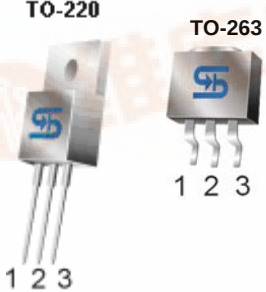


|                                                                                                                                                                                                           |                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
|                                                                                                                          | <h1>TS39150</h1> <h2>1.5A Ultra Low Dropout Fixed Positive Voltage Regulator</h2> |
|  <p>Pin assignment:</p> <ol style="list-style-type: none"> <li>1. Input</li> <li>2. Ground</li> <li>3. Output</li> </ol> | <p><b>Low Dropout Voltage 0.4V (typ.)</b></p>                                     |

### General Description

The TS39150 series are using process with a PNP pass element for high current, high accuracy and low dropout voltage regulators. These regulator s feature 400mV(typ) dropout voltages and very low ground current, these devices also find applications in lower current and low dropout critical systems, where their tiny dropout voltage and ground current values are important attributes.

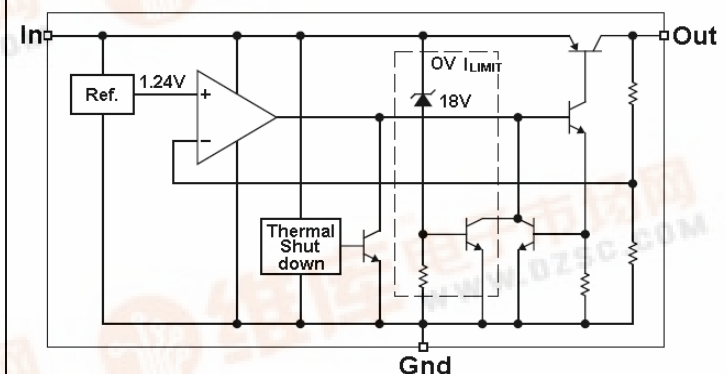
The TS39150 are fully protected against over current faults, reversed input polarity, reversed lead insertion, over temperature operation, and positive and negative transient voltage spikes.

This series is offered in 3-pin TO-263, TO-220 package.

### Features

- ✧ Dropout voltage typically 0.4V @ $I_o=1.5A$
- ✧ Output current up to 1.5A
- ✧ Low ground current
- ✧ Output voltage trimmed before assembly
- ✧ Extremely fast transient response
- ✧ +20V Transient peak voltage
- ✧ -20V Reverse peak voltage
- ✧ Internal current limit
- ✧ Thermal shutdown protection

### Block Diagram



### Applications

- ✧ Battery power equipment
- ✧ Automotive electronics
- ✧ High efficiency "Green" computer system
- ✧ High efficiency linear power supplies
- ✧ High efficiency post regulator for switching supply

### Ordering Information

| Part No.    | Operation Temp. (Junction) | Package |
|-------------|----------------------------|---------|
| TS39150CZxx | -40 ~ +125 °C              | TO-220  |
| TS39150CMxx |                            | TO-263  |

Note: Where **xx** denotes voltage option, available are 12V, 5.0V, 3.3V and 2.5V. Contact factory for additional voltage options.

### Absolute Maximum Rating (Note 1)

|                                      |                           |                    |    |
|--------------------------------------|---------------------------|--------------------|----|
| Input Supply Voltage (Note 2)        | V <sub>in</sub>           | -20V ~ +20         | V  |
| Operation Input Voltage              | V <sub>in</sub> (operate) | 20                 | V  |
| Power Dissipation (Note 3)           | P <sub>D</sub>            | Internally Limited | W  |
| Operating Junction Temperature Range | T <sub>J</sub>            | -40 ~ +125         | °C |
| Storage Temperature Range            | T <sub>STG</sub>          | -65 ~ +150         | °C |
| Lead Soldering Temperature (260 °C)  |                           | 5                  | S  |



| Electrical Characteristics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                        |          |          |          |        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|----------|----------|----------|--------|
| Vin = Vout + 1V, IL = 10mA, Co = 10uF, Ta = 25 °C, unless otherwise specified.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                        |          |          |          |        |
| Parameter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Conditions                             | Min      | Typ      | Max      | Unit   |
| Output Voltage                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                        | 0.990 Vo | 12 / 5.0 | 1.010 Vo | V      |
| Output Voltage                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 10mA ≤ IL ≤ 1.5A,<br>Vo+1V ≤ Vin ≤ 26V | 0.980 Vo | 3.3/ 2.5 | 1.020 Vo | V      |
| Input Supply Voltage                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                        | --       | --       | 20       | V      |
| Output Voltage Temperature Coefficient                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                        | --       | 40       | 100      | ppm/°C |
| Line Regulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Vo+1V ≤ Vin ≤ 26V                      | --       | 0.05     | 0.5      | %      |
| Load Regulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 10mA ≤ IL ≤ 1.5A                       | --       | 0.2      | 1.0      | %      |
| Dropout Voltage (Note 4)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | IL=100mA                               | --       | 80       | 200      | mV     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | IL=750mA                               | --       | 350      | 500      |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | IL=1.5A                                | --       | 400      | 600      |        |
| Quiescent Current (Note 5)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | IL=100uA                               | --       | 100      | --       | mA     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | IL=750mA                               | --       | 8        | --       |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | IL=1.5A                                | --       | 22       | --       |        |
| Short Circuit Current (Note 6)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Vout=0                                 | --       | 2.1      | 3.5      | A      |
| Output Noise,<br>10Hz to 100KHz, IL=100mA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | CL=2.2uF                               | --       | 600      | --       | uVrms  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | CL=10uF                                | --       | 400      | --       |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | CL=33uF                                | --       | 260      | --       |        |
| Thermal Performance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                        |          |          |          |        |
| Condition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Package type                           | Typ      |          |          | Unit   |
| Thermal Resistance<br>Junction to Ambient                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | TO-220                                 | 60       |          |          | °C/W   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | TO-263                                 | 80       |          |          |        |
| <p>Note 1: Absolute Maximum Rating is limits beyond which damage to the device may occur. For guaranteed Specifications and test conditions see the Electrical Characteristics.</p> <p>Note 2: Maximum positive supply voltage of 20V must be limited duration (&lt;100mS) and duty cycle (&lt;1%).</p> <p>Note 3: The maximum allowable power dissipation is a function of the maximum junction temperature, Tj, the junction to ambient thermal resistance, θja, and the ambient temperature , Ta. Exceeding the maximum allowable power dissipation will cause excessive die temperature, and the regulator will go into thermal shutdown. The effective value of θja can be reduced by using a heatsink.</p> <p>Note 4: Dropout voltage is defined as the input to output differential at which the output voltage drops 2% below its nominal value measured at 1V differential.</p> <p>Note 5: Ground pin current is the regulator quiescent current. The total current drawn from the source is the sum of the ground pin current and output load current.</p> <p>Note 6: Output current will decrease with increasing temperature, but it will be not dropped below 1.5A at the maximum specified temperature.</p> |                                        |          |          |          |        |



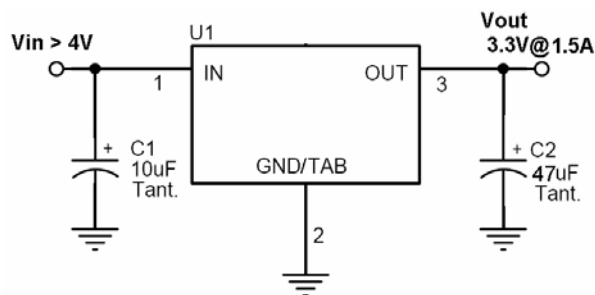
## Application Information

### Application Information

The TS39150 series are high performance with low dropout voltage regulator suitable for moderate to high current and voltage regulator application. Its 400mA(typ) dropout voltage at full load and over temperature makes it especially valuable in battery power systems and as high efficiency noise filters in post regulator applications. Unlike normal NPN transistor design, where the base to emitter voltage drop and collector to emitter saturation voltage limit the minimum dropout voltage, dropout performance of the PNP output of these devices is limited only by low Vce saturation voltage.

The TS39150 series is fully protected from damage due to fault conditions. Linear current limiting is provided. Output current during overload conditions is constant. Thermal shutdown the device when the die temperature exceeds the maximum safe operating temperature. Transient protection allows device survival even when the input voltage spikes above and below nominal. The output structure of these regulators allows voltages in excess of the desired output voltage to be applied without reverse current flow.

### Typical Application Circuit



### Capacitor Requirement

The TS39150 series requires an output capacitor to maintain stability and improve transient response is necessary. The value of this capacitor is dependent upon the output current, lower currents allow smaller capacitors. TS39150 series regulators are stable with the 10uF minimum capacitor value at full load. Where the regulator is powered from a source with high AC impedance, a 0.1uF capacitor connected between input and ground is recommended. The capacitor should have good characteristics to above 250KHz. The capacitance values will be improved transient response, ripple rejection and output noise.

### Minimum Load Current

The TS39150 series is specified between finite loads. If the output current is too small leakage currents dominate and the output voltage rises. A 10mA minimum load current swamps any expected leakage current across the operating temperature range.

### Thermal Characteristics

TS39150 series linear regulators are simple to use, the most complicated design parameters to consider are thermal characteristics, thermal design requires the following application specification parameters:

- Maximum ambient temperature, Ta
- Output current, I<sub>out</sub>
- Output voltage, V<sub>out</sub>
- Input voltage, V<sub>in</sub>

We calculate the power dissipation of the regulator from these numbers and the device parameters from this data sheet. A heatsink may be required depending on the maximum power dissipation and maximum ambient temperature of the application. Under all possible operating conditions, the junction temperature must be within the range specified under absolute maximum ratings. To determine if the heatsink is required, the power dissipated by the regulator, P<sub>D</sub> must be calculated.

The below formula shows the voltages and currents for calculating the P<sub>D</sub> in the regulator:

$$I_{in} = I_L + I_G$$

$$P_D = (V_{in} - V_{out}) * I_L + (V_{in}) * I_G$$

$$\begin{aligned} \text{Ex. } P_D &= (3.3V - 2.5V) * 1.5A + 3.3V * 11mA \\ &= 1200mW + 36mW \\ &= 1236mW \end{aligned}$$

Remark: I<sub>L</sub> is output load current,  
I<sub>G</sub> is ground current.  
V<sub>in</sub> is input voltage  
V<sub>out</sub> is output voltage

The next parameter which must be calculated is the maximum allowable temperature rise, T<sub>R(max)</sub>. this is calculated by the using to formula:

$$T_{R(max)} = T_J(max) - T_A(max)$$

Where: T<sub>J(max)</sub> is the maximum allowable junction temperature, which is 125°C for commercial grade parts.

T<sub>A(max)</sub> is the maximum ambient temperature which will be encountered in the application.



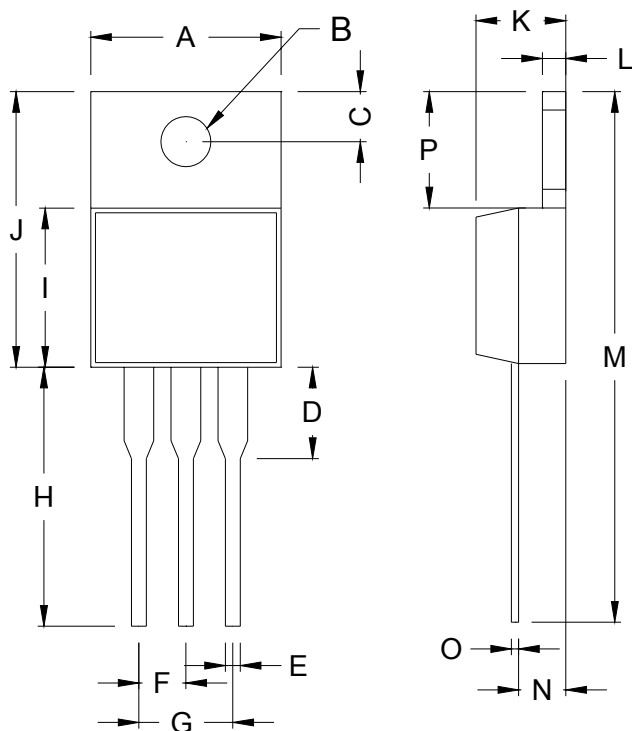
## Application Information (continues)

Using the calculated values for  $T_R(\text{max})$  and  $P_D$ , the maximum allowable value for the junction to ambient thermal resistance,  $\theta_{ja}$ , can now be found:

$$\theta_{ja} = T_R(\text{max}) / P_D$$

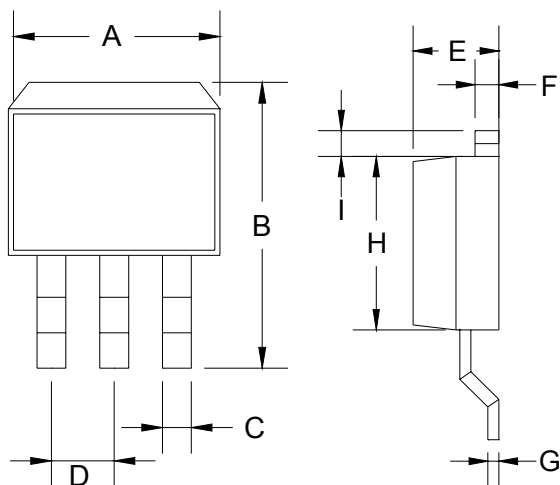
IMPORTANT: if the maximum allowable value for is found to be  $\geq 60$  °C/W for the TO-220 package,  $\geq 80$  °C/W for the TO-263 package, no heatsink is needed since the package alone will dissipate enough heat to satisfy these requirements. If the calculated value for  $\theta_{ja}$  falls below these limits, a heatsink is required.

## TO-220 Mechanical Drawing



| TO-220 DIMENSION |             |        |        |       |
|------------------|-------------|--------|--------|-------|
| DIM              | MILLIMETERS |        | INCHES |       |
|                  | MIN         | MAX    | MIN    | MAX   |
| A                | 10.000      | 10.500 | 0.394  | 0.413 |
| B                | 3.240       | 4.440  | 0.128  | 0.175 |
| C                | 2.440       | 2.940  | 0.096  | 0.116 |
| D                | -           | 6.350  | -      | 0.250 |
| E                | 0.381       | 1.106  | 0.015  | 0.040 |
| F                | 2.345       | 2.715  | 0.092  | 0.058 |
| G                | 4.690       | 5.430  | 0.092  | 0.107 |
| H                | 12.700      | 14.732 | 0.500  | 0.581 |
| I                | 8.382       | 9.017  | 0.330  | 0.355 |
| J                | 14.224      | 16.510 | 0.560  | 0.650 |
| K                | 3.556       | 4.826  | 0.140  | 0.190 |
| L                | 0.508       | 1.397  | 0.020  | 0.055 |
| M                | 27.700      | 29.620 | 1.060  | 1.230 |
| N                | 2.032       | 2.921  | 0.080  | 0.115 |
| O                | 0.255       | 0.610  | 0.010  | 0.024 |
| P                | 5.842       | 6.858  | 0.230  | 0.270 |

## TO-263 Mechanical Drawing



| TO-263 DIMENSION |             |        |        |       |
|------------------|-------------|--------|--------|-------|
| DIM              | MILLIMETERS |        | INCHES |       |
|                  | MIN         | MAX    | MIN    | MAX   |
| A                | 10.000      | 10.500 | 0.394  | 0.413 |
| B                | 14.605      | 15.875 | 0.575  | 0.625 |
| C                | 0.508       | 0.991  | 0.020  | 0.039 |
| D                | 2.420       | 2.660  | 0.095  | 0.105 |
| E                | 4.064       | 4.830  | 0.160  | 0.190 |
| F                | 1.118       | 1.400  | 0.045  | 0.055 |
| G                | 0.450       | 0.730  | 0.018  | 0.029 |
| H                | 8.280       | 8.800  | 0.325  | 0.346 |
| I                | 1.140       | 1.400  | 0.044  | 0.055 |
| J                | 1.480       | 1.520  | 0.058  | 0.060 |