

# Thermocouple vs. Thermopile: A Complete Comparison & Advantages of Each Type

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Why is the comparison between Thermocouple vs. Thermopile too important? The main difference between Thermocouple and Thermopile is their method of measurement. The thermocouple is a thermoelectric instrument, while the thermopile is an instrument that modifies thermal energy into electrical output. This post presents a fundamental comparison to explore the Thermocouple vs. Thermopile sensor completely and provides the main differences between Thermocouple and Thermopile working principles.

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## Thermocouple vs. Thermopile – What's the Difference?

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Thermocouple vs. Thermopile is a controversial subject in the field of measurement. Both the thermocouples and thermopiles employ the thermoelectricity principle to produce electricity by sensing the temperature. These instruments appear in various conditions, including applications like fireplace inserts and gas fireplaces. Explaining the differences between the thermocouple vs. thermopile subject needs an understanding of the differences in the working principle of these two instruments completely. Regardless of the scientific difficulty of knowing the thermocouples and thermopiles, their fundamental principle through a brief explanation is provided in this post.

As discussed before, the main difference between a thermocouple and a thermopile is that the thermocouple is physically a temperature sensor containing two dissimilar metals combined at a particular point; a voltage is generated that has relation with the temperature variation between the two parts introduced as junctions. However, the thermopile is an electronic instrument that transforms thermal values into electrical outputs normally manufactured employing the series arrangements of special thermocouples.

## **Thermocouple Definition**

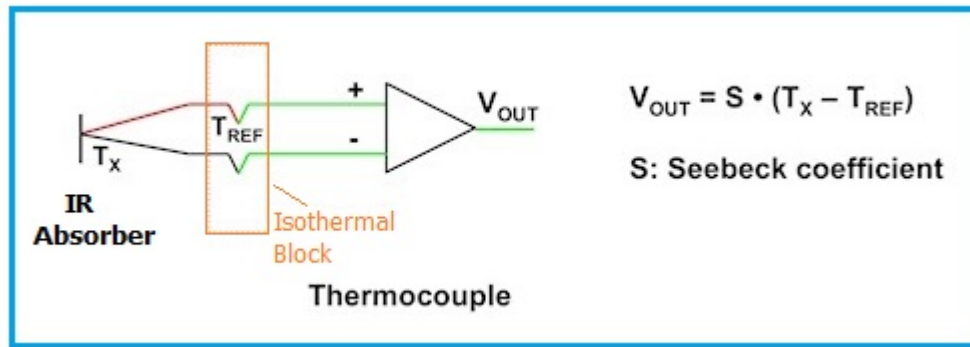
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Thermocouples were first constructed after the exploration of the thermoelectric phenomenon by Thomas Johann Seebeck in 1821. Seebeck found that joining special junctions between two wires constructed from dissimilar materials produces a voltage that is proportional to the temperature variation between those junctions. This voltage can be used to detect the temperature.



Thermocouple Definition (Reference: [farmandfleet.com](http://farmandfleet.com))

A thermocouple fundamentally is an electrical device containing two wires created of various metals joined together. They operated like electrical conductors producing electrical outputs at differing temperatures. The heat comes at one section, circulates, and moves down at each wire. When it backs, it produces electricity. The voltage of this electricity provides a precise reading of the temperature between the different parts of the system.



Thermocouple Structure and Mathematical Equation (Reference: **rfwireless-world.com**)

Simple or useful thermocouples are interchangeable, inexpensive, and are supplied with particular connectors. They can sense a broad range of temperatures. Thermocouples are self-powered and need no additional format of excitation in comparison with most other ways of temperature detecting. However, the considerable limitation of any thermocouple is precision. For example, system errors with values less than  $1^\circ\text{C}$  can be problematic to sense precisely with them.

Thermocouples are the most useful type of temperature detectors. They are widely used in scientific procedures and industrial applications. These applications contain temperature sensing for kilns, diesel engines, gas turbine exhaust, and other industrial functions. They are also utilized in buildings, offices, and other rooms as the temperature detectors in the thermostat system or as flame measurement at safety systems for gas-powered applications. If you want to explore more about this type of temperature sensors, visit our [“What is a Thermocouple”](#) post

## Thermopile Definition

A thermopile is an electronic instrument that modifies thermal power into an electrical one. It is also introduced as a Power pile. A thermopile may include several thermocouples combined normally in series or rarely in parallel forms. This format of connection can produce more outputs than employing a single thermocouple.



Fireplace Thermopiles (Reference: [friendlyfires.ca](http://friendlyfires.ca))

Each extra thermocouple located in a thermopile raises the ability of the system to generate electricity. For example, if a thermocouple produces two volts of electricity, and a thermopile includes five thermocouples, it can produce two volts outputs per thermocouple for an overall of eight volts. So, most thermopiles generally have five or more thermocouples joined together.

The most usual subject with thermopiles is the wiring connectors to detect low millivoltage outputs that are very loose. You require to have appropriate wiring connections when using thermopiles in your applications because you may meet new problems with such a few values of voltage.

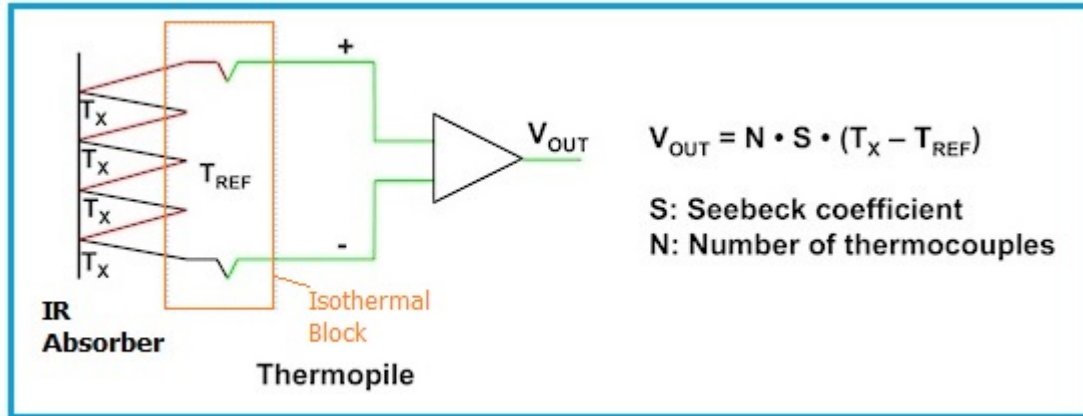
### Thermopile Installation

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- The wiring connections should be free of corrosion and completely clean.
- Long wire lengths may cause some issues in the system.

As discussed before, the thermopile includes nothing more than a series of particular thermocouples. Thermopiles can identify radiation in the surrounding in addition to sensing temperature variation and producing electricity. If you want to comprise thermocouple vs. thermopile more precise, you should consider that both thermocouples and thermopiles should employ a system that modifies the voltage of the wire to a temperature output when utilized to sense the temperature.

Thermopiles can be employed to measure the temperature variation from their junction section to the point where the thermocouple output voltage is produced. These thermocouples should be joined in series form with a particular junction placed on the other side of a thermal resistance cover. The output extracted from this section is a voltage that is straightly related to the temperature variation through the thermal resistance cover.



Thermopile Structure and Mathematical Equation (Reference: [rfwireless-world.com](http://rfwireless-world.com))

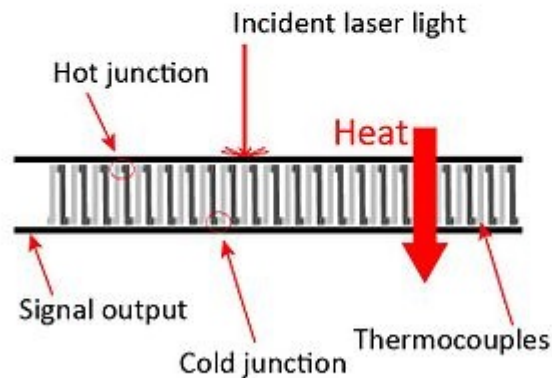
Additional thermocouple pairs in the series format can increase the intensity of the voltage output. Thermopiles can be designed with a single design, two thermocouple modeling, or more thermocouple pairs. They don't react to the temperature absolutely but produce an output voltage related to the local temperature variation or gradient of temperature.

### Thermopile Applications

Thermopiles are employed to supply an output to the temperature variation as a part of a temperature sensing system like the infrared thermometers commonly utilized in medical applications to sense the body temperature, or in particular, accelerometers to detect the temperature profile within the sealed cavity of the transducer.



## Thermopile Application in Heat Sensors



Thermopile Applications (Reference: [wikiwand.com](http://wikiwand.com))

They are also utilized in pyrheliometers, heat flux systems and gas burner controllers for safety applications. The output of the system is typically between tens to hundreds of millivolts. The system may be used to supply special temperature averaging in the form of increasing the signal situation. They are also employed to produce electrical energy from radioactive materials, solar wind, heat electrical parts, laser combustion, or radiation. The procedure of generating energy is also an example of the Peltier phenomenon or electric current moving from heat power.

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- **[Thermistor vs. Thermocouple: Complete Comparison & Practical Selection Guide](#)**
- **[What is a Thermocouple & How Does It Work?](#)**

## **The Main Differences between Thermocouple vs. Thermopile**

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There are three main differences between thermocouple and thermopile. The most obvious difference is that thermopiles include a series of interconnected and special thermocouples, which means that any system using thermopiles technically includes thermocouples.

Both thermocouples and thermopiles present precise temperature sensing; nevertheless, thermopiles produce more electricity, and it makes them more accurate in applications that employ them to produce electricity, not just to sense temperature.

Also, while both instruments identify radiation, thermopiles operate much more precisely, with a higher degree of sensitivity. The next figure provides a full comparison between thermocouple vs. thermopile transducers.

Features	Thermocouple	Thermopile
Size	It is thinner and has pointed end	It is bigger and thicker
Voltage output	Lower, between 8 mV to 30 mV	Higher, in 10s or 100s of mVs
Structure	Two dissimilar conductors i.e. made of single pair of wires	More than one thermocouples arranged in series/parallel along with IR absorber membrane
Mathematical Equation	$V_{out} = S(T_x - T_{REF})$	$V_{out} = N \cdot S(T_x - T_{REF})$ Where, N is number of thermocouples used in a thermopile
Application	It is used for contact based temperature measurement	It is used for non-contact based temperature measurement due to use of IR (infrared radiation) mechanism employed.

Comparison Chart between Thermocouple vs. Thermopile (Reference: [rfwireless-world.com](http://rfwireless-world.com))

## Thermocouple vs. Thermopile in Fireplaces

Fireplace inserts and Gas fireplaces utilize thermocouples and thermopiles to produce electricity. Thermocouples and thermopiles utilize the thermoelectricity effect to produce electricity by sensing the temperature. When the system is turned on, the pilot in a gas source produces heat, which moves inside the thermocouple. When the heat receives the next junction signal of the thermocouple, it starts to produce the electrical output. The fireplace uses this voltage to run the gas valve section, permitting gas to move and begin a firing process. Visit [here](#) to explore more about the differences between thermocouple vs. thermopile in fireplaces clearly.

Fireplaces with thermopiles can be attached to thermostats for temperature monitoring because thermopiles produce more electricity than thermocouples. On the other hand, fireplaces with thermocouples lack suitable electrical output in this process. So, thermocouples are basically utilized to detect the temperature in fireplaces, whereas the thermopiles are typically used to create electricity to run the valve and regulate temperature when employed a thermostat. Detecting this electricity voltage presents a precise temperature output between each section of the thermocouple pairs.

As explained before, A thermopile has multiple thermocouples and the more thermocouples utilized in a thermopile, the higher its capability to generate electricity will be. When you comprise thermocouple vs. thermopile, it would be obvious that



thermopiles are more sensitive and precise to identify radiation than thermocouples.

## **Thermocouple vs. Thermopile Replacement**

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If you can set up the pilot light at the fireplace but the pilot light won't work continually, there is a great opportunity that the thermocouples of the thermopile in the gas fireplace will need to be replaced.

According to the fact that a thermocouple vs. thermopile is designed to be insulated by the flame of pilot light repeatedly, it's usual that carbon materials will be more problematic over time and cause to reduce their effectiveness. Both instruments are too simple and inexpensive to replace, but it's quicker and cheaper to clean them first before the replacement process.

If your fireplace has not been serviced and cleaned in the last two years by a building professional, it certainly needs a complete cleaning. However, if it has, the replacement procedure should be applied to it to solve its problem.

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