

### TO-92



#### Pin Definition:

1. Output
2. Ground
3. Input

## General Description

The TS2950 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 is features very low quiescent current (75 $\mu$ A Typ.) and very low drop output voltage (Typ. 40mV at light load and 380mV at 100mA), extremely good load and line regulation 0.05% typ. and very low output temperature coefficient, making the TS2950 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 1 $\mu$ F for stability
- Use as Regulator or Reference
- Stable with low-ESR output capacitors
- Current and thermal limiting

## Ordering Information

Part No.	Package	Packing
TS2950CT $\underline{xx}$ B0	TO-92	1kpcs / Bulk
TS2950CT $\underline{xx}$ A3	TO-92	2kpcs / Ammo

Note: Refer to detail ordering information table.

## Applications

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

## Absolute Maximum Ratings

Parameter	Symbol	Limit	Unit
Input Supply Voltage	$V_{IN}$	- 0.3 ~ +30	V
Power Dissipation	$P_d$	Internally Limited	W
Operating Junction Temperature Range	$T_J$	- 40 ~ +125	$^{\circ}$ C
Storage Temperature Range	$T_{STG}$	-65 ~ +150	$^{\circ}$ C
Lead Temperature (Soldering 5 second)	$T_{STG}$	260	$^{\circ}$ C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	160	$^{\circ}$ C/W
Thermal Resistance Junction to Case	$R_{\theta JC}$	80	$^{\circ}$ 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	$T_J=25^{\circ}C$	0.985	5.0	1.015	V
	Full Operating temp	0.980	3.3	1.020	
	$100\mu A \leq I_L \leq 100mA$	0.975	3.0	1.025	
Output Voltage Temperature Coefficient	(Note 1)	--	50	150	ppm/ $^{\circ}C$
		--	20	100	
Line Regulation (Note 3)	$6V \leq V_{IN} \leq 30V$ (Note 4)	--	0.04	0.2	%
Load Regulation (Note 3)	$100\mu A \leq I_L \leq 100mA$	--	0.1	0.3	%
Dropout Voltage (Note 5)	$I_L=100\mu A$	--	50	80	mV
	$I_L=100mA$	--	380	450	mV
Ground Current	$I_L=100\mu A$	--	75	120	$\mu A$
	$I_L=100mA$	--	8	12	mA
Dropout Ground Current	$V_{IN}=4.5V$ , $I_L=100\mu A$	--	110	170	$\mu A$
Current Limit	$V_{OUT}=0$	--	160	250	mA
Thermal Regulation		--	0.05	0.2	%W
Output Noise, 10Hz to 100KHz	$C_L=1\mu F$	--	430	--	$\mu V/$ rms
	$C_L=200\mu F$	--	160	--	
	$C_L=3.3\mu F$	--	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 is requires a  $1\mu\text{F}$  ( $0.22\mu\text{F}$  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  $-25^{\circ}\text{C}$  solid tantalum is recommended since the many aluminum type have electrolytes the freeze at about  $-30^{\circ}\text{C}$ . The ESR of about  $5\Omega$  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  $0.33\mu\text{F}$  and  $0.1\mu\text{F}$  for 1mA.

The TS2950 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.

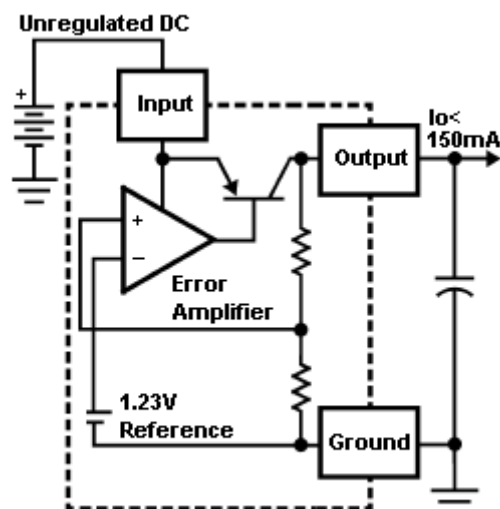
If at the input of TS2950 connected to battery or between AC filter capacitor and input is 10 inches wire then  $1\mu\text{F}$  tantalum or aluminum electrolytic capacitor should be connected between input and ground. This could cause more problems when using higher value of external to set the output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

#### Reducing Output Noise

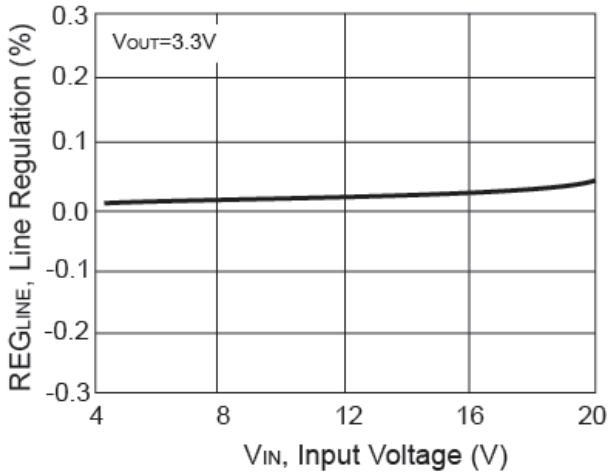
It could be an advantage to reduce the AC noise present at the output. One method is to reduce the regulator bandwidth by increasing the value of the output capacitor. This is the only method that noise could reduce on the TS2950, but is relatively inefficient, as increasing capacitor from  $1\mu\text{F}$  to  $220\mu\text{F}$  only decreases the noise from  $430\mu\text{V}$  to  $160\mu\text{Vrms}$  for a 100KHz bandwidth at 5V output.

the output capacitor must be increased to  $3.3\mu\text{F}$  to maintain stability. These change the output noise from  $430\mu\text{V/rms}$  for a 100 kHz bandwidth 5V, 3.3V & 3V output.

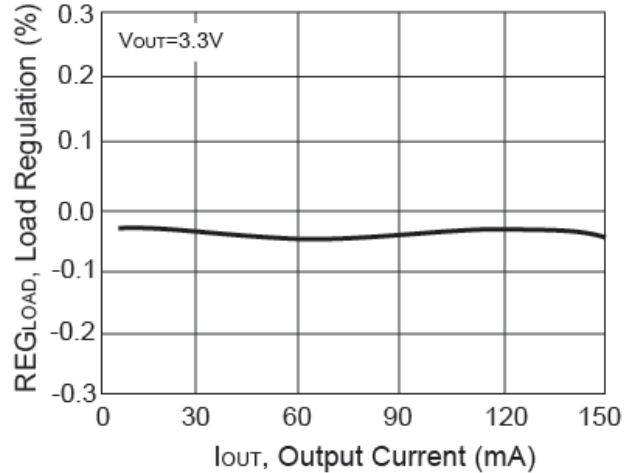
### Block Diagram and Typical Applications Circuit



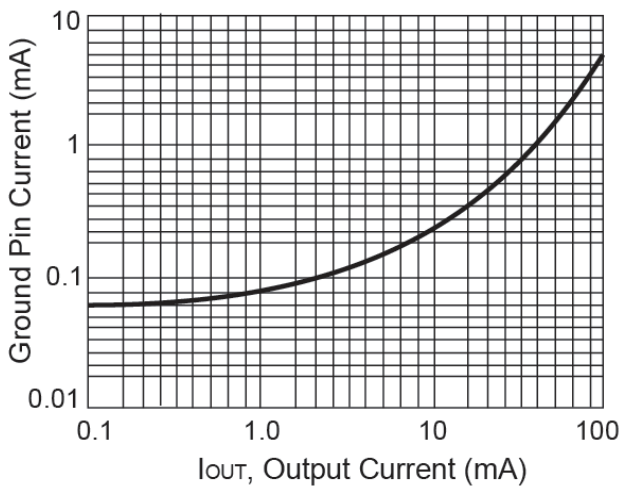
**Electrical Characteristics Curve** ( $T_a = 25^\circ\text{C}$ , unless otherwise noted)



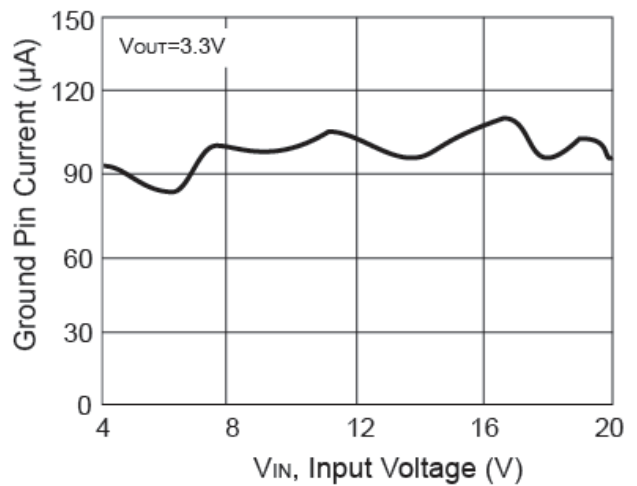
**Figure 1. Line Regulation vs. Input Voltage**



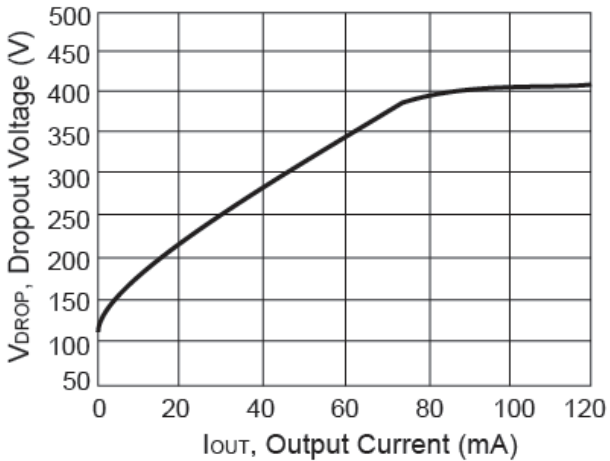
**Figure 2. Load Regulation vs. Output Current**



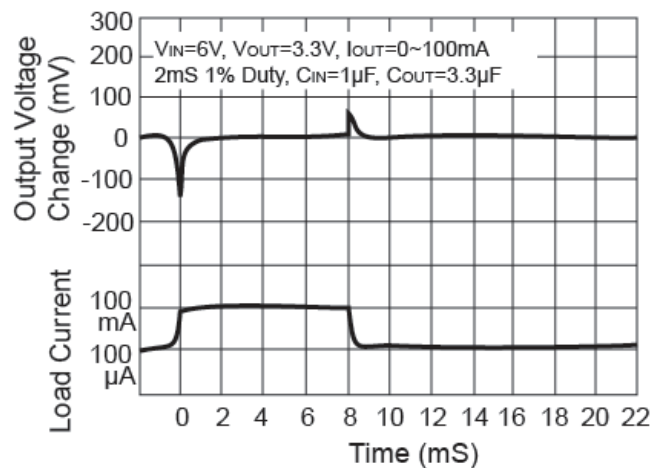
**Figure 3. Ground Pin Current vs. Output Current**



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



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



**Figure 6. Load Transient Response**

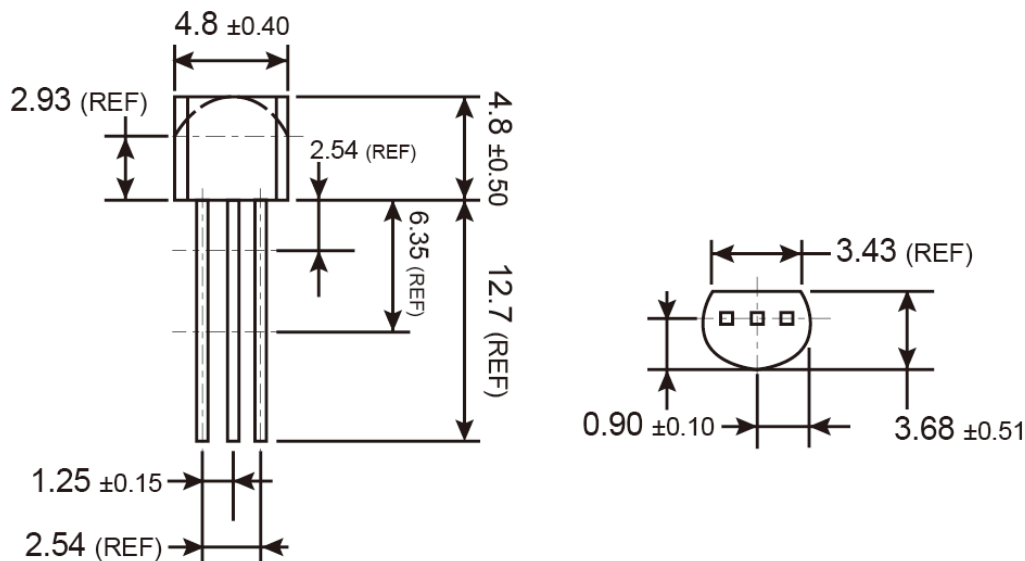
### Ordering information

Voltage	TO-92
3.3V	TS2950CT33 B0 TS2950CT33 A3
5V	TS2950CT50 B0 TS2950CT50 A3

### Packing code information

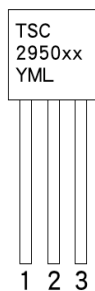
Packing	B0: 1kpcs / Bulk A3: 2kpcs / Ammo
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**TO-92 Mechanical Drawing**



Unit: Millimeters

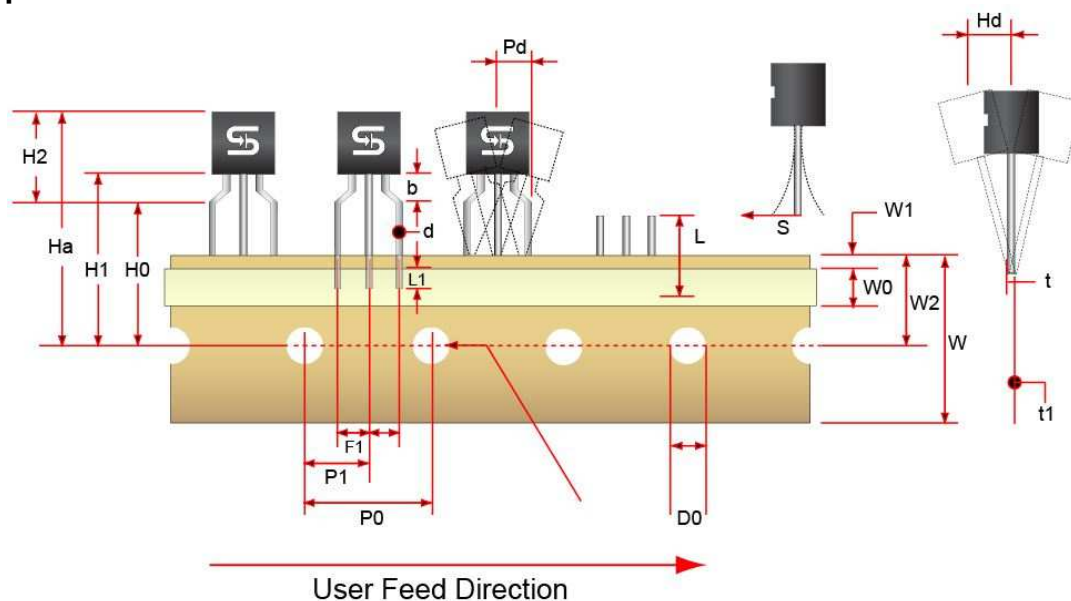
**Marking Diagram**



- XX** = Voltage Code  
(**50** = 5.0V, **33** = 3.3V)
- 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 Ammo Pack Specification**

**TO-92 Tape Leader and Trailer**



**TO-92 Tape Dimension**

Item Description	Symbol	Dimension
Base of Package to Lead Bend	b	3.0 (typ.)
Component Height	Ha	23.57 (typ.)
Lead Clinch Height	H0	16.0 ±0.5
Component Base Height	H1	19.0 ±0.5
Component Top to Lead Bend	H2	8.0 (max)
Component Alignment (side / side)	Pd	1.02 (max)
Component Alignment (front / back)	Hd	0.79 (max)
Feed Hole Pitch	P0	12.7 ±0.3
Hole Center to Component Center	P1	6.25 ±0.4
Lead Spread	F1	2.5 ±0.3
Lead Thickness	d	0.46 (typ.)
Cut Lead Length	L	10.9 (max)
Taped Lead Length	L1	5.31 (typ.)
Taped Lead Thickness	t	0.81 ±0.2
Carrier Tape Thickness	t1	0.5 ±0.2
Carrier Tape Width	W	18.0 ±0.5
Hold – down Tape Width	W0	0.5 ±0.2
Hold – down Tape position	W1	9.0 ±0.7
Feed Hole Position	W2	6.0 ±0.2
Sprocket Hole Diameter	D0	4.0 ±0.2



Lead Spring Out	S	0.1 (max)
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Note: All dimensions are in millimeter.

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## 150mA Ultra Low Dropout Voltage Regulator

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