

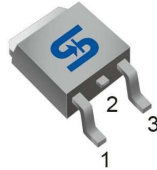
### TO-92



#### Pin Definition:

1. Output
2. Ground
3. Input

### TO-252 (DPAK)



#### Pin Definition:

1. Input
2. Ground
3. Output

## General Description

The TS2950/A are low power voltage regulators. These devices are excellent choice for use in battery-powered applications such as cordless telephone, radio control systems, and portable computers.

The TS2950/A is features very low quiescent current (75uA Typ.) and very low drop output voltage (Typ. 40uV at light load and 380 mV at 100 mA). This includes a tight initial tolerance of 1% (A version), extremely good load and line regulation 0.05% typ. and very low output temperature coefficient, making the TS2950/A useful as a low-power voltage reference.

## Features

- Extremely low quiescent current
- Low dropout voltage
- Extremely tight load and line regulation
- Very low temperature coefficient
- Need only 1uF for stability
- Use as Regulator or Reference
- Stable with low-ESR output capacitors
- Current and thermal limiting

## Application

- Battery powered systems
- SMPS Post-Regulator
- Voltage Reference
- Portable consumer equipment
- Radio control system

## Ordering Information

| Part No.                      | Package | Packing            |
|-------------------------------|---------|--------------------|
| TS2950CT $\underline{xx}$ B0  | TO-92   | 1Kpcs / Bulk       |
| TS2950CT $\underline{xx}$ A3  | TO-92   | 2Kpcs / Ammo       |
| TS2950ACT $\underline{xx}$ B0 | TO-92   | 1Kpcs / Bulk       |
| TS2950ACT $\underline{xx}$ A3 | TO-92   | 2Kpcs / Ammo       |
| TS2950CP $\underline{xx}$ RO  | TO-252  | 2.5Kpcs / 13" reel |
| TS2950ACP $\underline{xx}$ RO | TO-252  | 2.5Kpcs / 13" reel |

Note: Where  $\underline{xx}$  denotes voltage option, available are

**50**= 5.0V

**33**= 3.3V

**30**= 3.0V

Contact factory for additional output voltage option.

## Absolute Maximum Rating

| Parameter                              | Symbol         | Limit              |        | Unit |
|----------------------------------------|----------------|--------------------|--------|------|
|                                        |                | TO-92              | TO-252 |      |
| Input Supply Voltage                   | $V_{IN}$       | - 0.3 ~ +30        |        | V    |
| Power Dissipation                      | $P_d$          | Internally Limited |        | W    |
| Operating Junction Temperature Range   | $T_J$          | - 40 ~ +125        |        | °C   |
| Storage Temperature Range              | $T_{STG}$      | -65 ~ +150         |        | °C   |
| Lead Temperature (Soldering 5 second)  | $T_{STG}$      | 260                |        | °C   |
| Thermal Resistance Junction to Ambient | $R\theta_{JA}$ | 160                | 100    | °C/W |
| Thermal Resistance Junction to Case    | $R\theta_{JC}$ | 80                 | 2.87   | °C/W |

### Electrical Characteristics ( $V_{IN}=V_{OUT}+1V$ , $T_a=25^{\circ}C$ , unless otherwise specified.)

| Parameter                    | Test Conditions (note 2)                       |          | Min    | Typ               | Max   | Unit       |
|------------------------------|------------------------------------------------|----------|--------|-------------------|-------|------------|
| Output Voltage               | Tj=25°C                                        | TS2950   | 0.985  | 5.0<br>3.3<br>3.0 | 1.015 | V          |
|                              |                                                | TS2950A  | 0.990  |                   | 1.010 |            |
|                              | Full Operating temp                            | TS2950   | 0.980  |                   | 1.020 |            |
|                              |                                                | TS2950A  | 0.988  |                   | 1.012 |            |
|                              | 100uA≤ I <sub>L</sub> ≤100mA<br>Tj≤Tj(max)     | TS2950   | 0.975  |                   | 1.025 |            |
|                              |                                                | TS2950A  | 0.985  |                   | 1.015 |            |
|                              | Output Voltage Temperature Coefficient         | (Note 1) | TS2950 |                   | --    |            |
| TS2950A                      |                                                |          | --     | 20                | 100   |            |
| Line Regulation (Note 3)     | 6V≤ V <sub>IN</sub> ≤30V (Note 4)              |          | --     | 0.04              | 0.2   | %          |
| Load Regulation (Note 3)     | 100uA≤ I <sub>L</sub> ≤100mA                   |          | --     | 0.1               | 0.3   | %          |
| Dropout Voltage (Note 5)     | I <sub>L</sub> =100uA                          |          | --     | 50                | 80    | mV         |
|                              | I <sub>L</sub> =100mA                          |          |        | 380               | 450   | mV         |
| Ground Current               | I <sub>L</sub> =100uA                          |          | --     | 75                | 120   | uA         |
|                              | I <sub>L</sub> =100mA                          |          |        | 8                 | 12    | mA         |
| Dropout Ground Current       | V <sub>IN</sub> = 4.5V, I <sub>L</sub> = 100uA |          | --     | 110               | 170   | uA         |
| Current Limit                | V <sub>OUT</sub> = 0                           |          | --     | 160               | 250   | mA         |
| Thermal Regulation           |                                                |          | --     | 0.05              | 0.2   | %W         |
| Output Noise, 10Hz to 100KHz | C <sub>L</sub> = 1uF                           |          | --     | 430               | --    | uV/<br>rms |
|                              | C <sub>L</sub> = 200uF                         |          | --     | 160               | --    |            |
|                              | C <sub>L</sub> = 3.3uF                         |          | --     | 100               | --    |            |

**Note 1:** Output 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  $T_j=25^{\circ}C$ ,  $V_{IN}=6V$ ,  $I_L=100\mu A$  and  $C_L=100\mu F$ .

**Note 3:** Regulation 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:** line regulation is guaranteed by design to 0.2%.

**Note 5:** Dropout Voltage is defined as the input to output differential at which the output voltage drops 100mV below its nominal value measured at 1V differential at very low value of programmed output voltage, the minimum input supply voltage of 2V (2.3V over temperature) must be taken in to account.

### Application Hints

#### External Capacitors

For the stability of the TS2950/A is requires a 1.0uF(0.22uF is recommended for 3.0V & 3.3V) or greater capacitor between output and ground. Oscillation could occur without this capacitor. The tantalum or aluminum electrolytic works fine; could use the film type work but are not cost efficient. For the operation of below -25°C solid tantalum is recommended since the many aluminum type have electrolytes the freeze at about -30°C. The ESR of about 5Ω or less and resonant frequency above 500KHz are most important parameter in the value of Capacitor. The Capacitors value can be increased without any limit. At lower values of output current, less output capacitance is required for stability. For the currents below 10mA the value of capacitor can be reduce to 0.33uF and 0.1uF for 1mA.

The TS2950/A is not like other low dropout regulators will remain stable and regulation with no load in addition to the internal voltage divider. This feature very important in application, it is like CMOS RAM keep-alive.

If at the input of TS2950/A connected to battery or between AC filter capacitor and input is 10 inches wire then 1uF tantalum or aluminum electrolytic capacitor should be connected between input and ground. This could cause more problems when using higher value of external to set the output voltage. To fix this problem increasing output capacitance to 3.3uF.

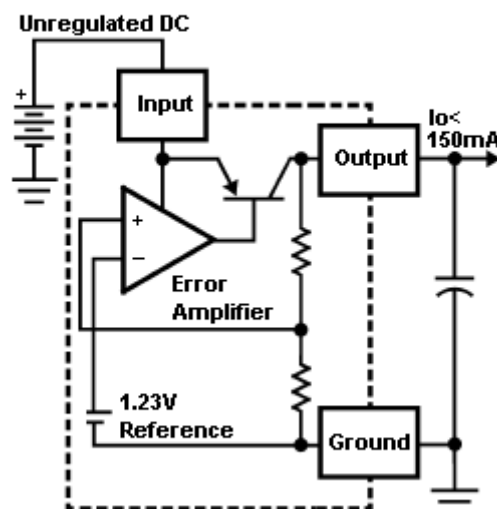
#### Reducing Output Noise

It could be an advantage to reduce the AC noise present at the output. One method is to reduce the regulator bandwidth by increasing the value of the output capacitor. This is the only method that noise could reduce on the TS2950/A, but is relatively inefficient, as increasing capacitor from 1uF to 220uF only decreases the noise from 430uV to 160uVrms for a 100KHz bandwidth at 5V output.

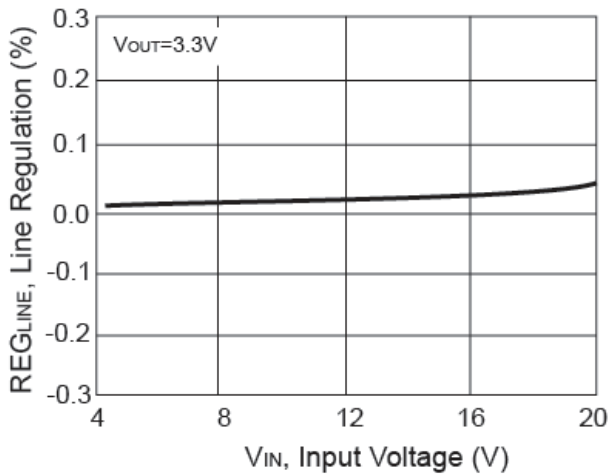
the output capacitor must be increased to 3.3uF to maintain stability. These change the output noise from 430uV/rms for a 100 kHz bandwidth 5V, 3.3V & 3V output.

### Block Diagram and Typical Applications Circuit

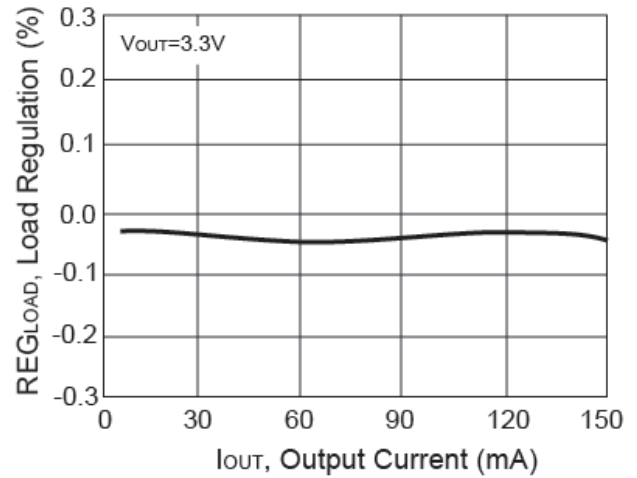
TS2950/A



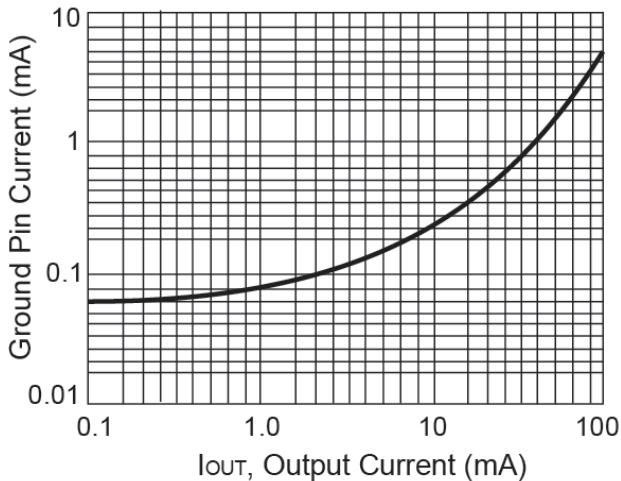
**Electrical Characteristics Curve** ( $T_a = 25^\circ\text{C}$ , unless otherwise noted)



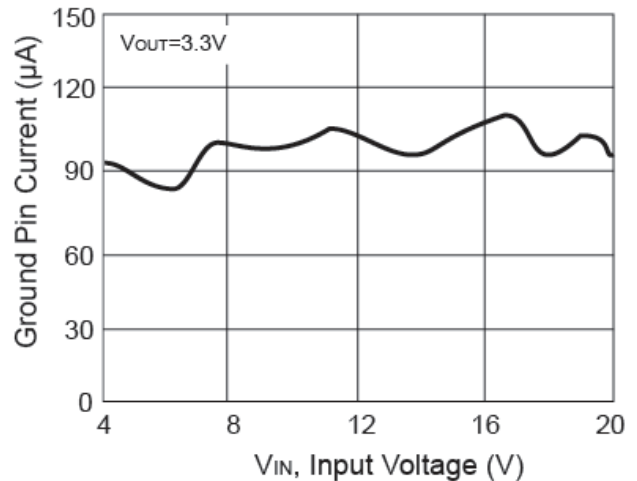
**Figure 1. Line Regulation vs. Input Voltage**



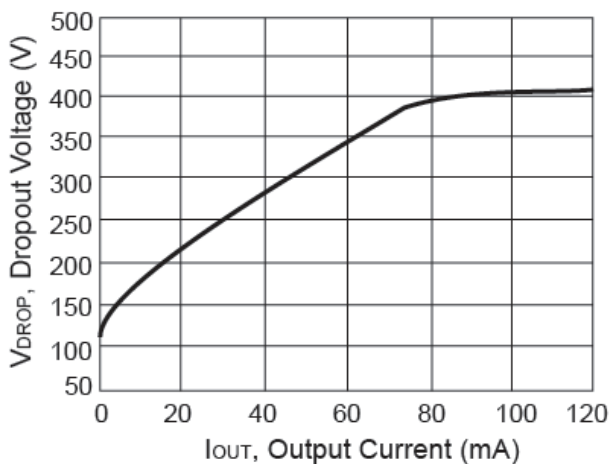
**Figure 2. Load Regulation vs. Output Current**



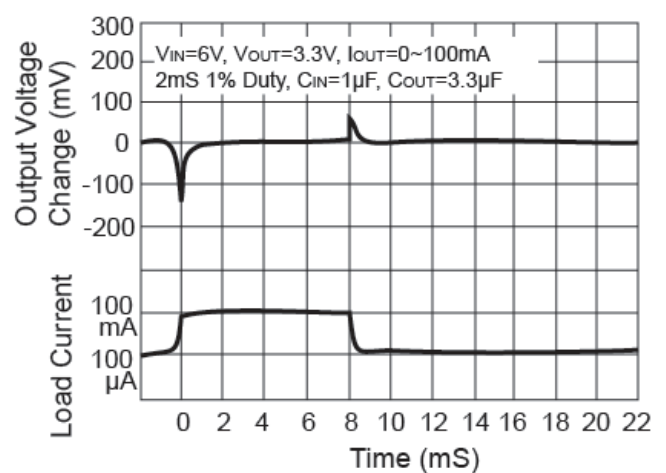
**Figure 3. Ground Pin Current vs. Output Current**



**Figure 4. Ground Pin Current vs. Input Voltage**

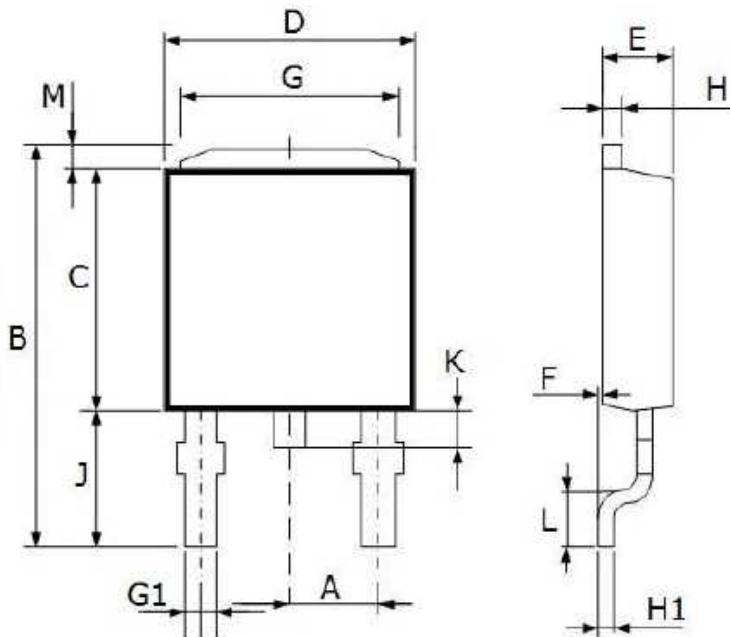


**Figure 5. Dropout Voltage vs. Output Current**



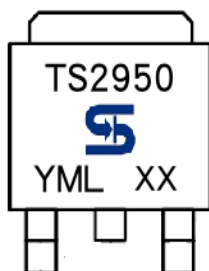
**Figure 6. Load Transient Response**

### TO-252 Mechanical Drawing



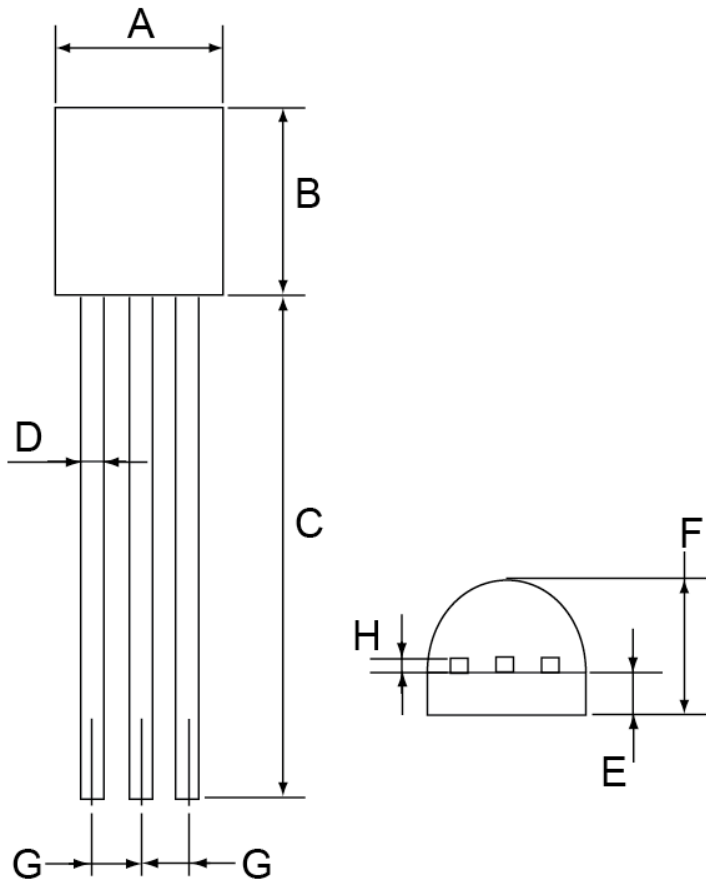
| TO-252 DIMENSION |             |       |           |       |
|------------------|-------------|-------|-----------|-------|
| DIM              | MILLIMETERS |       | INCHES    |       |
|                  | MIN         | MAX   | MIN       | MAX   |
| A                | 2.30 BSC    |       | 0.090 BSC |       |
| B                | 10.20       | 10.80 | 0.402     | 0.425 |
| C                | 5.30        | 5.70  | 0.209     | 0.224 |
| D                | 6.30        | 6.70  | 0.248     | 0.264 |
| E                | 2.10        | 2.50  | 0.083     | 0.098 |
| F                | 0.00        | 0.20  | 0.000     | 0.008 |
| G                | 4.80        | 5.20  | 0.189     | 0.205 |
| G1               | 0.40        | 0.80  | 0.016     | 0.031 |
| H                | 0.40        | 0.60  | 0.016     | 0.024 |
| H1               | 0.35        | 0.65  | 0.014     | 0.026 |
| J                | 3.35        | 3.65  | 0.132     | 0.144 |
| K                | 0.50        | 1.10  | 0.020     | 0.043 |
| L                | 0.90        | 1.50  | 0.035     | 0.059 |
| M                | 1.30        | 1.70  | 0.051     | 0.067 |

### Marking Diagram



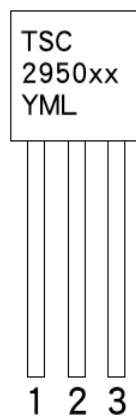
- XX** = Voltage Code  
(**50** = 5.0V, **33** = 3.3V, **30** = 3.0V)
- Y** = Year Code
- M** = Month Code  
(**A**=Jan, **B**=Feb, **C**=Mar, **D**=Apr, **E**=May, **F**=Jun, **G**=Jul, **H**=Aug, **I**=Sep, **J**=Oct, **K**=Nov, **L**=Dec)
- L** = Lot Code

### TO-92 Mechanical Drawing



| DIM | TO-92 DIMENSION |       |        |       |
|-----|-----------------|-------|--------|-------|
|     | MILLIMETERS     |       | INCHES |       |
|     | MIN             | MAX   | MIN    | MAX   |
| A   | 4.30            | 4.70  | 0.169  | 0.185 |
| B   | 4.30            | 4.70  | 0.169  | 0.185 |
| C   | 12.70           | 15.49 | 0.500  | 0.609 |
| D   | 0.39            | 0.49  | 0.015  | 0.019 |
| E   | 1.18            | 1.28  | 0.046  | 0.050 |
| F   | 3.30            | 3.70  | 0.130  | 0.146 |
| G   | 1.27            | 1.31  | 0.050  | 0.051 |
| H   | 0.33            | 0.43  | 0.013  | 0.017 |

### Marking Diagram



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# TS2950/A

## 150mA Ultra Low Dropout Voltage Regulator

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