Guide to Thermostatic Expansion Valves

- What are the basic air conditioning controls and switches?
- What is the function of each air conditioning control or air conditioning switch?
- What check first if your air conditioning won't start

This air conditioning repair article explains the function and installation of the thermostatic expansion valve or TEV (or thermal expansion valve) which controls the metering of refrigerant into the evaporator coil of an air conditioning or heat pump system. TEV components are used on both air conditioning systems and on heat pumps; heat pumps are essentially the same in components as air conditioners except for additional control features to permit refrigerant to circulate in either direction in the system, moving heat outside (air conditioning) or moving heat inside (heat pumps).

Photograph of the thermostatic expansion valve above courtesy of Alan Carson, Carson Dunlop in Toronto. Contact us to suggest text changes and additions and, if you wish, to receive online listing and credit for that contribution.

Also see FROST BUILD-UP on AIR CONDITIONER COILS or start diagnosing air conditioning problems at LOST COOLING CAPACITY.

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Guide to Thermostatic Expansion Valves on Air Conditioners & Heat Pumps
Thermostatic expansion valve (TEV): An air conditioner thermal expansion valve or "TEV" or just "expansion valve" (tan colored device in the photo) is a device located at the cooling coil and connected between the incoming refrigerant line and the refrigerant inlet to the cooling coil in the air handler. (Schematic of a thermostatic expansion valve courtesy of Carson Dunlop.)

The TEV valve maintains the pressure difference (high and low) at the entry point to the cooling coil, thus assuring that as the high-pressure refrigerant enters the low pressure space of the cooling coil, it can "evaporate" from a refrigerant liquid to a gaseous form, thus producing the temperature drop that cools the cooling coil itself.

All cooling systems and heat pumps using refrigerant gases make use of some type of expansion valve or refrigerant metering device, of varying complexity.

Even a simple window air conditioner or a refrigerator makes use of an expansion valve, in the form of a small-diameter capillary tube or "cap tube" which meters refrigerant into the cooling coil.

The thermostatic expansion valve is a refrigerant metering control device, and it is not a control or switch which can be directly operated when using an air conditioning system, but it is a critical control needed for metering refrigerant into the cooling coil, so we include its description here.

The TEV shown in the photo is used on a heat pump system so it includes extra tubing so that it can permit the refrigerant to reverse its flow of direction when changing from cooling mode (move indoor heat to outdoors) to heating mode (collect and move outdoor heat to indoors).

How Does a Thermostatic Expansion Valve (TEV) or Capillary Tube Work to Meter Refrigerant?
The air conditioning system thermal expansion valve, or more properly called a thermostatic expansion valve, or "TEV" is a metering device which regulates the flow of refrigerant from the incoming high pressure side (from the compressor/condenser) into the low pressure side (in the cooling coil).

Inside of the thermostatic expansion valve (TEV) the refrigerant passing through is mostly liquid. The liquid refrigerant being metered into the evaporator coil through the TEV converts increasingly to a gas as it flows down through the evaporator coil, until the refrigerant is totally in a low-pressure, low temperature gaseous state by the time it reaches the end of the evaporator coil.

This low pressure, low temperature refrigerant gas is drawn back into the compressor via the suction line connecting the evaporator coil outlet to the compressor inlet port.

Our sketch simplifies the concept of the TEV down to a simple capillary tube - this is the simplest possible refrigerant metering device. Sketch courtesy of Carson Dunlop.

A capillary tube or a thermostatic expansion valve (improperly called thermal expansion valve) valve maintains the pressure difference (high and low) at the entry point to the cooling coil, thus assuring that as the high-pressure refrigerant enters the low pressure space of the cooling coil, it can "evaporate" from a refrigerant liquid to a gaseous form, thus producing the temperature drop that cools the cooling coil itself.

To the capillary tube the TEV adds a level of control - the TEV can open or shut in response to an attached bulb which actually monitors temperatures in the refrigerant tubing. Capillary tubes are found on residential refrigerators, dehumidifiers, and many window air conditioners. TEVs are found on larger air conditioners and central air conditioning systems where more control is needed.

As refrigerant liquid is metered into the entry point of the evaporator coil it is entering the low side of the air conditioning system. The change from high pressure to low pressure permits the refrigerant to evaporate, changing from a liquid to a gas. [The boiling point of R12 refrigerant is -21 deg F, and the boiling point of R22 refrigerant is -41 deg F. Newer refrigerants will have similar characteristics.]

It is this state change, from liquid to gas, occurring inside of the cooling coil (evaporator coil on the A/C system's low side) that absorbs latent heat, thus cooling the evaporator coil itself.

The job of the refrigerant metering device such as a capillary tube or a TEV is to provide a restriction in the refrigerant tubing system so that there will be a pressure difference maintained between the high side and
low side of the system. The air conditioning compressor, by pulling on the suction line or low pressure side of the closed refrigerant piping system is causing pressure to be low on that side. The same compressor is delivering high pressure liquid refrigerant to the high side of the system. The TEV is between these two pressure systems.

Latent heat, state change, high side and low side are defined at SEER RATINGS & OTHER DEFINITIONS.

All cooling systems using refrigerants use some type of expansion valve, of varying complexity. Even a simple window air conditioner or a refrigerator makes use of an expansion valve, in the form of a small-diameter capillary tube or "cap tube" which meters refrigerant into the cooling coil.)

**Thermostatic Expansion Valve or Capillary Tube Installation & Inspection Guide**

The TEV should be installed as close as possible to the air conditioning or heat pump evaporator coil inlet. Sketch of capillary tube defects is courtesy of Carson Dunlop. Other TEV and cap-tube defects listed below were obtained from an installation guide for TEV's provided by Singer Controls Corp.

- Most installation guides require that the thermostatic expansion valve has nothing else installed on the refrigerant tubing that extends between the TEV and the evaporator coil, except in commercial installations where a refrigerant distributor may have been installed. In this instance (use of a TEV with a refrigerant distributor), the TEV should be a unit that provides an external equalizer.

- The sensing bulb that controls the thermostatic expansion valve is clamped to the refrigerant suction line where it monitors the system's temperature. On a small suction line such as on a residential cooling system or heat pump, the sensing bulb is clamped on top of the suction line; on a commercial system that uses a larger diameter line (more than 7/8" in diameter) the bulb is clamped at the 5-o'clock position or 7-o'clock position on the lower portion of the suction line.

- The sensing bulb that controls the thermostatic valve can be clamped on a vertical or on a horizontal section of the refrigerant suction line, but never on a trap or elbow in the suction line where oil and liquid refrigerant can interfere with proper bulb and temperature sensing operation.
• If multiple TEV's are installed (on a multi-evaporator cooling or heat pump system), each thermostatic expansion valve has to be installed at a refrigerant suction line that will indicate conditions in each individual evaporator, never on a common suction line fed by multiple evaporators.

• On commercial cooling installations it is also important that the TEV be installed in a location leaving enough access to adjust the device.

• Because differences in temperature in and around the cooling equipment can affect the TEV's operation, in commercial cooling installations the Thermostatic Expansion Valve has to be placed where its sensor, usually located in the top or "head" of the TEV, will be warmer than the thermal bulb which controls the device. Otherwise liquid refrigerant may be improperly discharged by the valve.

• Do not install the Thermostatic Expansion Valve higher than the liquid refrigerant receiver. If a TEV is placed too high in a commercial system, refrigerant vapor or flash gas from the receiver may enter the TEV and prevent its proper operation.

• After installing a TEV the system must be tested for leaks using dry nitrogen; the system is then evacuated (a vacuum is drawn on the refrigerant coils and piping to remove gases and contaminants), the system is charged with proper refrigerant type and amount, the system is turned on and allowed to run until it is in stable operating condition, and then the TEV is checked according to the manufacturer's specifications (such as presence of a liquid seal at the valve and that the suction pressure is in the proper range.)

See THERMOSTATS for other details of the operation of primary air conditioning thermostats and switches.

At A/C - HEAT PUMP CONTROLS & SWITCHES we explain the many electrical switches and controls that control an air conditioner or heat pump system. You'll need to check these if your air conditioner won't start.

At OPERATING DEFECTS we take you through the major air conditioning problem symptoms and how to get the air conditioning system working again.

At a companion article, LOST COOLING CAPACITY, our focus is on the case in which the air conditioning system seems to be "running" but not enough cool air, or no cool air at all is being delivered to the occupied space.