

## Adjustable 0.6V Open Collector Shunt Voltage Reference

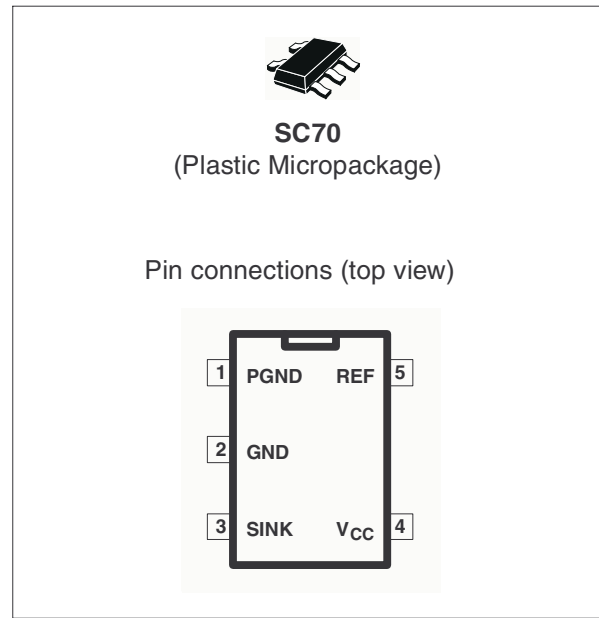
- Internal 0.6V  $\pm 0.5\%$  precision
- Low output saturation voltage  
75mV max. between SINK and GND
- Low current consumption: 150 $\mu$ A
- Low supply voltage 1.7V
- Industrial temperature range: -40 to +85°C
- 150ppm/°C temperature coefficient
- Lead free available

### Description

The TS4436 is a four-terminal device dedicated to low voltage Switch Mode Power Supplies (SMPS).

It integrates a 0.6V voltage reference, an amplifier, and an open collector output transistor in a single package. The TS4436's operating mode is similar to the well-known standard voltage reference, the TL431. It maintains the desired feedback voltage at the REF pin in a closed loop configuration by sinking a current proportional to the error voltage at the REF pin.

TS4436 features an open collector transistor with an ultra-low saturation voltage. This feature allows it to be used in series with the optocoupler in an SMPS for regulation up to a 1.8V output voltage.



### Applications

- Low voltage switch mode power supplies
- Isolated DC/DC converter
- Computers
- Low voltage discrete regulators

### Order Codes

| Part Number | Accuracy | Temperature Range | Package | Packing     | Marking |
|-------------|----------|-------------------|---------|-------------|---------|
| TS4436AICT  | 0.5%     | -40, +85°C        | SC70    | Tape & Reel | L22     |
| TS4436ICT   | 1%       |                   |         |             | L21     |

# 1 Absolute Maximum Ratings and Operating Conditions

**Table 1. Key parameters and their absolute maximum ratings**

| Symbol            | Parameter                                | Value       | Unit |
|-------------------|------------------------------------------|-------------|------|
| I <sub>SINK</sub> | Output sink current                      | 30          | mA   |
| V <sub>CC</sub>   | Supply voltage                           | 12          | V    |
| V <sub>SINK</sub> | Output voltage                           | 12          | V    |
| P <sub>diss</sub> | Power Dissipation <sup>(1)</sup> SOT23-5 |             | mW   |
| P <sub>diss</sub> | Power Dissipation <sup>(2)</sup> SC70    | 310         | mW   |
| T <sub>STD</sub>  | Storage Temperature                      | -65 to +150 | °C   |
| ESD               | Human Body Model (HBM)                   | 2           | kV   |
|                   | Machine Model (MM)                       | 200         | V    |
| T <sub>LEAD</sub> | Lead Temperature (soldering, 10 seconds) | 250         | °C   |

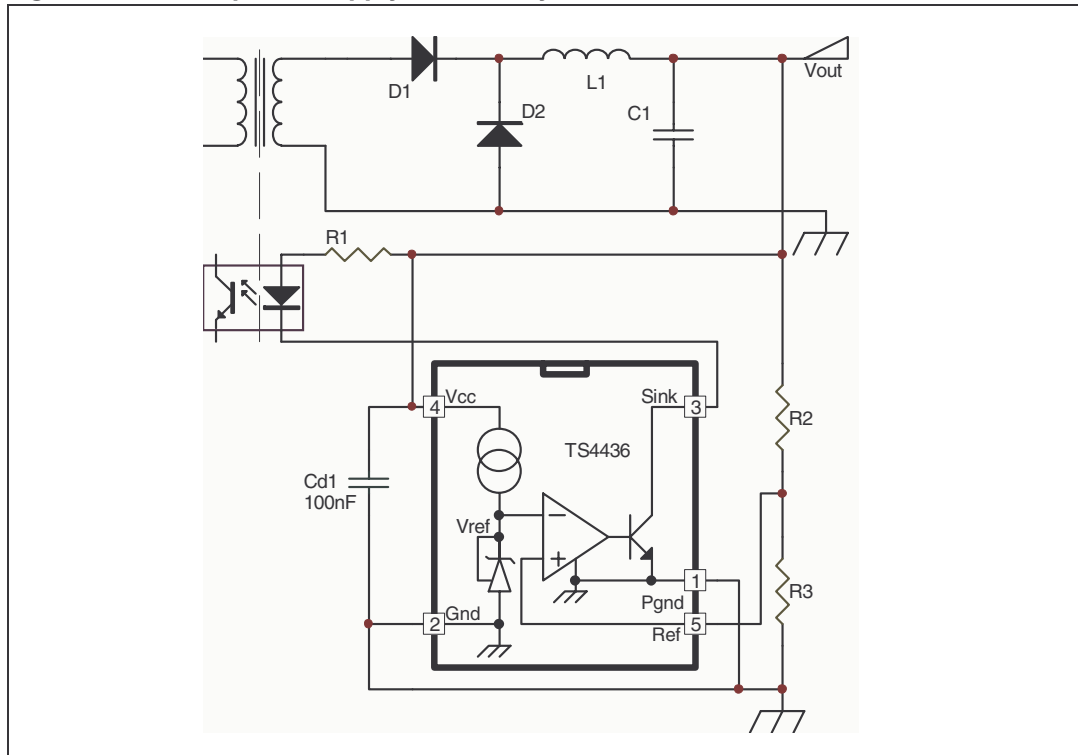
1. P<sub>diss</sub> has been calculated with T<sub>AMB</sub> = 25°C, T<sub>Junction</sub>=150°C and  
 R<sub>thJA</sub> = 250°C/W for the SOT23-5 package  
 R<sub>thJC</sub> = 81°C/W for the SOT23-5 package
2. P<sub>diss</sub> has been calculated with T<sub>AMB</sub> = 25°C, T<sub>Junction</sub>=150°C and  
 R<sub>thJA</sub> = 250°C/W for the SOT23-5 package  
 R<sub>thJC</sub> = 81°C/W for the SOT23-5 package

**Table 2. Operating conditions**

| Symbol            | Parameter                   | Value      | Unit |
|-------------------|-----------------------------|------------|------|
| T <sub>OPER</sub> | Operating temperature range | -40 to +85 | °C   |
| V <sub>CC</sub>   | Supply voltage              | 1.7 to 10  | V    |
| I <sub>SINK</sub> | Output sink current         | up to 20   | mA   |

## 2 Typical Application Schematic

Figure 1. SMPS power supply: secondary side



### 3 Electrical Characteristics

**Table 3. Electrical characteristics for  $T_{amb} = 25^{\circ}\text{C}$ ,  $V_{CC} = 1.8\text{V}$ ,  $I_{SINK} = 2\text{mA}$  unless otherwise specified**

| Symbol    | Parameter                                                                     | Test Conditions                                 | Min.  | Typ. | Max.  | Unit                    |
|-----------|-------------------------------------------------------------------------------|-------------------------------------------------|-------|------|-------|-------------------------|
| $V_{ref}$ | Reference voltage<br>TS4436A 0.5%                                             |                                                 | 0.597 | 0.6  | 0.603 | V                       |
|           |                                                                               | $-40^{\circ}\text{C} < T < +85^{\circ}\text{C}$ | 0.589 |      | 0.611 |                         |
| $V_{ref}$ | Reference voltage<br>TS4436 1%                                                |                                                 | 0.594 | 0.6  | 0.606 | V                       |
|           |                                                                               | $-40^{\circ}\text{C} < T < +85^{\circ}\text{C}$ | 0.589 | 0.6  | 0.611 |                         |
| $T_C$     | Temperature coefficient                                                       |                                                 |       |      | 150   | ppm/ $^{\circ}\text{C}$ |
| RegLine   | Change in $V_{ref}$ due to<br>change in $V_{CC}$                              | $V_{CC}=1.7$ to $10\text{V}$                    |       | 1    | 2.5   | mV                      |
|           |                                                                               | $-40^{\circ}\text{C} < T < +85^{\circ}\text{C}$ |       | 2    | 3     |                         |
| RegLoad   | Change in $V_{ref}$ due to<br>change in $I_{SINK}$                            | $I_{SINK}=0.1$ to $20\text{mA}$                 |       | 3.5  | 7     | mV                      |
|           |                                                                               | $-40^{\circ}\text{C} < T < +85^{\circ}\text{C}$ |       |      | 10    |                         |
| $I_{CC}$  | Supply current                                                                | $I_{SINK}=2\text{mA}$                           |       | 150  | 200   | $\mu\text{A}$           |
|           |                                                                               | $-40^{\circ}\text{C} < T < +85^{\circ}\text{C}$ |       |      | 250   |                         |
| $I_{REF}$ | Change in $I_{ref}$ Reference<br>input current due to<br>change in $I_{SINK}$ | $0.1 < I_{SINK} < 10\text{mA}$                  |       | 20   | 50    | nA                      |
|           |                                                                               | $-40^{\circ}\text{C} < T < +85^{\circ}\text{C}$ |       |      | 65    |                         |
| $V_{SAT}$ | Output transistor<br>saturation voltage                                       | $I_{SINK}=5\text{mA}$                           |       | 30   | 50    | mV                      |
|           |                                                                               | $-40^{\circ}\text{C} < T < +85^{\circ}\text{C}$ |       |      | 60    |                         |
|           |                                                                               | $I_{SINK}=20\text{mA}$                          |       | 90   | 120   |                         |
|           |                                                                               | $-40^{\circ}\text{C} < T < +85^{\circ}\text{C}$ |       |      | 140   |                         |
| $I_{OH}$  | Output leakage current                                                        | $V_{SINK}=V_{CC}$                               |       |      | 0.05  | $\mu\text{A}$           |
|           |                                                                               | $-40^{\circ}\text{C} < T < +85^{\circ}\text{C}$ |       |      | 0.1   |                         |

*Note: Limits are 100% production tested at  $25^{\circ}\text{C}$ . Limits over temperature are guaranteed through correlation and by design.*

Figure 2.  $V_{ref}$  vs. temperature

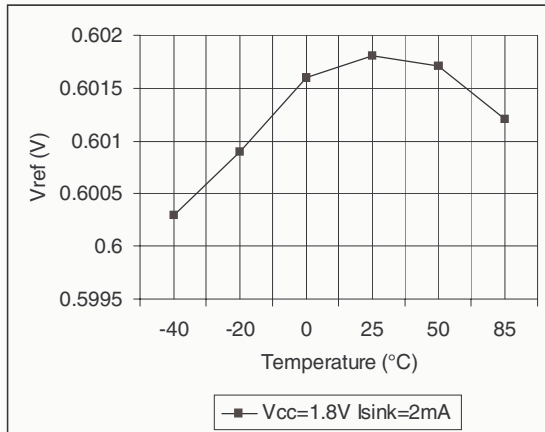


Figure 3.  $V_{ref}$  vs. temperature

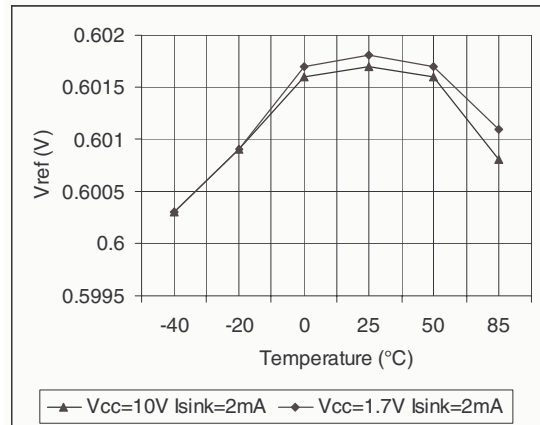


Figure 4.  $I_{CC}$  vs. temperature

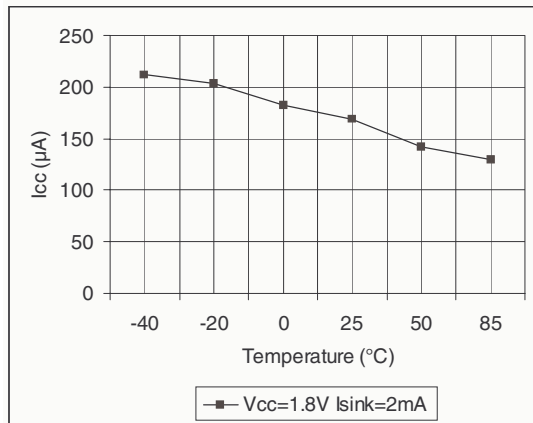


Figure 5.  $I_{CC}$  at 25°C

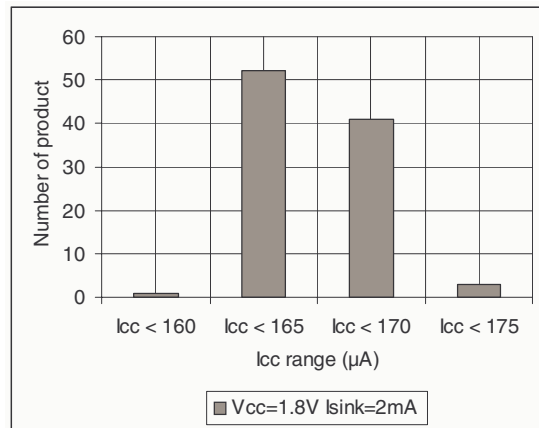


Figure 6.  $V_{SAT}$  vs. temperature

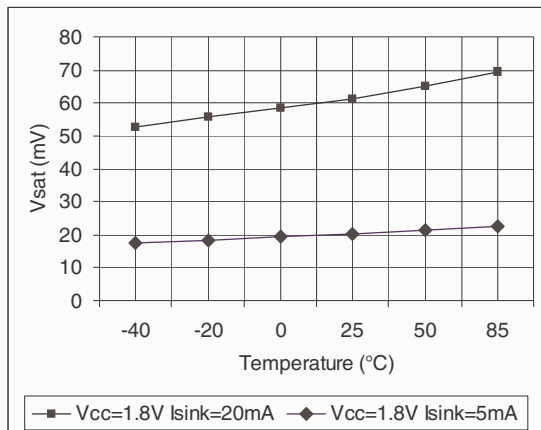
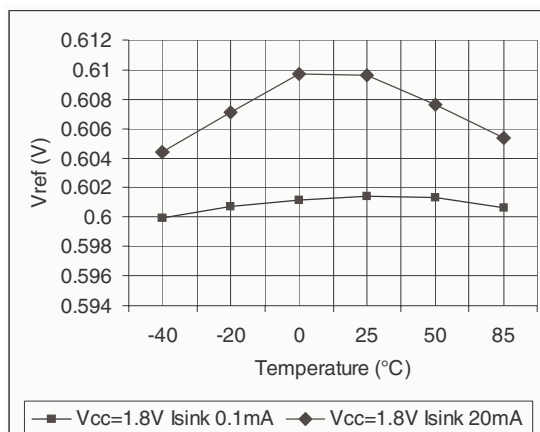


Figure 7.  $V_{ref}$  vs. temperature

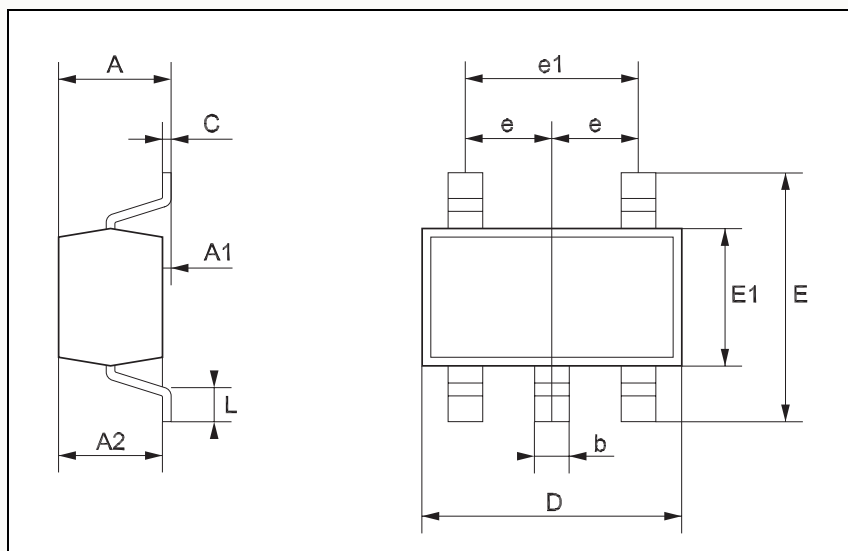


## 4 Package Mechanical Data

In order to meet environmental requirements, ST offers these devices in ECOPACK<sup>®</sup> packages. These packages have a Lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com).

### SC70 Package

| SOT323-5L MECHANICAL DATA |      |      |      |      |      |      |
|---------------------------|------|------|------|------|------|------|
| DIM.                      | mm.  |      |      | mils |      |      |
|                           | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A                         | 0.80 |      | 1.10 | 31.5 |      | 43.3 |
| A1                        | 0.00 |      | 0.10 | 0.0  |      | 3.9  |
| A2                        | 0.80 |      | 1.00 | 31.5 |      | 39.4 |
| b                         | 0.15 |      | 0.30 | 5.9  |      | 11.8 |
| C                         | 0.10 |      | 0.18 | 3.9  |      | 7.1  |
| D                         | 1.80 |      | 2.20 | 70.9 |      | 86.6 |
| E                         | 1.80 |      | 2.40 | 70.9 |      | 94.5 |
| E1                        | 1.15 |      | 1.35 | 45.3 |      | 53.1 |
| e                         |      | 0.65 |      |      | 25.6 |      |
| e1                        |      | 1.3  |      |      | 51.2 |      |
| L                         | 0.10 |      | 0.30 | 3.9  |      | 11.8 |



## 5 Revision History

**Table 4. Document revision history**

| Date      | Revision | Changes                     |
|-----------|----------|-----------------------------|
| Feb. 2006 | 1        | First release of datasheet. |

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