

## 1.224V Open Collector Shunt Voltage Reference

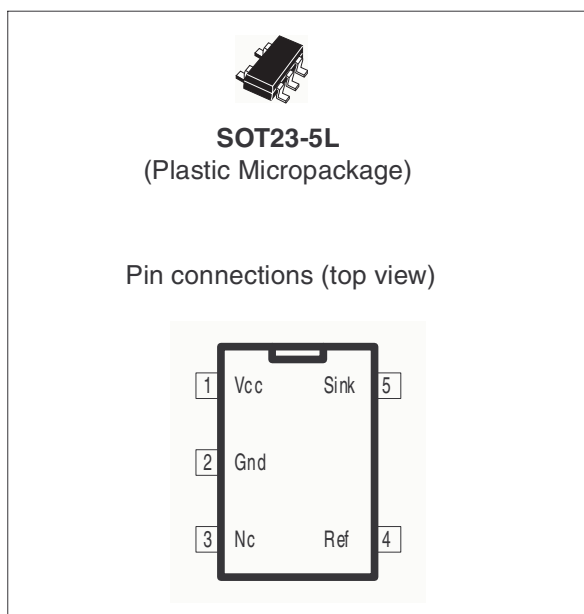
- Internal 1.224V  $\pm 0.5\%$  precision
- Low output saturation voltage  
75 mV max between SINK and GND
- Low current consumption: 250 $\mu$ A
- Industrial temperature range: -40 to +85°C
- 100ppm/°C temperature coefficient

### Description

The TS4431 is a four-terminal device dedicated to low voltage Switch Mode Power Supplies (SMPS).

It integrates a 1.224V voltage reference, an amplifier, and an open collector output transistor in a single package. The TS4431'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.

TS4431 features an open collector transistor with an ultra-low saturation voltage, allowing it to be used in series with the optocoupler in an SMPS architecture to regulate low voltage SMPS.



### Applications

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

### Order Codes

| Part Number | Accuracy | Temperature Range | Package | Packing     | Marking |
|-------------|----------|-------------------|---------|-------------|---------|
| TS4431AILT  | 0.5%     | -40, +85°C        | SOT23-5 | Tape & Reel | L288    |
| TS4431ILT   | 1%       |                   |         |             | L275    |

# 1 Absolute Maximum Ratings

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

| Symbol     | Parameter                                | Value       | Unit |
|------------|------------------------------------------|-------------|------|
| $I_{SINK}$ | Output sink current                      | 30          | mA   |
| $V_{CC}$   | Supply voltage                           | 12          | V    |
| $V_{SINK}$ | Output voltage                           | 12          | V    |
| $P_D$      | Power Dissipation <sup>(1)</sup> SOT23-5 | 500         | mW   |
| $T_{STD}$  | Storage Temperature                      | -65 to +150 | °C   |
| ESD        | Human Body Model (HBM)                   | 2           | kV   |
|            | Machine Model (MM)                       | 200         | V    |
| $T_{LEAD}$ | Lead Temperature (soldering, 10 seconds) | 250         | °C   |

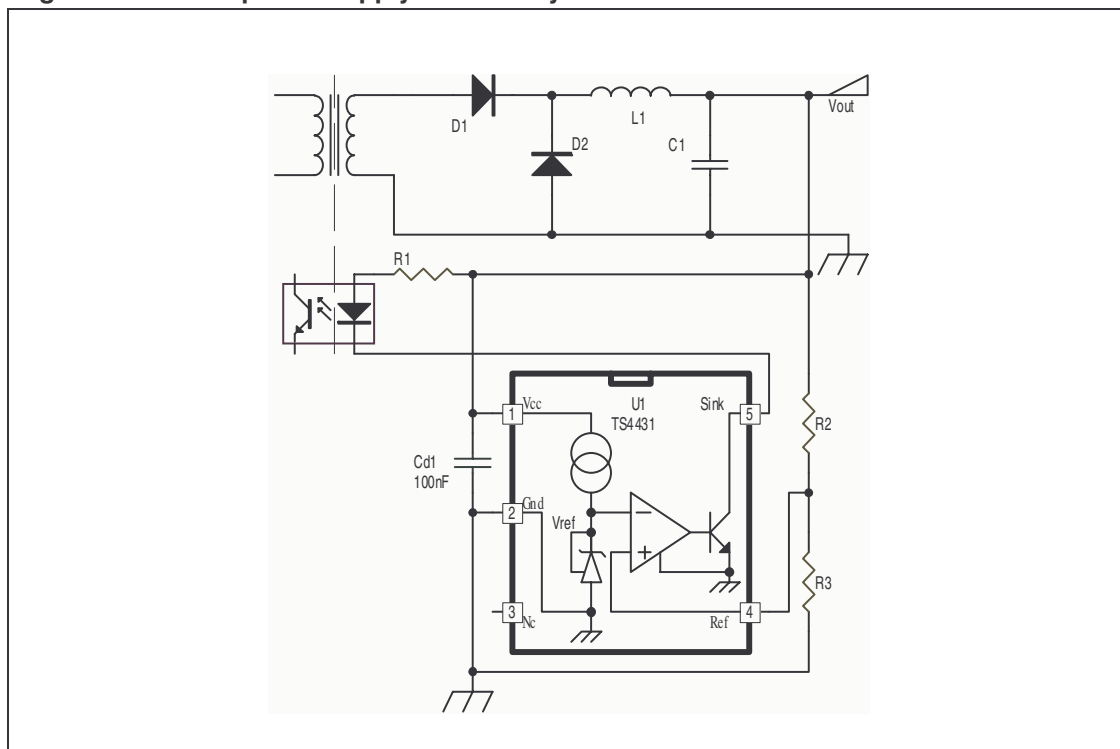
1.  $P_D$  has been calculated with  $T_{AMB} = 25^{\circ}\text{C}$ ,  $T_{Junction} = 150^{\circ}\text{C}$  and  
 $R_{thJA} = 250^{\circ}\text{C/W}$  for the SOT23-5 package  
 $R_{thJC} = 81^{\circ}\text{C/W}$  for the SOT23-5 package

**Table 2. Operating conditions**

| Symbol     | Parameter                   | Value      | Unit |
|------------|-----------------------------|------------|------|
| $T_{OPER}$ | Operating temperature range | -40 to +85 | °C   |
| $V_{CC}$   | Supply voltage              | 1.5 to 10  | V    |
| $I_{SINK}$ | Output sink current         | 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 Condition                                  | Min.  | Typ.  | Max.  | Unit                    |
|------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------|-------|-------|-------------------------|
| $V_{REF}$                                | Reference voltage TS4431A 0.5%                  |                                                 | 1.218 | 1.224 | 1.230 | V                       |
|                                          |                                                 | $-40^{\circ}\text{C} < T < +85^{\circ}\text{C}$ | 1.209 |       | 1.239 |                         |
| $V_{REF}$                                | Reference voltage TS4431 1%                     |                                                 | 1.212 | 1.224 | 1.236 | V                       |
|                                          |                                                 | $-40^{\circ}\text{C} < T < +85^{\circ}\text{C}$ | 1.203 |       | 1.245 |                         |
| $T_C$                                    | Temperature coefficient                         |                                                 |       |       | 100   | ppm/ $^{\circ}\text{C}$ |
| $\frac{\Delta V_{REF}}{\Delta V_{CC}}$   | Change in $V_{REF}$ due to change in $V_{CC}$   | $V_{CC}=1.5$ to $10\text{V}$                    |       | 1     | 2     | mV                      |
|                                          |                                                 | $-40^{\circ}\text{C} < T < +85^{\circ}\text{C}$ |       | 2     | 3     |                         |
| $\frac{\Delta V_{REF}}{\Delta I_{SINK}}$ | Change in $V_{REF}$ due to change in $I_{SINK}$ | $I_{SINK}=0.5$ to $20\text{mA}$                 |       | 7     | 10    | mV                      |
|                                          |                                                 | $-40^{\circ}\text{C} < T < +85^{\circ}\text{C}$ |       |       | 15    |                         |
| $I_{CC}$                                 | Supply current                                  | $I_{SINK}=2\text{mA}$                           |       | 250   | 300   | $\mu\text{A}$           |
|                                          |                                                 | $-40^{\circ}\text{C} < T < +85^{\circ}\text{C}$ |       |       | 350   |                         |
| $I_{OFF}$                                | OFF-State supply current                        | $\text{Ref} < 0.6\text{V}$                      |       | 15    | 20    | $\mu\text{A}$           |
|                                          |                                                 | $-40^{\circ}\text{C} < T < +85^{\circ}\text{C}$ |       |       | 30    |                         |
| $I_{REF}$                                | Reference input current                         | $0.1 < I_{SINK} < 10\text{mA}$                  |       | 0.4   | 1     | $\mu\text{A}$           |
|                                          |                                                 | $-40^{\circ}\text{C} < T < +85^{\circ}\text{C}$ |       |       | 2     |                         |
| $V_{SAT}$                                | Output transistor 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    | 100   |                         |
|                                          |                                                 | $-40^{\circ}\text{C} < T < +85^{\circ}\text{C}$ |       |       | 120   |                         |
| $I_{OH}$                                 | 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. Vref vs. temp. Isink=2mA

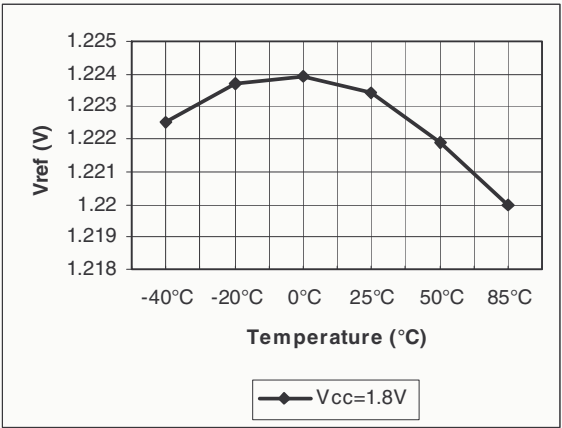


Figure 3. Vref vs. temp. Isink=2mA

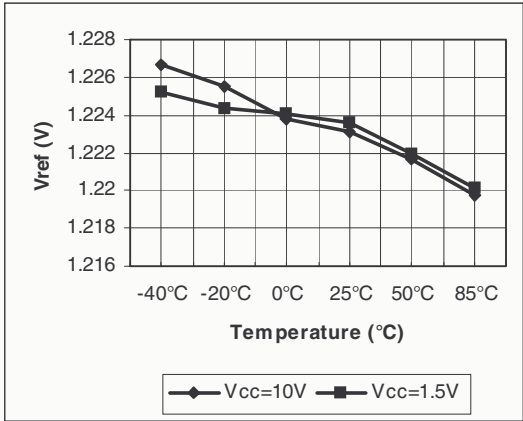


Figure 4. dVref/dVcc vs. temp. Isink=2mA

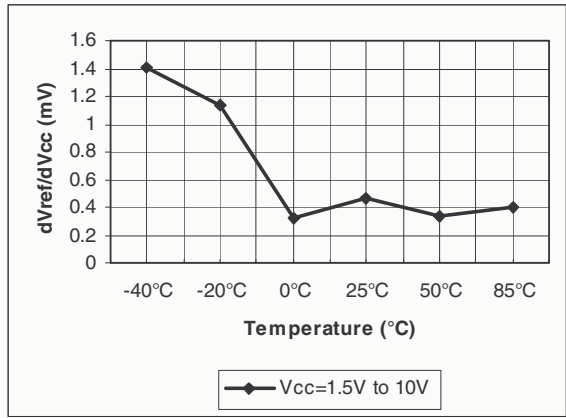


Figure 5. Icc vs. temp. Isink=2mA

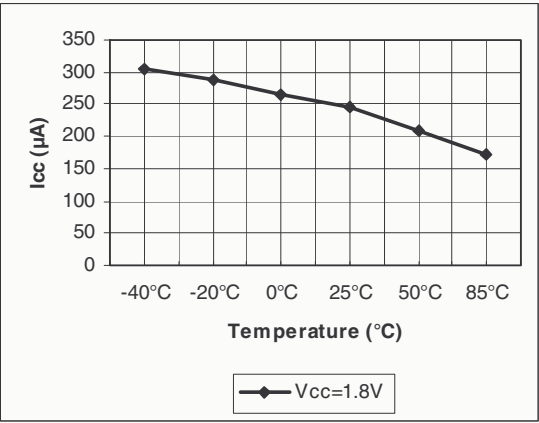


Figure 6. Icc vs. temp. Isink=2mA

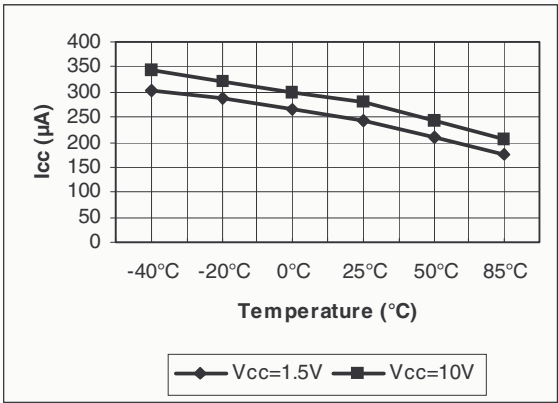


Figure 7. Vref vs. temp. Vcc=1.8V

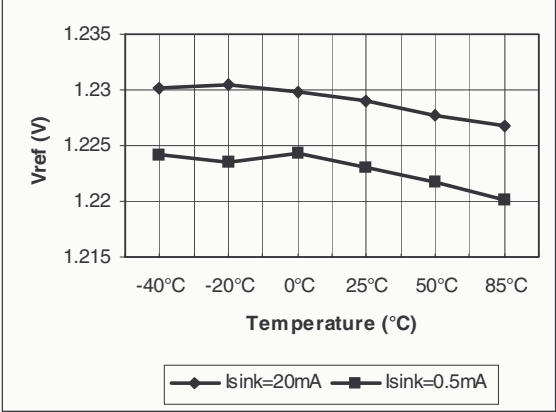


Figure 8.  $dV_{ref}/dI_{sink}$  vs. temp.  $V_{cc}=1.8V$

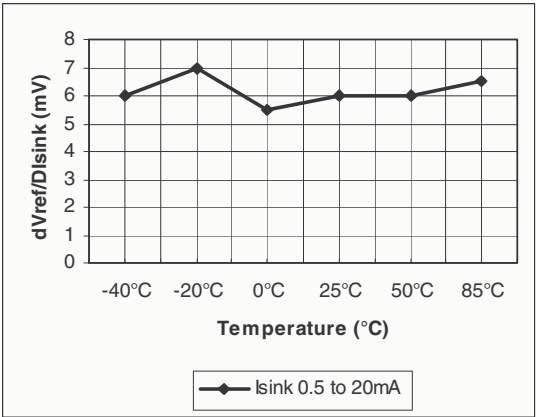


Figure 9.  $I_{ref}$  vs. temp.  $V_{cc}=1.8V$

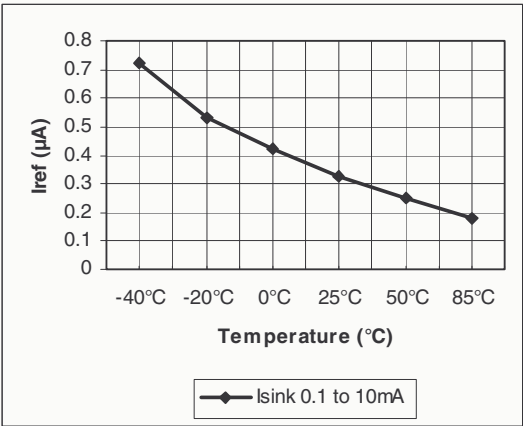
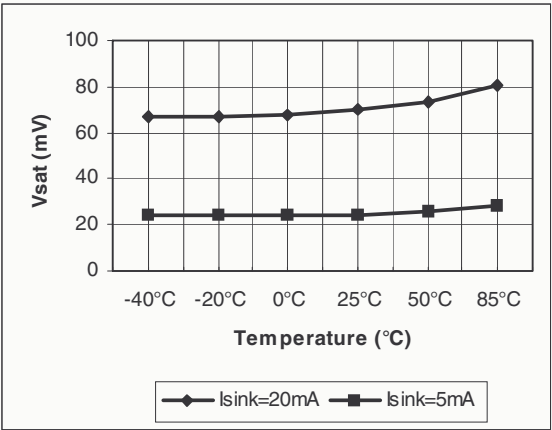


Figure 10.  $V_{sat}$  vs. temp.  $V_{cc}=1.8V$



# 4 Package Mechanical Data

In order to meet environmental requirements, ST offers these devices in ECOPACK® 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).

## SOT23-5L Package

| SOT23-5L MECHANICAL DATA |      |      |      |       |      |       |
|--------------------------|------|------|------|-------|------|-------|
| DIM.                     | mm.  |      |      | mils  |      |       |
|                          | MIN. | TYP  | MAX. | MIN.  | TYP. | MAX.  |
| A                        | 0.90 |      | 1.45 | 35.4  |      | 57.1  |
| A1                       | 0.00 |      | 0.15 | 0.0   |      | 5.9   |
| A2                       | 0.90 |      | 1.30 | 35.4  |      | 51.2  |
| b                        | 0.35 |      | 0.50 | 13.7  |      | 19.7  |
| C                        | 0.09 |      | 0.20 | 3.5   |      | 7.8   |
| D                        | 2.80 |      | 3.00 | 110.2 |      | 118.1 |
| E                        | 2.60 |      | 3.00 | 102.3 |      | 118.1 |
| E1                       | 1.50 |      | 1.75 | 59.0  |      | 68.8  |
| e                        |      | 0.95 |      |       | 37.4 |       |
| e1                       |      | 1.9  |      |       | 74.8 |       |
| L                        | 0.35 |      | 0.55 | 13.7  |      | 21.6  |

The diagram illustrates the mechanical dimensions of the SOT23-5L package. The left view is a side profile showing dimensions A (total width), A1 (lead thickness), A2 (lead length), C (lead thickness at base), and L (package height). The right view is a top-down perspective showing dimensions D (package width), E (package length), E1 (package length excluding leads), b (lead spacing), e (lead pitch), and e1 (total lead pitch).

## 5 Revision History

| Date       | Revision | Changes                                                               |
|------------|----------|-----------------------------------------------------------------------|
| March 2005 | 1        | First release corresponding to Preliminary Data version of datasheet. |
| Nov. 2005  | 2        | First release of fully mature product data sheet.                     |

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