

## Precision Temperature-to-Voltage Converter

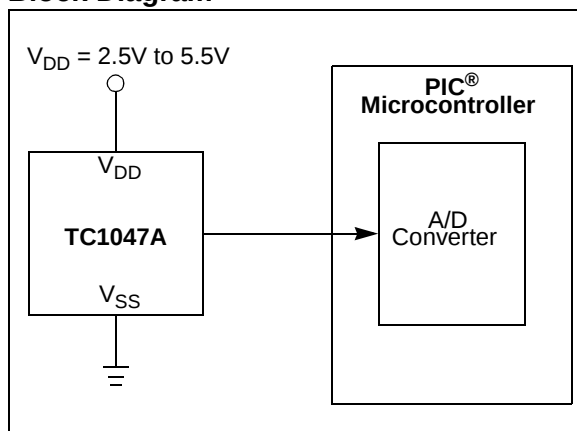
### Features

- Supply Voltage Range:
  - **TC1047:** 2.7V to 4.4V
  - **TC1047A:** 2.5V to 5.5V
- Wide Temperature Measurement Range:
  - -40°C to +125°C
- High Temperature Converter Accuracy:
  - $\pm 2^\circ\text{C}$ , Max, at 25°C
- Linear Temperature Slope: 10 mV/°C (typ.)
- Available in 3-Pin SOT-23B Package
- Very Low Supply Current:
  - 35  $\mu\text{A}$  Typical

### Applications

- Cellular Phones
- Power Supply Thermal Shutdown
- Temperature-Controlled Fans
- Temperature Measurement/Instrumentation
- Temperature Regulators
- Consumer Electronics
- Portable Battery-Powered Equipment

### Block Diagram

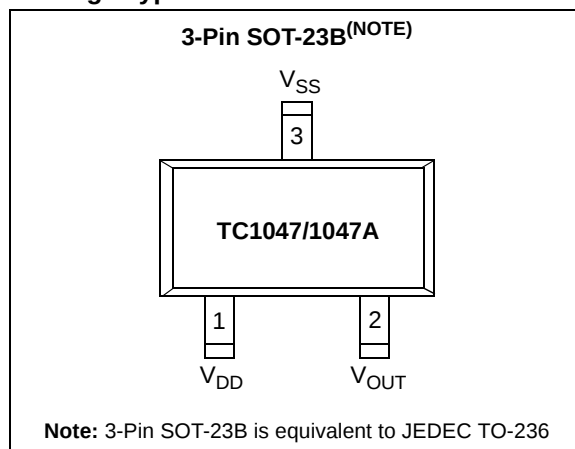


### General Description

The TC1047 and TC1047A are linear voltage output temperature sensors whose output voltage is directly proportional to the measured temperature. The TC1047 and TC1047A can accurately measure temperature from -40°C to +125°C. With the TC1047, the supply voltage can vary between 2.7V and 4.4V. The power supply range of the TC1047A is from 2.5V to 5.5V.

The output voltage range for these devices is typically 100 mV at -40°C, 500 mV at 0°C, 750 mV at +25°C and 1.75V at +125°C. A 10 mV/°C voltage slope output response allows for a predictable temperature measurement over a wide temperature range. The TC1047 and TC1047A are packaged in 3-pin SOT-23B packages, making them ideal for space-critical applications.

### Package Type



# TC1047/TC1047A

## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings\*

Supply Voltage .....+7V  
Voltage on Any Pin with Respect to Supplies:  
..... $V_{SS} - 0.3$  to  $V_{DD} + 0.3V$   
Operating Temperature .....-40°C to +125°C  
Storage Temperature Range .....-55°C to +150°C

\*Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operation sections of the specifications is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

### ELECTRICAL CHARACTERISTICS

**Electrical Specifications:** Unless otherwise indicated, these specifications apply for the entire supply voltage range and for  $T_A = -40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .

| Parameters                      | Sym                       | Min  | Typ       | Max  | Units                        | Conditions                   |
|---------------------------------|---------------------------|------|-----------|------|------------------------------|------------------------------|
| Supply Voltage                  | $V_{DD}$                  | 2.7  | —         | 4.4  | V                            | TC1047                       |
|                                 |                           | 2.5  | —         | 5.5  | V                            | TC1047A                      |
| Supply Current, Operating       | $I_Q$                     | —    | 35        | 60   | $\mu\text{A}$                |                              |
| Average Slope of Output Voltage | $A_V$                     | —    | 10        | —    | $\text{mV}/^{\circ}\text{C}$ |                              |
| Temperature Accuracy            | $\text{TMP}_{\text{ACY}}$ | -2   | $\pm 0.5$ | +2   | $^{\circ}\text{C}$           | $T_A = 25^{\circ}\text{C}$   |
|                                 |                           | -3   | $\pm 0.5$ | +3   | $^{\circ}\text{C}$           | $T_A = +125^{\circ}\text{C}$ |
|                                 |                           | —    | 1.0       | —    | $^{\circ}\text{C}$           | $T_A = -40^{\circ}\text{C}$  |
| Output Voltage                  | $V_{\text{OUT}}$          | —    | 100       | —    | mV                           | $T_A = -40^{\circ}\text{C}$  |
|                                 |                           | 730  | 750       | 770  | mV                           | $T_A = 25^{\circ}\text{C}$   |
|                                 |                           | 1720 | 1750      | 1780 | mV                           | $T_A = +125^{\circ}\text{C}$ |
| Output Source and Sink Current  | $I_{\text{OUT}}$          | 100  | —         | —    | $\mu\text{A}$                |                              |

### TEMPERATURE CHARACTERISTICS

**Electrical Specifications:** Unless otherwise indicated,  $V_{DD} = +2.3V$  to  $+5.5V$  and  $V_{SS} = \text{GND}$ .

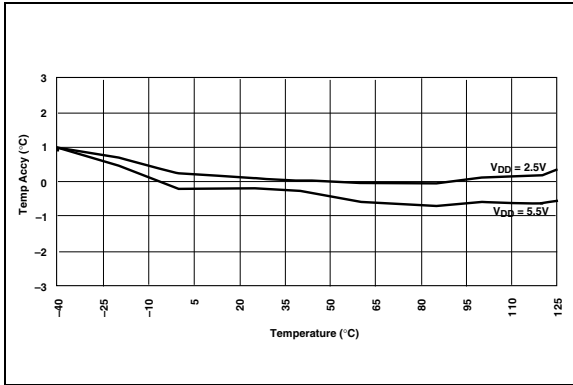
| Parameters                         | Sym           | Min | Typ | Max  | Units                       | Conditions    |
|------------------------------------|---------------|-----|-----|------|-----------------------------|---------------|
| <b>Temperature Ranges</b>          |               |     |     |      |                             |               |
| Specified Temperature Range        | $T_A$         | -40 | —   | +85  | $^{\circ}\text{C}$          |               |
| Operating Temperature Range        | $T_A$         | -40 | —   | +125 | $^{\circ}\text{C}$          | <b>Note 1</b> |
| Storage Temperature Range          | $T_A$         | -65 | —   | +150 | $^{\circ}\text{C}$          |               |
| <b>Thermal Package Resistances</b> |               |     |     |      |                             |               |
| Thermal Resistance, 3L-SOT-23B     | $\theta_{JA}$ | —   | 336 | —    | $^{\circ}\text{C}/\text{W}$ |               |

**Note 1:** The TC1047/TC1047A operate over this extended temperature range, but with reduced performance. In any case, the Junction Temperature ( $T_J$ ) must not exceed the Absolute Maximum specification of  $+150^{\circ}\text{C}$ .

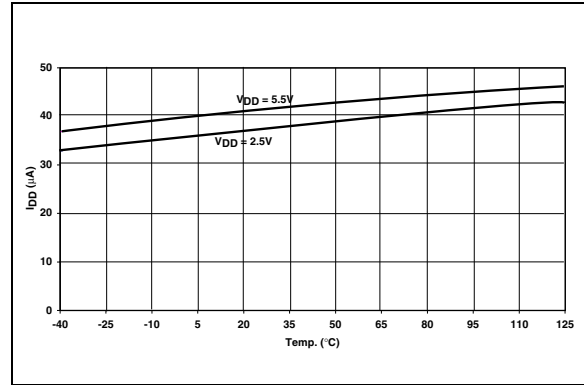
## 2.0 TYPICAL PERFORMANCE CURVES

**Note:** The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

**Note:** Unless otherwise indicated,  $V_{DD} = 2.7V$  thru  $4.4V$  and  $T_A = -40^{\circ}C$  to  $+125^{\circ}C$ .



**FIGURE 2-1:** Temperature Accuracy vs. Temperature.



**FIGURE 2-2:** Supply Current vs. Temperature.

# TC1047/TC1047A

## 3.0 PIN DESCRIPTIONS

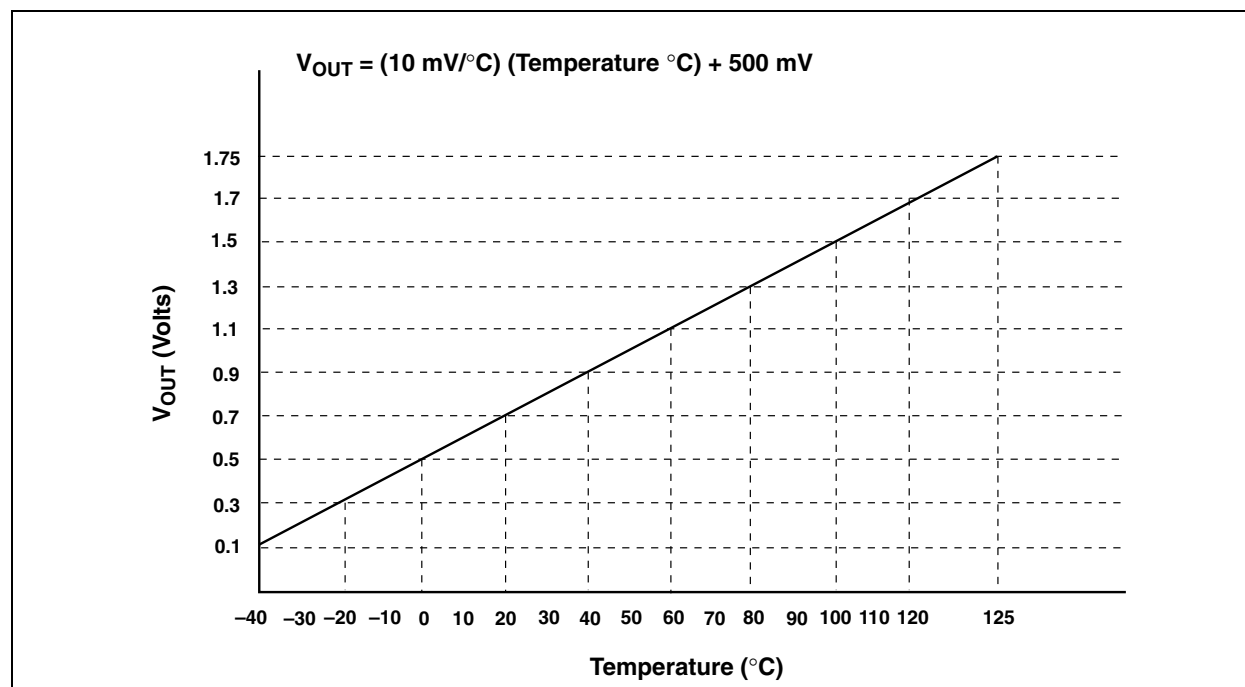
The descriptions of the pins are listed in Table 3-1.

**TABLE 3-1: PIN FUNCTION TABLE**

| Pin No. | Symbol    | Description                        |
|---------|-----------|------------------------------------|
| 1       | $V_{DD}$  | Input Supply Voltage               |
| 2       | $V_{OUT}$ | Temperature Sensor Output Terminal |
| 3       | $V_{SS}$  | Ground Terminal                    |

## 4.0 DETAILED DESCRIPTION

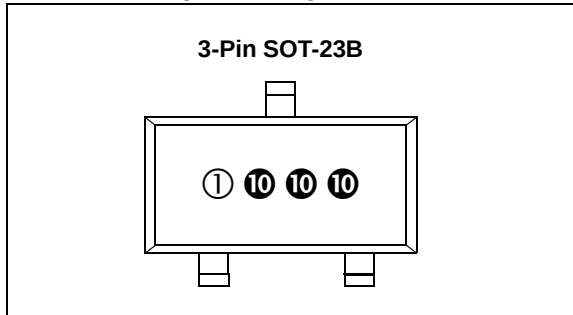
The TC1047 and TC1047A have an output voltage that varies linearly with temperature in degrees Celsius. Figure 4-1 shows a plot of the output voltage versus temperature for the TC1047 and TC1047A. The temperature slope is fixed at 10 mV/°C and the output voltage at 0°C is 500 mV.



**FIGURE 4-1:** Output Voltage vs. Temperature.

## 5.0 PACKAGE INFORMATION

### 5.1 Package Marking Information



1 & 2 = part number code + temperature range and voltage

| Part Number | Code |
|-------------|------|
| TC1047      | AL   |
| TC1047A     | BL   |

3 = year and quarter code

4 = lot ID number

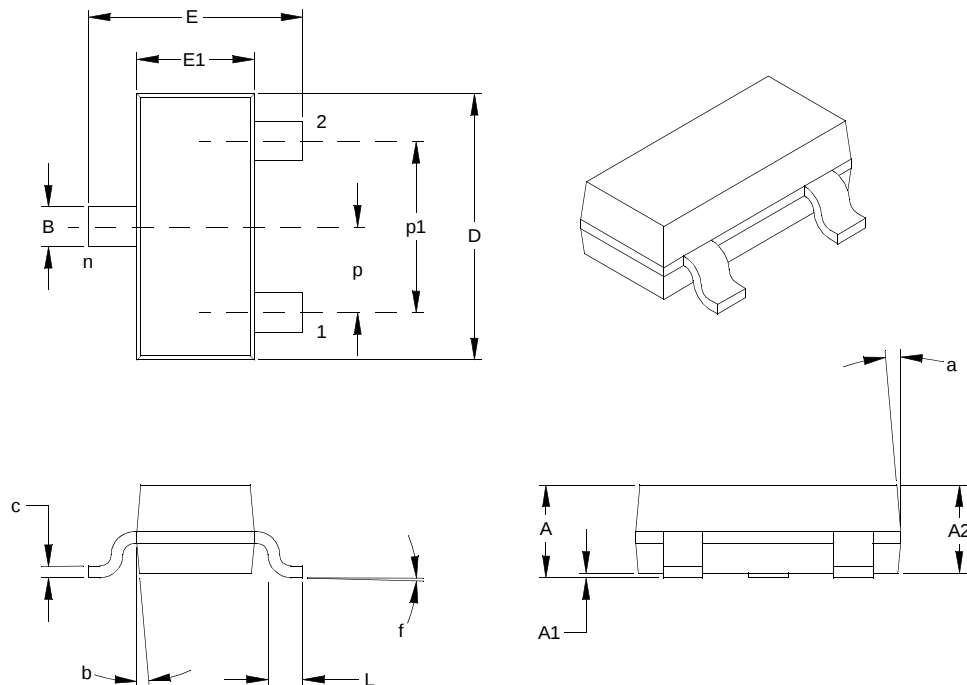
**Legend:** XX...X Customer-specific information\*  
Y Year code (last digit of calendar year)  
YY Year code (last 2 digits of calendar year)  
WW Week code (week of January 1 is week '01')  
NNN Alphanumeric traceability code  
Ⓔ3 Pb-free JEDEC designator for Matte Tin (Sn)  
\* This package is Pb-free. The Pb-free JEDEC designator Ⓔ3 can be found on the outer packaging for this package.

**Note:** In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information.

# TC1047/TC1047A

## 3-Lead Plastic Small Outline Transistor (TT) (SOT-23)

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



| Units                      |    | INCHES* |      |      | MILLIMETERS |      |      |
|----------------------------|----|---------|------|------|-------------|------|------|
| Dimension Limits           |    | MIN     | NOM  | MAX  | MIN         | NOM  | MAX  |
| Number of Pins             | n  |         | 3    |      |             | 3    |      |
| Pitch                      | p  |         | .038 |      |             | 0.96 |      |
| Outside lead pitch (basic) | p1 |         | .076 |      |             | 1.92 |      |
| Overall Height             | A  | .035    | .040 | .044 | 0.89        | 1.01 | 1.12 |
| Molded Package Thickness   | A2 | .035    | .037 | .040 | 0.88        | 0.95 | 1.02 |
| Standoff                   | A1 | .000    | .002 | .004 | 0.01        | 0.06 | 0.10 |
| Overall Width              | E  | .083    | .093 | .104 | 2.10        | 2.37 | 2.64 |
| Molded Package Width       | E1 | .047    | .051 | .055 | 1.20        | 1.30 | 1.40 |
| Overall Length             | D  | .110    | .115 | .120 | 2.80        | 2.92 | 3.04 |
| Foot Length                | L  | .014    | .018 | .022 | 0.35        | 0.45 | 0.55 |
| Foot Angle                 | f  | 0       | 5    | 10   | 0           | 5    | 10   |
| Lead Thickness             | c  | .004    | .006 | .007 | 0.09        | 0.14 | 0.18 |
| Lead Width                 | B  | .015    | .017 | .020 | 0.37        | 0.44 | 0.51 |
| Mold Draft Angle Top       | a  | 0       | 5    | 10   | 0           | 5    | 10   |
| Mold Draft Angle Bottom    | b  | 0       | 5    | 10   | 0           | 5    | 10   |

\*Controlling Parameter

Notes:

Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .005" (0.127mm) per side.

JEDEC Equivalent: TO-236

Drawing No. C04-104

Revised 03-11-05

## **APPENDIX A: REVISION HISTORY**

### **Revision D (December 2012)**

Added a note to each package outline drawing.

### **Revision C (May 2005)**

The following is the list of modifications:

1. Added Appendix A: Revision History.

### **Revision B (May 2002)**

### **Revision A (March 2001)**

- Original Release of this Document.

# TC1047/TC1047A

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NOTES:

## PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

|                                                                                                                                                                                                                                                    |                                                                                                                                                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>PART NO.</b></p> <p><b>Device</b>      <b>Temperature Range</b>      <b>Package</b></p>                                                                                                                                                      | <p><b>Examples:</b></p> <p>a) TC1047VNBTR: Precision Temp-to-Voltage Converter</p> <p>b) TC1047AVNBTR: Precision Temp-to-Voltage Converter</p> |
| <p>Device: TC1047: Precision Temp-to-Voltage Converter<br/>TC1047xTR: Precision Temp-to-Voltage Converter (Tape and Reel)</p> <p>Temperature Range: V = -40°C to +125°C</p> <p>Package: NB = Plastic Small Outline Transistor, SOT-23B, 3-lead</p> |                                                                                                                                                |

# TC1047/TC1047A

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NOTES:

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