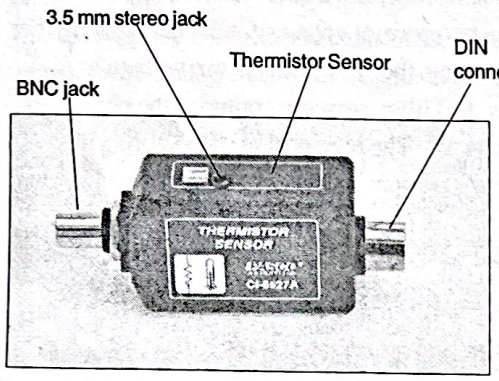
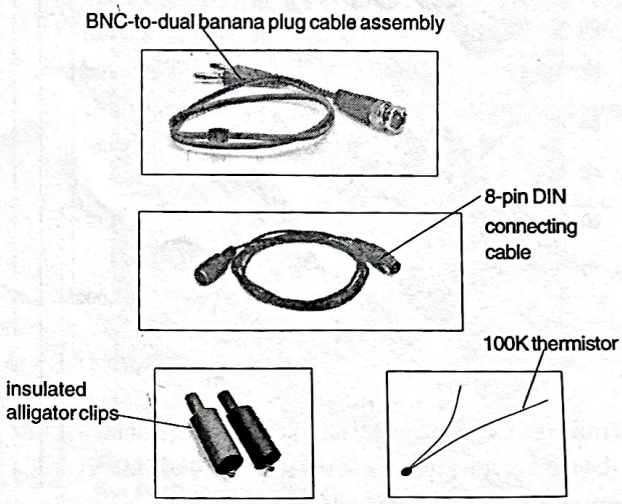
Instruction Sheet for the PASCO Model CI-6527A

Thermistor Sensor





Introduction

The CI-6527A Thermistor Sensor is used for converting resistance measurements to temperature. When used with a *ScienceWorkshop*® interface and DataStudio software (version 1.8.5 or later), the sensor allows you to directly measure the temperature or simultaneously view both resistance and temperature measurements in one graph.

The sensor is a two-thermistor circuit built into one sensor case. *Thermistors* are resistors that change resistance as their temperature changes. One themistor circuit is used with PASCO 10K thermistors that have a 3.5 mm male stereo jack.

The other thermistor circuit is 100K ohms and is used with a BNC jack. The 100K circuit is designed for use with a 100K thermistor, like that installed in the PASCO Mechanical Equivalent of Heat Apparatus (TD-8551A) or the Thermal Expansion Apparatus (TD-8558A).

Equipment included:

- PASCO CI-6527A Thermistor Sensor
- Cable assembly, BNC-to-dual banana plug
- 8-pin DIN connecting cable
- Two insulated alligator clip adapters
- Thermistor, 100K ohm

Additional equipment required:

- *ScienceWorkshop*® Interface
- DataStudio® Software, version 1.8.5 or later

Applications

- Used with PASCO products that contain built-in 10K and 100K thermistors (i.e. TD-8579, TD-8580, etc.)
- Thermal expansion studies
- Mechanical equivalent of heat
- Energy transfer studies
- Thermodynamics

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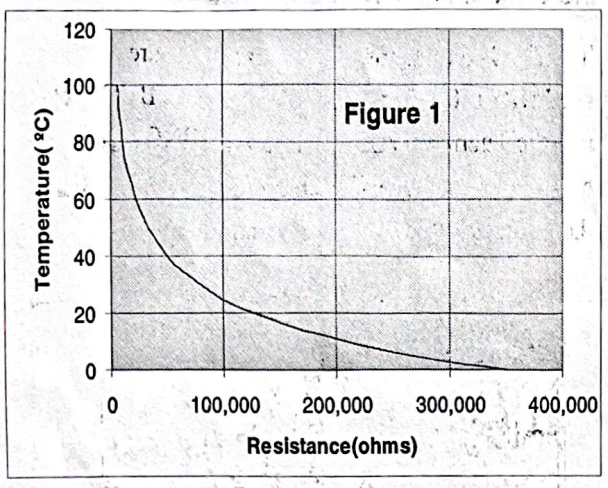
Thermistor Description

Figure 1 illustrates a typical resistance vs. temperature curve for a 100K ohm thermistor.



Thermistors have a negative temperature coefficient. As the temperature increases, the resistance of the thermistor decreases. The Steinhart-Hart equation is used to convert from resistance to temperature, where **T** in degrees Celsius is

$$\frac{1}{(8.25\times10^{-4}+2.05\times10^{-4}\cdot\ln(R100)+1.14\times10^{-7}\cdot\ln(R100)^3)}-273.15$$

and $\mathbf{R_{100}}$ is the resistance in ohms.

10K thermistor - The 10K thermistor wire plugs into the 3.5 mm jack and has an output voltage ranging from 0 to -10 volts. The DataStudio software converts the voltage to resistance and temperature.

100K thermistor - The 100K thermistor plugs into the BNC jack and outputs a voltage ranging from 0 to +10 volts. The DataStudio software converts the voltage to resistance and temperature.

When the Thermistor Sensor is connected to a *ScienceWorkshop* interface, DataStudio determines which thermistor, the 10K or the 100K, is connected to the unit by the polariy of the V_{out} signal, as long as the thermistors are connected appropriately (10K to the stereo jack and 100K to the BNC connector).

Electronic Circuitry and Internal Operation

10K Thermistor Circuit - The 10K thermistor circuit uses a precision voltage source and voltage divider to determine the thermistor's resistance. The thermistor (Rt) is one resistor, and a 13K resistor (R_{ref}) is the other in a two-resistor voltage divider network. In the sensor housing, the reference resistor, voltage regulator, and filter capacitor comprise the remainder of the network. The relationship of the 10K thermistor's resistance (Rt) to voltage output (V_{out}) is

$$Rt=-V_{out}*R_{ref}/(V_{ref}-V_{out})$$

where V_{ref} is 10V reference voltage. R_{ref} is 13 Kohms. The normalized resistance is R10=Rt/10,000.

The Steinhart equation is used to convert from resistance to temperature, where **T**, the temperature in degrees Celsius is

$$\frac{1}{(3.35\times10^{-3}+2.56\times10^{-4}\cdot\ln(R10)+2.38\times10^{-6}\cdot\ln(R10)^2+8.37\times10^{-8}\cdot\ln(R10)^3)}-273.15$$

and $\mathbf{R_{10}}$ is the normalized resistance of the thermistor in ohms.

100K Thermistor Circuit - The 100K thermistor circuit outputs a positive voltage that is directly proportional to the resistance of the resistor. The range of resistance over which the sensor functions is 0 to 360K ohms. This resistance range maps into a 0 to 10 VDC output from the sensor. The relationship is Rt = $36{,}000*V_{out}$. The normalized resistance $R_{100}=R_t/100{,}000$. The Steinhart-Hart equation is used to convert from resistance to temperature, where **T**, the temperature in degrees Celsius is

$$\frac{1}{(8.25\times10^{-4}+2.05\times10^{-4}\cdot\ln(R100)+1.14\times10^{-7}\cdot\ln(R100)^3)}-273.15$$

and $\mathbf{R_{100}}$ is the normalized resistance of the thermistor in ohms.

Connecting the Thermistor Sensor to a Computer Interface

1. Connect the 8-pin DIN plug of the Thermistor Sensor into analog channel A, B, or C of a *ScienceWorkshop* computer interface (Figure 2a).
   or
   Use the supplied DIN cable to connect the Thermistor Sensor to the analog channel of the interface box (Figure 2b).
2. Connect the cable assembly to the Thermistor Sensor (See Figures 3a and 3b). [**Note:** Use the BNC cable assembly for 100K thermistors and the stereo jack cable for 10K thermistors.]
3. (For external thermistors): Attach the alligator clips to the banana plugs on the cable. Clip an alligator clip over each end of thermistor.

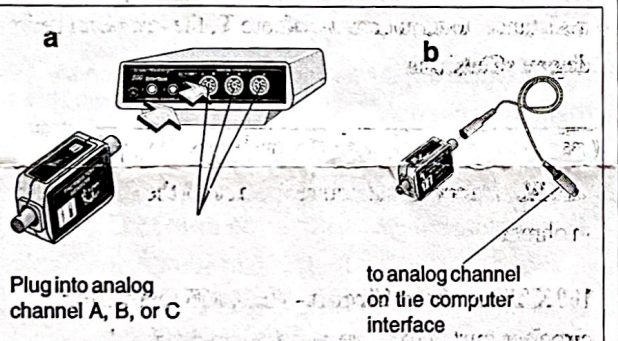


Figure 2:
Connecting the Thermistor Sensor to the computer interface (two methods)

Connecting Cables to the Thermistor Sensor

Connecting the BNC-to-Dual Banana Plug Cable to the CI-6527A Thermistor Sensor

The BNC-to-dual banana plug cable (Figure 3a) is used with 100K thermistors. To plug the BNC cable into the Thermistor Sensor, insert the BNC metal connector into the BNC jack on the sensor, and turn the connector clockwise until it snaps in place.

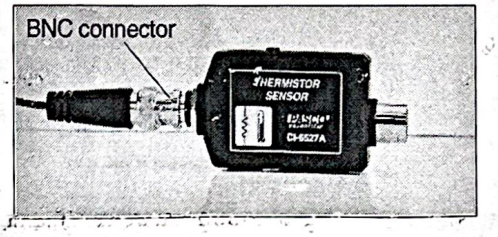


Figure 3a: Connecting the BNC connector to the BNC jack on the Thermistor sensor.

Connecting the Stereo-to-Dual Banana Plug Cable to the CI-6527A Thermistor Sensor

The stereo-to-dual banana plug cable (Figure 3b) is used with 10K thermistors. PASCO's more recent thermal products contain built-in 10K thermistors and come with a stereo-to-dual banana plug cable. To order a stereo-to-dual banana plug cable separately, use part no. 514-08366.

To plug the stereo-to-dual banana plug cable into the Thermistor Sensor, insert the stereo plug into the stereo jack on the top of the sensor (Figure 3b).

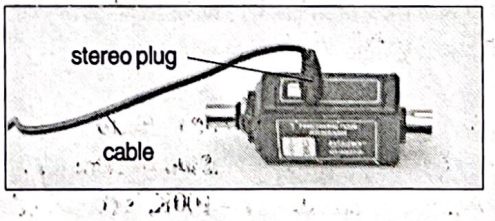


Figure 3b: Inserting the stereo plug from the dual banana-stereo plug cable into the Thermistor Sensor

Connecting a Temperature Probe to the Thermistor Sensor

1. To connect a Temperature Probe to a Thermistor Sensor, insert the stereo plug on the probe into the stereo jack on the top of the sensor.

Note: Probes without stereo jacks cannot be connected to the Thermistor Sensor.

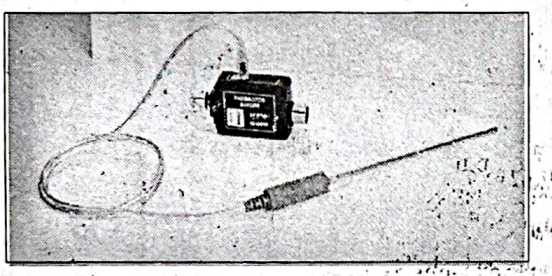


Figure 4: Temperature Probe connected to a Thermistor Sensor

Sensor Calibration

The Thermistor Sensor is factory calibrated. However, the unit may be calibrated or have the calibration verified. Resistors with a known value are required for calibration. For more information about calibration, see the DataStudio online help.

Sensor Accuracy and Resolution

The resolution and accuracy of resistance measurements with the Thermistor Sensor are directly related to the resolution and accuracy of the *ScienceWorkshop* interface used. For example, if the interface has a resolution and accuracy of ±0.005V, the resistance measurement will have an accuracy of 36,000 ohms/V times 0.005V or ±180 ohms.

Collecting Data with the Thermistor Sensor

1. Follow the Procedure under "Connecting the Thermistor Sensor to a Computer Interface."
2. Open DataStudio and double click "Create Experiment."
3. Click the **Setup** button to open the Experiment Setup window.
4. In the Sensors list, scroll to the Thermistor Sensor icon and drag it to an analog channel on the picture of the interface (the same channel in which you have the sensor connected).
5. Double click on the Thermistor icon, click in the Measurement tab, select a measurement type, and click **OK**.
6. Open a Graph display and click the **Start** button to begin collecting data.

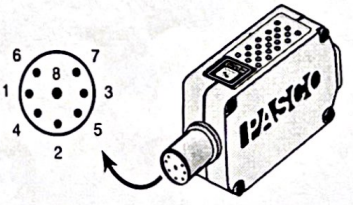
Sensor Specifications*:

Temperature Range:	10K:	-35 to +135°C
	100K:	0 to 100°C
Resolution:	10K:	0.05°C
	100K:	0.05°C
Repeatability:	10K:	0.10°C
	100K:	0.10°C
Accuracy:	10K:	0.5°C
	100K:	0.5°C

*Note: These specifications are dependent on the quality of the thermistor used with the CI-6527A Thermistor Sensor Amplifier. The specifications are typical of the 10K and 100K thermistor used in PASCO temperature probes and physics apparatus (at 25°C).

DIN Connector Specifications:

1: analog output, -10 to +10 V
2: analog (-) signal ground
3: no connection
4: +5 VDC power
5: power ground
6: +12 VDC power
7: -12 VDC power
8: no connection



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Contacting Technical Support

Before you call the PASCO Technical Support staff, prepare the following information:

➤ If your problem is with the PASCO apparatus, note:

- Title and model number (usually listed on the label);
- Approximate age of apparatus;
- A detailed description of the problem/sequence of events (in case you can't call PASCO right away, you won't lose valuable data);
- If possible, have the apparatus within reach when calling to facilitate description of individual parts.

Phone: 1-800-772-8700 (toll-free within the U.S.)
or (916) 786-3800
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Web: www.pasco.com

➤ ***Note:*** This instruction sheet was written assuming that the user has a basic familiarity with *DataStudio software*. Users can gain basic skills by working through the tutorial within the *DataStudio software* program.

Limited Warranty

PASCO scientific warrants the product to be free from defects in materials and workmanship for a period of one year from the date of shipment to the customer. PASCO will repair or replace, at its option, any part of the product which is deemed to be defective in material or workmanship. The warranty does not cover damage to the product caused by abuse or improper use. Determination of whether a product failure is the result of a manufacturing defect or improper use by the customer shall be made solely by PASCO scientific. Responsibility for the return of equipment for warranty repair belongs to the customer. Equipment must be properly packed to prevent damage and shipped postage or freight prepaid. (Damage caused by improper packing of the equipment for return shipment will not be covered by the warranty.) Shipping costs for returning the equipment after repair will be paid by PASCO scientific.

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