

## ADVANCED INFORMATION

## CMOS LDO REGULATOR WITH HIGH ACTIVE CONTROL

### FEATURES

- Low Dropout Voltage
- Very Low Quiescent Current (50  $\mu$ A maximum)
- Internal Bandgap Reference
- Regulates down to 1.8 V
- Short Circuit Protection
- Very Low Standby Current (1  $\mu$ A maximum)
- Miniature Package (SOT-23-5)

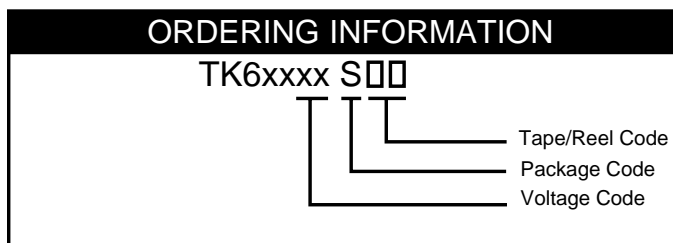
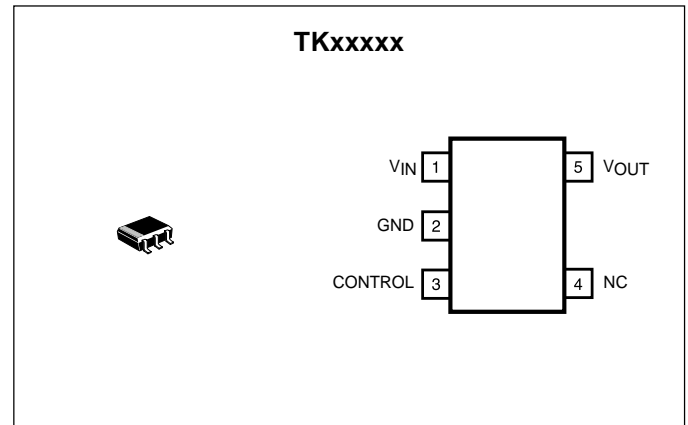
### APPLICATIONS

- Battery Powered Systems
- Cellular Telephones
- Pagers
- Toys
- Radio Control Systems
- Low Voltage Systems
- Personal Communications Systems
- Portable Instrumentation
- Portable Consumer Equipment

### DESCRIPTION

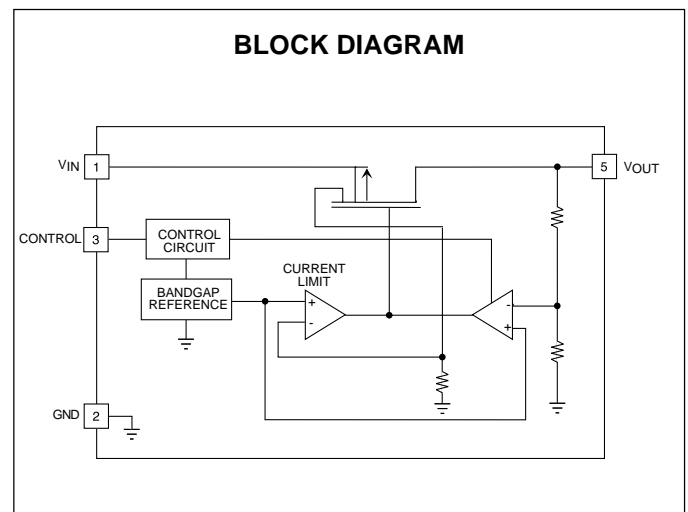
The device is a low dropout linear regulation housed in a small SOT-23-5 package, rated at 500 mW.

An internal P Channel pass transistor is used in order to achieve low dropout voltage. The device has extremely low quiescent current (max 50  $\mu$ A). The device offers high precision output voltage of 2% at over temperature. The low quiescent current and dropout voltage make this part ideal for battery powered applications. In the standby mode when the device is disabled, the linear regulator only draws 1  $\mu$ A (max).



| VOLTAGE CODE |            |            |
|--------------|------------|------------|
| 18 = 1.8 V   | 33 = 3.3 V | 55 = 5.5 V |
| 20 = 2.0 V   | 35 = 3.5 V | 60 = 6.0 V |
| 25 = 2.5 V   | 40 = 4.0 V |            |
| 28 = 2.8 V   | 45 = 4.5 V |            |
| 30 = 3.0 V   | 50 = 5.0 V |            |

| TAPE/REEL CODE |           |
|----------------|-----------|
| TL:            | Tape Left |
| PACKAGE CODE   |           |
| S:             | SOT-23-5  |



## ADVANCED INFORMATION

### ABSOLUTE MAXIMUM RATINGS

All pins except GND ..... 9 V  
 Power Dissipation (Note 1) ..... 500 mW  
 Storage Temperature Range ..... -55 to +150 °C

Operating Temp. Range ..... -30 to +80 °C  
 Junction Temperature ..... 150 °C

### ELECTRICAL CHARACTERISTICS

Test conditions:  $V_{IN} = V_{OUT(TYP)} + 1\text{ V}$ ,  $T_A = 25\text{ °C}$ , unless otherwise specified.

| SYMBOL                                 | PARAMETER           | TEST CONDITIONS   | MIN | TYP       | MAX  | UNITS         |
|--|---------------------|---|-----|-----------|------|---------------|
| $V_{IN}$                               | Input Supply        |   |     |           | 8    | V             |
| $I_Q$                                  | Quiescent Current   | No Load   |     | 30        | 50   | $\mu\text{A}$ |
| $I_{STBY}$                             | Standby Current     | $V_{IN} = 8\text{ V}$ , Output Off  |     |           | 1    | $\mu\text{A}$ |
| $I_{OUT}$                              | Output Current      |   | 50  |           |      | mA            |
| $V_{OUT}$                              | Output Voltage      | Note 2, $T_A = -30\text{ to }+80\text{ °C}$ , $I_{OUT} = 1\text{ mA}$               | -2% | $V_{OUT}$ | 2%   | V             |
| Load Reg                               | Load Regulation     | $I_{OUT} = 1\text{ mA to }50\text{ mA}$   |     |           | 200  | mV            |
| Line Reg                               | Line Regulation     | $V_{OUT(TYP)} + 0.5\text{ V} \leq V_{IN} \leq 8\text{ V}$ , $I_{OUT} = 1\text{ mA}$ |     | TBD       |      | mV            |
| $V_{DROP}$                             | Dropout Voltage     | $I_{OUT} = 50\text{ mA}$  |     | 55        | 200  | mV            |
| <b>CONTROL TERMINAL SPECIFICATIONS</b> |                     |   |     |           |      |               |
| $I_{CONT}$                             | Control Current     | $V_{CONT} = 1.5\text{ V}$ , Output ON   |     | TBD       |      | $\mu\text{A}$ |
| $V_{CONT}$ (ON)                        | Control Voltage ON  | Output ON   | 1.5 |           |      | V             |
| $V_{CONT}$ (OFF)                       | Control Voltage OFF | Output OFF  |     |           | 0.25 | V             |

Note 1: Power dissipation is 500 mW when mounted as recommended (150 mW in Free Air). Derate at 1.8 mW/°C for operation above 25 °C.

Note 2:  $V_{OUT} = 1.8\text{ V to }6\text{ V}$ , 0.1 V step.

## ADVANCED INFORMATION

### DEFINITION AND EXPLANATION OF TECHNICAL TERMS

#### OUTPUT VOLTAGE ( $V_{OUT}$ )

The output voltage is specified with  $V_{IN} = (V_{OUT(TYP)} + 1 \text{ V})$  and  $I_{OUT} = 1 \text{ mA}$ .

#### DROPOUT VOLTAGE ( $V_{DROP}$ )

The dropout voltage is the difference between the input voltage and the output voltage at which point the regulator starts to fall out of regulation. Below this value, the output voltage will fall as the input voltage is reduced. It is dependent upon the load current and the junction temperature.

#### OUTPUT CURRENT ( $I_{OUT}$ )

Normal operating output current. This is limited by package power dissipation.

#### LINE REGULATION (Line Reg)

Line regulation is the ability of the regulator to maintain a constant output voltage as the input voltage changes. The line regulation is specified as the input voltage is changed from  $V_{IN} = V_{OUT} + 0.5 \text{ V}$  to  $V_{IN} = 8 \text{ V}$ .

#### LOAD REGULATION (Load Reg)

Load regulation is the ability of the regulator to maintain a constant output voltage as the load current changes. It is a pulsed measurement to minimize temperature effects with the input voltage set to  $V_{IN} = V_{OUT} + 1 \text{ V}$ . The load regulation is specified under output current step conditions of 1 mA to 50 mA.

#### QUIESCENT CURRENT ( $I_Q$ )

The quiescent current is the current which flows through the ground terminal under no load conditions ( $I_{OUT} = 0 \text{ mA}$ ).

#### STANDBY CURRENT ( $I_{STBY}$ )

Standby current is the current which flows into the regulator when the output is turned off by the control function ( $V_{CONT} = 0 \text{ V}$ ). It is measured with  $V_{IN} = 8 \text{ V}$ .

#### SENSOR CIRCUITS

##### Overcurrent Sensor

The overcurrent sensor protects the device if the output is shorted to ground.

##### PACKAGE POWER DISSIPATION ( $P_D$ )

This is the power dissipation level at which the thermal sensor is activated. The IC contains an internal thermal sensor which monitors the junction temperature. When the junction temperature exceeds the monitor threshold of 150 °C, the IC is shut down. The junction temperature rises as the difference between the input power ( $V_{IN} \times I_{IN}$ ) and the output power ( $V_{OUT} \times I_{OUT}$ ) increases. The rate of temperature rise is greatly affected by the mounting pad configuration on the PCB, the board material, and the ambient temperature. When the IC mounting has good thermal conductivity, the junction temperature will be low even if the power dissipation is great. When mounted on the recommended mounting pad, the power dissipation of the SOT-23-5 is increased to 500 mW. For operation at ambient temperatures over 25 °C, the power dissipation of the SOT-23-5 device should be derated at 4.0 mW/°C. To determine the power dissipation for shutdown when mounted, attach the device on the actual PCB and deliberately increase the output current (or raise the input voltage) until the thermal protection circuit is activated. Calculate the power dissipation of the device by subtracting the output power from the input power. These measurements should allow for the ambient temperature of the PCB. The value obtained from  $P_D / (150 \text{ °C} - T_A)$  is the derating factor. The PCB mounting pad should provide maximum thermal conductivity in order to maintain low device temperatures. As a general rule, the lower the temperature, the better the reliability of the device. The thermal resistance when mounted is expressed as follows:

$$T_j = \theta_{jA} \times P_D + T_A$$

For Toko ICs, the internal limit for junction temperature is 150 °C. If the ambient temperature ( $T_A$ ) is 25 °C, then:

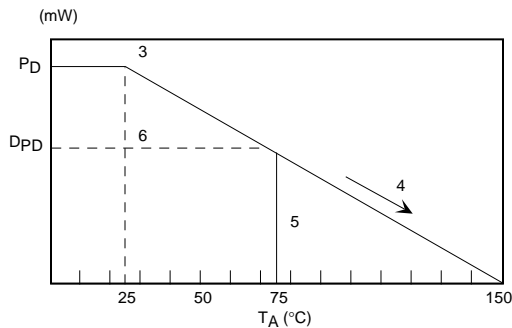
$$150 \text{ °C} = \theta_{jA} \times P_D + 25 \text{ °C}$$
$$\theta_{jA} = 125 \text{ °C} / P_D$$

## ADVANCED INFORMATION

### DEFINITION AND EXPLANATION OF TECHNICAL TERMS (CONT.)

$P_D$  is the value when the thermal protection circuit is activated. A simple way to determine  $P_D$  is to calculate  $V_{IN} \times I_{IN}$  when the output side is shorted. Input current gradually falls as temperature rises. You should use the value when thermal equilibrium is reached.

The range of usable currents can also be found from the graph below.

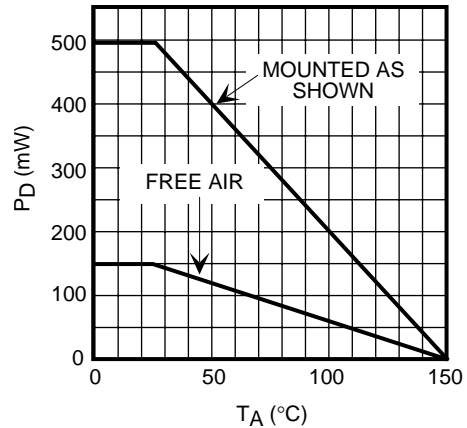


Procedure:

- 1) Find  $P_D$
- 2)  $P_{D1}$  is taken to be  $P_D \times (-0.8 - 0.9)$
- 3) Plot  $P_{D1}$  against  $25^\circ\text{C}$
- 4) Connect  $P_{D1}$  to the point corresponding to the  $150^\circ\text{C}$  with a straight line.
- 5) In design, take a vertical line from the maximum operating temperature (e.g.,  $75^\circ\text{C}$ ) to the derating curve.
- 6) Read off the value of  $P_D$  against the point at which the vertical line intersects the derating curve. This is taken as the maximum power dissipation,  $D_{PD}$ .

The maximum operating current is:

$$I_{OUT} = (D_{PD} / (V_{IN(MAX)} - V_{OUT}))$$

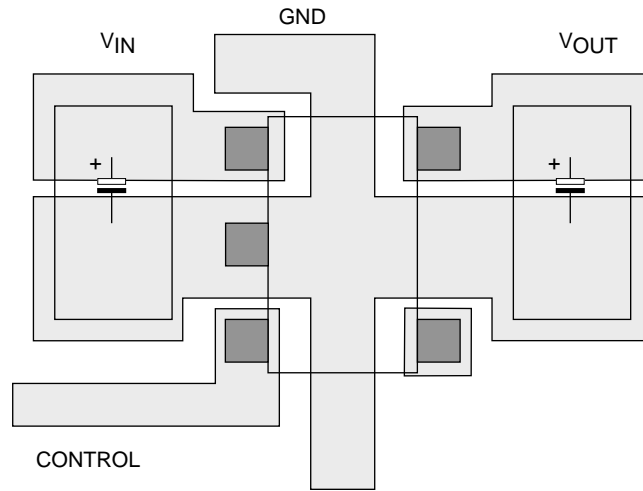


**SOT-23-5 POWER DISSIPATION CURVE**

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## APPLICATION INFORMATION

### BOARD LAYOUT

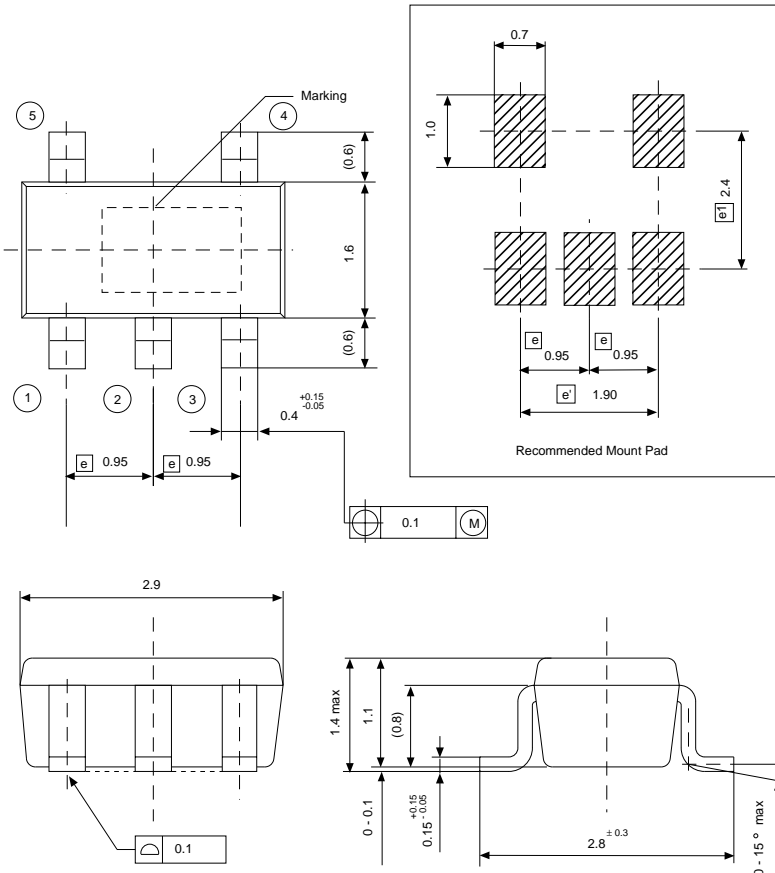


### SOT-23-5 BOARD LAYOUT

# ADVANCED INFORMATION

## PACKAGE OUTLINE

### SOT-23-5



Dimensions are shown in millimeters  
Tolerance: x.x = ± 0.2 mm (unless otherwise specified)

### Marking Information

Part Number      Marking



**Toko America, Inc. Headquarters**  
1250 Feehanville Drive, Mount Prospect, Illinois 60056  
Tel: (847) 297-0070    Fax: (847) 699-7864

### TOKO AMERICA REGIONAL OFFICES

**Midwest Regional Office**  
Toko America, Inc.  
1250 Feehanville Drive  
Mount Prospect, IL 60056  
Tel: (847) 297-0070  
Fax: (847) 699-7864

**Western Regional Office**  
Toko America, Inc.  
2480 North First Street, Suite 260  
San Jose, CA 95131  
Tel: (408) 432-8281  
Fax: (408) 943-9790

**Eastern Regional Office**  
Toko America, Inc.  
107 Mill Plain Road  
Danbury, CT 06811  
Tel: (203) 748-6871  
Fax: (203) 797-1223

**Semiconductor Technical Support**  
Toko Design Center  
4755 Forge Road  
Colorado Springs, CO 80907  
Tel: (719) 528-2200  
Fax: (719) 528-2375

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