Data Sheet

Peltier effect heat pumps

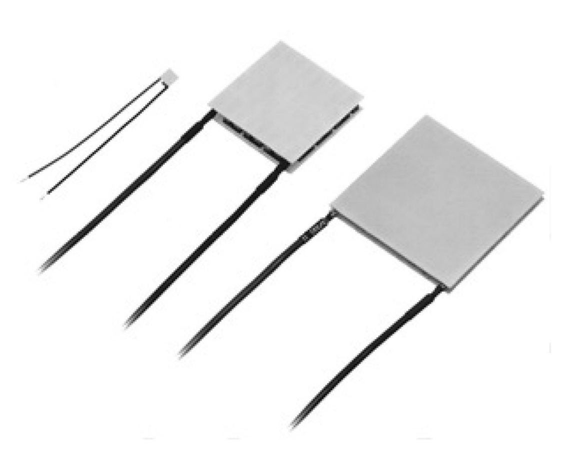
RS stock numbers 618-724, 618-730

A range of semi-conductor thermoelectric devices working on the Peltier effect. When supplied with a suitable electric current they can either cool or heat. When subjected to an externally applied temperature gradient these devices will generate a small amount of electrical power.

Available in three sizes the larger devices can be used for cooling or controlling the temperature of sub-assemblies.

Features

- Solid state, long term stability
- Capable of heating or cooling - dependent on current flow
- Generates no acoustic noise
- Capable of generating power.

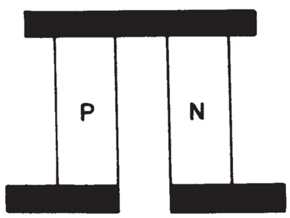


Introduction to the Peltier effect

In 1834 Jean C. A. Peltier discovered that the passage of an electric current through the junction of two dissimilar conductors can either cool or heat this junction depending on the direction of current. Heat generation or absorption rates are proportional to the magnitude of the current and also the temperature of the junction.

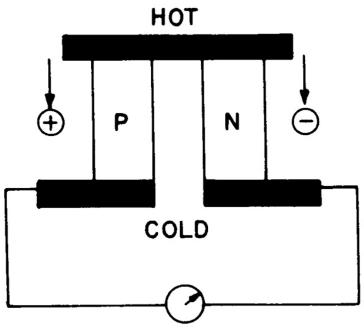
Practical Peltier Effect Heat Pumps consist of many such couples connected electrically in series and thermally in parallel.

Figure 1 **A single couple**



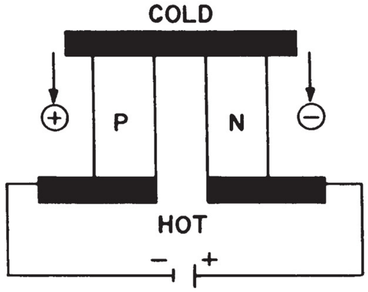
Semiconductors doped both p and n type form the elements of the couple and are soldered to copper connecting strips. Ceramic faceplates electrically insulate these connecting strips from external surfaces. The semiconductor material used is bismuth telluride as this shows the most pronounced effect at moderate operating temperatures.

Figure 2 **Generation of voltage**



At open circuit a temperature gradient maintained across the device creates a potential across its terminals proportional to the temperature difference. If the temperature difference is maintained, and if the device is connected to an electrical load power is generated.

Figure 3 **Use as a heat pump**



If, instead the device is connected to a dc source, heat will be absorbed at one end of the device, cooling it, while heat is rejected at the other end, where the temperature rises. Reversing the current reverses the flow of heat. Therefore the module can generate electric power or, depending on how it is connected to external circuitry, heat or cool an object.

A common misconception is that the Peltier device somehow absorbs heat and carries it away, perhaps with the electric current. This is simply not true. The device only transfers or pumps heat from one of its sides to the opposite side. At the hot side, the heat must be removed through the use of a heat sink or by some other means. It is important to realise that the heat delivered to the hot side of the device includes the pumped heat plus the electrical power dissipated within the device.

Peltier 18.8W (**RS** stock no 618-724) and 68.8W (**RS** stock no 618-730) modules

Electrical characteristics

at hot side temperature Th = 25°C

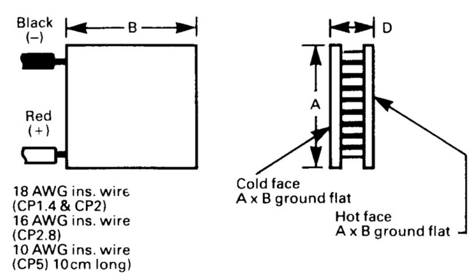
Parameter	**RS** stock no 618-724	**RS** stock no 618-730
Maximum temperature difference (Δ T)	70°C	65°C
Maximum current	9A	8.5A
Maximum voltage	3.75	15.4
Heat pumping capacity (Q_c)	18.8W	68.8W
Operating temperature range	-150°C to +110°C	

Specifications

Universal multipliers			Dimensions		
N No. of Couples	G Geometry factor	G x N	A (mm)	B (mm)	C (mm)
31 RS stock no (618-724)	0.18	5.58	30	30	5.6
127 RS stock no (618-730)	0.17	21.60	40	40	3.3

Larger Peltier devices of 18.8W and 68.8W ratings. The 18.8W module takes a maximum current of 9A with the 68.8W device taking 8.5A. They are both suitable for cooling sub-assemblies.

Figure 5 **Dimensions in millimetres**



Using Peltier devices

When trying to determine the heat pumping capacity required, two factors must be considered; active heating elements and heat leak.

Active heating elements are any components which have a power consumption. All of this power consumption (input power) will eventually be converted to heat and should be considered as heat load.

An object that is held at a temperature below ambient will draw heat from the surroundings onto its cold surface. The results of this additional heat is that a cooled object which is not insulated will not be able to maintain temperatures as low as one which has insulation. This additional heat load requirement is called the heat leak. Three main factors affect the magnitude of the heat leak. These are:

1. The temperature difference between ambient and the cooled device.
2. The surface area of the cooled device.
3. The amount of insulation used. It is advantageous to thermally insulate the device being cooled in order to reduce the heat leak to a minimum.

There are other sources of heat leak such as conduction heat from electrical wires or heat leak from the heat sink back to the cold plate of the Peltier device. Hence precise calculation of heat leak is difficult and it may be best determined empirically.

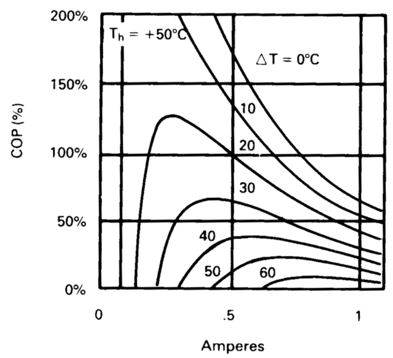
The total heat pumping capacity required is the sum of the active heat load and the heat leak.

Choosing the proper heat sink

Once the required heat pumping capacity has been determined the next step is choosing the proper heat sink. A Peltier device is not a sponge which absorbs heat, rather, it is a heat pump. The heat which is pumped out of the cold surface is deposited on the hot side of the module. This heat must be dissipated in some way. If it is not the hot side of the device will heat up the point where it will stop functioning as a cooling device and actually begin to heat the cold surface.

From fundamentals, a heat sink must be maintained at a temperature higher than ambient to transfer heat from its surface out into the surroundings. The higher the heat sink temperature above the ambient temperature the more heat can be transferred out of the heat sink. This points to choosing a heat sink which will get as hot as possible. However, reference to the performance curves shows that as the ΔT across the module becomes larger (as a result of the increased hot side temperature) the heat pumping capacity and the coefficient of performance (COP) both decrease. Considering both these phenomena a heat sink which rises to a temperature between 5 and 15°C above ambient is a practical choice.

Figure 6 **Coefficient of performance vs current**



How to use universal performance graphs

Example:

a device dissipates 31 watts of power. It is desired to maintain the device at a constant temperature of +5°C, the ambient temperature being +35° (ie. T_c = +5°C, T_h = +35°C). To select the appropriate module, approach with the following method:

1. $\Delta T = T_h - T_c$
   $= +35° - 5° = +30°C.$

Choose operating current (typically from 30G to 40G) at 35G (equals 35/50 = 70% of I max).

2. From T_h = +35°C graph (ΔT = +30°, I = 35G), obtain Q_c/ G x N = 1.65; Then G x N = Q_c/1.65 = 31/1.65 = 18.8.

3. Choose module with G x N ≥ 18.8

This implies that the 68.8W (**RS** stock no 618-730) module is the most suitable for the application.

Figure 7 **Hot side mounted to heat sink**

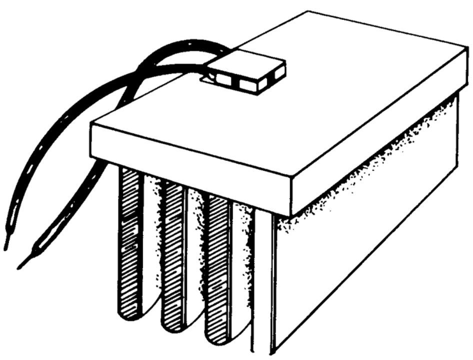
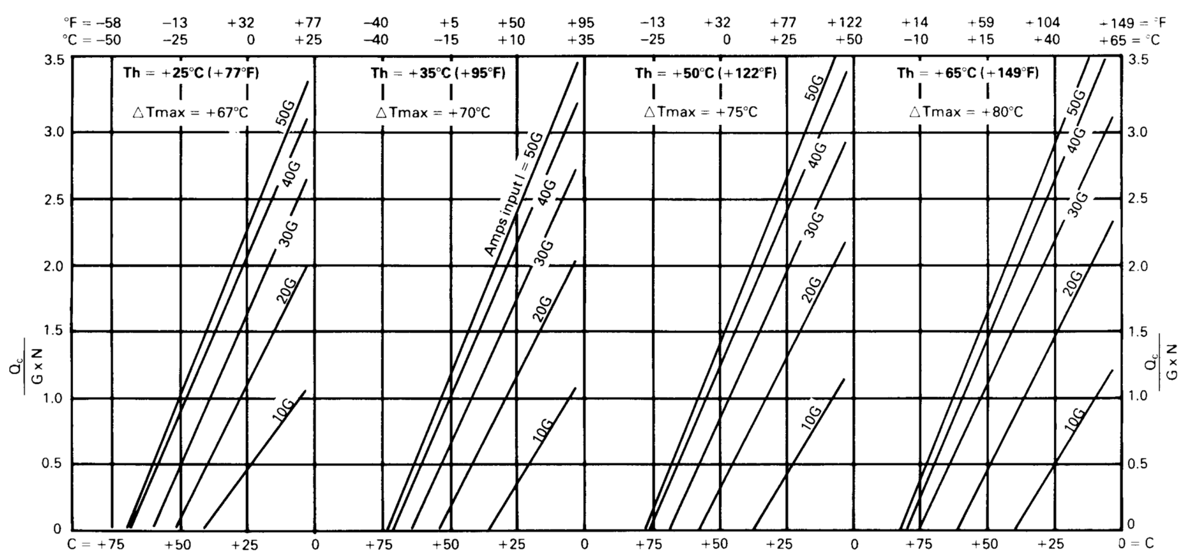


Figure 8 **Universal performance graphs**



$\Delta T = T_h - T_c$

T_c = Cold face temperature T_h = Hot face temperature   I = Module current amps   V = Module voltage, volts Q_c = Watts heat pumped
N = Number of thermocouples   G = Thermoelement geometry factor

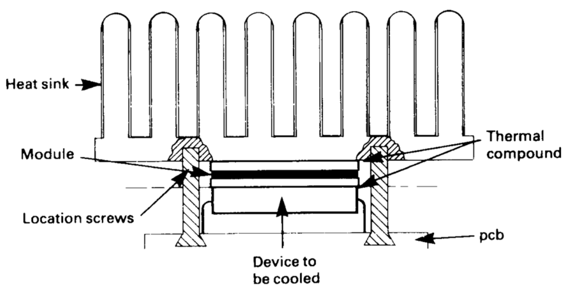
Installation of Peltier devices

Peltier devices are only as strong as the semiconductor materials used in their fabrication and thus may be damaged by the application of excessive stress. Modules should never be designed as a mechanical supporting member of an assembly.

Two mounting methods are recommended with the clamping method being generally preferred. Epoxy bonding should not be used when operation in the vacuum is required.

Clamping method

Figure 9 **Fixing by clamping**



1. The mounting surfaces should be smooth to within ±0.001 in.

2. Clean the module and mounting surfaces to remove any burrs, grit, etc.

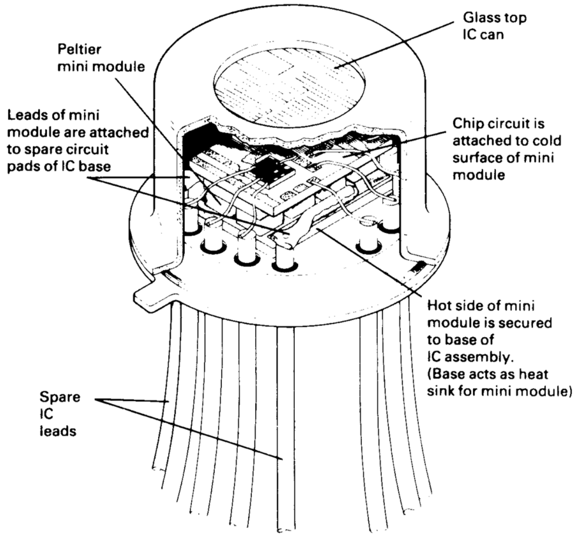
3. Coat the module hot side with a thin film of heatsink compound and place the module on the heat sink. Applying firm but even downward pressure, rock the module from side to side until a slight resistance is felt and excess heatsink compound is squeezed out.

4. Coat the cold side of the module with a thin film of heatsink compound. Place the object to be cooled in contact with the module and rock the object slightly from side to side to squeeze out excess thermal grease.

5. Both the object to be cooled and heat sink together using either stainless steel screws with spring washers or nylon screws. To ensure even pressure across the module surfaces, tighten all screws finger tight and then continue tightening in an alternate or diagonal pattern starting with the centre screws (if any) first. Maximum recommended compression loading is 15 pounds per square inch of module surface. **Do not over tighten.**

Expoxy bonding method

Figure 10 **Fixing by bonding**



1. The mounting surfaces should be smooth, flat and free from grease or burrs.

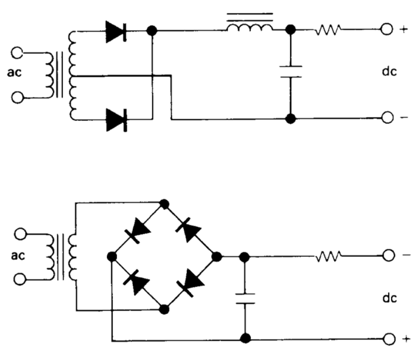
2. Coat the module hot side with a thin layer of silver loaded epoxy.

3. Place the module on the heat sink and rock slightly to squeeze out excess epoxy.

4. Weight or lightly clamp the module to hold it in place until the epoxy has cured.

Power supply considerations

Figure 11 **Base power supplies**



Peltier devices operate from direct current and the power requirements are usually not stringent or precise. For most applications, unregulated dc power with a ripple content of 10% or less is satisfactory and it is possible that higher levels of ripple can be tolerated for certain non-critical applications. However, because

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