

# Smart Springs (contraction type)

**Warning:** Smart springs are made from a nickel/titanium alloy and are heat-treated to provide the remarkable memory property. Please read the following notes and under no circumstances overheat a spring. This will reduce its working life or destroy it. Passing an excessive electrical current through a spring may cause it to heat up like an electric fire element posing a risk of burning or ignition of surrounding materials. Even during normal working conditions contact should be avoided with a heated spring.

**After initial use (doing mechanical work), the spring will never close fully again when heated. This should be allowed for in design work.**

## Introduction

The contraction type smart spring “remembers” that it should be closed and is supplied in this condition. At room temperature, the spring can be extended up to a recommended maximum of 150mm. When it is heated by immersion in hot water (70° C+) or by passing an electrical current not exceeding 3A, the spring returns to its closed condition with a pulling force approximately equal to the force needed to lift a 1 kg weight vertically. At room temperature the spring “feels” soft and pliable; above 70°C the transition temperature it behaves more like a stiff metal spring and cannot be extended again until it has cooled down.

## A First Experiment

Extend the smart spring to between 100 - 150 mm and place in a beaker. Pour in hot water between 70° C and boiling point. The spring will immediately return to its closed condition. (This is one of the advantages over bi-metallic strip actuators: the alloy changes condition fully at a specific temperature change point.)

## Electrical heating

Alkaline batteries offer the safest method of electrical heating. Two “D” size batteries in series give a supply voltage of 3v and a current of up to 3A when the batteries are in good condition. The smart spring alloy itself has a low electrical resistance. However, its surface has a high electrical resistance and also will not permit soldering. The best way of connecting a spring to battery leads is by small screw connectors cut from multi-way connecting or terminal blocks. Using pliers, bend about 8mm of spring material at both ends parallel to the spring's main axis and screw these into the connectors alongside the connecting wires. Additional wire(s) in the connectors can also be used to link the ends of the spring to whatever the spring is meant to move or actuate.

## Design notes

In most applications a biasing spring or weight has to be used to open the smart spring out at room temperature. This spring or weight should be just enough to open the spring to the required length when it is cool - remembering that the smart spring is quite soft at room temperature. (For the sake of experiments, the bias spring could be a spring balance pulling on one end.) When current is applied, the contraction force of about 10 Newton's will overcome the bias force and the spring will contract. If

the bias force is too high, the spring will not contract at all when heated. In any event, the magnitude of the bias force will determine how far the spring will contract and this must be allowed for in any design work. Please also note that the speed of contraction depends on the rate of heating, and the rate of relaxation during cooling depends on the temperature of surroundings. Relaxation will usually be slower than contraction but can be speeded up, for example, by *moving* the surrounding air.

#### Possible applications.

- Temperature sensor/actuator - fluids, hot gases etc. If the spring is used as a one-off emergency actuator (e.g. shutting a lid on a burning waste bin) it can be stretched once and left -obviating the need for a bias spring.
- Electro-mechanical actuator - shutter, window, vent, locking bolt, robotic device, pump.