2007

Introduction:

360° Test Labs has been retained to test and analyze supplied heat activated devices. What follows are the **findings** from our independent analysis:

Supplied to 360° Test Labs:

Device - # 1 Good
Device - # 2 Dead
Device - # 3 Uneven heat
Device - # 4 Uneven heat
Device - # 5 Uneven heat
Device - # 6 Dead
Device - # 7 Too hot
Device - # 8 Good

Model 2 Non-RoHS
Model 1
Device Supplies

Notes & Findings:

Sample assignment:

Prior to testing all device samples were assigned a number from 1 – 8 (see index above).

Power:

When device samples were tested for power draw, samples drew 240-watts when heating. Upon reaching operating temperature, the draw is reduced to 7-watts (same for standby power). The sample is cycled full power on and off to maintain temperature. However, the deivce packaging notes 1 x 175W.

Sample specific analysis:

Sample 1: Good - used for comparison

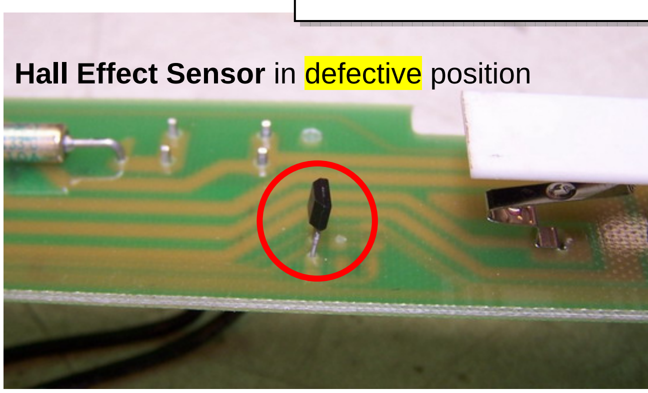
Sample 2: Dead -
Problem with the magnet sensor prevents sample from powering up.
Small amounts of metal, e.g., the metal washer included to position mechanism in transport, on some trials would activate unit, other times it would not.

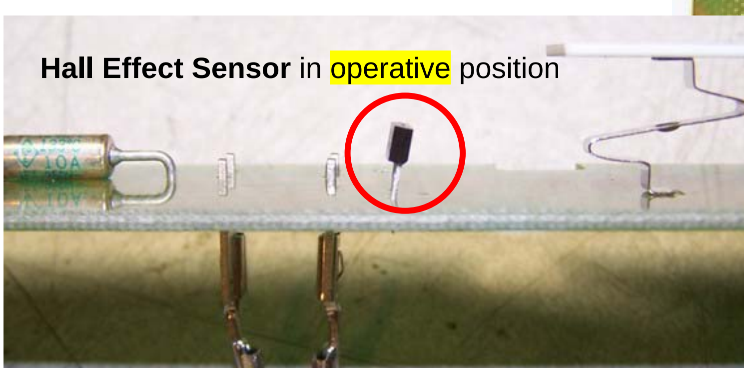
The device is switched on via a moving magnet that is attracted to a piece of metal, e.g., Steelback Binding Spine. When the material containing metal is placed on the heating plate the magnet is pulled up toward the material. Nearby is a hall effect sensor that detects the magnet and activates the heating circuit.

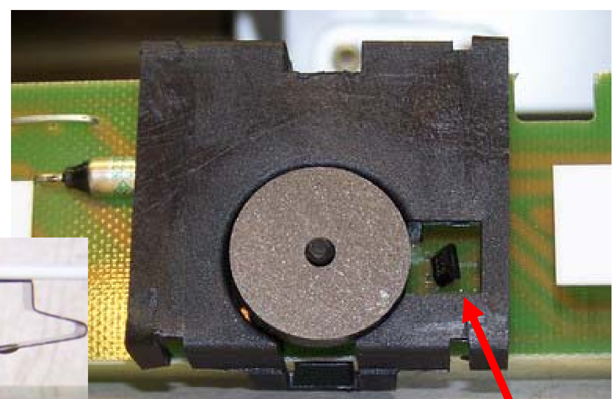
Sample 2 was one of the least reliable samples for powering on, and when it did activate removing the metal or material did not cause the device to deactivate.[1] An initial investigation explored the possibility that the magnet's plastic housing was to blame for the activation issues. However, the housing and center post holding the magnet did not appear rough or otherwise indicate that the magnet assembly unable to move freely.

What was observed is that on this sample, the hall effect sensor was bent-in a too far thereby allowing it to touch the magnet.

Below illustrates the remedy for Sample 2's defect

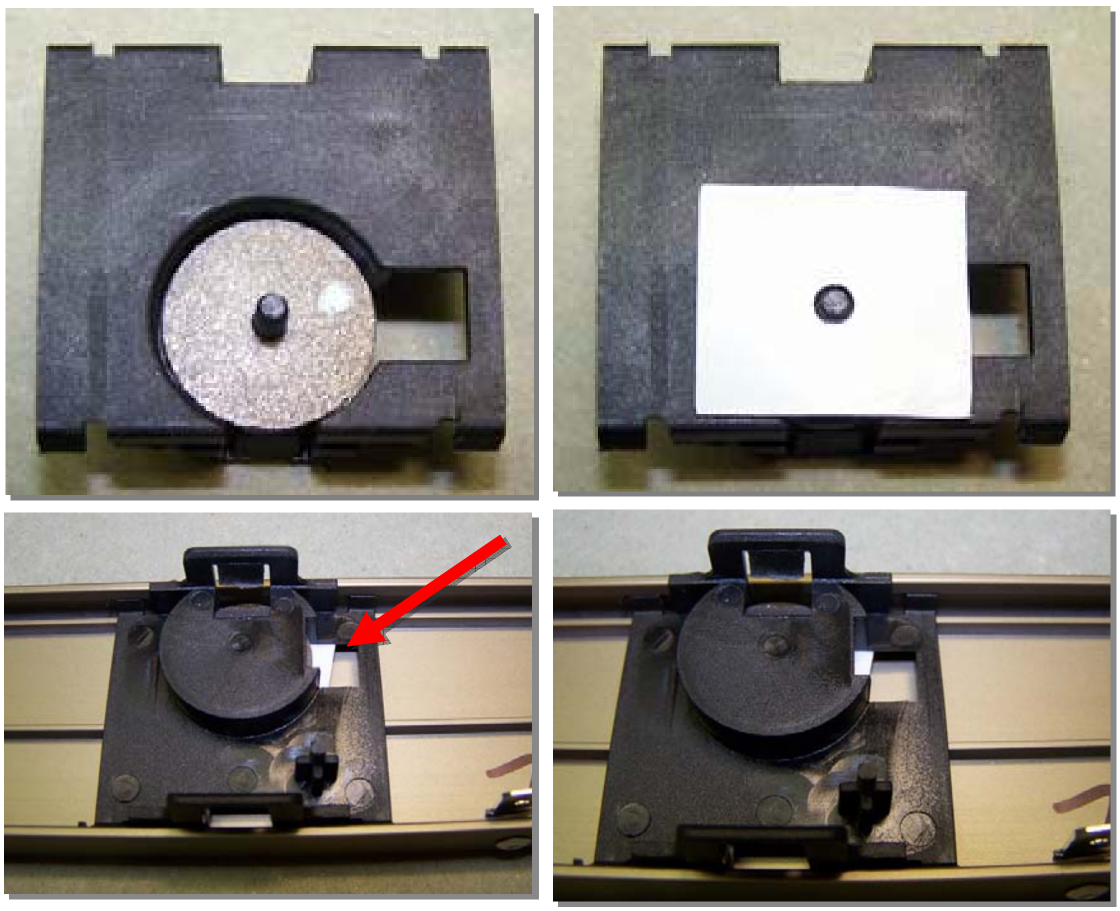

Hall Effect Sensor in defective position


Hall Effect Sensor in operative position


Hall Effect Sensor in operative position with magnetic assembly (above)

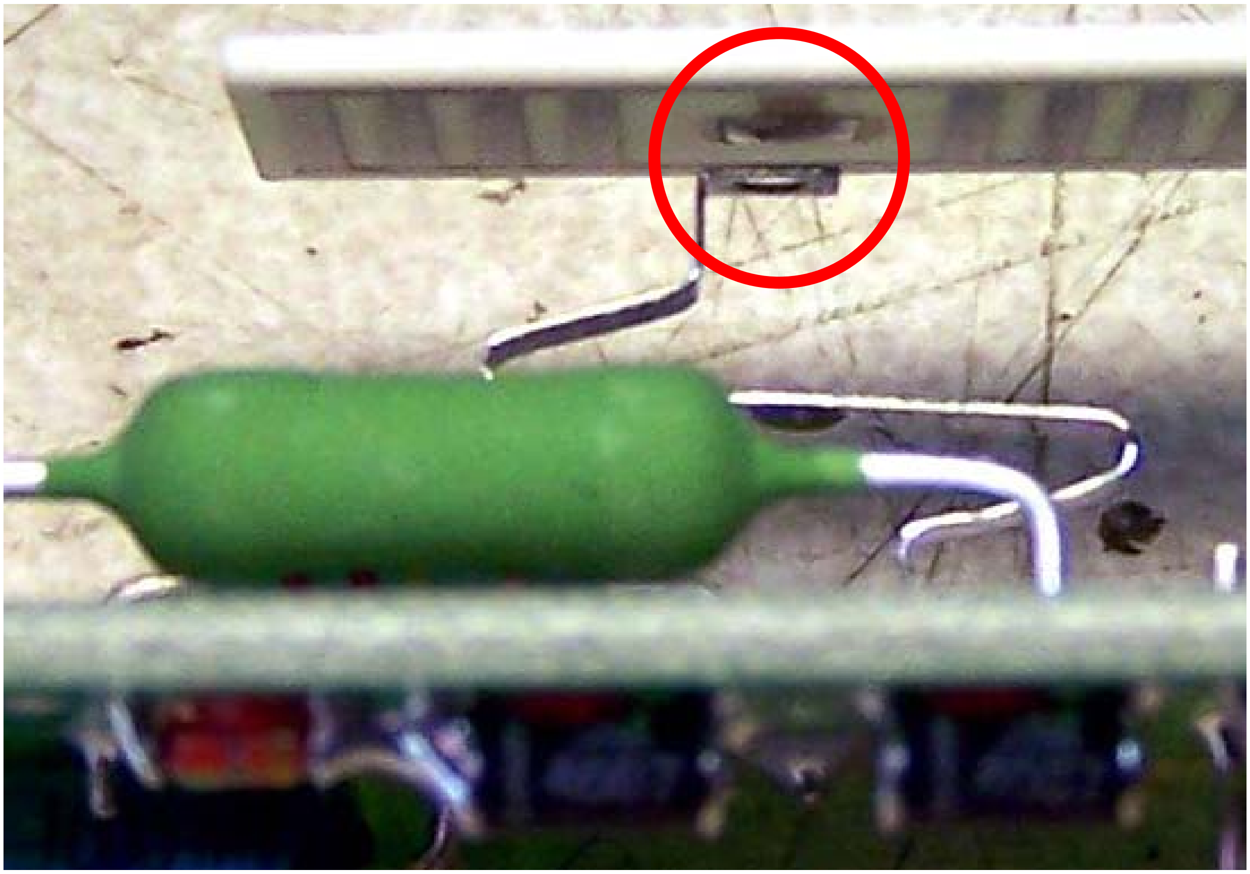
[1] Sample #6 acted similarly, but not with the same severity.

Sample 6: Dead -
Sample 6, as with Sample 2, evidenced a magnet sticking problem -- though not as severe. In Sample 6, the problem was traced to an off center, center post. The only identifiable cause for the improper centering relates to the white plastic piece covering the magnet. During assembly, this white piece of plastic is placed over the magnet and the assembly is slid sideways into the aluminum holder. If the thickness of this white plastic is too thick, or other tolerance too tight, the piece may drag. In this process, the center post holding the white plastic piece is being pulled sideways, which can cause the magnet to bind as it is no longer centered in its intended cavity.

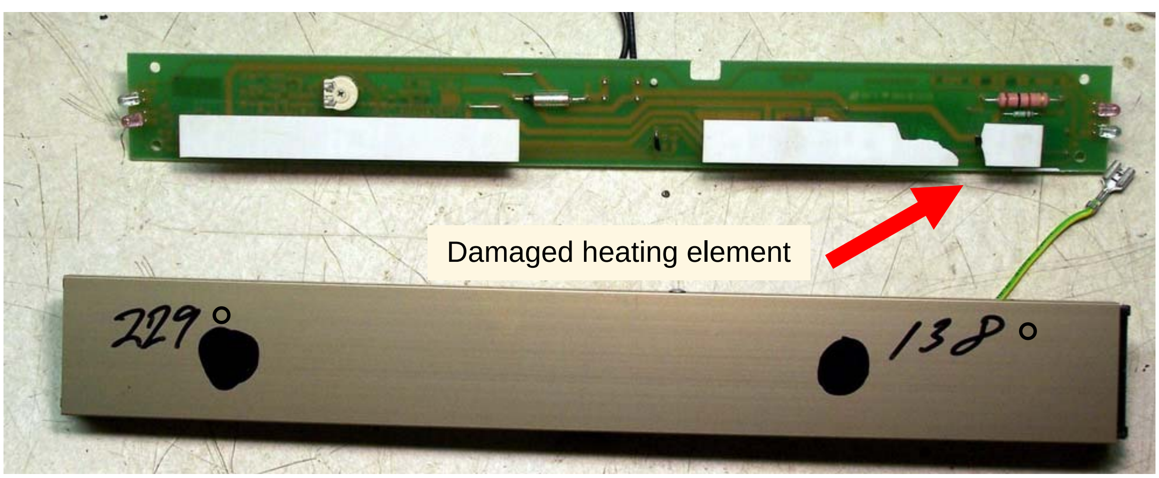


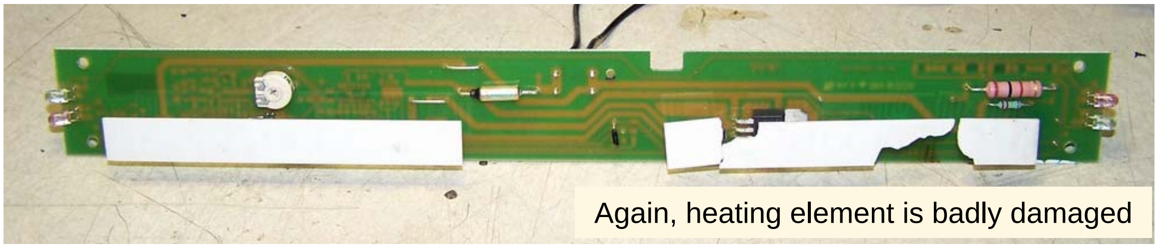
The upper left picture shows the center post, and the upper right shows the plastic cover. The bottom two images illustrate the holder when pulled right. Note how the white plastic piece moves when the assembly is pulled into postion.

The next three samples, Samples 3, 4, and 5, were reported to have problems with uneven heating. Their disassembly tells the story.

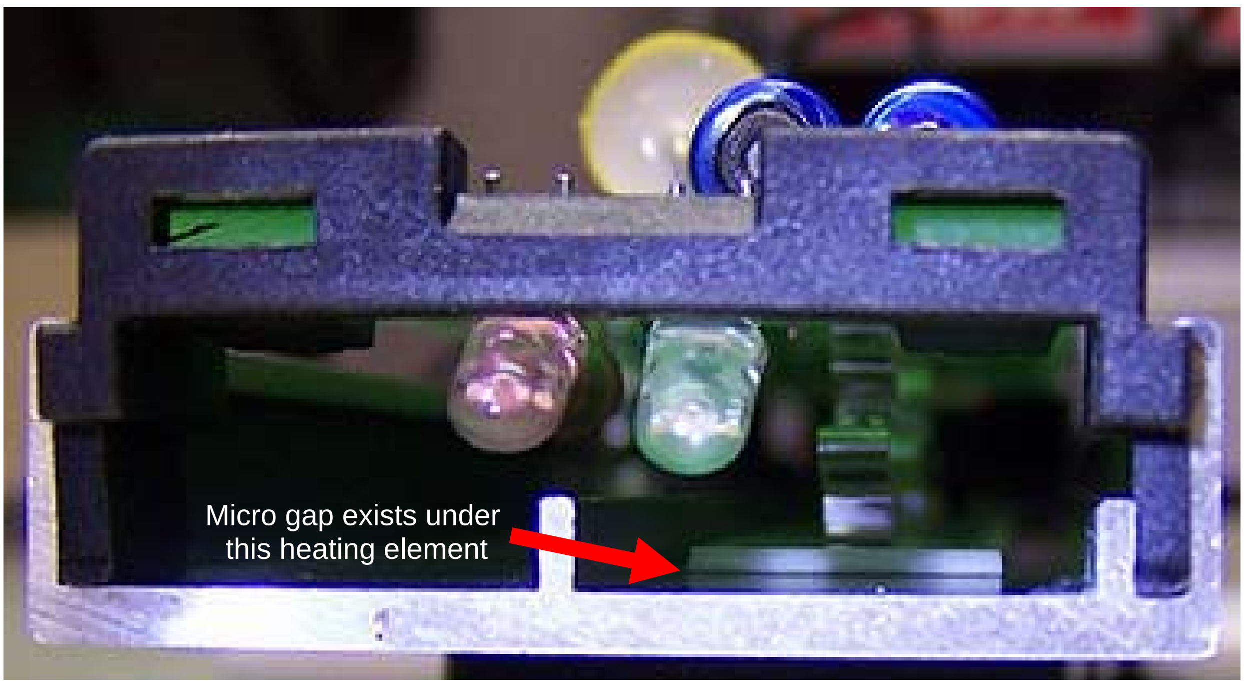


Above, the connection was pulled off from the heating element.





All damaged heating elements were on the right side. Investigation into the cause of the damage to the right elements revealed that the heating elements were controlled differently. Only the left side element had temperature feedback to the control circuit. The problem observed could be caused by small air gaps between the heating elements and the heat sink (hot bar).



Ideally, since both elements are drawing the same power in watts, and both are conducting the heat to the hot bar, there should not be a problem. In the current design, the left element, with its feedback sensor to the control circuit, detects when the operating temperature is reached. The design assumes that both elements are at the same temperature. If there is a problem conducting heat away from the right heating element, the left element may not reflect the overheating quickly enough to prevent damage to this right element.

When the left element no longer can transfer its generated heat fast enough into the hot bar, it will shutdown thanks to its control circuit. However, if the right element cannot transfer its generated heat fast enough into the hot bar, the control circuit will not quickly respond to this spiking element temperature, and power will continue to flow as the right element goes into thermal meltdown.

Several bench tests were performed to validate that micro air gaps can trigger the above described thermal meltdown.

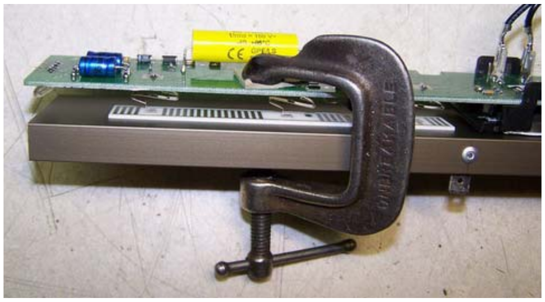
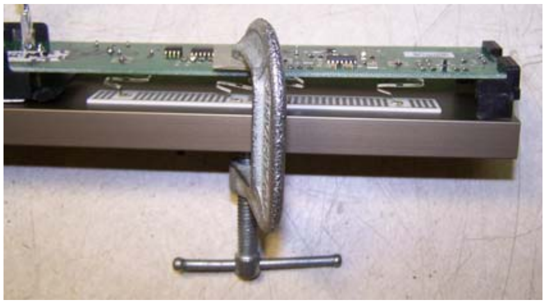
Bench Simulation:
In the device's assembly, it is difficult to measure accurately the element temperatures. Below, the sample was clamped upside down to allow each element's temperature to be measured during operation via an infrared probe.

In testing, the back of the left element would reach 360° F, or even in one case, 388° F, while the front of the hot bar would be 260 and 270°F. At the same time, the right element could get up to 400° F without shutdown, if there was not a good connection to the hot bar.

These very high temperatures could be measured on either heating element side at various times. As noted above, even the controlled left element with its feedback built-in could reach to 388° F (this measurement was made at the element perimeter not from the middle-point). Slow deactivation may be explained by the need for excess heat to migrate to the sensor area, which is located in the middle of the element.

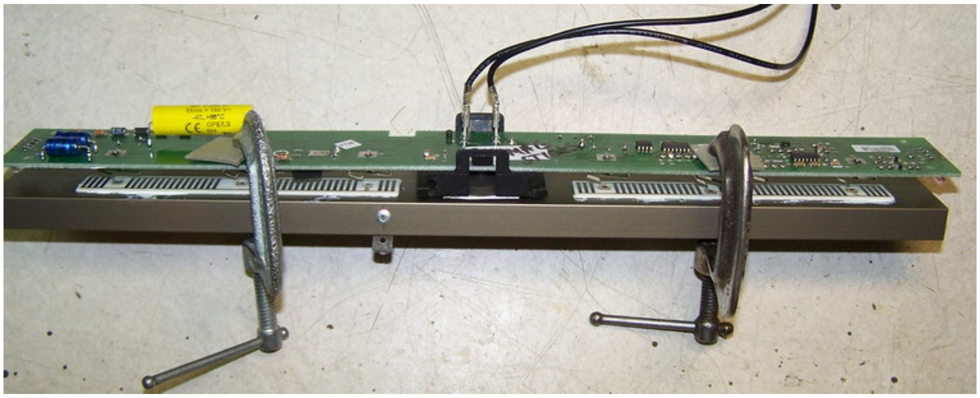
Of concern...
<u>An element on the hot bar with only a 0.001" micro gap on the extremity can reach a temperature > 400° F in that end area with the gap. Clearly, air gap control is crucial to minimizing heating defects.</u> We would expect a major determinant of the longevity of the elements to be the speed at which heat can be transferred from the heating element into the hot bar, and this speed is largely influenced by intimate contact with the hot car.

Below clamps are holding the assembly in place as applied Super Glue dries. After curing, the above test was rerun, to determine if there was any improvement due attributable to gluing.

After gluing, the maximum element temperature was around ~309° F, a material improvement.

In our next test, we used an epoxy adhesive.



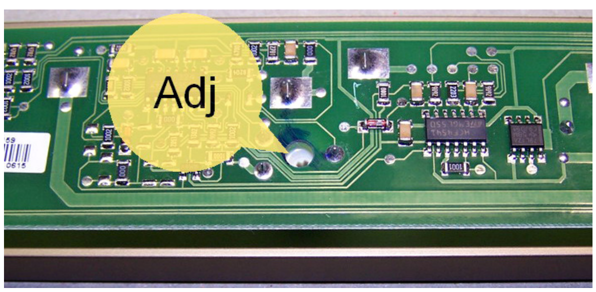

After curing, the temperature test was repeated. Now, the maximum element temperature was 299° F.

Sample 7 and 8: Too hot –
No problems were found with the circuit. Once the temperature setting was readjusted, the operating temperature became 260° F without incidence.

In this process, a temperature reading was first taken with an infrared thermometer looking at the hot bar in two locations. The first measured sample had one side reaching 299° F, the other 289° F, while the other sample was reaching up to 303° F and 295° F. We did observe that in all samples, there was a difference of at least 5° F between sides, and at times as much as 10° F difference.

On high temperature samples 7 and 8, the adjustment control was turned counter clockwise 1/8 turn at a time, then the device was allowed to run until it reached maximum operating temperature. When the device cooled, if needed, a similar adjustment was again made until the desired 260° F was reached.[2]

On both of these sample, there were no signs of damage to the PC Board or otherwise that might have caused the faulty temperature settings -- the adjustment control worked as needed.



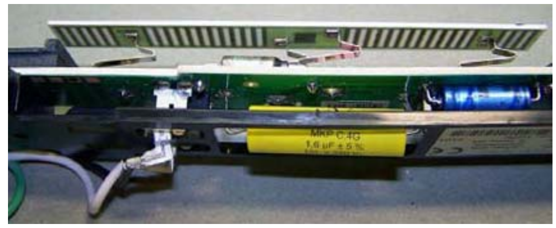
Adjustment Point on the board

Note that, in general, the device's electronics, PC Board and components were all noted to be of very good quality.

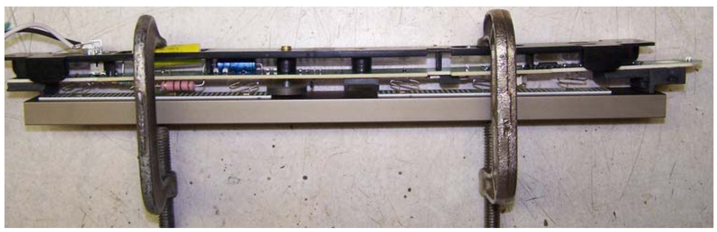
[2] 260° was set as it was the measured temperature of Sample 1 -- a sample believed to be operating within desired parameters.

Model 1

In these samples the heating elements differed from that of the device.

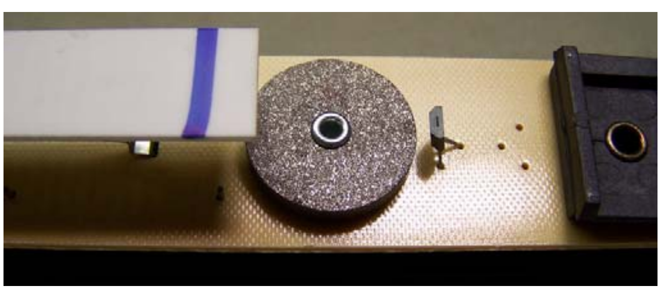


As before, the elements are clamped to the hot bar.



Testing found that the maximum temperature of these elements was 320° F on the left side, and 293° F on the right.[3] Whereas the hot bar temperature was 255° F and 245° F respectively. Again, it appeared to take time for heat to travel through the elements substrate, en route to the sensor area. Further, testing suggests that 320° F heat is not overly detrimental to the element,[4] as this model is not known to have a failure rate paralleling the device. The power draw of this sample was 180-watts on heating that drops to 100-watts while at temperature. Stand by power, as with the device was 7-watts.

If Model 1 does enjoy a longer service life, the difference may be largely the influence of the lower wattage heating elements.



No issues were noted with magnet activation on this model's differing assembly.

[3] However, in contrast to the device, the right element is the controlled element.

[4] Naturally, lower temperature operation prolongs service life, other things being equal

Model 2

The Model 2, is very similar to the Model 1. It has the same circuit board in a different layout within the enclosure.

Conclusions:

Testing suggests the following items will materially reduce device defects...

- Check heating elements for continuity, post assembly to PC Board

- Ensure that the hall effect sensor does not touch the magnet

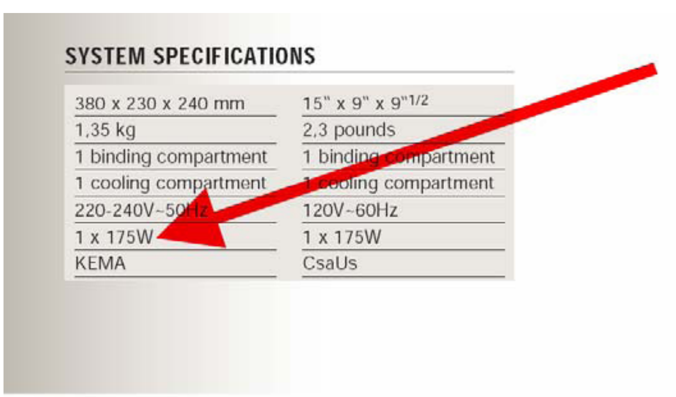
- Tighten tolerance on factory temperature setting

- The small white piece of plastic appears extraneous and may potentially be eliminated. The manner in which the holder fits into the aluminum bar should prevent the magnet from falling out. If this remedy is not adequate—apply a small amount of glue to the holder, and then allow the glue to set before inserting the magnet assembly.

- Have both elements use the built in sensor, and wire the heating sensors in series to force the circuit to see both elements. Alternatively, use a high temp compound to mount the elements to the hot bar. This will permit more reliable transfer of generated heat from the element to the hot bar.

  Most electronics reqiring heat transfer to a heat sink, e.g., the processor in PC CPU, use a conductive compound to fill in any micro gaps and facilitate efficient rapid heat transfer.

- The other devices use the 170-watts noted on their packaging, unlike the misrepresented 175-watts specified on the device (including its datasheet).



SYSTEM SPECIFICATIONS

380 x 230 x 240 mm	15" x 9" x 9"1/2
1,35 kg	2,3 pounds
1 binding compartment	1 binding compartment
1 cooling compartment	1 cooling compartment
220-240V~50Hz	120V~60Hz
1 x 175W	1 x 175W
KEMA	CsaUs

The devices are drawing 240, not 175, watts.

Further, there did not seem to be a problem with the heating elements in the lower wattage systems (Model 1 and Model 2). The additional 70-watts total, or 35-watts per element, used in the device might be pushing the heating elements to the point where the additional heat cannot be transferred fast enough—especially if air gaps exist under the hot bar.