## FEATURES

- High accuracy output voltage
- Guaranteed 100 mA output
- Very low quiescent current
- Extremely tight load and line regulation
- Very low temperature coefficient
- Current and thermal limiting
- Low dropout voltage
- Need only 1 uF for stability
- Error flag warns of output dropout
- Logi-control electronic shutdown
- Output programmable from 1.24 to 29 V
- Moisture Sensitivity Level 3


## Applications

- High-efficiency linear regulator, voltage reference
- Battery powered systems
- Portable consumer equipment
- Portable / Parm, Desktop / Notebook computers
- Portable Instrumentation, cordless telephones
- Automotive Electronics, Radio control systems


ORDERING INFORMATION

| DEVICE | PKG |
| :---: | :---: |
| LM2950-XX | TO-92 (Bulk) |
| LM2950TA-XX | TO-92 (Tape) |
| LM2951D-XX | SOP-8 |

( $X X=1.5,1.8,2.8,2.85,3.0,3.3,5.0 \mathrm{~V}$,
Adjustable)

- SMPS Post-Regulator, Avionics


## DESCRIPTION

The LM2950/1 is a low power voltage regulator. This device excellent choice for use in battery powered application such as cordless telephone, radio control systems, and portable computers.
The LM2950/1 features very low quiescent current ( $75 \mu \mathrm{~A}$ Typ.) and very low drop output voltage (Typ. 400 mV at light load and 380 mV at 100 mA ).
This includes a tight initial tolerance of $0.5 \%$ Typ., extremely good load and line regulation of $0.05 \%$ Typ., and very low output temperature coefficient, making the LM2950/1 useful as a low-power voltage reference.
The error flag output feature is used as power-on reset for warn of a low output voltage, due to following batteries on input. Other feature is the logic-compatible shutdown input which enable the regulator to be switched on and off. The LM2950/1 is available in 8-pin plastic packages. The regulator output voltage may be pin-strapped for a -XX volt or programmed from 1.24 volt to 29 volts with external pair of resistors. The LM2950/1 is offered in 3-pin to-92 package compatible with other fixed regulator.

BLOCK DIAGRAM AND TYPICAL APPLICATIONS (LM2950)


BLOCK DIAGRAM AND TYPICAL APPLICATIONS (LM2951)


ABSOLUTE MAXIMUM RATINGS

| POWER DISSIPATION | INTERNALLY LIMITED |
| :--- | :---: |
| Lead Temperature (Soldering, 5 seconds) | $260^{\circ} \mathrm{C}$ |
| Storage Temperature Range | $-65^{\circ} \mathrm{C}$ to $+150^{\circ} \mathrm{C}$ |
| Operating Junction Temperature Range | $-55^{\circ} \mathrm{C}$ to $+150^{\circ} \mathrm{C}$ |
| Input Supply Voltage | -0.3 to +30 V |
| Feedback Input Voltage | -1.5 to +30 V |
| Shutdown Input Voltage | -0.3 to +30 V |
| Error Comparator Output | -0.3 to +30 V |

ELECTRICAL CHARACTERISTICS (at $\mathrm{T}_{\mathrm{a}}=25^{\circ} \mathrm{C}, \mathrm{V}_{\mathrm{IN}}=15 \mathrm{~V}$, unles otherwise specified)

| PARAMETER | CONDITIONS (Note 2) | MIN | TYP | MAX | UNITS |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Output Voltage | $-25^{\circ} \mathrm{C} \leq \mathrm{T}_{\mathrm{J}} \leq 85{ }^{\circ} \mathrm{C}$ | $0.985\left\|\mathrm{~V}_{0}\right\|$ | $\mathrm{V}_{0}$ | 1.015 \| V ${ }_{0}$ | V |
|  | Full Operating Temperature | $0.980\left\|\mathrm{~V}_{0}\right\|$ |  | $1.020 \mid \mathrm{V}_{0}$ \| |  |
| Output Voltage | $100 \mu \mathrm{~A} \leq \mathrm{I}_{\mathrm{L}} \leq 100 \mathrm{~mA}, \mathrm{~T}_{J} \leq \mathrm{T}_{\text {JMAX }}$ | $0.976\left\|\mathrm{~V}_{0}\right\|$ | $\mathrm{V}_{0}$ | $1.024 \mid \mathrm{V}_{0}$ \| |  |
| Output Voltage Temperature Coefficient | (Note 1) |  | 50 | 150 | $\mathrm{ppm} /{ }^{\circ} \mathrm{C}$ |
| Line Regulation (Note 3) | $\mathrm{V}_{0}+1 \mathrm{~V} \leq \mathrm{V}_{\text {IN }} \leq 30 \mathrm{~V}$ |  | 0.04 | 0.4 | \% |
| Load Regulation (Note 3) | $100 \mu \mathrm{~A} \leq \mathrm{I}_{\mathrm{L}} \leq 100 \mathrm{~mA}$ |  | 0.1 | 0.3 | \% |
| Dropout Voltage (Note 4) | $\mathrm{L}_{\mathrm{L}}=100 \mu \mathrm{~A}$ |  | 50 | 80 | mV |
|  | $\mathrm{L}_{\mathrm{L}}=100 \mathrm{~mA}$ |  | 380 | 450 |  |

ELECTRICAL CHARACTERISTICS (at $\mathrm{T}_{\mathrm{a}}=25^{\circ} \mathrm{C}, \mathrm{V}_{\mathrm{IN}}=15 \mathrm{~V}$, unles otherwise specified)

| Ground Current | $\mathrm{I}_{\mathrm{L}}=100 \mu \mathrm{~A}$ |  | 75 | 120 | $\mu \mathrm{A}$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\mathrm{I}_{\mathrm{L}}=100 \mathrm{~mA}$ |  | 8 | 12 | mA |
| Dropout Ground Current | $\mathrm{V}_{\text {IN }}=\mathrm{V}_{0}-0.5 \mathrm{~V}, \mathrm{I}_{\mathrm{L}}=100 \mu \mathrm{~A}$ |  | 110 | 170 | $\mu \mathrm{A}$ |
| Current Limit | $\mathrm{V}_{\text {OUT }}=0$ |  | 160 | 250 | mA |
| Thermal Regulation |  |  | 0.05 | 0.2 | \%/W |
| Output Noise, 10 Hz to 100 kHz | $\begin{aligned} & \mathrm{C}_{\mathrm{L}}=1 \mu \mathrm{~F} \\ & \hline \mathrm{C}_{\mathrm{L}}=200 \mu \mathrm{~F} \\ & \hline \mathrm{C}_{\mathrm{L}}=3.3 \mu \mathrm{~F} \\ & \text { (Bypass }=0.01 \mu \mathrm{~F} \text { pins } 7 \text { to } 1 \\ & (\mathrm{LP} 2951-\mathrm{XX}) \text { ) } \end{aligned}$ |  | $\begin{aligned} & 430 \\ & 160 \\ & 100 \end{aligned}$ |  | $\mu \mathrm{Vrms}$ |
| Error Comparator |  |  |  |  |  |
| Output Leakage Current | $\mathrm{V}_{\mathrm{OH}}=30 \mathrm{~V}$ |  | 0.01 | 1.0 | $\mu \mathrm{A}$ |
| Output Low Voltage | $\mathrm{V}_{\mathrm{IN}}=4.5 \mathrm{~V}, \mathrm{I}_{\mathrm{OL}}=400 \mu \mathrm{~A}$ |  | 150 | 250 | mV |
| Upper Threshold Voltage | (Note 5) | 40 | 60 |  |  |
| Lower Threshold Voltage | (Note 5) |  | 75 | 95 |  |
| Hysteresis | (Note 5) |  | 15 |  |  |
| Shutdown Input |  |  |  |  |  |
| Input Logic Voltage | Low (Regulator ON) |  | 1.3 | 0.7 | V |
|  | High (Regulator OFF) | 2 |  |  |  |
| Shutdown Pin Input Current | $\mathrm{V}_{\mathrm{S}}=2.4 \mathrm{~V}$ |  | 30 | 50 | $\mu \mathrm{A}$ |
|  | $\mathrm{V}_{\mathrm{S}}=30 \mathrm{~V}$ |  | 450 | 600 |  |
| Regulator Output Current Shutdown | (Note 6) |  |  |  |  |
|  | $\mathrm{V}_{\text {OUT }}=5.0 \mathrm{~V}$ |  | 3 | 10 |  |
|  | $3.3 \mathrm{~V} \leq \mathrm{V}_{\text {OUT }}<5.0 \mathrm{~V}$ |  |  | 20 |  |
|  | $2.0 \mathrm{~V} \leq \mathrm{V}_{\text {OUT }}<3.3 \mathrm{~V}$ |  |  | 30 |  |


| 8 -pin Versions only |  | 1.21 | 1.235 | 1.26 |  |
| :--- | :--- | :---: | :---: | :---: | :---: |
| Reference Voltage | V |  |  |  |  |
| Reference Voltage | Over Temperature(Note 7) | 1.185 |  | 1.285 |  |
| Feedback Pin Bias Current |  |  | 20 | 40 |  |
| Reference Voltage Temperature Coefficient | (Note 8) |  | 50 |  | $\mathrm{ppm} /{ }^{\circ} \mathrm{C}$ |
| Feedback Pin Bias Current Temperature Coefficient |  | 0.1 |  | $\mathrm{nA} /{ }^{\circ} \mathrm{C}$ |  |

Note 1 : Output or reference voltage temperature coefficients defined as the worst case voltage change divided by the total temperature range.
Note 2 : Unless otherwise specified all limits guaranteed for $T J=25^{\circ} \mathrm{C}, \mathrm{V}_{I_{N}}=\mathrm{V}_{0}+1 \mathrm{~V}, \mathrm{I}_{\mathrm{L}}=100 \mu \mathrm{~A}$ and $\mathrm{C}_{\mathrm{L}}=1 \mu \mathrm{~F}$. Additional condition for the 8-pin versions are feedback tied to - XX V tap and output tied to output Sense (Vout=XX V) and Vshoutdown $\leq 0.8 \mathrm{~V}$

Note 3 : Regulations is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

Note 4 : Dropout voltage is defined as the input to output differential at which the output voltage drops 100 mV below its nominal value measured at 1 V differential. At very low values of programmed output voltage, the minimum input supply voltage( 2.3 V over temperature) must be taken into account.

Note 5 : Comparator thresholds are expressed in terms of a voltage differential at the feedback terminal below the nominal reference voltage measured at Vout+1V input. To express these thresholds in terms of output voltage changed, multiply by the error amplifier gain $=\mathrm{V}$ out $/ \mathrm{VREF}=(\mathrm{R} 1+\mathrm{R} 2) / \mathrm{R} 2$. For example, at a programmed output voltage of 5 V , the error output is guaranteed to go low when the output drops by $95 \mathrm{mV} \times 5 \mathrm{~V} / 1.235 \mathrm{~V}=384 \mathrm{mV}$. Thresholds remain constant as a percent V out as Vout is varied, with the dropout warning occurring at typically $5 \%$ below nominal, $7.5 \%$ guaranteed.

Note 6 : Vshutdown $\geq 2 \mathrm{~V}, \mathrm{~V} \operatorname{In} \leq 30 \mathrm{~V}$, Vout=0, Feed-back pin tied to -XX V Tap.
Note 7 : Vref $\leq$ Vout $\leq(\operatorname{Vin}-1 \mathrm{~V}), 2.3 \mathrm{~V} \leq \operatorname{Vin} \leq 30 \mathrm{~V}, 100 \mathrm{uA} \leq \mathrm{IL} \leq 100 \mathrm{~mA}$, TJ $\leq$ TJMax
Note 8 : Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

