitance is needed for stability. For the worst case operating condition of a 100 mA load at 1.23 V output (output Pin 1 connected to the feedback Pin 7) a minimum capacitance of 3.3  $\mu\text{F}$  is recommended.

The LP2950 will remain stable and in regulation when operated with no output load. When setting the output voltage of the LP2951 with external resistors, the resistance values should be chosen to draw a minimum of 1.0  $\mu\text{A}$ .

A bypass capacitor is recommended across the LP2950/LP2951 input to ground if more than 4 inches of wire connects the input to either a battery or power supply filter capacitor.

Input capacitance at the LP2951 Feedback Pin 7 can create a pole, causing instability if high value external resistors are used to set the output voltage. Adding a 100 pF capacitor between the Output Pin 1 and the Feedback Pin 7 and increasing the output filter capacitor to at least 3.3  $\mu\text{F}$  will stabilize the feedback loop.

### Error Detection Comparator

The comparator switches to a positive logic low whenever the LP2951 output voltage falls more than approximately 5.0% out of regulation. This value is the comparator's designed-in offset voltage of 60 mV divided by the 1.235 V internal reference. As shown in the representative block diagram. This trip level remains 5.0% below normal regardless of the value of regulated output voltage. For example, the error flag trip level is 4.75 V for a normal 5.0 V regulated output, or 9.50 V for a 10 V output voltage.

Figure 2 is a timing diagram which shows the  $\overline{\text{ERROR}}$  signal and the regulated output voltage as the input voltage

to the LP2951 is ramped up and down. The  $\overline{\text{ERROR}}$  signal becomes valid (low) at about 1.3 V input. It goes high when the input reaches about 5.0 V ( $V_{\text{out}}$  exceeds about 4.75 V). Since the LP2951's dropout voltage is dependent upon the load current (refer to the curve in the Typical Performance Characteristics), the input voltage trip point will vary with load current. The output voltage trip point does not vary with load.

The error comparator output is an open collector which requires an external pullup resistor. This resistor may be returned to the output or some other voltage within the system. The resistance value should be chosen to be consistent with the 400  $\mu\text{A}$  sink capability of the error comparator. A value between 100 k and 1.0 M $\Omega$  is suggested. No pullup resistance is required if this output is unused.

When operated in the shutdown mode, the error comparator output will go high if it has been pulled up to an external supply. To avoid this invalid response, the error comparator output should be pulled up to  $V_{\text{out}}$  (see Figure 17).

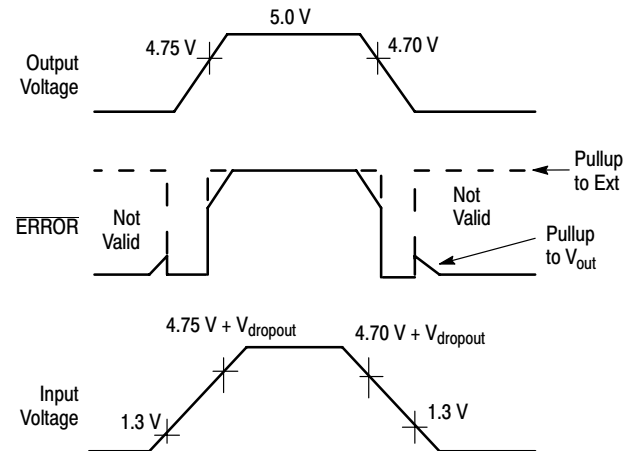
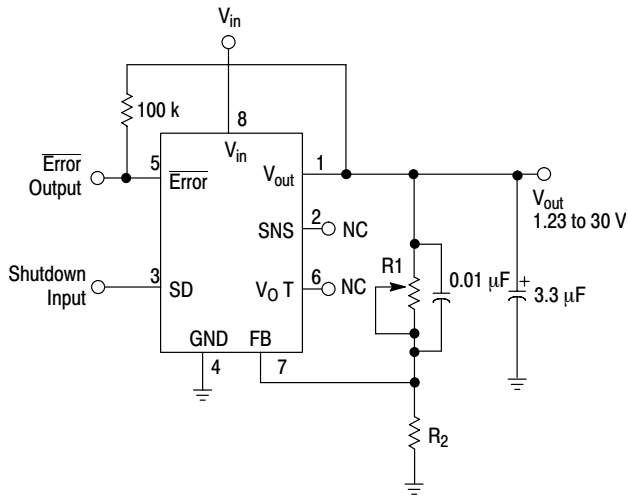


Figure 17.  $\overline{\text{ERROR}}$  Output Timing

### Programming the Output Voltage (LP2951)

The LP2951CX may be pin-strapped for the nominal fixed output voltage using its internal voltage divider by tying Pin 1 (output) to Pin 2 (sense) and Pin 7 (feedback) to Pin 6 (5.0 V tap). Alternatively, it may be programmed for any output voltage between its 1.235 reference voltage and its 30 V maximum rating. An external pair of resistors is required, as shown in Figure 18.

## LP2950, LP2951, NCV2951



**Figure 18. Adjustable Regulator**

The complete equation for the output voltage is:

$$V_{out} = V_{ref} (1 + R1/R2) + I_{FB} R1$$

where  $V_{ref}$  is the nominal 1.235 V reference voltage and  $I_{FB}$  is the feedback pin bias current, nominally  $-20$  nA. The minimum recommended load current of  $1.0$   $\mu$ A forces an upper limit of  $1.2$  M $\Omega$  on the value of  $R2$ , if the regulator must work with no load.  $I_{FB}$  will produce a 2% typical error in  $V_{out}$  which may be eliminated at room temperature by adjusting  $R1$ . For better accuracy, choosing  $R2 = 100$  k reduces this error to 0.17% while increasing the resistor program current to  $12$   $\mu$ A. Since the LP2951 typically draws  $75$   $\mu$ A at no load with Pin 2 open circuited, the extra  $12$   $\mu$ A of current drawn is often a worthwhile tradeoff for eliminating the need to set output voltage in test.

### Output Noise

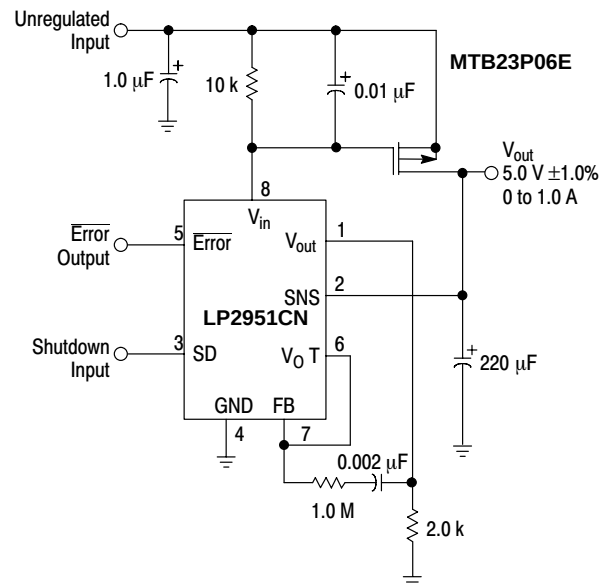
In many applications it is desirable to reduce the noise present at the output. Reducing the regulator bandwidth by increasing the size of the output capacitor is the only method

for reducing noise on the 3 lead LP2950. However, increasing the capacitor from  $1.0$   $\mu$ F to  $220$   $\mu$ F only decreases the noise from  $430$   $\mu$ V to  $160$   $\mu$ Vrms for a  $100$  kHz bandwidth at the  $5.0$  V output.

Noise can be reduced fourfold by a bypass capacitor across  $R1$ , since it reduces the high frequency gain from 4 to unity. Pick

$$C_{Bypass} \approx \frac{1}{2\pi R1 \times 200 \text{ Hz}}$$

or about  $0.01$   $\mu$ F. When doing this, the output capacitor must be increased to  $3.3$   $\mu$ F to maintain stability. These changes reduce the output noise from  $430$   $\mu$ V to  $126$   $\mu$ Vrms for a  $100$  kHz bandwidth at  $5.0$  V output. With bypass capacitor added, noise no longer scales with output voltage so that improvements are more dramatic at higher output voltages.



**Figure 19. 1.0 A Regulator with 1.2 V Dropout**

TYPICAL APPLICATIONS

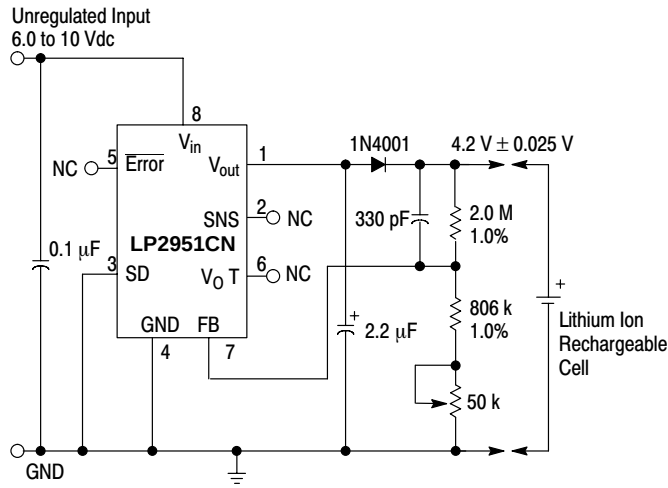


Figure 20. Lithium Ion Battery Cell Charger

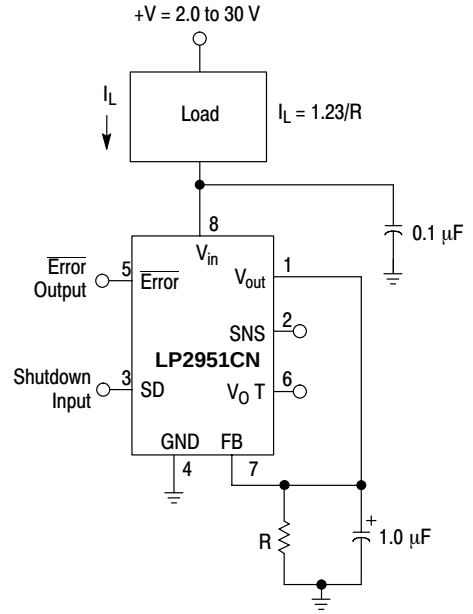
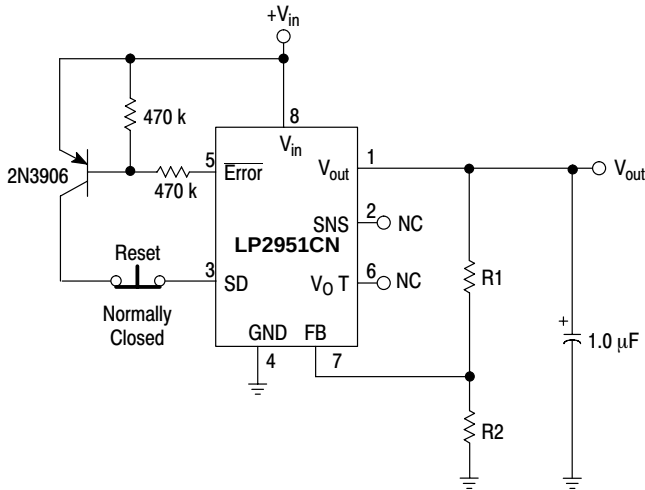


Figure 21. Low Drift Current Sink



Error flag occurs when V<sub>in</sub> is too low to maintain V<sub>out</sub>, or if V<sub>out</sub> is reduced by excessive load current.

Figure 22. Latch Off When Error Flag Occurs

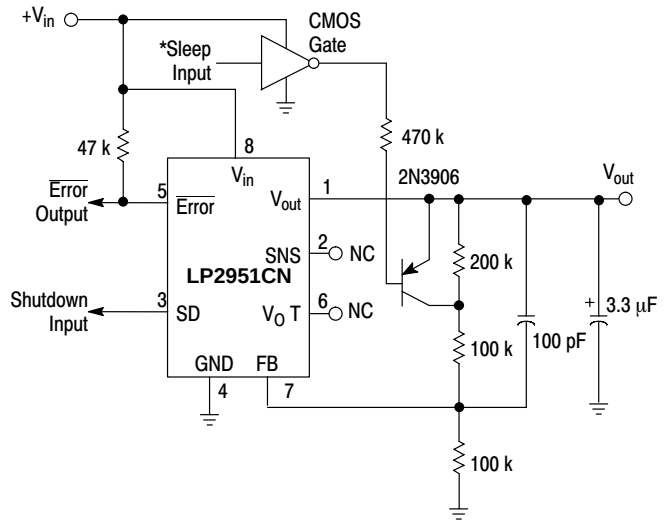
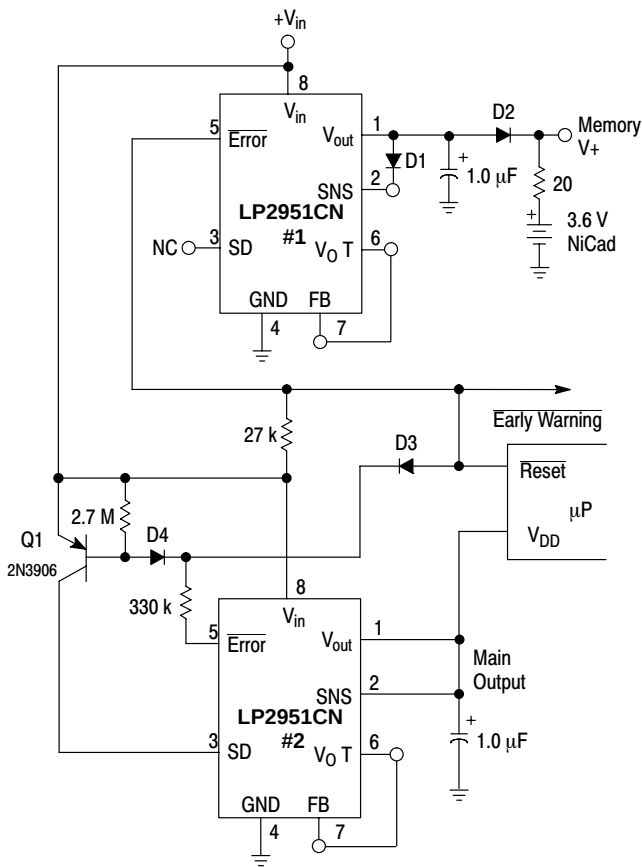


Figure 23. 5.0 V Regulator with 2.5 V Sleep Function

## LP2950, LP2951, NCV2951



All diodes are 1N4148.

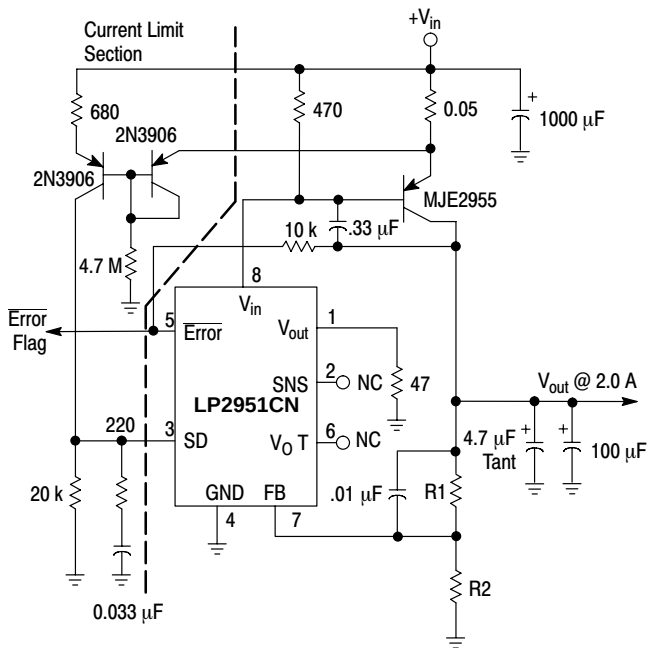
Early Warning flag on low input voltage.

Main output latches off at lower input voltages.

Battery backup on auxiliary output.

Operation: Regulator #1's  $V_{OUT}$  is programmed one diode drop above 5.0 V. Its error flag becomes active when  $V_{in} \leq 5.7$  V. When  $V_{in}$  drops below 5.3 V, the error flag of regulator #2 becomes active and via Q1 latches the main output "off". When  $V_{in}$  again exceeds 5.7 V, regulator #1 is back in regulation and the early warning signal rises, unlatching regulator #2 via D3.

### Figure 24. Regulator with Early Warning and Auxiliary Output



$$V_{out} = 1.25V (1.0 + R1/R2)$$

For 5.0 V output, use internal resistors. Wire Pin 6 to 7, and wire Pin 2 to +V<sub>out</sub> Bus.

### Figure 25. 2.0 A Low Dropout Regulator

## LP2950, LP2951, NCV2951

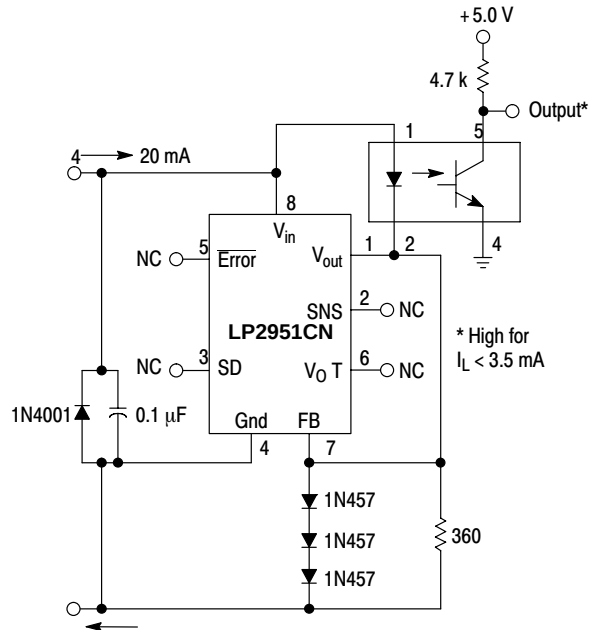


Figure 26. Open Circuit Detector for 4.0 to 20 mA Current Loop

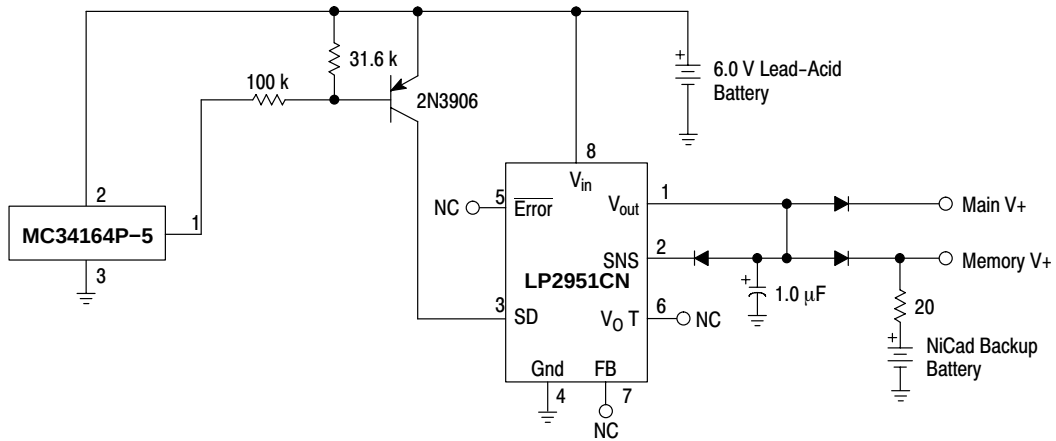


Figure 27. Low Battery Disconnect

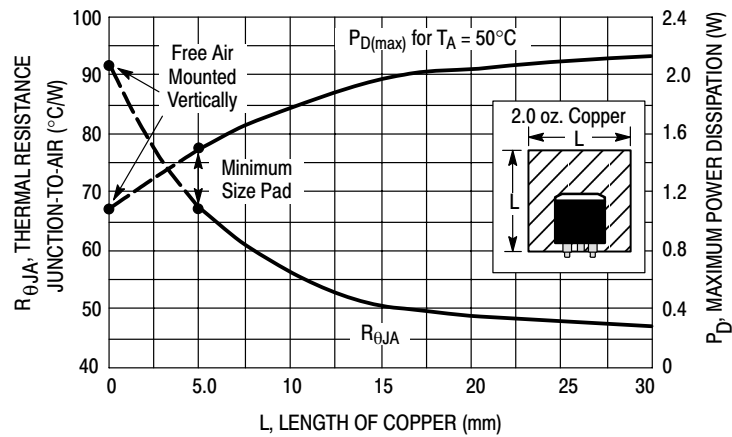


Figure 28. DPAK Thermal Resistance and Maximum Power Dissipation versus PCB Copper Length

# LP2950, LP2951, NCV2951

## ORDERING INFORMATION (LP2950)

| Part Number       | Output Voltage (Volts) | Tolerance (%) | Package         | Shipping <sup>†</sup>    |
|-------------------|------------------------|---------------|-----------------|--------------------------|
| LP2950CZ-3.0      | 3.0                    | 1.0           | TO-92           | 2000 Units / Bag         |
| LP2950CZ-3.0G     | 3.0                    | 1.0           | TO-92 (Pb-Free) | 2000 Units / Bag         |
| LP2950CZ-3.0RA    | 3.0                    | 1.0           | TO-92           | 2000 Units / Tape & Reel |
| LP2950CZ-3.0RAG   | 3.0                    | 1.0           | TO-92 (Pb-Free) | 2000 Units / Tape & Reel |
| LP2950ACZ-3.0     | 3.0                    | 0.5           | TO-92           | 2000 Units / Bag         |
| LP2950ACZ-3.0G    | 3.0                    | 0.5           | TO-92 (Pb-Free) | 2000 Units / Bag         |
| LP2950ACZ-3.0RA   | 3.0                    | 0.5           | TO-92           | 2000 Units / Tape & Reel |
| LP2950ACZ-3.0RAG  | 3.0                    | 0.5           | TO-92 (Pb-Free) | 2000 Units / Tape & Reel |
| LP2950CZ-3.3      | 3.3                    | 1.0           | TO-92           | 2000 Units / Bag         |
| LP2950CZ-3.3G     | 3.3                    | 1.0           | TO-92 (Pb-Free) | 2000 Units / Bag         |
| LP2950CZ-3.3RA    | 3.3                    | 1.0           | TO-92           | 2000 Units / Tape & Reel |
| LP2950CZ-3.3RAG   | 3.3                    | 1.0           | TO-92 (Pb-Free) | 2000 Units / Tape & Reel |
| LP2950ACZ-3.3     | 3.3                    | 0.5           | TO-92           | 2000 Units / Bag         |
| LP2950ACZ-3.3G    | 3.3                    | 0.5           | TO-92 (Pb-Free) | 2000 Units / Bag         |
| LP2950ACZ-3.3RA   | 3.3                    | 0.5           | TO-92           | 2000 Units / Tape & Reel |
| LP2950ACZ-3.3RAG  | 3.3                    | 0.5           | TO-92 (Pb-Free) | 2000 Units / Tape & Reel |
| LP2950CZ-5.0      | 5.0                    | 1.0           | TO-92           | 2000 Units / Bag         |
| LP2950CZ-5.0G     | 5.0                    | 1.0           | TO-92 (Pb-Free) | 2000 Units / Bag         |
| LP2950CZ-5.0RA    | 5.0                    | 1.0           | TO-92           | 2000 Units / Tape & Reel |
| LP2950CZ-5.0RAG   | 5.0                    | 1.0           | TO-92 (Pb-Free) | 2000 Units / Tape & Reel |
| LP2950CZ-5.0RP    | 5.0                    | 1.0           | TO-92           | 2000 Units / Ammo Pack   |
| LP2950CZ-5.0RPG   | 5.0                    | 1.0           | TO-92 (Pb-Free) | 2000 Units / Ammo Pack   |
| LP2950ACZ-5.0     | 5.0                    | 0.5           | TO-92           | 2000 Units / Bag         |
| LP2950ACZ-5.0G    | 5.0                    | 0.5           | TO-92 (Pb-Free) | 2000 Units / Bag         |
| LP2950ACZ-5.0RA   | 5.0                    | 0.5           | TO-92           | 2000 Units / Tape & Reel |
| LP2950ACZ-5.0RAG  | 5.0                    | 0.5           | TO-92 (Pb-Free) | 2000 Units / Tape & Reel |
| LP2950CDT-3.0     | 3.0                    | 1.0           | DPAK            | 75 Units / Rail          |
| LP2950CDT-3.0G    | 3.0                    | 1.0           | DPAK (Pb-Free)  | 75 Units / Rail          |
| LP2950CDT-3.0RK   | 3.0                    | 1.0           | DPAK            | 2500 Units / Tape & Reel |
| LP2950CDT-3.0RKG  | 3.0                    | 1.0           | DPAK (Pb-Free)  | 2500 Units / Tape & Reel |
| LP2950ACDT-3.0    | 3.0                    | 0.5           | DPAK            | 75 Units / Rail          |
| LP2950ACDT-3.0G   | 3.0                    | 0.5           | DPAK (Pb-Free)  | 75 Units / Rail          |
| LP2950ACDT-3.0RK  | 3.0                    | 0.5           | DPAK            | 2500 Units / Tape & Reel |
| LP2950ACDT-3.0RKG | 3.0                    | 0.5           | DPAK (Pb-Free)  | 2500 Units / Tape & Reel |
| LP2950CDT-3.3     | 3.3                    | 1.0           | DPAK            | 75 Units / Rail          |

## LP2950, LP2951, NCV2951

### ORDERING INFORMATION (LP2950)

| Part Number       | Output Voltage (Volts) | Tolerance (%) | Package        | Shipping <sup>†</sup>    |
|-------------------|------------------------|---------------|----------------|--------------------------|
| LP2950CDT-3.3G    | 3.3                    | 1.0           | DPAK (Pb-Free) | 75 Units / Rail          |
| LP2950CDT-3.3RK   | 3.3                    | 1.0           | DPAK           | 2500 Units / Tape & Reel |
| LP2950CDT-3.3RKG  | 3.3                    | 1.0           | DPAK (Pb-Free) | 2500 Units / Tape & Reel |
| LP2950ACDT-3.3    | 3.3                    | 0.5           | DPAK           | 75 Units / Rail          |
| LP2950ACDT-3.3RG  | 3.3                    | 0.5           | DPAK (Pb-Free) | 75 Units / Rail          |
| LP2950ACDT-3.3RK  | 3.3                    | 0.5           | DPAK           | 2500 Units / Tape & Reel |
| LP2950CDT-5.0     | 5.0                    | 1.0           | DPAK           | 75 Units / Rail          |
| LP2950CDT-5.0G    | 5.0                    | 1.0           | DPAK (Pb-Free) | 75 Units / Rail          |
| LP2950CDT-5.0RK   | 5.0                    | 1.0           | DPAK           | 2500 Units / Tape & Reel |
| LP2950CDT-5.0RKG  | 5.0                    | 1.0           | DPAK (Pb-Free) | 2500 Units / Tape & Reel |
| LP2950ACDT-5.0    | 5.0                    | 0.5           | DPAK           | 75 Units / Rail          |
| LP2950ACDT-5.0G   | 5.0                    | 0.5           | DPAK (Pb-Free) | 75 Units / Rail          |
| LP2950ACDT-5.0RK  | 5.0                    | 0.5           | DPAK           | 2500 Units / Tape & Reel |
| LP2950ACDT-5.0RKG | 5.0                    | 0.5           | DPAK (Pb-Free) | 2500 Units / Tape & Reel |

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

# LP2950, LP2951, NCV2951

## ORDERING INFORMATION (LP2951)

| Part Number      | Output Voltage (Volts) | Tolerance (%) | Package          | Shipping <sup>†</sup>    |
|------------------|------------------------|---------------|------------------|--------------------------|
| LP2951CD-3.0     | 3.0                    | 1.0           | SOIC-8           | 98 Units / Rail          |
| LP2951CD-3.0G    | 3.0                    | 1.0           | SOIC-8 (Pb-Free) | 98 Units / Rail          |
| LP2951CD-3.0R2   | 3.0                    | 1.0           | SOIC-8           | 2500 Units / Tape & Reel |
| LP2951CD-3.0R2G  | 3.0                    | 1.0           | SOIC-8 (Pb-Free) | 2500 Units / Tape & Reel |
| LP2951ACD-3.0    | 3.0                    | 0.5           | SOIC-8           | 98 Units / Rail          |
| LP2951ACD-3.0G   | 3.0                    | 0.5           | SOIC-8 (Pb-Free) | 98 Units / Rail          |
| LP2951ACD-3.0R2  | 3.0                    | 0.5           | SOIC-8           | 2500 Units / Tape & Reel |
| LP2951ACD-3.0R2G | 3.0                    | 0.5           | SOIC-8 (Pb-Free) | 2500 Units / Tape & Reel |
| LP2951CD-3.3     | 3.3                    | 1.0           | SOIC-8           | 98 Units / Rail          |
| LP2951CD-3.3G    | 3.3                    | 1.0           | SOIC-8 (Pb-Free) | 98 Units / Rail          |
| LP2951CD-3.3R2   | 3.3                    | 1.0           | SOIC-8           | 2500 Units / Tape & Reel |
| LP2951CD-3.3R2G  | 3.3                    | 1.0           | SOIC-8 (Pb-Free) | 2500 Units / Tape & Reel |
| LP2951ACD-3.3    | 3.3                    | 0.5           | SOIC-8           | 98 Units / Rail          |
| LP2951ACD-3.3G   | 3.3                    | 0.5           | SOIC-8 (Pb-Free) | 98 Units / Rail          |
| LP2951ACD-3.3R2  | 3.3                    | 0.5           | SOIC-8           | 2500 Units / Tape & Reel |
| LP2951ACD-3.3R2G | 3.3                    | 0.5           | SOIC-8 (Pb-Free) | 2500 Units / Tape & Reel |
| LP2951CD         | 5.0 or Adj.            | 1.0           | SOIC-8           | 98 Units / Rail          |
| LP2951CDG        | 5.0 or Adj.            | 1.0           | SOIC-8 (Pb-Free) | 98 Units / Rail          |
| LP2951CDR2       | 5.0 or Adj.            | 1.0           | SOIC-8           | 2500 Units / Tape & Reel |
| LP2951CDR2G      | 5.0 or Adj.            | 1.0           | SOIC-8 (Pb-Free) | 2500 Units / Tape & Reel |
| LP2951ACD        | 5.0 or Adj.            | 0.5           | SOIC-8           | 98 Units / Rail          |
| LP2951ACDG       | 5.0 or Adj.            | 0.5           | SOIC-8 (Pb-Free) | 98 Units / Rail          |
| LP2951ACDR2      | 5.0 or Adj.            | 0.5           | SOIC-8           | 2500 Units / Tape & Reel |
| LP2951ACDR2G     | 5.0 or Adj.            | 0.5           | SOIC-8 (Pb-Free) | 2500 Units / Tape & Reel |
| LP2951CDM-3.0R2  | 3.0                    | 1.0           | Micro8           | 4000 Units / Tape & Reel |
| LP2951CDM-3.0R2G | 3.0                    | 1.0           | Micro8 (Pb-Free) | 4000 Units / Tape & Reel |
| LP2951ACDM-3.0R2 | 3.0                    | 0.5           | Micro8           | 4000 Units / Tape & Reel |
| LP2951CDM-3.3R2  | 3.3                    | 1.0           | Micro8           | 4000 Units / Tape & Reel |
| LP2951CDM-3.3R2G | 3.3                    | 1.0           | Micro8 (Pb-Free) | 4000 Units / Tape & Reel |
| LP2951ACDM-3.3RG | 3.3                    | 0.5           | Micro8 (Pb-Free) | 4000 Units / Tape & Reel |
| LP2951ACDM-3.3R2 | 3.3                    | 0.5           | Micro8           | 4000 Units / Tape & Reel |
| LP2951CDMR2      | 5.0 or Adj.            | 1.0           | Micro8           | 4000 Units / Tape & Reel |
| LP2951CDMR2G     | 5.0 or Adj.            | 1.0           | Micro8 (Pb-Free) | 4000 Units / Tape & Reel |
| LP2951ACDMR2     | 5.0 or Adj.            | 0.5           | Micro8           | 4000 Units / Tape & Reel |
| LP2951ACDMR2G    | 5.0 or Adj.            | 0.5           | Micro8 (Pb-Free) | 4000 Units / Tape & Reel |

## LP2950, LP2951, NCV2951

### ORDERING INFORMATION (LP2951)

| Part Number      | Output Voltage (Volts) | Tolerance (%) | Package          | Shipping <sup>†</sup>    |
|------------------|------------------------|---------------|------------------|--------------------------|
| LP2951ACDM-5.0R2 | 5.0 or Adj.            | 0.5           | Micro8           | 4000 Units / Tape & Reel |
| LP2951CN-3.0     | 3.0                    | 1.0           | PDIP-8           | 50 Units / Rail          |
| LP2951CN-3.0G    | 3.0                    | 1.0           | PDIP-8 (Pb-Free) | 50 Units / Rail          |
| LP2951ACN-3.0    | 3.0                    | 0.5           | PDIP-8           | 50 Units / Rail          |
| LP2951ACN-3.0G   | 3.0                    | 0.5           | PDIP-8 (Pb-Free) | 50 Units / Rail          |
| LP2951CN-3.3     | 3.3                    | 1.0           | PDIP-8           | 50 Units / Rail          |
| LP2951CN-3.3G    | 3.3                    | 1.0           | PDIP-8 (Pb-Free) | 50 Units / Rail          |
| LP2951ACN-3.3    | 3.3                    | 0.5           | PDIP-8           | 50 Units / Rail          |
| LP2951ACN-3.3G   | 3.3                    | 0.5           | PDIP-8 (Pb-Free) | 50 Units / Rail          |
| LP2951CN         | 5.0 or Adj.            | 1.0           | PDIP-8           | 50 Units / Rail          |
| LP2951CNG        | 5.0 or Adj.            | 1.0           | PDIP-8 (Pb-Free) | 50 Units / Rail          |
| LP2951ACN        | 5.0 or Adj.            | 0.5           | PDIP-8           | 50 Units / Rail          |
| LP2951ACNG       | 5.0 or Adj.            | 0.5           | PDIP-8 (Pb-Free) | 50 Units / Rail          |

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

### ORDERING INFORMATION (NCV2951)

| Part Number       | Output Voltage (Volts) | Tolerance (%) | Package          | Shipping <sup>†</sup>    |
|-------------------|------------------------|---------------|------------------|--------------------------|
| NCV2951ACD-3.3R2* | 3.3                    | 0.5           | SOIC-8           | 2500 Units / Tape & Reel |
| NCV2951ACD3.3R2G  | 3.3                    | 0.5           | SOIC-8 (Pb-Free) | 2500 Units / Tape & Reel |
| NCV2951ACDR2*     | 5.0 or Adj.            | 0.5           | SOIC-8           | 2500 Units / Tape & Reel |
| NCV2951ACDR2G     | 5.0 or Adj.            | 0.5           | SOIC-8 (Pb-Free) | 2500 Units / Tape & Reel |
| NCV2951CDR2*      | 5.0 or Adj.            | 1.0           | SOIC-8           | 2500 Units / Tape & Reel |
| NCV2951CDR2G*     | 5.0 or Adj.            | 1.0           | SOIC-8 (Pb-Free) | 2500 Units / Tape & Reel |

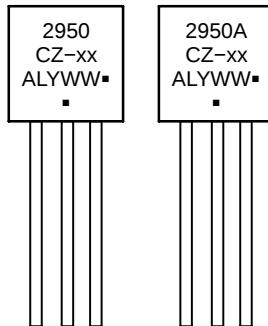
<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

\*NCV prefix is for automotive and other applications requiring site and control changes.

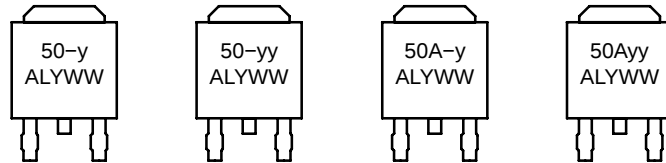
# LP2950, LP2951, NCV2951

## MARKING DIAGRAMS

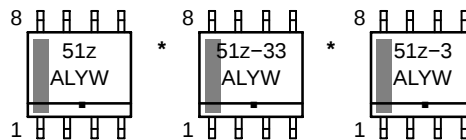
**TO-92**  
**Z SUFFIX**  
**CASE 029**



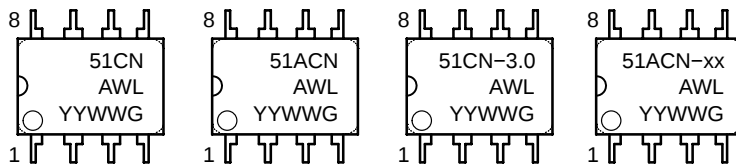
**DPAK**  
**DT SUFFIX**  
**CASE 369C**



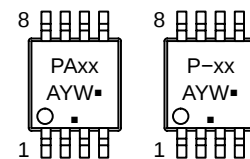
**SOIC-8**  
**D SUFFIX**  
**CASE 751**



**PDIP-8**  
**N SUFFIX**  
**CASE 626**



**Micro8**  
**DM SUFFIX**  
**CASE 846A**



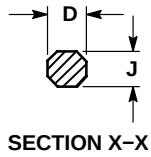
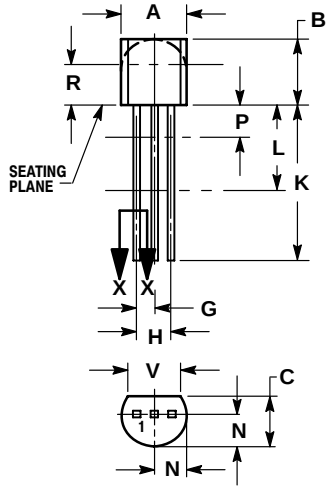
xx = 3.0, 3.3, or 5.0  
y = 3 or 5  
yy = 30, 33, or 50  
z = A or C  
A = Assembly Location  
WL, L = Wafer Lot  
YY, Y = Year  
WW, W = Work Week  
G = Pb-Free Package  
▪ = Pb-Free Package  
(Note: Microdot may be in either location)

\*This marking diagram also applies to NCV2951.

# LP2950, LP2951, NCV2951

## PACKAGE DIMENSIONS

TO-226AA/TO-92  
Z SUFFIX  
PLASTIC PACKAGE  
CASE 29-11  
ISSUE AL



### NOTES:

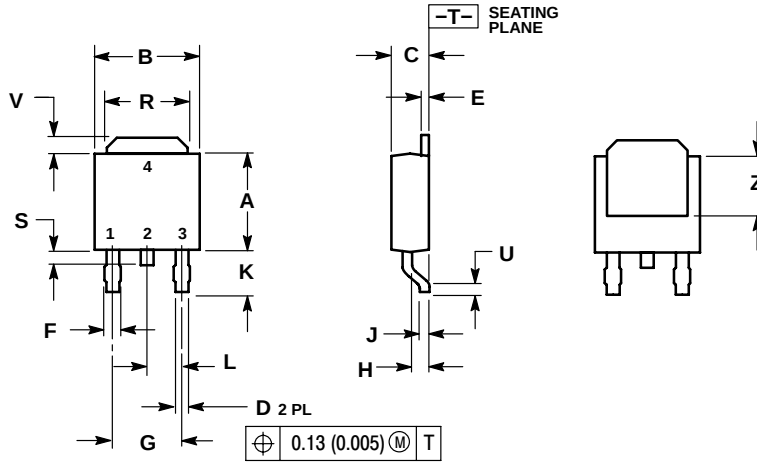
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

| DIM | INCHES |       | MILLIMETERS |       |
|-----|--------|-------|-------------|-------|
|     | MIN    | MAX   | MIN         | MAX   |
| A   | 0.175  | 0.205 | 4.45        | 5.20  |
| B   | 0.170  | 0.210 | 4.32        | 5.33  |
| C   | 0.125  | 0.165 | 3.18        | 4.19  |
| D   | 0.016  | 0.021 | 0.407       | 0.533 |
| G   | 0.045  | 0.055 | 1.15        | 1.39  |
| H   | 0.095  | 0.105 | 2.42        | 2.66  |
| J   | 0.015  | 0.020 | 0.39        | 0.50  |
| K   | 0.500  | ---   | 12.70       | ---   |
| L   | 0.250  | ---   | 6.35        | ---   |
| N   | 0.080  | 0.105 | 2.04        | 2.66  |
| P   | ---    | 0.100 | ---         | 2.54  |
| R   | 0.115  | ---   | 2.93        | ---   |
| V   | 0.135  | ---   | 3.43        | ---   |

# LP2950, LP2951, NCV2951

## PACKAGE DIMENSIONS

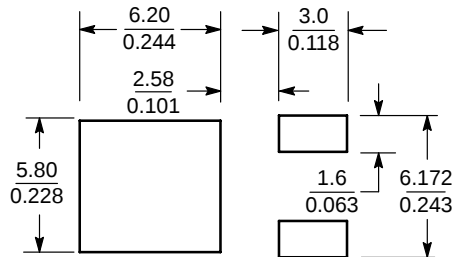
**DPAK**  
**DT SUFFIX**  
 PLASTIC PACKAGE  
 CASE 369C-01  
 ISSUE O



- NOTES:  
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.  
 2. CONTROLLING DIMENSION: INCH.

| DIM | INCHES    |       | MILLIMETERS |      |
|-----|-----------|-------|-------------|------|
|     | MIN       | MAX   | MIN         | MAX  |
| A   | 0.235     | 0.245 | 5.97        | 6.22 |
| B   | 0.250     | 0.265 | 6.35        | 6.73 |
| C   | 0.086     | 0.094 | 2.19        | 2.38 |
| D   | 0.027     | 0.035 | 0.69        | 0.88 |
| E   | 0.018     | 0.023 | 0.46        | 0.58 |
| F   | 0.037     | 0.045 | 0.94        | 1.14 |
| G   | 0.180 BSC |       | 4.58 BSC    |      |
| H   | 0.034     | 0.040 | 0.87        | 1.01 |
| J   | 0.018     | 0.023 | 0.46        | 0.58 |
| K   | 0.102     | 0.114 | 2.60        | 2.89 |
| L   | 0.090 BSC |       | 2.29 BSC    |      |
| R   | 0.180     | 0.215 | 4.57        | 5.45 |
| S   | 0.025     | 0.040 | 0.63        | 1.01 |
| U   | 0.020     | ---   | 0.51        | ---  |
| V   | 0.035     | 0.050 | 0.89        | 1.27 |
| Z   | 0.155     | ---   | 3.93        | ---  |

## SOLDERING FOOTPRINT\*



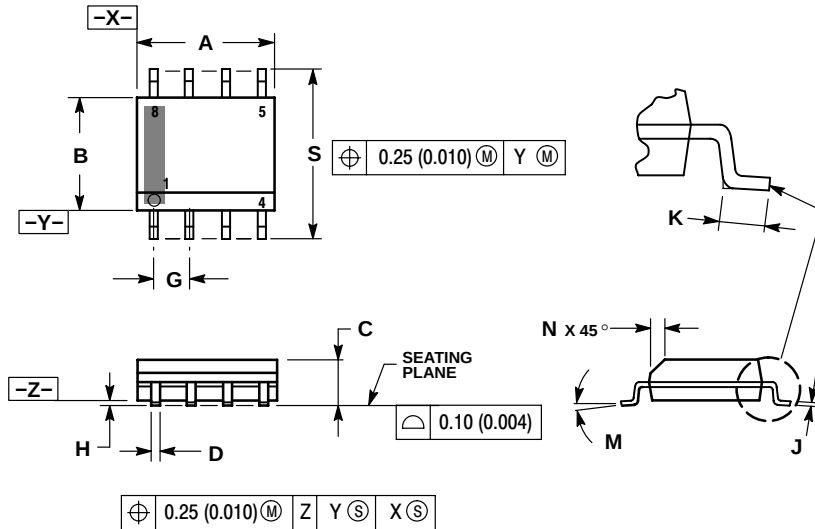
SCALE 3:1  $\left( \frac{\text{mm}}{\text{inches}} \right)$

\*For additional information on our Pb-Free strategy and soldering details please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# LP2950, LP2951, NCV2951

## PACKAGE DIMENSIONS

SOIC-8  
D SUFFIX  
PLASTIC PACKAGE  
CASE 751-07  
ISSUE AG

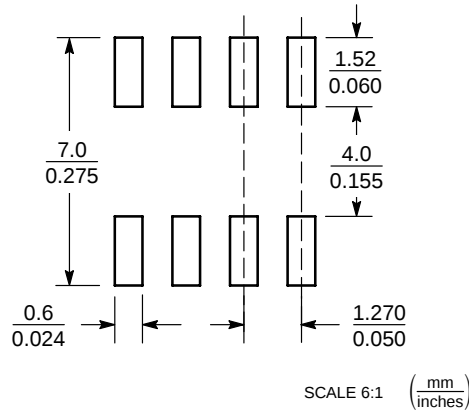


### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | MAX   |
| A   | 4.80        | 5.00 | 0.189     | 0.197 |
| B   | 3.80        | 4.00 | 0.150     | 0.157 |
| C   | 1.35        | 1.75 | 0.053     | 0.069 |
| D   | 0.33        | 0.51 | 0.013     | 0.020 |
| G   | 1.27 BSC    |      | 0.050 BSC |       |
| H   | 0.10        | 0.25 | 0.004     | 0.010 |
| J   | 0.19        | 0.25 | 0.007     | 0.010 |
| K   | 0.40        | 1.27 | 0.016     | 0.050 |
| M   | 0°          | 8°   | 0°        | 8°    |
| N   | 0.25        | 0.50 | 0.010     | 0.020 |
| S   | 5.80        | 6.20 | 0.228     | 0.244 |

## SOLDERING FOOTPRINT\*

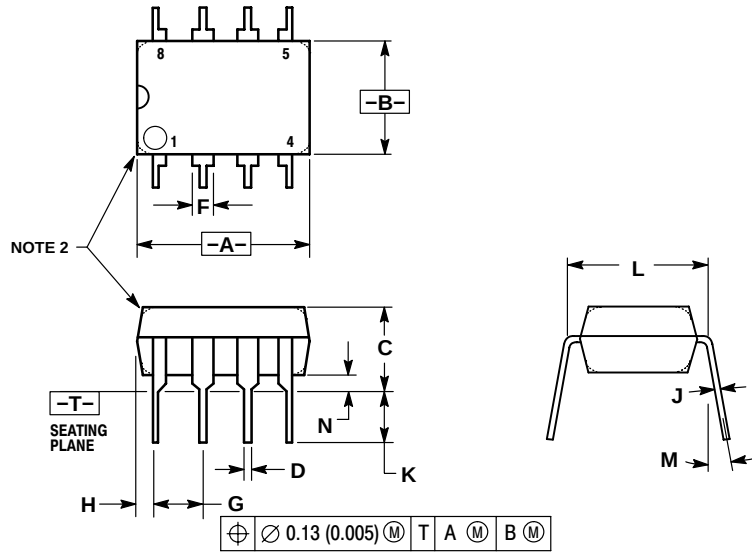


\*For additional information on our Pb-Free strategy and soldering details please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# LP2950, LP2951, NCV2951

## PACKAGE DIMENSIONS

PDIP-8  
N SUFFIX  
PLASTIC PACKAGE  
CASE 626-05  
ISSUE L



### NOTES:

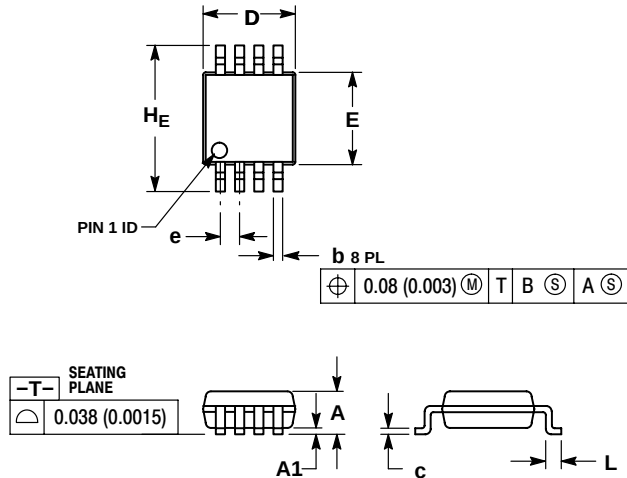
1. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
2. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

| DIM | MILLIMETERS |       | INCHES    |       |
|-----|-------------|-------|-----------|-------|
|     | 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 |

# LP2950, LP2951, NCV2951

## PACKAGE DIMENSIONS

Micro8™  
DM SUFFIX  
PLASTIC PACKAGE  
CASE 846A-02  
ISSUE G

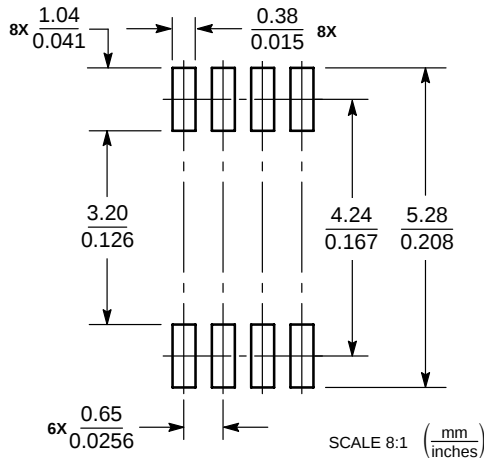


### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. 846A-01 OBSOLETE, NEW STANDARD 846A-02.

| DIM | MILLIMETERS |      |      | INCHES    |       |       |
|-----|-------------|------|------|-----------|-------|-------|
|     | MIN         | NOM  | MAX  | MIN       | NOM   | MAX   |
| A   | --          | --   | 1.10 | --        | --    | 0.043 |
| A1  | 0.05        | 0.08 | 0.15 | 0.002     | 0.003 | 0.006 |
| b   | 0.25        | 0.33 | 0.40 | 0.010     | 0.013 | 0.016 |
| c   | 0.13        | 0.18 | 0.23 | 0.005     | 0.007 | 0.009 |
| D   | 2.90        | 3.00 | 3.10 | 0.114     | 0.118 | 0.122 |
| E   | 2.90        | 3.00 | 3.10 | 0.114     | 0.118 | 0.122 |
| e   | 0.65 BSC    |      |      | 0.026 BSC |       |       |
| L   | 0.40        | 0.55 | 0.70 | 0.016     | 0.021 | 0.028 |
| HE  | 4.75        | 4.90 | 5.05 | 0.187     | 0.193 | 0.199 |

### SOLDERING FOOTPRINT\*



\*For additional information on our Pb-Free strategy and soldering details please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# LP2950, LP2951, NCV2951

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