Applying thermal switches

Thermal switch technology has been established in many industries for a number of years. In these high-tech times, there is still a place for these electro-mechanical devices, since they are self-contained, reliable and cost-effective

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Control Products, Inc. was founded in 1946 with a line of thermal switches for aerospace and industrial applications. Developing expertise in precise calibration of these devices over a broad temperature range, the company's business expanded into many different industries, providing a diverse portfolio of experience.

While many applications have gone the way of sensors and controllers, there are still distinct advantages to electro-mechanical temperature control – units are completely self-contained, extremely reliable and cost-effective. Specifying the right thermal switch and having a complete understanding of system characteristics and thermal parameters in advance will ensure success. Control Products, Inc. develops application solutions through factory-based regional project managers visiting the OEM to gather application data. Supported by CPI's capable engineering and production team, the OEM enjoys the benefit of a tested, documented component solution.

Thermal switch technologies

As one might expect, different thermal switch technologies have their pros and cons. Depending on the application, there is generally one technology which is most suitable. Some thermal switch technologies more commonly found on industrial vehicles are discussed below.

Bimetal
Bimetal devices are slow-make and break, and provide excellent tolerance and close differential (Figure 1).

Rod and tube
This type operates utilizing differences in coefficients of expansion of two materials, the rod and tube (Figure 2). Since the external tube is the high expanding element, this

Thermal parameters
- Set point
- Tolerance
- Differential
- Max/min probe overshoot/undershoot
- Max/min head overshoot/undershoot
- Repeatability

Electrical parameters*
- Current
- Voltage
- Type of load
- Endurance required, mechanical, electromechanical

**along with contact life, consider the effect on set point of heat generated by the load*

Environmental factors
- Corrosives
- Shock, vibration
- Probe pressure

Mechanical constraints
- Terminations
- Mounting (surface mount, probe, bulkhead)
- Probe length

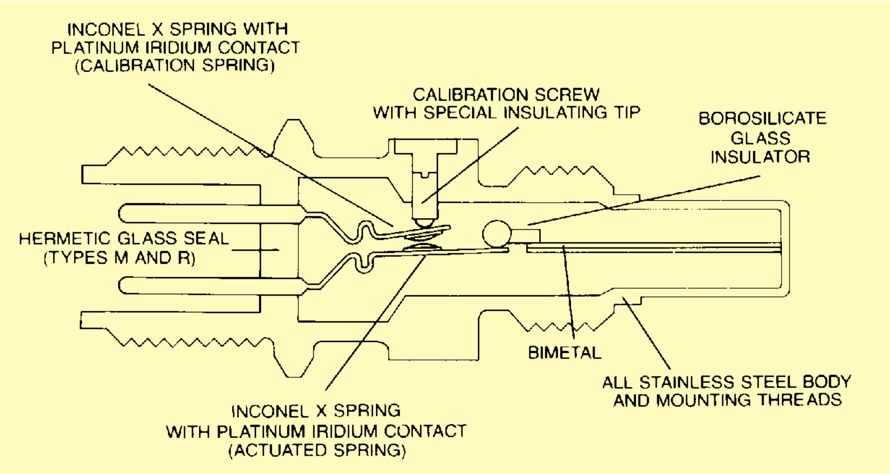

Figure 1: Bimetal

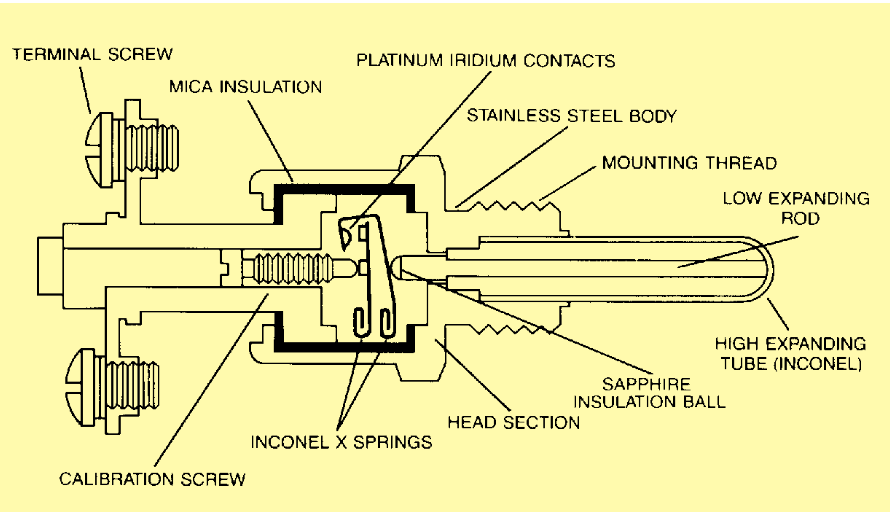

Figure 2: Rod and tube

product offers outstanding response time. It also has the highest set point capability.

Bimetallic disc

Contact movement is achieved using a bimetallic snap disc. Snap action provides shock and vibration immunity, and broader differential is the important thermal characteristic (Figure 3).

Filled system

These include liquid-, gas-, and vapor-filled. Movement is achieved via volumetric expansion. While this product also has a fairly high set point capability, response time and accuracy are mediocre. This type is extremely shock and vibration resistant.

All these technologies have been around for a long time and are readily available.

"Correlating precise production calibration with field conditions is not always a matter of applying a formula"

Thermal parameters – correlation

Correlating precise production calibration conditions at the factory with field conditions on OEM equipment is not always a matter of applying a formula. Rate of temperature change varies per application and generally is not constant. Erratic flow rates, differences in heat transfer properties of media, and wide ranging ambient conditions are realities which favor a planned trial-and-error method.

Parameters required to specify a thermal switch are:

- Set point – contacts open/close at this temperature;
- Tolerance – degree of accuracy, express as plus/minus degrees;
- Differential or hysterisis – switch reset temperature;
- Switch action – close on rise, open on rise, close on fall, open on fall.

For example, a close on rise switch with a set point of 100°F, ±5°F, with a 0-5°F differential will operate as follows. As temperature rises from ambient through 110°F, the contacts will close somewhere between 95 and 105°F. As the system cools to ambient, the contacts will reopen between 105 and 90°F.

It is possible to select a product which fits the packaging constraints, and simply provide these parameters to the local thermal switch representative. In some cases, the component will operate in the system exactly as desired. To achieve this, it is essential that every possible operating

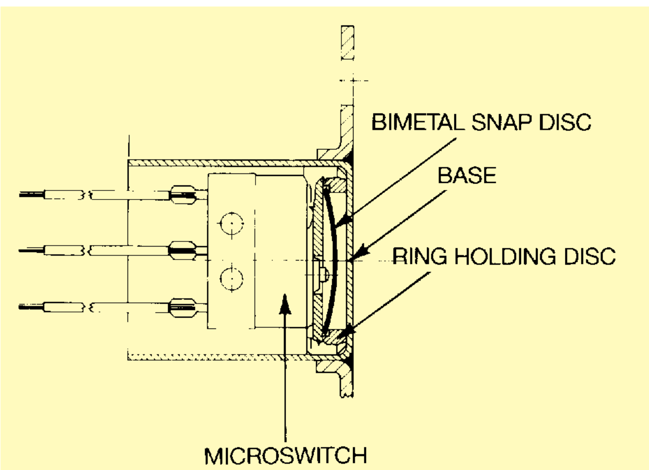

Figure 3: Bimetallic disc

Figure 4: Rod and tube, bimetallic disc, bimetal construction

Figure 5: Shrouded versus non-shrouded rod and tube

scenario is considered, and confirmation should be obtained that the component operates as expected for each. CPI has experienced what appeared to be changes in thermal switch performance only to learn that all possible ambient conditions had not been considered.

One pitfall of thermal systems is that anticipation may occur in rod and tube switches where the system has a very rapid rate of change and the switch activates prematurely. This problem can be rectified by shrouding the tube, or a portion of the tube, providing additional thermal mass (Figure 5).

Normally, success in the design will come from thorough consideration of the requirements, and applying good science in validating the component selection. Table 1 shows a complete list of the parameters and application considerations which should be taken into account when specifying thermal switches.

The 'evasive' set point

Where testing of switches set at different increments does not effectively establish the set point, CPI recommends field adjusting a test unit in the application. This test unit can be correlated to a set point in the factory calibration facility. Finally, a sealed test unit calibrated to this set point should be tested in the application to verify no change has occurred in handling and transit.

There is no substitute for field testing the component in the application. Where this is not possible, or in addition to field testing, lab testing the component simulating the application will minimize unpleasant surprises. Performance characteristics should be tested to 110-150 per cent of the application requirements, depending on the parameter and number of units tested.