



4707 SE 17th Avenue
PO Box 82189
Portland, OR 97282
Tel (503) 233-6401 / Fax (503) 233-6407

T158 THERMOSTAT

Model Description

| | |
|--------------|---|
| TA158 | 3 Digit LCD Display with 24 VAC On/Off Outputs |
| TB158 | 3 Digit LCD Display with 24 VAC 3 Wire Floating Valve Outputs (configurable as On/Off outputs) |

Thermostat Theory

On/Off thermostats

Heating, Ventilation, and Air Conditioning systems have relied on mechanical thermostats, to performing simple ON/OFF control of the heating or cooling sources, for decades. These mechanical thermostats have differentials (the difference between the ON and OFF temperatures), typically ranging from 2°F to 6°F. Fluctuations in room temperatures are commonly large enough, in these applications, to effect occupancy comfort.

The addition of anticipation to mechanical thermostats, and in recent years the introduction of electronic ON/OFF thermostats, have been used to reduce differentials, but noticeable fluctuations in temperature still exists.

Three Wire Floating Valve Thermostats

Three wire floating valves were used for controlling the water flow in hydronic heating/cooling systems. The T158 thermostat is used for precise adjustment of these valves to any point, from fully closed to fully open.

Three wire floating valves have a known time in which they open and close. For example, when power is applied to the open wire of a fully closed three wire valve, the valve would begin to open. If the valve had a 2-minute stroke from fully closed to fully open, and the power was applied for 1 minute, the valve would be ½ way open. These infinitely adjustable valves allow for very precise control over the heating or cooling capacity of a system. When connected to the proper temperature control, such as the T158, these valves can control room temperature fluctuations under optimum conditions to within .1°F.

This style of valve has three electrical connections, which includes an open wire, a close wire, and a common wire, hence the term "Three Wire Floating Valve".



4707 SE 17th Avenue
PO Box 82189
Portland, OR 97282
Tel (503) 233-6401 / Fax (503) 233-6407

T158 FEATURES

General Features

The T158 is a low voltage thermostat designed to drive 24VAC valves. The TA158 model comes factory configured with two ON/OFF outputs only, the TB158 model can be factory configured for three wire floating valves and the TC158 thermostat has outputs capable of driving two 0-10VDC valves and is not configurable for three wire floating or ON/OFF output. In addition the TB158 can be configured for On/Off valves with smart fan switching or staged heat.

Push button controls adjust temperature setpoint and mode.

On/Off Operation

On/Off operation is available on the TA158, which is specified to have only a main 1 and secondary 1 output, or by clipping jumper on the TB158. See Output Configuration listed below.

Three Wire Valve Control

The T158, a micro controller based thermostat with digital temperature display and push button controls, uses a Proportional/Integral algorithm¹ that continually adjusts three wire valves to maintain a constant room temperature. This control can be used with one through three minute stroke valves.

Two sets of outputs, referred to as main and secondary, control valve position as follows:

- Main 1 output opens main valve
- Main 2 output closes main valve
- Secondary 1 output opens secondary valve
- Secondary 2 output closes secondary valve

Optional Features

Setback operation

A 24VAC setback input option is available for connection to a building automation system or setback timer. When in the setback mode of operation, the T158 controls the three

¹For more information see product specification ES3210-0019 Item 7.5



4707 SE 17th Avenue
PO Box 82189
Portland, OR 97282
Tel (503) 233-6401 / Fax (503) 233-6407

wire floating valves as if they were ON/OFF valves. The differential is 3F during setback mode, for both the three wire valve and ON/OFF configurations.

When a setback signal is applied, the digital display will show only the temperature, and not the mode setting. Pressing setpoint or mode push buttons initiates the timed override. Upon initiation of the timed override, the mode setting will reappear on the digital display and the thermostat will switch to the occupied mode for a period of 1 hour. Pressing a push-button any time during the 1 hour override condition, causes the 1 hour override to restart. At the end of the 1 hour time period, the thermostat will revert to the setback condition. The setback control points are field configurable for wide (50°F heating, 90°F cooling) or narrow (60°F heating, 85°F cooling) by cutting jumper 6 on the circuit board.

Fan Switch

The T158 has an optional line voltage fan switch which can be included for manual control of three speed fans. The fan switch includes an OFF position which turns off the fan, causes the thermostat outputs to go to their off states, and blanks the display. The T158 is a "split voltage device" meaning that the fan switch circuitry is line voltage while the thermostat is 24VAC only.

Remote Probe

Remote probe terminals can be added for connection of a return air sensor used typically in unit mount fancoil applications. The jumper on header JP1 must be removed when the remote probe is connected.

Output Configuration

The TB158 main and secondary outputs can be independently configured for ON/OFF operation by cutting jumpers 4 and 5 of S1 on the circuit board. When configured for ON/OFF operation, the thermostat has a 1F differential. When the main output is configured for ON/OFF operation, the main 1 output (Terminal 10) is the main valve output. The main 2 output (Terminal 11) is enabled whenever there is a heating or cooling demand. One possible use for the main 2 output terminal would be smart fan switching. When the secondary output is configured for ON/OFF operation, the secondary 1 output (Terminal 12) is the secondary valve output, and the secondary 2 output (Terminal 13) controls staged heating. The staged heating output is enabled whenever the room temperature is more than 3°F below the point that the primary heat is enabled. The staged heating output would typically be used to control a backup heating source such as an electric strip heater. When configured as ON/OFF outputs, the Main 1 and Secondary 1 outputs may additionally be configured for use with normally open valves by cutting jumpers 1 and 2 of S1 on the circuit board.



4707 SE 17th Avenue
PO Box 82189
Portland, OR 97282
Tel (503) 233-6401 / Fax (503) 233-6407

Mode Button

The T158 is an auto change over thermostat. The optional mode button allows selection of operating modes. The current operating mode is displayed along the bottom edge of the digital display. The following four modes may be available:

OFF - All thermostat outputs off, Fan is still operational is connected to manual fan speed switch.

AUTO - The thermostat automatically selects heating or cooling mode depending upon the relationship of the set point and room temperature. The appropriate HEAT or COOL indicator is enabled in addition to the word AUTO. A 3°F deadband is provided between the heating and cooling modes to prevent temperature overshoot from causing the thermostat to cycle back and forth between heating and cooling modes. The control points automatically shift so that when heating, the heating off point equals the set point temperature, and when cooling, the cooling off point equals the set point temperature.

COOL - The thermostat operates as a cooling only thermostat. The heating outputs are disabled.

HEAT - The thermostat operates as a heating only thermostat. The cooling outputs are disabled.

If the T158 thermostat assembly is constructed without a mode button, the thermostat operates in its default mode which is determined by the configuration of the 2/4 pipe jumper and pipe sensor input.

Optional Pipe Sensor Input

Pipe sensors are used where coil water temperature is changed to accommodate seasonal demands. The most typical application of this device would be for two pipe, summer/ winter changeover systems. Another common configuration supplies two stages (On-Off) of heating in winter and one stage each of heating and cooling in the summer.

These systems behave in the default operating configuration (SUMMER mode) when the pipe sensor detects a cold water supply at the main coil.

When the main coil supply is hot, the thermostat will control with the main coil in heating and no signal to the secondary output (WINTER mode). During WINTER operation, only Heating is available. This configuration will handle 2 pipes, 2 pipes with intermediate season electric heat and intermediate season 4 pipe systems.



4707 SE 17th Avenue
PO Box 82189
Portland, OR 97282
Tel (503) 233-6401 / Fax (503) 233-6407

Should the thermostat call for heating or cooling, and the pipe sensor reading is within 15°F of the ambient zone temperature, the mode is Ambiguous (not Summer and not Winter). The thermostat will:

1. Start a 3-minute timer
2. If there is a heat demand the secondary valve will remain open. If not, the thermostat will close the secondary valve, if open.
3. Open the main valve for the 3-minute period.

After the initial 3-minute purge cycle, the thermostat will first check the coil temperature for an ambiguous condition.

If not ambiguous

The thermostat will set the appropriate mode and resume normal operation.

If mode is still ambiguous (the ambient zone temperature is within 15°F of the pipe sensor temperature reading), the thermostat checks to see if the coil temperature is below 60°F or above 80°F.

If yes, the unit has detected a non-ambiguous condition and will select either Summer (coil <60) or Winter (coil > 80) mode and resume normal operation.

If no (the coil temperature is between 60 and 80°F) the thermostat will repeat the purge cycle until a non-ambiguous condition is sensed.

After detecting a non-ambiguous condition, the thermostat will wait for a 1 hour time period before checking and allowing another purge cycle to occur. This feature allows the pipe sensor of a two-way valve system to be up to 25 feet from the supply riser. This eliminates the need for 3 way valves.

At Power up, if the pipe sensor is disconnected (open) the thermostat will function in SUMMER mode. If the pipe sensor terminals are shorted (closed) it will force the unit into WINTER mode operation. This input is monitored by the program and will support the use of an Aquastat that provides a open circuit for summer and closed circuit for winter.

Two Pipe/Four Pipe Option:

The standard configuration of the T158 is for four pipe operations in which the thermostat is controlling a system with both a main and secondary coil. In SUMMER mode, the main coil is used for cooling and the secondary coil is used for heating. In WINTER mode, the main coil is used for heating and the secondary coil is normally



4707 SE 17th Avenue
PO Box 82189
Portland, OR 97282
Tel (503) 233-6401 / Fax (503) 233-6407

disabled (the main coil usually has a greater capacity than the secondary coil). The second stage heat can be used during winter mode for auxiliary heat.

The T158 can be factory configured for use with a two pipe system in which there is only one coil. The valve controlling the coil would be connected to the main thermostat output. When configured for two-pipe operation, auto mode is not available on the digital display. With this configuration, the user can only change the mode between OFF and HEAT on heating only installations, or OFF and COOL in cooling only installations. The two pipe configuration also changes the 3F dead-band between heating and cooling modes to OFF preventing unnecessary large temperature swings when the demand changes for example, from heating to cooling.

Power-On Operating Sequence for T158 in Three Wire Floating Valve Mode:

Upon application of power, a T158 thermostat, configured for three wire floating valves, will operate as follows:

1. Enable digital display showing zone temperature.
2. Enable a default setpoint temperature of 70 F.
3. Enable auto mode of operation. Either heat or cool mode may be enabled in addition to auto depending upon room temperature.
4. Close both the main and secondary valves for a period of three minutes by applying power to the main two and second two outputs.
5. At the end of three minutes, the T158 will stop closing the valves by removing power from the main 2 and secondary 2 outputs.
6. The T158 may then open either the main or secondary valve by applying power to either the main 1 or secondary 1 output. The choice of which valve is opened depends on demand and system configuration (summer/winter, 2/4 pipe). The valve may be opened for up to three minutes depending on demand.

NOTE: This sequence assumes that the fan switch is not off.



4707 SE 17th Avenue
 PO Box 82189
 Portland, OR 97282
 Tel (503) 233-6401 / Fax (503) 233-6407

| T158 OUTPUT CONFIGURATION | | | | |
|----------------------------------|-------------------------------------|----------------------------------|---|--|
| Output | TA 158 | TB158 | | |
| | On/Off Operation | Three Wire Valve | On/Off | |
| | | | N.O. | N.C. |
| Main 1 | On or Off For N.O. Or N.C. Valve | Powers Main Valve Open | Off at Temperature demand | On at Temperature demand |
| Main 2 | N/A | Powers Main Valve Closed | Cycles Fan On With Demand | Cycles Fan On With Demand |
| Secondary 1 | On or Off For N.O. or N.C. Valve | Powers Secondary Valve Open | Summer: Off at heat Demand Winter: Disabled | Summer: On at heat Demand Winter: Disabled |
| Secondary 2 | N/A | Powers Secondary Valve Closed | On at Second Stage Heating Demand | On at Second Stage Heating Demand |