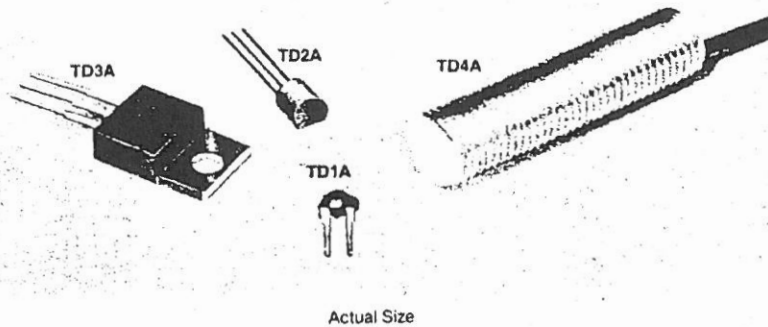


## Precision Interchangeable Temperature Sensors

### TD Series



#### FEATURES

- Interchangeability
- Very small thermal mass for fast response
- Air or liquid temperature sensing
- Linear temperature sensitivity
- Proven thin film processing reliability
- Low cost
- Long term stability
- 2000 ohms nominal resistance at 20° C

#### TYPICAL APPLICATIONS

- Heating, Venting and Air Conditioning
  - Room, duct and refrigerant temperature
- Motors
  - Overload protection
- Electronic circuits
  - Semiconductor protection
- Process control
  - Temperature regulation
- Automotive
  - Air and oil temperature
- Appliances
  - Cooking temperature

MICRO SWITCH TD Series temperature sensors respond quickly to a change in temperature. They are interchangeable, without calibration, to an accuracy of  $\pm 0.7^\circ\text{C}$  at  $20^\circ\text{C}$ . These RTD (resistance temperature detector) sensors provide sensitivity of  $8\text{mV}/^\circ\text{C}$  with  $1\text{mA}$  excitation and have an inherently near linear output.

The sensing element for each sensor is a  $0.040" \times 0.050"$  silicon chip. A thin film resistive network containing a sensing resistor and a laser trimmable resistor is patterned on the chip. Each chip is laser trimmed to provide 2000 ohms nominal resistance at room temperature ( $20^\circ\text{C}$ ). Room temperature trim is accurate to  $\pm 0.7^\circ\text{C}$ , and maximum error over the entire operating range of  $-40^\circ\text{C}$  to  $+150^\circ\text{C}$  ( $-40^\circ\text{F}$  to  $+302^\circ\text{F}$ ) is  $\pm 2.5^\circ\text{C}$ . This accurate trimming provides true sensor-to-sensor interchangeability without recalibration of the users circuit.

#### TD1A FAST RESPONSE TEMPERATURE SENSOR

The TD1A is a very small two-terminal fast response temperature sensor packaged onto a 0.2 inch square ceramic substrate. Termination pins are located on 0.1 inch centers to permit plug-in connection or PC board mounting. Typical response time (one time constant) for the TD1A is 5 seconds in moving air and 14 seconds in still air. Temperature rise is  $.25^\circ\text{C}/\text{milliwatt}$  suspended in still air by #24 wires and  $.13^\circ\text{C}/\text{milliwatt}$  taped to a bench top.

#### TD2A INDUSTRY STANDARD TO-92 PACKAGE TEMPERATURE SENSOR

The TD2A is a three-terminal (center lead not connected) precision temperature sensor packaged in an industry standard TO-92 transistor package. Typical response time (one time constant) for the TD2A is 9 seconds in moving air and 30 seconds in still air. Temperature rise is  $.23^\circ\text{C}/\text{milliwatt}$  suspended in still air.

#### TD3A SURFACE TEMPERATURE SENSOR

The TD3A is designed primarily for sensing surface temperatures. The TD3A is packaged in an industry standard TO-220 transistor package. Typical response time (one time constant) for the TD3A is 75 seconds in still air, suspended by leads. Temperature rise is  $.04^\circ\text{C}/\text{milliwatt}$  bolted to a metal plate. However, when mounted the response time is the same as the mounting surface.

#### TD4A LIQUID TEMPERATURE SENSOR

The TD4A is a two-terminal (threaded anodized aluminum housing) liquid temperature sensor. The package is environmentally sealed and designed for simplicity of installation, such as in the side of a tank. The TD4A is not designed to be totally immersed into liquids. Typical response time (one time constant) for the TD4A is 4 minutes in still air and 5 seconds in still water (unmounted position). Temperature rise is  $.12^\circ\text{C}/\text{milliwatt}$  suspended by leads in still air and  $.08^\circ\text{C}/\text{milliwatt}$  when mounted on 1 square foot  $.25"$  thick aluminum plate.

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# Precision Interchangeable Temperature Sensors

## ABSOLUTE MAXIMUM RATINGS

Operating Range	-40°C (-40°F) to 150°C (302°F)
Storage Temperature	-55°C (-67°F) to 170°C (338°F)

## INTERCHANGEABILITY (With 1 mA Max Current)

Note:

1. Overload testing shows 10VDC continuous for 100 hours without damage.

Temperature	Resistance (Ohms)
-40°C (-40°F)	1584 ± 10 (±1.5°C)
-30°C (-22°F)	1649 ± 9 (±1.3°C)
-20°C (-4°F)	1716 ± 8 (±1.2°C)
-10°C (14°F)	1784 ± 7 (±1.0°C)
0°C (32°F)	1855 ± 6 (±0.8°C)
+10°C (50°F)	1926 ± 6 (±0.8°C)
+20°C (68°F)	2000 ± 5 (±0.7°C)
+30°C (86°F)	2075 ± 6 (±0.8°C)
+40°C (104°F)	2153 ± 7 (±0.9°C)
+50°C (122°F)	2231 ± 7 (±0.9°C)
+60°C (140°F)	2312 ± 9 (±1.1°C)
+70°C (158°F)	2394 ± 10 (±1.2°C)
+80°C (176°F)	2478 ± 12 (±1.4°C)
+90°C (194°F)	2564 ± 14 (±1.6°C)
+100°C (212°F)	2651 ± 16 (±1.8°C)
+110°C (230°F)	2740 ± 18 (±2.0°C)
+120°C (248°F)	2831 ± 20 (±2.2°C)
+130°C (266°F)	2924 ± 22 (±2.3°C)
+140°C (284°F)	3018 ± 24 (±2.5°C)
+150°C (302°F)	3114 ± 25 (±2.5°C)

### Equation For Computing Resistance:

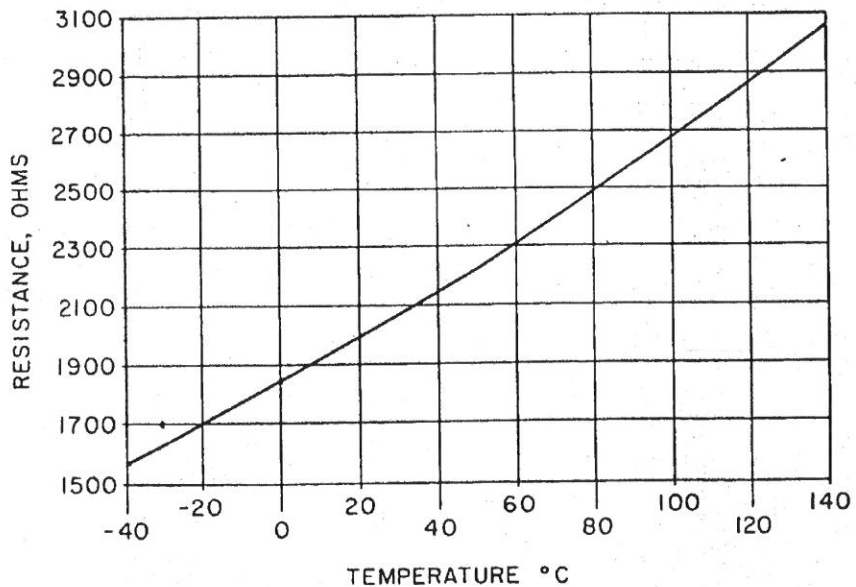
$$R_T = R_0 + (3.83 \times 10^{-3} \times R_0 \times T) + (4.64 \times 10^{-6} \times R_0 \times T^2)$$

$R_T$  = Resistance at temperature T

$R_0$  = Resistance at 0°C

T = Temperature in °C

Figure 1  
TD Series Resistance Versus Temperature



**ELECTRICAL INTERFACING**

The high nominal resistance, positive temperature coefficient and linear sensitivity characteristics of the TD Series temperature sensors simplifies the task of designing the electrical interface. Figure 2 illustrates an interface for applications requiring a voltage that varies linearly with temperature. In the example shown the current regulator can be affected by temperature, so only the temperature sensor should be exposed to thermal changes.

In some applications it may be desirable to detect one particular temperature. Figure 3 illustrates one way this can be accomplished. In the comparator circuit shown the potentiometer can be adjusted to correspond to the desired temperature.

Figure 2 Simple Current Regulator Interface

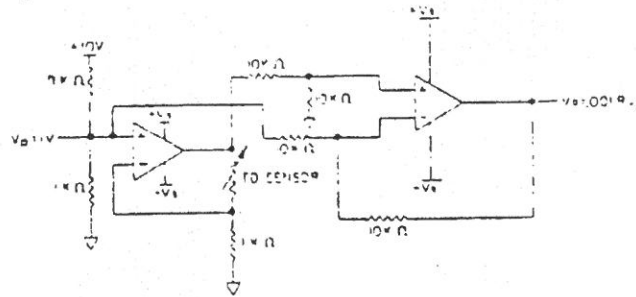
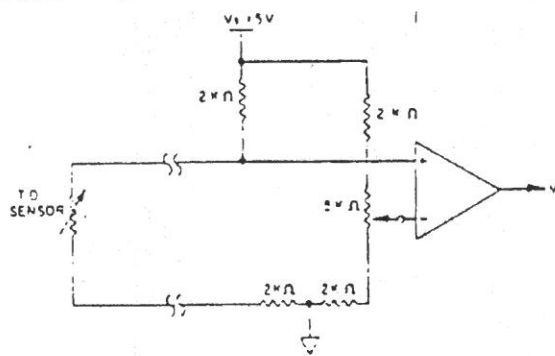


Figure 3 Adjustable Point (Comparator) Interface



**ORDER GUIDE**

Description	Catalog Listing
Fast response temperature sensor, 0.2 inch square ceramic package, 0.1 inch centers.	TD1A
Industry standard TO-92 package temperature sensor, three leads (center lead not connected).	TD2A
Surface temperature sensor, standard TO-220 transistor package, .15" diameter hole for mounting.	TD3A
Liquid temperature sensor, 1/50" threaded (3/8-24 UNF-2A) anodized aluminum housing, 2 six-inch black teflon insulated leads.	TD4A

**OTHER OPTIONS**

MICRO SWITCH has the capability to package the TD Series temperature sensors in plastic, aluminum, brass, stainless steel or other materials depending on customer need and volume. By designing the sensing element of the TD Series on a silicon chip, a great deal of versatility is possible. Custom packaging can be for surface, liquid or gas temperature sensing, with signal conditioning electronics circuits possible.

**SALES AND SERVICE**

MICRO SWITCH serves its customers through a worldwide network of sales offices. For application assistance or pricing contact a nearby MICRO SWITCH sales office. Or contact:

MICRO SWITCH  
11 W. Spring St.  
Freeport, Illinois 61032  
Tel: 815-235-6600

While we provide application assistance on all MICRO SWITCH products, personally and through our literature, it is up to the customer to determine the suitability of the product in the application.

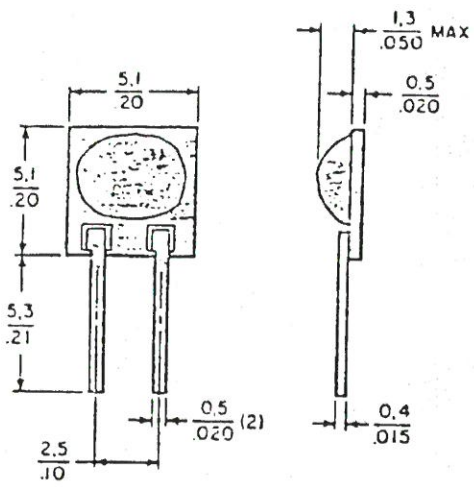
Together, we can find the answers.

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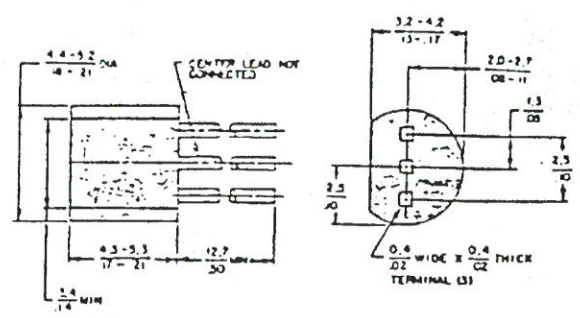
MOUNTING DIMENSIONS  
(For Reference Only)

$\frac{0.0}{.00}$ mm
$\frac{0.00}{.00}$ inches

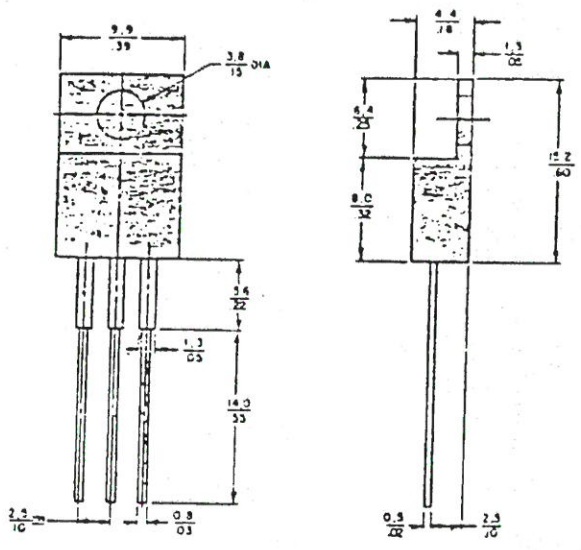
TD1A Fast Response Temperature Sensor



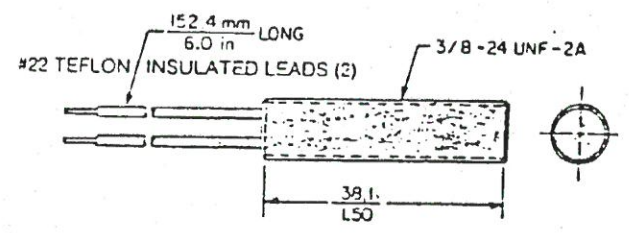
TD2A Industry Standard TO-92 Package Temperature Sensor



TD3A Surface Temperature Sensor



TD4A Liquid Temperature Sensor



**TEMPERATURE SENSOR APPLICATION NOTE 1**

15 AUG. 1985

**4-20 mA CIRCUIT FOR TD1A, 2A, 3A, 4A**

**Introduction**

In long distance wiring applications, measuring current rather than voltage may be desirable. Current is less susceptible to errors from electromagnetic interference (EMI) generated by pumps and other high-voltage equipment. Plus, current remains constant over long control lines, eliminating voltage drop problems.

**Interfacing with 4-20 mA Circuit**

If more than 1 mA of current flows through the TD, self-heating will occur. The self-heating effect is typically 0.2°C/milliwatt. The circuit in Figure 1 provides a maximum current flow of 1 mA.

TD1A or TD4A, when used in this circuit, provides 4 mA at -40°C, changing linearly to 20 mA at +150°C.

There are a number of ways to measure the 4 to 20 mA current.

1. Ammeter - an ammeter can be placed anywhere between A and B or between C and D. If this method is used, eliminate resistor R<sub>1</sub>.
2. Resistance - measure voltage drop across resistor R<sub>1</sub> ( $I = V/250$ ).
3. Other current sensing devices - the 4-20 mA change in current can be used as an input to a programmable controller, or MICRO SWITCH's SID-2000 Sensor Interface.

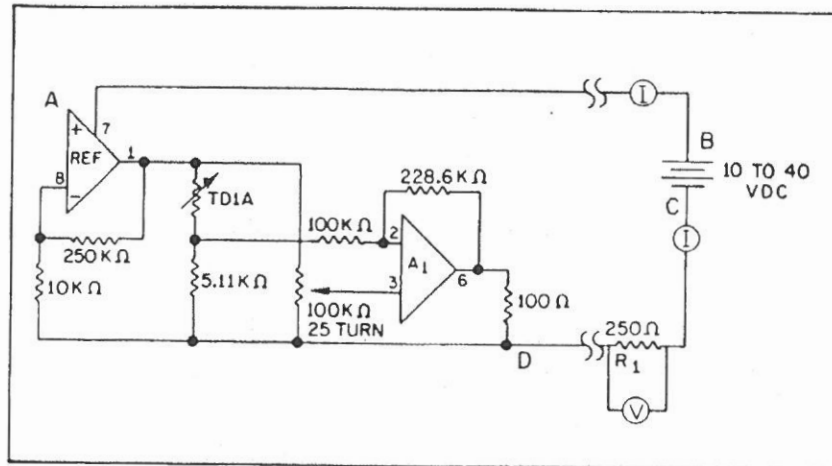


Figure 1

1. Reference and A1 are LM10 dual op amp.
2. Voltage at pin 1 should be set to 5.0 Volts.
3. A<sub>1</sub> gain should be 2.286.
4. Adjust potentiometer to provide 0.004 amp (4 mA) with 1584 ohm resistor substituted for TD1A.

Together, we can find the answers.

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