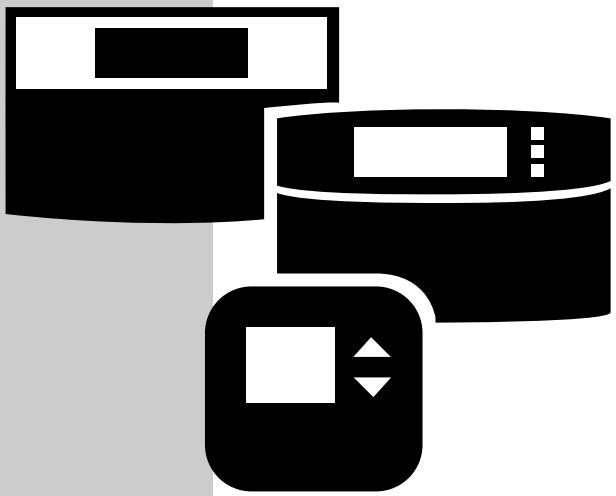
Honeywell

Power Stealing Thermostats



OVERVIEW:

In the mid-1980's, Honeywell introduced the Chronotherm® III family of programmable, electronic thermostats. With these products came the introduction of power stealing. Initially, some systems were not compatible with this powering method and isolation relays, fan centers, or shunt resistors had to be installed in the equipment to allow the thermostat to operate properly. Over time, many equipment manufacturers modified their equipment design so they were compatible with power stealing thermostats. However, there were still many systems that were not compatible with power stealing.

Today, Honeywell's Next Generation Thermostats have an improved power stealing method that is compatible with virtually all heating and cooling applications. Additional relays, fan centers, and shunt resistors are no longer required. Technological, engineering, and production advancements have made improved power stealing an economical and highly effective way of powering a thermostat.

WHAT IS POWER-STEALING?

From the start, thermostats used a bimetal to sense temperature and respond to temperature changes in the room. The movement of the bimetal was used to directly open and close an electrical circuit. Power was delivered to an electro-mechanical actuator, usually a solenoid or relay coil in the HVAC equipment whenever the contact was closed to provide heating or cooling to the controlled space. Since these thermostats did not require electrical power to operate, the wiring connections were very simple—only one wire connected to the transformer and another wire connected to the load. The 24 Vac supply transformer, thermostat, and 24 Vac HVAC equipment actuator all connected in a loop with each device having only 2 external connections required (See Fig. 1). The relay and solenoids were designed to have a nearly "ideal" switch contact provided by the thermostat. This means that when the contact was "closed" it had a very low resistance, so that all the transformer voltage appeared across the relay coil or solenoid.

When electronics began to be used in thermostats the fact that the thermostat was not directly wired to both sides of the transformer for it's power source created a problem. This meant either the thermostat had to have it's own independent power source, such as a battery or hardwired directly from the system transformer, or it needed to derive it's power source from the transformer through the equipment load. The methods for powering an electronic thermostat from the transformer with a single direct wire connection to the transformer is called "power stealing". The thermostat "steals" or draws its power during the "OFF" periods of the heating or cooling system by allowing a small amount of current to flow through it into the load coil below it's response threshold (even at maximum transformer output voltage). During the "ON" periods of the heating or cooling system the thermostat draws it's power by allowing a small voltage drop across itself. This voltage drop will not cause the load coil to dropout below it's response threshold (even at minimum transformer output voltage).

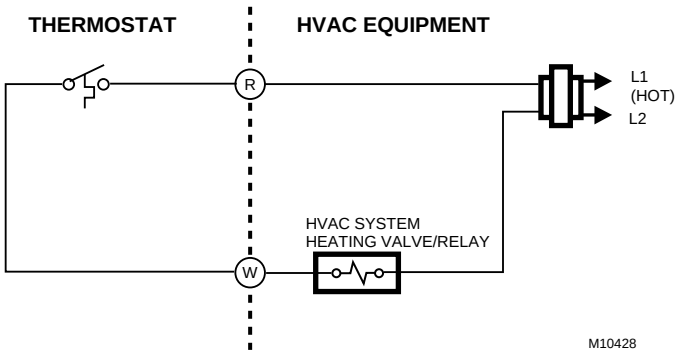


Figure 1. Electromechanical Thermostat Operation

HOW DOES HONEYWELL'S CHRONOTHERM® III POWER STEALING OPERATE?

Honeywell's Chronotherm® III thermostat family has three powering methods

Hard Wired:	T8601, T8611, T8621, T8624 models
Battery:	T8602
Power Stealing:	T8600

Prior to November 1991, the T8600 had two internal power supplies that allowed it to steal power through the equipment; one was current driven and one was voltage driven. When the T8600 called for heat or cool, the current driven power supply required a minimum of 80 mA of current to steal power properly and allow the thermostat to operate. When the T8600 was not calling for heat or cool, the voltage driven power supply allowed 10mA of current to run through the heating load. This level of current was selected because it did not pull in the heating relay and initiate "false" calls for heat. Figure 2 illustrates this power stealing method.

If the T8600 did not receive enough current in the on or off cycle, or if the power to the heating load was interrupted, -AC was shown on the thermostat display. To correct this situation, an isolation relay, fan center, or shunt resistor was installed. Often, this was done by a service technician during a service call.

Beginning in 1992, T8600 power stealing was improved. The same current and voltage driven power supplies were used, but a second internal voltage driven power supply was added that allowed 10 mA of current to run through the cooling load. That meant that now the T8600 could power steal even if the heating load was interrupted. Enhancing the T8600 power stealing in this manner eliminated virtually all -AC service calls. Figure 3 illustrates the enhanced T8600 power stealing method.

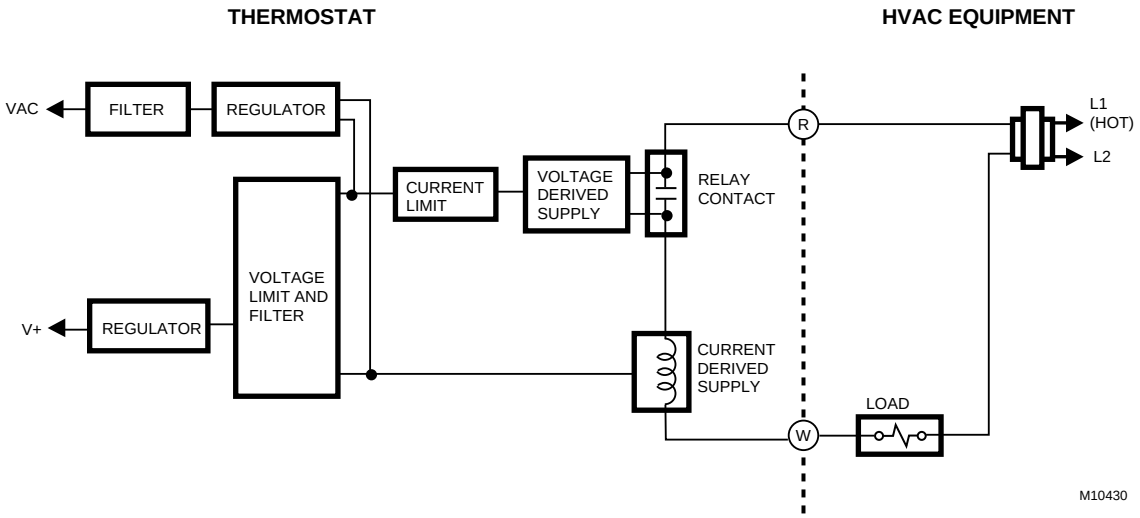


Figure 2. Original Pre-1991 Chronotherm® III Powerstealing Method

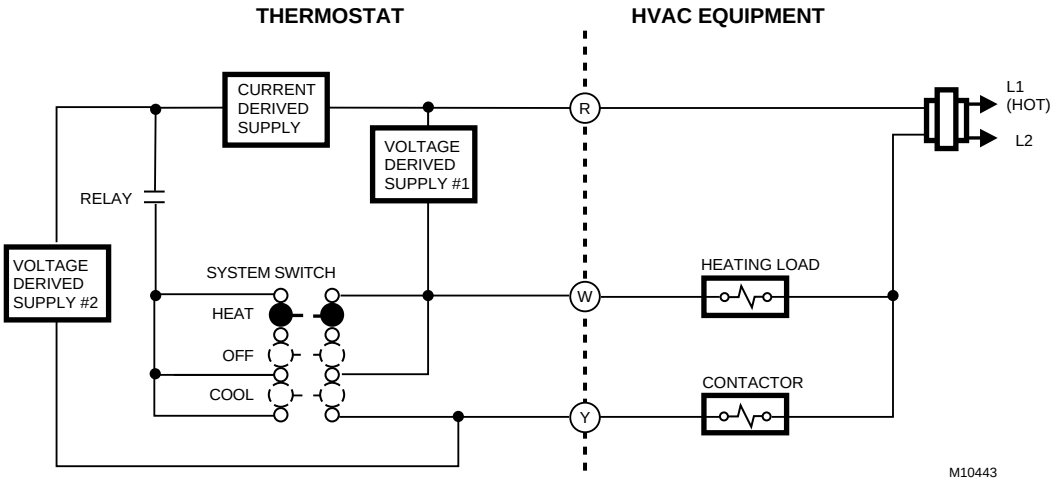


Figure 3. Improved 1992 Chronotherm® III Powerstealing Method

WHAT ARE THE LIMITATIONS OF CHRONOTHERM® III POWER STEALING?

Because the T8600 Chronotherm® III power stealing relies on the heating and/or cooling equipment to be powered properly, not all HVAC systems meet the requirements of the T8600. Here are some of the limitations of power stealing:

- Systems that do not provide a minimum of 80 mA of current during calls for heat or cool. Lower current levels will result in -AC on the thermostat display. Most older equipment has high current loads and power stealing presents no problems. However, some new equipment operate at current levels below 80 mA, not meeting the minimum requirements of power stealing
- Systems that are activated when 10 mA of current run through it. If loads are activated by 10 mA, false calls for heat or cool will result. Again, most older equipment requires high current loads during calls for heat or cool, so this presents no problems. However, newer, more complex HVAC controls are activated by current levels as low as 10 mA.
- Systems that provide more than 1.2 amps of current during calls for heat or cool. Overheating of the T8600 current driven supply will result, displaying -AC on the thermostat and interrupting calls for heat or cool before the temperature setting is reached.
- Loads with distorted or intermittent power provide the thermostat with waveforms that temporarily fall below the 10 mA or 80 mA, causing the thermostat to loose power.
- DC powered loads or equipment will not allow the thermostat to power steal.

When the T8600 calls for heat or cool, 80 mA of current must flow through the heating or cooling load. With older equipment, this method works well because most equipment relays and solenoids have high current loads. However, some newer, more complex HVAC controls generate low levels of current with calls for heat or cool.

When the T8600 is not calling for heat or cool, 10 mA of current must flow through either the heating or cooling load.

WHAT IS HONEYWELL'S NEW PATENTED POWER-STEALING METHOD?

A new patented method of powerstealing provides the solution of operating with new digital controls and offers virtually universal compatibility with new and existing heating/cooling equipment.

The new method is based on a more advanced and intelligent power supply technique and made possible by a custom power stealing ASIC (Application Specific Integrated Circuit) used with a pair of solid state electronic switches called MOSFETs.

HOW DOES THE NEW POWER-STEALING METHOD WORK?

During the heating and cooling system "OFF" period, the thermostat has both outputs (MOSFETs) off continuously but allows a small amount of current to flow into the power stealing ASIC to charge it's power supply and power the ASIC and other logic components of the thermostat. The significant improvement is that an average current of only 1.0 mA is required to operate the T8500 and T8600 families—instead of the 10 mA previously required by the Chronotherm® III family. In addition, the T8400 family of thermostats only require 0.1 mA to operate.

During the heating and cooling system "ON" periods the thermostat has both outputs (MOSFETs) turned on so that the full voltage of the transformer is applied to the controlled load except for short periods when the power supply is charged. This ON-cycle power stealing function automatically adapts to full or half-wave loads even with significantly distorted load current power. The significant improvement in this area is that an average current of only 25 mA is required to operate T8500 and T8600 families instead of the 80 mA presently required by the Chronotherm® III power supply. The T8400 family only requires 2.5 mA to operate. (See Fig. 4)

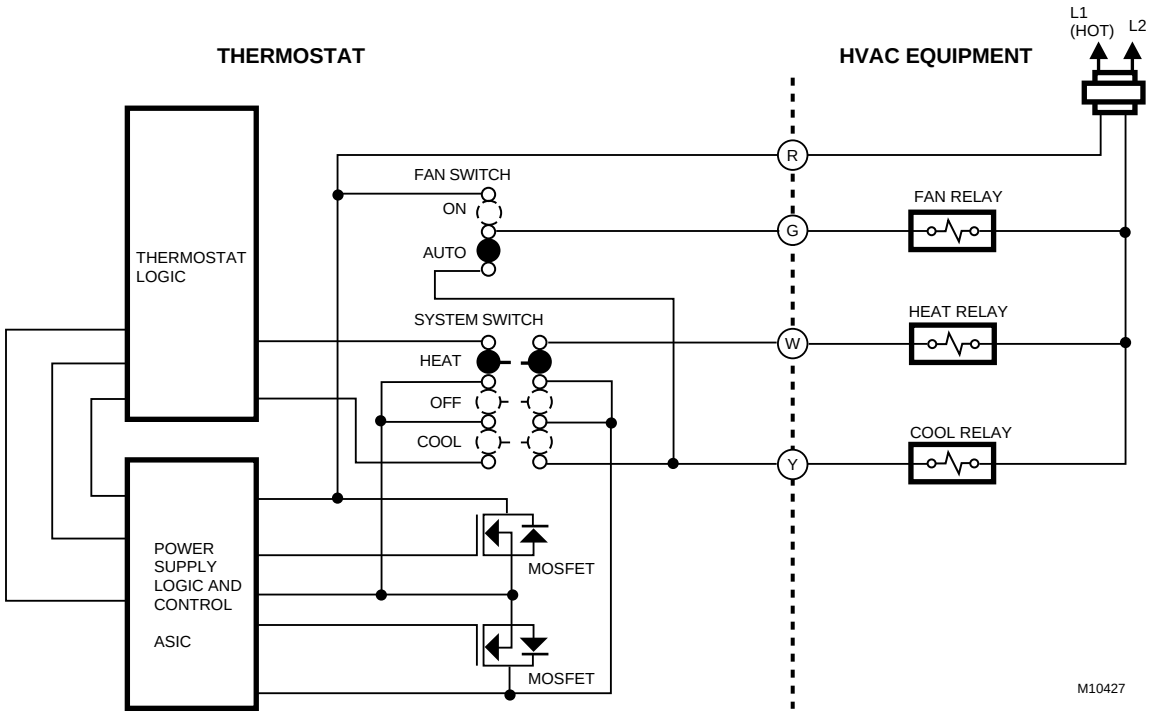


Figure 4. New Patented Powerstealing Method

WHAT ARE SOME OF THE BENEFITS OF THE NEW PATENTED POWER-STEALING METHOD?

- The new patented method significantly increases compatibility with low current loads. The current drawn through the load during thermostat “OFF” periods is reduced from the 10 mA of Chronotherm® III thermostat by a factor of at least 100 times for the T8400 (.1mA) and 10 times for the T8500 and T8600 (1mA).
- Honeywell’s patented method significantly reduces the minimum load current requirements compared to Chronotherm® III (80 mA). The estimated load current requirements are only 25 mA for the T8500 and T8600 and 2.5 mA for the T8400 during the thermostat “ON” periods. This is an improvement of three times for T8500 and T8600 and 32 times for T8400.
- With the new powerstealing design, thermostats are compatible with loads that have high initial (in-rush) currents. An integrated protection method for the MOSFET power switches prevents shorted or malfunctioning loads from overheating the thermostat by turning off the load 0.5 seconds after the current exceeds the rated current (up to 1.5A). The thermostat will automatically retry operating the load (once a minute in heating) as long as the need for system operation is required.
- The thermostat will retain power even with distorted or intermittent power supplied.
- The new power stealing method is compatible with DC powered systems. (Estimated maximum of .5A)
- The output switching devices (power MOSFETs) provide reduced internal thermostat heating. This is an improvement to Triac based power stealing designs that generate internal heat which affects temperature control.

DOES THE NEW DESIGN HAVE ANY LIMITATIONS?

Yes. Even with the significant improvements, there are several applications where the new patented powerstealing method will not operate. These limited applications include:

- 50/60 Hz dual rated equipment applications. The new method requires dedicated models for 50 Hz and 60 Hz operation. This is not a field configurable option.
- Millivolt systems. A battery powered thermostat is needed with special gold-plated contacts for use with this type of equipment.
- Line voltage (120/240/277 Vac systems).
- Zone valves (such as TACO) and other systems that open the load circuit for more than .5 seconds during an ON period of the thermostat

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