

TECH TIP # 13



One of a series of dealer contractor technical advisories prepared by HARDI wholesalers as a customer service.

Control Terminology

The following is a glossary of common heating and cooling control terms, definitions and circuit notations relating to unitary systems.

Ambient temperature - the temperature surrounding or in the vicinity of a control.

Anticipator - small resistance heater placed inside thermostat housing to help thermostat lead or “anticipate” room heating and cooling needs by artificially warming thermostat’s sensing elements.

Automatic pilot - refers to the system that provides ignition and safety shut-off for gas burners using a tiny “pilot” flame.

Bimetal - sensing element made of two metals with different coefficients of expansion rigidly joined together to cause useful mechanical motion due to heating or cooling of the bimetal.

CdS cell - acronym for photo resistance cell made of cadmium sulfide. This solid state device changes its electrical resistance when exposed to light. It is used as a oil burner safety shutdown device.

Changeover relay - control element is used in heat pump systems to activate refrigerant reversing valve for heating or cooling operation. Not to be confused with reversing relay.

Combination furnace controls - a common controller that combines the functions of the fan switch and high limit safety control into one device.

Compensated control - the setpoint of a controller is adjusted up or down as conditions elsewhere change (e.g. setpoint of room thermostat is raised as outdoor temperature decreases)

Contactor - a magnetic relay of suitable high capacity that can switch large motor compressor electrical loads.

Contacts - the switch side of a relay or contactor.

Control agent - the medium regulated by a controlled device. It may be air or gas flow, steam or water, or even electric current.

(continued)

Published by the Independent Study Institute, a division of the Heating, Airconditioning & Refrigeration Distributors International. The Institute offers accredited, industry training courses in HVAC/R technology. Direct inquiries to HARDI 3455 Mill Run Drive, Ste. 820, Columbus, OH 43026. Phone 888/253-2128 (toll free) · 614/345-4328 · Fax 614/345-9161

www.hardinet.org

Controlled variable - the variable condition temperature, humidity, or pressure that must be held constant.

Controller - principal device, say a thermostat, in a control system that measures some variable condition that must be held constant (e.g., room air), and then activates a second device to regulate a medium (e.g., fuel) that affects the variable condition.

Control point - the pressure, temperature or humidity actually being maintained as distinguished from the controller's setpoint which may be higher or lower.

CSR - acronym for capacitor start, capacitor run induction motor.

Diode - an electronic device (vacuum tube or solid state) that conducts electricity in only one direction. One use is to convert AC to DC current.

Droop - the difference between a controller's setpoint and the actual control point (e.g., room thermostat set at 75° F, but room air stays at 73° F).

Factory wiring - control circuit diagrams presented in functional arrangement using symbols and other shorthand notations.

Fan switch - a controller that features a switch and sensing element inserted in a furnace that turns the blower on or off at preset leaving air temperatures.

Field wiring - control circuit diagrams presented in a pictorial or "as installed" fashion.

Final control element - last component in control chain. That portion of the controlled device that regulates control agent - - valve, damper, etc.

High limit control - a controller that features normally closed switch and sensing element inserted in a furnace (or boiler) that shuts down burner (or electric heater) regardless of room thermostat demand when circulating air (or water) exceeds preset limits.

Humidistat - a controller designed to sense changes in moisture levels in air. Uses nylon or hair sensor to open and close low voltage switch.

Impedance relay - prevents compressor start-up after a high or low refrigerant pressure shutdown, until a manual reset is performed. Sometimes called a lockout relay.

Inherent protector - a temperature and current sensitive device placed in a hermetic compressor to provide motor overload protection.

Line voltage - full voltage available for use. Usually 120 or 240 volts.

Low limit control - a controller that features a switch and sensing element used in heating boilers that also provide domestic hot water. The device assures that a minimum water temperature is maintained for domestic use by activating burner regardless of heating thermostat demand.

Low voltage - voltage that is 30 volts or less. Usually provided by means of a step-down transformer.

Modulating control - differs from simple on-off or two position control action in that control agent can be regulated from fully on down to full off in continuous or discreet steps.

Motor starter - a magnetic contactor that also contains a current overload relay to protect motor.

NEC - Acronym for National Electrical Code published by the National Fire Protection Association.

NEMA - Acronym for National Electrical Manufacturers Association.

Operating differential - the overall swing (high point minus low point) of a controlled variable that's necessary to activate a controller.

Operator - one of two functional components in a controlled device. The operator converts signal from controller into a useful local action (e.g.,) motor that converts electric signal into rotating mechanical motion). Also see final control element.

Photocell - a special vacuum tube that generates a small electric current when exposed to light.

Pilot generator - refers to pilot burner/thermocouple side of an automatic gas pilot system, and is usually applied to systems using other than just a single thermocouple.

PF - acronym for power factor, the correction factor to be applied to the product of volts times amps in AC circuits to account for voltage and current phase differences.

Potential relay - sometimes called starting or voltage relay. This device cuts out the starting circuit in CSR motor driven compressors.

Primary control - used most often in reference to an oil burner controller whose functions include starting and stopping the burner, ignition and safety shutdown.

PSC - acronym for permanent split capacitor motor.

Relay - an electric switch that permits low voltage controllers to operate equipment powered by higher voltages.

Reversing relay - permits SPDT thermostat to control heating and cooling equipment by forming an interlock that prevents mutual operation.

Safety device - a control that is added to detect a dangerous condition and stop an action or take a new action to remedy problem.

SCR - acronym for silicon controlled rectifier. It is, in effect, a solid state or electronic switch with no moving parts that can turn current on and off.

Sensing element - one or two recognizable components in a controller. Sensing element measures any change in the controlled variable. Also see transducer.

Set point - the value of the controlled variable (e.g., room air) at which the controller (e.g., thermostat) is set and represents the desired or idealized value to be maintained.

Solenoid - an electric device for converting electric energy into a mechanical displacement. Usually consists of a magnetic coil and plunger that can move short back and forth distances as the coil is energized or de-energized.

Solid state device - a group of electronic components that perform jobs similar to vacuum tubes, but unlike tubes they are not electrodes enclosed in glass but rather specifically prepared solid matter.

Switching action - the terms *pole* and *throw* in combination with the terms *single* and *double* are used to describe the action of electric switches. A single switch has functionally one movable “blade” contact. A double pole switch has two. A single throw switch can connect to only one circuit or one fixed contact. A double throw switch can connect a common lead to either of two circuits or two different fixed contacts. These features are usually abbreviated SPST -- single pole, single throw; SPDT - - single pole, double throw, etc.

Thermal delay relay - prevents short cycling of compressor by delaying thermostat’s call for cooling for several seconds.

Thermistor - a solid state sensing device whose electrical resistance varies dramatically with changes in temperature.

Thermocouple - a means to directly convert heat into small amounts of useful electric current. One end of two dissimilar wires connected together is heated, producing a small voltage across the other ends.

Thermostat - once a trade name, it has become a standard term for a temperature controller, but particularly in reference to a room air temperature sensing device.

Timer motor - electric motor drives a cam that actuates defrost switch at specific time intervals to begin defrosting of outdoor coil when heat pump is on heating cycle.

Trade names - because of pioneering development or merely common usage, some control devices are referred to by their manufacturer’s marketing names. The new control technician should not let this become confusing.

Transducer - one of two recognizable components in a controller. The transducer converts the effect of a controller’s sensor into a more useful and sometimes more powerful action.

Transistor - current amplifying solid state device that’s equivalent to a triode vacuum tube.

Transformer - an electrical device that efficiently converts high voltage power to low voltage power (or vice versa).

Two position control - a mode of control action that can only turn equipment fully on or fully off.

Wiring Symbols & Abbreviations

Schematic or factory type wiring diagrams are used most often to illustrate electrical component functions. It is essential that the student become thoroughly familiar with the standard symbols and circuit abbreviations used in the heating and air conditioning industry. The most common component symbols currently being used are shown in Figure A-1.

Line Voltage

Terminals

Function

L1, L2, L3

Incoming power connections

T1, T2, T3

Switched power load connections

(4) (5) (6)

Auxiliary switched load connections

Load Designations

Component

CC

Contactor coil

CC1, CC2, CC3

Contactor contacts

FR

Fan relay coil

FR1, FR2, FR3

Fan relay contacts

SR

Solenoid relay or reversing valve

SR1, SR2

Solenoid relay contacts

TD

Time delay device

TD1, TD2

Time delay contacts

Low voltage terminal designations

Two distinct systems of low voltage terminal designations have been used in the heating and air conditioning industry. One was based on the *function* of the specific load to which the terminals are connected - - "F" for fan circuit, "C" for cooling circuit, etc. The other system was based on a *color code*. In this system, "G" was used for the fan circuit, "Y" for the cooling circuit, "W" for the heating circuit and "R" for the power supply. Using color coded cable -- green for the fan circuit, etc. --- simplified system hook-up and troubleshooting.

The existence of both systems caused some confusion and for a period of time a *combination terminal marking* system was used. In the combination system, terminal designations for a fan circuit were marked "F/G" and terminals for a cooling circuit were marked "C/Y."

At the present time only the *color code* method is used for low voltage terminal designations.

Low Voltage Code

Color	Function	
R	V	Hot switched leg of 24 volt AC power used on heating only thermostats and heat/cool thermostats with a common power supply.
W	H	Heating - single stage.
Y	C	Cooling - single stage
G	F	Indoor fan circuit.
B	Z	Heating circuit -- constantly energized through a manual switch.
Rh	M	Isolated power terminal for a heating circuit used on heat/cool thermostats with isolated circuits -- jumper supplied.
Rc	V	Isolated power terminal for a cooling circuit used on heat/cool thermostats with isolated circuits -- jumper supplied.
W1	H1	Heating - first stage of two stage units.
W2	H2	Heating - second stage of two stage units.
Y1	C1	Cooling - first stage of two stage units.
Y2	C2	Cooling - second stage of two stage units.
X	L	Warning light (dirty filter, electric heat, etc.)