What is the temperature stability of the HV^{HT} oven?

The HV^{HT} oven is closed loop PID controled through proprietary IPS 7 Control Boards. The calculations for power levels and adjustments to the power levels are made for every zone, every ½ second. Because the IPS7 Control boards do these calculations and adjustments, these calculations do not rely on the speed of the microprocessor of the PC. The PC does not directly control the oven temperature.

The temperature of the oven is stable to $\pm 2^{o}$C from setpoint at full blower speeds with no load in the oven. Very often, the temperature never varies more than $\pm 1^{o}$C.

NOTE: All zones must require a minimum average power level of 5% to guarantee stability. *Example:*

Top Zone 1 Setpoint = 100C

Lower Zone 1 Setpoint = 200C

Top Zone 1 reaches equilibrium at 130C with 0% power required. 0% is less than 5%.

What is the recommended process window for the HV^{HT} oven?

The peak temperature of the board is repeatable $\pm 2.5^{o}$C point to point, 0-90% loading. The temperature of the PCB is stable when the HV^{HT} is set for a process ready window of $\pm 10^{o}$C. During random loading of the oven, the temperature will normally vary $\pm 5^{o}$C. If the loading is very heavy, or if the oven is loaded with very heavy boards, the temperature will vary as much as $\pm 10^{o}$C.

The temperature control scheme is based on adjusting power levels based on loading conditions. If the loading of the oven is with many boards, or the oven is loaded with very heavy boards, the temperature will drop and power will be increased to the heaters. If the loading stops, the temperature will increase and the power will be lowered to the heaters.

It is important that the temperature of the oven changes. An oven temperature that did not change would not give good PCB results. The thermocouple is mounted to measure the air temperature exiting the faceplate inside the oven. This location is very important so the thermocouple measures temperature changes rapidly when the oven is loaded. If the thermocouple was mounted inside a large aluminum plate, the temperature of the aluminum plate would be very stable, but the temperature of the board moving under the aluminum plate would not always be heated the same. If there were many boards, the heat loss would not be sensed, and the last board would not heat up as much as the first board.

How much heat does the HV^{HT} oven put into the factory?

Typical power consumption, HVC70 = 13KW, HVC102 = 16KW, HVC155 = 19KW. (Actual power consumption is dependent on profile and loading conditions.) The amount of heat put into the factory can be estimate by assuming the following equation:

Heat into the room = Power into the oven – heat exhausted out of the factory

Heat into the room = 13KW(HVC70) – 2(75 CFM *.24 btu/lbmF * .07 lbm/ft^{3} * (150-75F))*

Heat into the room = 13KW(HVC70) – 189 btu/minute

Heat into the room = 13KW(HVC70) – 3.3KW = 9.7KW

How much temperature difference can be maintained between zones?

The HV^{HT} conserves nitrogen and power consumption by reusing the nitrogen and heat over and over again. The nitrogen is inserted into cooling zone and is recirculated into the last reflow zone. From the last reflow zone, the heat and nitrogen is recirculated through the oven and finally exits the oven at the entrance exhaust where the flux cooled and trapped in a disposable duct.

The design makes the HV^{HT} ideal for Pb-Free profiles requiring ramp and hold in reflow.

For the HV^{HT}, all zones must require a minimum average power level of 5% to guarantee stability. *Example:*

Top Zone 1 Setpoint = 100C

Lower Zone 1 Setpoint = 200C

Top Zone 1 reaches equilibrium at 130C with 0% power required. 0% is less than 5%.

Heat moving from one zone to another will affect the amount of power needed to maintain the heating setpoint, because the nitrogen is already preheated. When the temperature of a heater is stable,

Then:

Heat in = Heat out.

Where:

Heat in = Power added to zone + Hot air in from another zone

"Power added to the zone" is calculated by the IPS7 card.

"Hot air from another zone" increases as blower speeds increase.

and where:

Heat out = Heat losses from zone + Heat into conveyor + Heat into air + Heat into boards

"Heat losses from the zone" increase as setpoint temperatures increase. It is easier to maintain large temperature differences with higher setpoint temperatures.

"Heat into conveyor" increases with conveyor belt speed, and has a greater effect on the lower zones. It is easier to maintain a lower setpoint on the bottom zones because the conveyor takes heat away.

"Heat into Air" is the power going into the air, and the air being moved to another zone.

"Heat into boards" is the heat that moves from the oven heater into the PCB. It is easier to maintain temperature differences under load with boards going through the oven.

At right is a screenshot where zone 5 was set to 300°C and all other zones had fans running but no heat turned on. It is clear to see that the flow moves from off-load to on-load.