

## Application Note: HC-001 How the HVAC Works

### Brief Description of technology:

The HVAC-Chip is a fully encapsulated, weather and rain proof retro-fit product used to save energy in HVAC systems. The HVAC-Chip are available in different models. Its basic functions are:

- 1) To extend the ventilation fan run time of a HVAC (Heating Ventilating and Air Conditioning) systems up to 5 mins after the heating or cooling unit has turned off. This extension run time is programmable.
- 2) To turn off the air conditioning compressor for a few minutes and then turn back on again, all the while with the ventilation fan still running, if the compressor has been running for 30 mins cycles. This time period is programmable.

### Background

In July 2008, the California Energy Commissions came out with a report on energy performance of hot, dry optimized air-conditioning system. Out of the 112 pages, only 2 pages ( 65 and 66) discusses the merits of extending the fan run time. Essentially, the report validates the fact that when the compressor shuts down, latent cool energy on its cooling coils can be harnessed. Correspondingly, when the heater shuts down, the residual heat energy trapped in the heat exchanger can also be harnessed.

Further studies and evaluation done by PG&E and SCE also showed similar results. See references listed below.

- 1) *Energy Performance of hot, dry optimized air-conditioning system*, California Energy Commission, July 2008. Report Number: CEC-500-2008-056. See pages 65 and 66
- 2) Pacific Gas and Electric Company, *Emerging Technology Program*. 2/8/2008. Report Number 0724. See page 23.
- 3) Southern California Edison. *Effects of delaying evaporator fan cycle off time for residential air conditioning units*. March 20, 2012. Report Number ET11SCE1130

The original report by California Energy Commission motivated the development of the HVAC-chip, and the feedbacks from end users confirms the energy saving properties of this simple feature. All the above studies is only on the extending ventilation fan run time.

Since there were many applications where the fan must run continuously during office hours or that the compressor seldom shuts down, we have added a new feature to the HVAC Chip. This new feature is that of shutting down the compressor for a few minutes and automatically re-starts it up again in a cooling cycle. This is based on the same principle that latent energy can be harnessed when water that has condensed onto the cooling coils is made to evaporate away

with the fan blowing across the coils. By shutting down the compressor for a few minutes while the fan evaporates away the water, cool air still gets into the conditioned space but a lot of energy can be saved. Even though re-starting the compressor will draw some start up energy cost, the net saving from compressor stopping for a few minutes is much higher and contributes to a substantial savings.

### Conventional Thermostat

A conventional HVAC consists of heating units, air conditioning units and the ventilation fan unit at the air handler. A thermostat is used to control the conditions of the air in a conditioned space by sending control signals to a control circuit located at the air handler unit or the roof top unit (RTU). This control circuit activate or deactivate one or more of the heating, air conditioning or ventilation fan units.

Conventional HVAC control circuit typically operates the ventilation fan for a fixed 0 second to 90 seconds after the heating or cooling unit has been turned off, regardless of how long the compressor or heater has been running.

Studies has shown that even after this 90 seconds duration, the heat exchanger surfaces and the cooling coil surface still has some energy left. This wasted energy is not delivered to the conditioned space when the fan stops blowing.

Therefore there is a need in a HVAC system with an secondary fan controller device that can be used to recover additional heating and cooling capacity and operate HVAC equipment at higher efficiency.

### HVAC-Chip

The HVAC-chip built-in extend fan delay controller will adjusts the fan operation automatically for heating based on gas valve activation time or electric heater operating time or Heat Pump activation time. For air conditoning, the same HVAC-chip's extend fan delay controller will adjust fan operation automatically for cooling based on air-conditioning compressor run time.

The amount of time the fan continues to operate after the heater is off or after the air conditional compressor is off, varies with the amount of time the heating or cooling units are turned on. This is done by using a microprocessor and software. The heater or furnace additional fan run time indicates how much left over heat is stored in the heat exchanger. The air conditioner compressor additional fan run time indicates how much cold energy is left on its cooling or evaporator coils, and also how much cold water is condensed on the evaporator coil.

The delay fan delay controller can recovers and delivers more heating and cooling energy to the conditioned space than is possible with original HVAC control circuits. The extend fan delay controller improves the efficiency of HVAC equipment by delivering additional heating or cooling capacity for a small amount of additional electric energy (kWh).

In cases where the air conditioning compressor keeps running for a long period of time or the

fan never shuts down, the HVAC-chip built-in controller will shut the compressor down for a few minutes to allow the water condensed onto the cooling coil to evaporate, and then power the compressor back on.

Air conditioners cool conditioned spaces by removing sensible and latent heat from the return air which reduces the supply air temperature and humidity. Latent heat is removed as water vapor is condensed out of the air due to the temperature of the evaporator coil being less than the return air dew point temperature.

Latent heat is the quantity of heat absorbed or released by air undergoing a change of state, such as water vapor condensing out of the air as water onto a cold evaporator coil or cold water evaporating to water vapor which will cool the air.

Most cooling coils are cold and wet (below 40 to 50°F) after the compressor turns off. Cooling energy left on the cooling coil after the compressor turns off is generally wasted. Even though the excess cold water condensed on the coil flows down the condensate drain, the cooling coil itself is still wet and laden with latent energy. The extend fan delay controller recovers the remaining cooling energy from this coil by operating the fan after the compressor turns off to cool the conditioned space.

Most furnace heat exchangers are still hot (above 135 to 210°F) after the furnace fan turns off. HVAC-chip extend fan delay controller recovers the remaining heat energy from the hot surfaces of the heat exchanger after the furnace turns off and delivers this heat to the conditioned space.

The HVAC-chip extend fan delay controller works by hijacking the thermostat's fan control output signal and replace it with the new fan control signal from the HVAC-chip itself. In this way, the HVAC ventilation fan only receives the fan control signals from the HVAC-chip, and not from the thermostat directly.

Please see <http://www.hvac-chip.com/Specifications.php> for more details and block diagrams.

When the thermostat send out the fan activate or deactivate command signal, it goes only to the extend fan delay controller. This device reads this command and together with other environmental conditions from the HVAC, computes the additional fan run time. Then, the extend fan delay controller sends an adjusted command signal to the HVAC fan controller requesting it to run for a programmed additional extended time.

Similarly, the HVAC-Chip compressor shut off controller works by hijacking the thermostat's compressor (Yellow wire) control signal and replace it with a new compressor control signal from the HVAC-chip. In this way, the HVAC compressor only receives control signals from the HVAC-chip and not from the thermostat directly. The HVAC-chip therefore can instruct the compressor when to shut down for a few minutes and when to power up again.

Confirmation that technology does not void manufacturer warranty

The HVAC-chip operates on the same 24vac used on the thermostat. It is wired to the same wirings used on a thermostat, and generates the same signals voltages and currents as a thermostat. It does not interfere with the high voltage side of the HVAC system. Therefore this technology does not void manufacturer warranty.

Compliance with State or Federal code

The HVAC-chip complies with all State and Federal codes. It uses only the existing household 24vac that are used to power a thermostat. It conforms to the same standard as a thermostat in terms of amperage, voltage levels and safety standards.

Identification of prior energy efficiency program assessment or eligibility

Please see rebate program on manufactured homes with Southern California Edison.

[https://www.sce.com/wps/portal/home/residential/rebates-savings/manufactured-home-program!/ut/p/b1/hc\\_BCoJAEAbgZ-ngMXd00bTbFmlrUZhStpfQ2FbB3LAt6e3boktUNrd\\_-H6YQQxliDX5tRK5qmST14\\_M3J3lhWRGE6Bh4BCgE\\_BTZ-7idGprsNUAfgYBf\\_ONYn0ktvAHWI1soNE6mC8nlg2e\\_QJ-CMEsWmqQxhg0jmGREIIB3BfoOTJCTNSyeD68JU2BPYFYw-85a15afW6VOp0HhtgQNd1ppBS1Nzcy6MB3yqIPCuUvUt0OmZQ0SErbt3gDuMLDIM!/dl4/d5/L2dBISEvZ0FBIS9nQSEh/?from=/residential/rebates-savings/cmhp.htm](https://www.sce.com/wps/portal/home/residential/rebates-savings/manufactured-home-program!/ut/p/b1/hc_BCoJAEAbgZ-ngMXd00bTbFmlrUZhStpfQ2FbB3LAt6e3boktUNrd_-H6YQQxliDX5tRK5qmST14_M3J3lhWRGE6Bh4BCgE_BTZ-7idGprsNUAfgYBf_ONYn0ktvAHWI1soNE6mC8nlg2e_QJ-CMEsWmqQxhg0jmGREIIB3BfoOTJCTNSyeD68JU2BPYFYw-85a15afW6VOp0HhtgQNd1ppBS1Nzcy6MB3yqIPCuUvUt0OmZQ0SErbt3gDuMLDIM!/dl4/d5/L2dBISEvZ0FBIS9nQSEh/?from=/residential/rebates-savings/cmhp.htm)

Estimate of approximate installation cost

Installation takes approximately 30 minutes. Estimated installation cost using a licensed HVAC technician is \$75.00

Estimate of unit cost from wholesaler or supplier

Please contact your authorized dealer