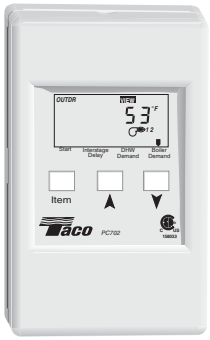
Instruction Sheet
PC702–1 Two Stage Boiler Reset & DHW Control

102-106

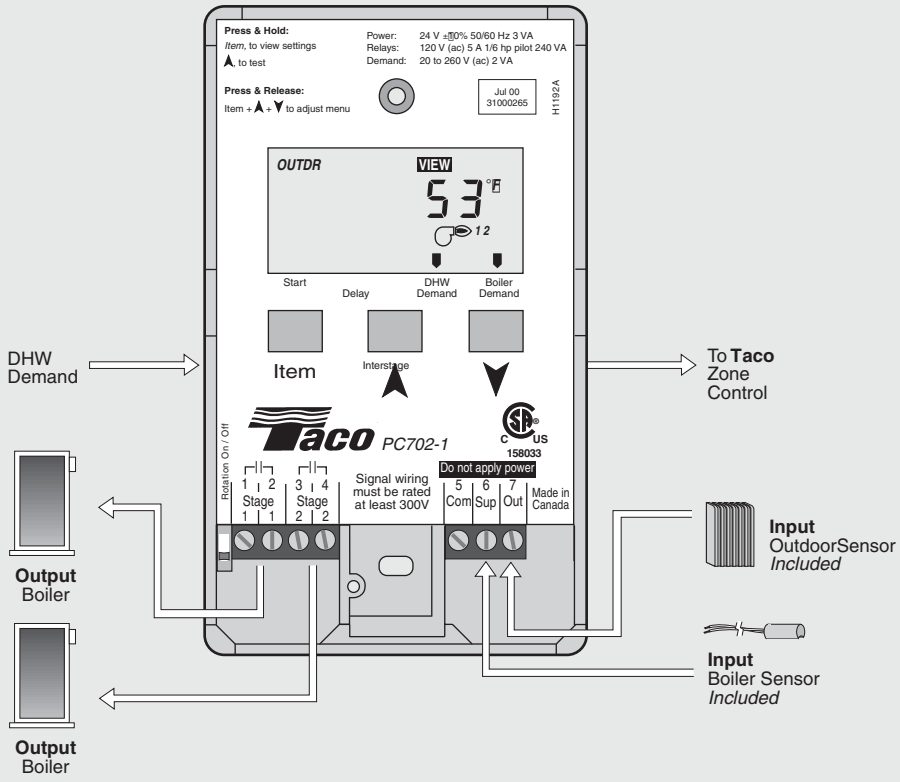
SUPERSEDES : 102-106, dated June 1, 2000 EFFECTIVE: March 1, 2004

Plant ID# 9300-1059



The PC702-1 is a microprocessor-based control designed to regulate the supply water temperature from a two stage boiler system based on the outdoor temperature or DHW requirements. A wiring harness is provided to be easily connected to the Taco Expandable (-EXP) Controls.

The PC702-1 includes functions such as automatic reset ratio calculation, Warm Weather Shut Down (WWSD), Minimum Boiler setting, adjustable interstage delay setting, optional boiler rotation, and an optional automatic boiler differential. The control has a digital, liquid crystal display (LCD) that normally displays the Boiler Supply temperature, but can display other temperatures and settings.

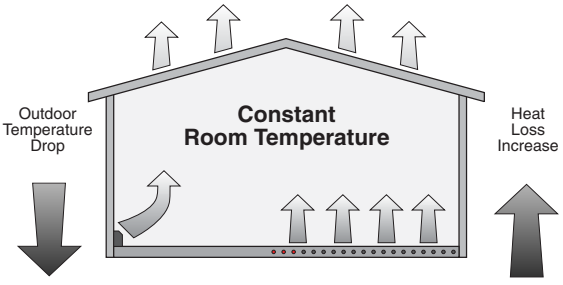


Control Strategy

OUTDOOR RESET

In order to properly control a hot water heating system, the heat supplied to the building must equal the heat lost by the building.

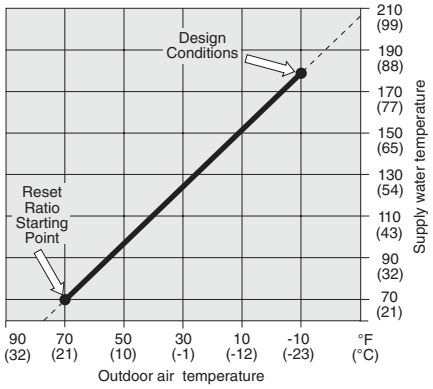
- The heat supplied to a building is proportional to the temperature of the supply water and the surface area of the heating element. A small surface area such as baseboard radiators requires a higher water temperature than a larger surface area such as radiant floors.
- The heat lost from a building is dependent on the outdoor temperature, as well as other factors. As the outdoor temperature drops, the building heat loss increases.



Reset Ratio

Operation of a hot water heating system can generally be improved by modulating the supply water temperature as the outdoor temperature changes. Using this approach, the heat lost from the building is matched by the heat input to the building. The PC702-1 Boiler Reset Control utilizes a reset ratio to set the relationship between outdoor temperature and supply water temperature. The reset ratio determines the amount the supply water temperature is raised for every 1° drop in outdoor air temperature, and it is determined from the starting point and the system design conditions. In order for the control to automatically determine the reset ratio, a starting point and design conditions must be established. These two points are set by the following 4 adjustments:

- Boiler starting temperature
- Outdoor starting temperature
- Boiler design supply water temperature
- Outdoor Design Temperature



See **Settings - Step Four** for a complete description of each setting.

Reset Ratio Starting Point

The first point used to establish the reset ratio calculation is the starting point. It is a combination of an adjustable boiler starting water temperature setting and an adjustable outdoor starting temperature setting.

Design Conditions

The second point to establish the reset ratio calculation is the design conditions. This point represents the required water temperature during the coldest day of the year.

Warm Weather Shut Down (WWSD)

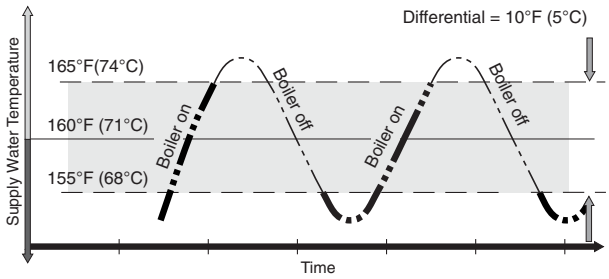
When the outdoor air temperature is warmer than the Warm Weather Shut Down setting, no additional heat is required in the building; therefore, the heating system can be shut down. This setting has no effect on the reset ratio calculation.

BOILER OPERATION

The supply water temperature from the boiler(s) can be controlled by cycling the boiler(s) on and off. Modulation of the operating temperature in hot water heating systems not only provides more comfort but also offers significant energy savings. The cooler the boiler(s) runs, the more efficient it is due to less heat losses up the flue and reduced boiler jacket losses.

Differential

An on / off boiler must be operated with a differential in order to prevent short cycling. When the supply water temperature drops below the bottom rail of the differential, the boiler is turned on. The boiler is then kept on until the supply water temperature rises above the top rail of the differential. If the differential is too wide, there can be large supply water temperature swings; however, if the differential is too narrow, the boiler short cycles and operates inefficiently. This control can automatically calculate the boiler differential in order to achieve an appropriate balance between temperature swings and boiler efficiency. This also permits the control to adapt to changing loads and conditions.

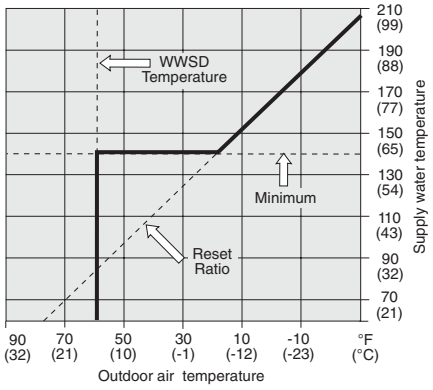


Minimum Boiler Supply

Most boilers require a minimum supply water temperature in order to prevent corrosion from flue gas condensation. The control should therefore only modulate the boiler supply water temperature down to the boiler manufacturer's minimum recommended operating temperature. Some boilers are designed to condense and should be operated at low water temperatures as much as possible for maximum efficiency.

Domestic Hot Water (DHW) Boiler Supply

Most indirect DHW tanks require a relatively high supply water temperature in order to produce adequate amounts of DHW. The control should therefore override the reset ratio when there is a demand for DHW and raise the system supply temperature to a temperature that is suitable for DHW generation.



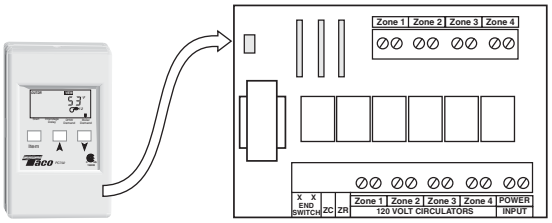
Sequence of Operation

POWERING UP THE CONTROL

After the PC702-1 is powered up, all the LCD segments are turned on for 2 seconds, followed by a software version number. The control then displays the outdoor temperature.

BOILER DEMAND

The PC702-1 obtains a boiler demand through the Taco Zone Control when a zone calls for heat. When the PC702-1 receives a boiler demand, the *Boiler Demand* pointer is displayed in the LCD.



DHW DEMAND

The PC702-1 obtains a DHW demand when a voltage between 24 and 240 V(ac) is applied across the two DHW demand wires (black wires) that come out of the back of the control. When the PC702-1 receives a DHW demand, the *DHW Demand* pointer is displayed in the LCD.

WARM WEATHER SHUT DOWN (WWSD)

When the outdoor temperature rises above the WWSD setting, the PC702-1 displays the WWSD segment in the LCD and turns off the boiler(s). If the PC702-1 receives a boiler demand from the Taco Zone Control while in a WWSD, the boiler(s) remain off. If the PC702-1 receives a DHW demand while in a WWSD, the boiler(s) are fired to satisfy the DHW demand.

BOILER OPERATION

The boiler(s) operates around a differential that is either manually set or automatically controlled by the PC702-1. The control includes a minimum on and off time for the heat source(s), in order to minimize short cycling. The automatic boiler differential increases system efficiency by adjusting to changing loads.

Boiler Demand

While the PC702-1 has a boiler demand, the system supply water temperature is controlled by turning the boiler(s) on and off. The PC702-1 calculates the target supply water temperature based on the outdoor temperature, the reset ratio settings, and the boiler minimum setting.

DHW Demand

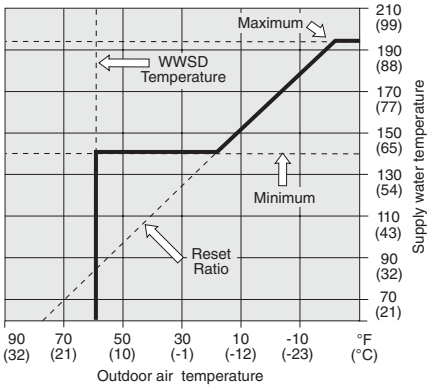
While the PC702-1 has a DHW demand, the system supply water temperature is controlled by turning the boiler(s) on and off. The PC702-1 targets a supply water temperature of at least 180°F (83°C).

Maximum Boiler Supply

The PC702-1 does not allow the boiler target temperature to exceed the boiler design temperature setting plus 10°F (6°C) to a maximum of 225°F (107°C). When operating at the maximum, the control displays the MAX segment in the LCD when either that boiler supply or boiler target temperature are being viewed.

Minimum Boiler Supply

The PC702-1 has a minimum boiler setting which selects a minimum boiler target temperature in order to prevent corrosion from flue gas condensation. During mild outdoor conditions, the boiler(s) cycles around the minimum boiler setting. This programmed function has an OFF setting for condensing and electric boilers. When operating at the minimum setting, the control displays the MIN segment in the LCD when either that boiler supply or boiler target temperature are being viewed.



ROTATION

The PC702-1 has an optional boiler rotation function that is selected using the DIP switch located next to terminal 1 in the wiring chamber. The PC702-1's boiler rotation function is fixed at 48 hours. The firing order of the boilers changes whenever one stage accumulates 48 hours more running time than the other stage. After each rotation, the stage with the least running hours is the first to fire, and the stage with the most running hours is the last to fire. This function ensures that both stages receive equal amounts of use. When the *Rotation On / Off* DIP switch is set to the *Off* position, Stage 1 is always the first stage to fire.
NOTE: If the boiler used is a lo-hi fire boiler, set the *Rotation On / Off* DIP switch to the *Off* position.

STAGING

The PC702-1 controls up to two stages in order to supply the required target temperature. After the first stage is turned on in the firing sequence, the control waits a minimum amount of time before turning on the next stage. This minimum amount of time is set using the interstage delay setting. After the interstage delay has expired, the PC702-1 examines the current supply water temperature to determine when the next stage is to fire. The control uses Proportional, Integral and Derivative (PID) logic.

Proportional - compares the actual supply temperature to the boiler target temperature. The colder the supply water temperature, the sooner the next stage is turned on.

Integral - compares the actual supply temperature to the boiler target temperature over a period of time.

Derivative - determines how fast or slow the supply water temperature is changing. If the supply temperature is increasing slowly, the next stage is turned on sooner. If the supply temperature is increasing quickly, the next stage is turned on later, if at all.

INTERSTAGE DELAY

The PC702-1 has an adjustable interstage delay setting. This setting sets the minimum time delay between the firing of the first stage and the firing of the second stage.

Each stage has a minimum on time, and a minimum off time of 30 seconds.

Installation

Caution

Improper installation and operation of this control could result in damage to the equipment and possibly even personal injury. It is your responsibility to ensure that this control is safely installed according to all applicable codes and standards. This electronic control is not intended for use as a primary limit control. Other controls that are intended and certified as safety limits must be part of the control circuit.

STEP ONE

Check the contents of this package. If any of the contents listed are missing or damaged, please contact your sales representative for assistance.

Type PC702-1 includes:
- PC702-1 Boiler Reset Control
- One Outdoor Sensor
- One Strap on Sensor
- Instruction Sheet

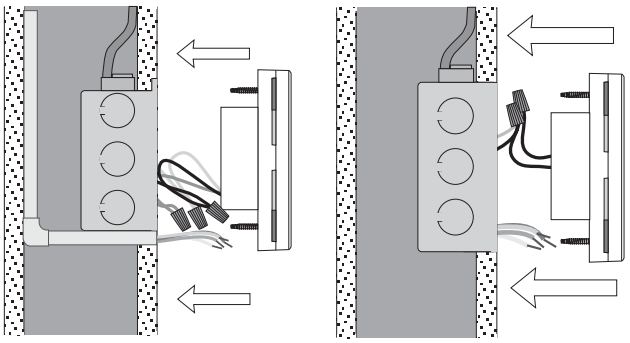
Replacement sensors are available from Taco, Inc. Strap on Sensor – 9300-2044RP Outdoor Sensor – 9300-2052RP

***Note** : Carefully read the details of the Sequence of Operation section in this brochure to ensure that you have chosen the proper control for your application.*

STEP TWO

Installing the Control

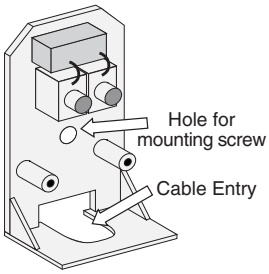
- Grasp the front cover by the fingertip grips on the top and bottom of the enclosure and pull the front cover off. Remove the wiring cover screw.
- The enclosure is mounted onto a 2" x 4" electrical box near the Taco Zone Control.
- The mounting holes in the enclosure accept #6 screws.
- Wiring to the control enters the wiring chamber through the back or bottom of the enclosure.
- To reassemble the enclosure, first replace the wiring chamber cover and then push the front cover onto the enclosure until it snaps into place.



Installing the Outdoor Sensor

***Note** The temperature sensor (thermistor) is built into the enclosure.*

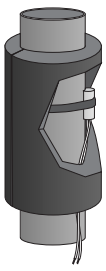
- Take the sensor cover off by sliding it upward relative to the sensor base.
- Use one round or pan head screw to attach the base of the sensor to the wall.
- The sensor is wall mounted and the wiring enters through the bottom of the enclosure. The hole for the cable entry must face downward in order to prevent water from entering and filling the enclosure.
- The sensor should be mounted on a wall which best represents the heat load on the building (i.e. a northern wall for most buildings and a southern facing wall for buildings with large south facing glass areas). The sensor should not be installed near heat sources such as ventilation or window openings.
- The sensor should be installed at an elevation above the ground that will prevent accidental damage or tampering.
- Install the Outdoor Sensor and run the wiring back to the control mounting location.

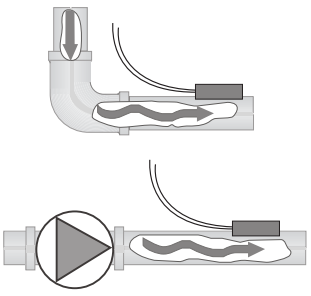


Installing the Boiler Sensor

***Note** This sensor is designed to mount on a pipe or in a temperature immersion well.*

- The sensor can be strapped directly to the pipe using the cable tie provided. Insulation should be placed around the sensor to reduce the effect of air currents on the sensor measurement.
- The Boiler Sensor should be placed downstream of a pump or after an elbow or similar fitting. This is especially important if large diameter pipes are used because the thermal stratification within the pipe can result in erroneous sensor readings. Proper sensor location requires that the fluid is thoroughly mixed within the pipe before it reaches the sensor.





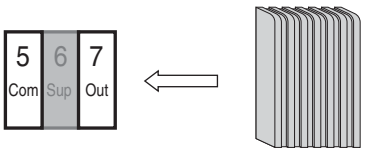
STEP THREE

Wiring to the Zone Control

Connect the PC702-1 cable to the Add-On interface on the Taco Zone Control. Ensure the *Mode* switch on the Zone Control is set to *Reset*.

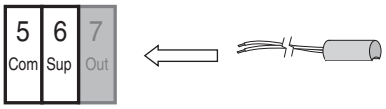
Wiring the Sensors

Do not apply power to these terminals as this will damage the control.



Outdoor Sensor

Connect the two wires from the Outdoor Sensor to the terminals *Com — Out* (5 and 7). The Outdoor Sensor measures the outdoor air temperature.



Boiler Sensor

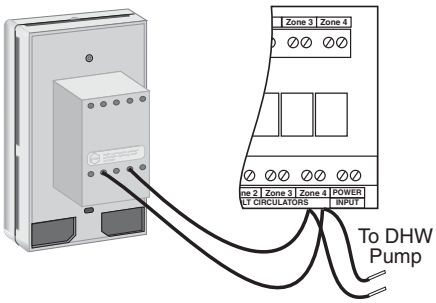
Connect the two wires from the Boiler Sensor to the terminals *Com — Sup* (5 and 6). The Boiler Sensor measures the supply water temperature going from the boiler to the system.

Wiring the Boilers

The Stage 1 and Stage 2 terminals (1 & 2 and 3 & 4) are isolated outputs in the PC702-1. There is no power available on these terminals from the control. These terminals are to be used as a switch to either make or break the boiler circuit. When the PC702-1 requires the boiler(s) to fire, it closes the contact between terminals 1 and 2 and/or 3 and 4.

DHW Demand

To generate a DHW demand, a voltage between 24 and 240 V(ac) must be applied across the two DHW demand wires (black wires) coming from the back of the control. This can be achieved by wiring these two wires in parallel to the DHW (priority) zone on the Taco Zone Control.



Settings

Before adjusting the settings, read through the sequence of operation to ensure that you understand how the control operates. The following page describes how to program these settings into the control once it has been powered up.

STEP FOUR

Boiler Starting Temperature (BOIL Start)

The *BOIL Start* setting is the starting supply water temperature of the reset ratio, and can be adjusted from 35 to 150°F (2 to 66°C). This setting is typically set to the desired building temperature. In applications where fan coils are used, the *BOIL Start* may need to be set higher to prevent cold drafts during mild outdoor conditions. If the building feels cool during mild outdoor conditions, the BOIL Start setting should be increased.

Outdoor Starting Temperature (OUTDR Start)

The OUTDR Start setting is the outdoor temperature at which the starting temperature is supplied. The adjustment range is from 35 to 85 °F (2 to 29°C). This setting is typically set to the desired building temperature.

Boiler Design Temperature (BOIL DSGN)

The BOIL DSGN setting is the water temperature required to satisfy the building heat loss during the coldest outdoor temperature. This adjustment is typically dependent on the type of heating terminal used. The following are suggested settings for different terminal units:

- Inslab Radiant ..... 100 to 140°F (38 to 60°C)
- Staple-up Radiant ..... 130 to 160°F (54 to 71°C)
- Radiators ..... 140 to 160°F (60 to 71°C)
- Radiant Baseboard ..... 130 to 160°F (54 to 71°C)
- Convective Baseboard ..... 160 to 190°F (71 to 88°C)
- Fan Coil ..... 180 to 200°F (82 to 93°C)

Outdoor Design Temperature (OUTDR DSGN)

The OUTDR DSGN setting is the outdoor temperature used in the heat loss calculation. It is set to the typical coldest outdoor temperature.

Boiler Minimum Supply Temperature (BOIL MIN)

Most boilers require a minimum operating temperature to prevent corrosion from flue gas condensation. The *Minimum Boiler* setting should be programmed to the lowest supply water temperature at which the boiler can operate without causing the boiler flue gases

to condense. Consult the boiler manufacturer for recommended minimum boiler supply temperatures. Some typical settings are as follows:

- Steel fire tube boiler ..... 140 to 160°F (60 to 71°C)
- Cast iron boiler ..... 135 to 160°F (57 to 71°C)
- Copper tube boiler ..... 125 to 150°F (52 to 66°C)
- Condensing boiler ..... Off
- Electric boiler ..... Off

Differential (DIFF)

The differential adjustment sets how far the actual boiler supply water temperature may deviate from the desired temperature before the boiler is turned on or off, and it is determined by the flow rate through the system pump relative to the heat output by the boiler. The differential can be adjusted to Ad (Auto differential) or from 2 to 42°F (1 to 23°C). The following formula can be used to calculate the desired differential:

$$\textbf{Differential} = \frac{\textbf{Btu/hr input}}{\textbf{System US GPM x 500}} \qquad \textbf{Example:} \quad \frac{\textbf{100,000 Btu/hr}}{\textbf{20 US GPM x 500}} = \textbf{10°F (6°C)}$$

When the adjustment is set to *Ad (Auto Differential)*, the differential is continuously calculated by the control, and varies as the heating load changes.

Interstage Delay

The interstage delay setting is used to set the minimum time delay between the first stage firing and the second stage firing, and is adjustable from 30 seconds to 4 minutes.

Warm Weather Shut Down (WWSD)

The WWSD can be adjusted from 35 to 100°F (2 to 38°C). The boiler will be shut down when the outdoor temperature is warmer than this setting. If the WWSD is set to OFF, the control continues to provide a minimum boiler temperature even during warm outdoor temperatures.

Control Adjustments

Boiler Start: _____

Outdoor Start: _____

Boiler Design: _____

Outdoor Design: _____

Boiler Minimum: _____

Differential: _____

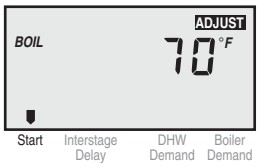
Interstage Delay: _____

WWSD: _____

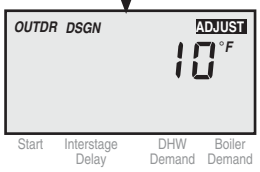
ADJUST MENU

To enter the adjustment mode, **Press** and **Hold** simultaneously, the ***Item***, ▲ and ▼ Buttons. The **ADJUST** element will turn on.

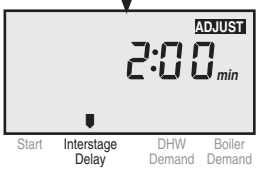
BOIL Start
Use the ▲ and ▼ buttons to set the desired boiler starting tempeature.



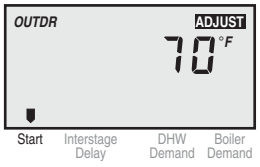
OUTDR DSGN
Press and release the **Item** button. Use the ▲ and ▼ buttons to set the outdoor design tempeature.



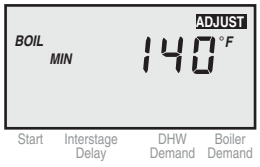
Interstage Delay
Press and release the **Item** button. Use the ▲ and ▼ buttons to set the desired interstage delay time.



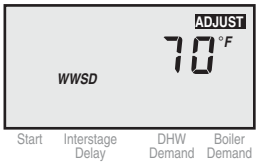
OUTDR Start
Press and release the **Item** button. Use the ▲ and ▼ buttons to set the desired outdoor starting tempeature.



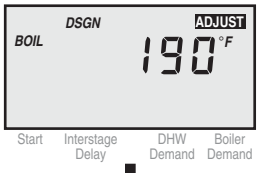
BOIL MIN
Press and release the **Item** button. Use the ▲ and ▼ buttons to set the boiler minimum tempeature.



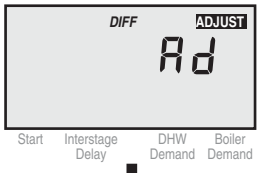
WWSD
Press and release the **Item** button. Use the ▲ and ▼ buttons to set the desired WWSD tempeature.



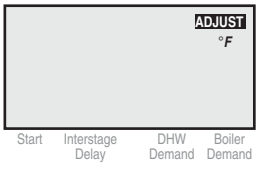
BOIL DSGN
Press and release the **Item** button. Use the ▲ and ▼ buttons to set the boiler design tempeature.



DIFF
Press and release the **Item** button. Use the ▲ and ▼ buttons to set the boiler differential tempeature.



Units
Press and release the **Item** button. Use the ▲ and ▼ buttons to select between °F and °C

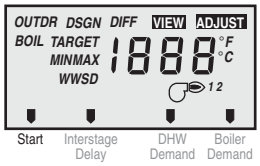


The control automatically goes back to viewing when the buttons are left alone for 20 seconds

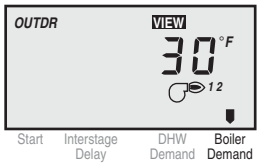
All settings will be saved even during power down of the control

POWER UP

On power up, the control displays all segments for 2 seconds and the control version number.

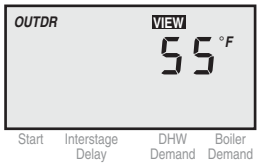


The control then automatically goes to operating mode, and displays the outdoor temperature.

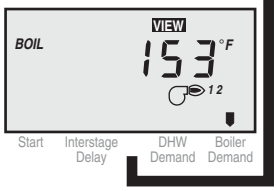


VIEW MENU

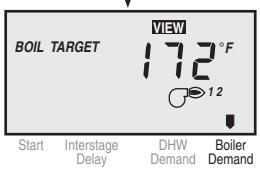
Outdoor Temperature
The OUTDR element is turned on. The outdoor temperature is displayed



Boiler Temperature
Press and release the **Item** button. The boiler supply temperature is displayed.



Boiler Target Temperature
Press and release the **Item** button. The boiler target temperature is displayed.



To view all control settings, the ***Item*** button may be pressed and held while in the View Menu. The control will then scroll through all the adjustable items.

Troubleshooting

STEP FIVE

As in any troubleshooting procedure, it is important to isolate a problem as much as possible before proceeding. The error messages greatly simplify troubleshooting of the PC702-1. When the control displays an error message, identify the fault from the look-up table on page 8 and follow standard testing procedures to confirm the problem. If you suspect a wiring fault, return to step three and carefully check all external wiring and wiring connections.

Sensor and Internal Faults

- If an outdoor sensor fault occurs, the PC702-1 will assume a fixed outdoor temperature of 32°F (0°C) and will target the appropriate supply water temperature. An error message is displayed.
- If a supply sensor fault occurs, the PC702-1 turns the boiler off and displays an error message.
- If an EEPROM fault occurs, the PC702-1 turns the boilers off until all the settings are checked.

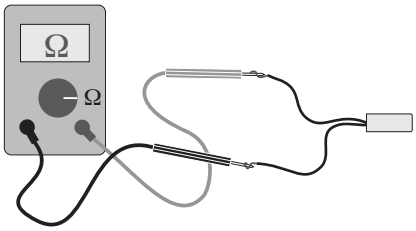
Adjustment of Settings

- If the outdoor temperature is cold and the rooms are cold, increase the BOIL DSGN setting by 5°F (3°C) per day.
- If the outdoor temperature is near the WWSD temperature and the rooms are cold, increase the BOILStart setting.
- If the boiler is cycling too often, increase the Differential setting or set control to Ad (Auto Differential). If the second stage is coming on too soon, increase the Interstage Delay setting.

Testing the Sensors

A good quality test meter capable of measuring up to 5,000 kΩ (1 kΩ = 1000 Ω) is required to measure the sensor resistance. In addition to this, the actual temperature must be measured with either a good quality digital thermometer, or, if a thermometer is not available, a second sensor can be placed alongside the one to be tested and the readings compared.

First measure the temperature using the thermometer and then measure the resistance of the sensor at the control. The wires from the sensor must not be connected to the control while the test is performed. Using the chart below, estimate the temperature measured by the sensor. The sensor and thermometer readings should be close. If the test meter reads a very high resistance, there may be a broken wire, a poor wiring connection or a defective sensor. If the resistance is very low, the wiring may be shorted, there may be moisture in the sensor or the sensor may be defective. To test for a defective sensor, measure the resistance directly at the sensor location.



Do not apply voltage to a sensor at any time as damage to the sensor may result.

Temperature		Resistance	Temperature		Resistance	Temperature		Resistance	Temperature		Resistance
°F	°C	Ω	°F	°C	Ω	°F	°C	Ω	°F	°C	Ω
-30	-34	234,196	30	-1	34,558	90	32	7,334	150	66	2,045
-20	-29	165,180	40	4	26,099	100	38	5,828	160	71	1,689
-10	-23	118,018	50	10	19,900	110	43	4,665	170	77	1,403
0	-18	85,362	60	16	15,311	120	49	3,760	180	82	1,172
10	-12	62,465	70	21	11,883	130	54	3,050	190	88	983
20	-7	46,218	80	27	9,299	140	60	2,490	200	93	829

STEP SIX

- Install the wiring cover over the wiring chamber and secure it with the screw provided.
- Place the front cover on the control and snap it into place.
- It is important to explain the operation of this control within the system to the end user, and to anyone else who may be operating the system.

Error Messages

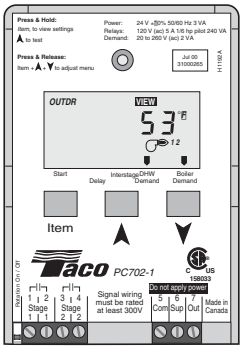
Whenever a fault is detected, an error message will be displayed to indicate the location of the problem.

EEPROM Read Error	E01	**Outdoor Sensor Open Circuit**	OUTDR OPn	**Boiler Sensor Open Circuit**	BOIL OPn
Outdoor Sensor Short Circuit	OUTDR Shr	**Boiler Sensor Short Circuit**	BOIL Shr	**Refer to the troubleshooting section for operation details.**	

Technical Data

PC702-1 Two Stage Boiler Reset & DHW Control

			Factory
Control	—	Microprocessor PI control; This is **not a safety (limit) control**.	
Packaged weight	—	1.5 lb. (670 g)	
Dimensions	—	4-3/4" H x 2-7/8" W x 7/8" D (120 x 74 x 22 mm)	
Approvals	—	CSA NRTL /C; Meets ICES & FCC regulations for EMI/RFI.	
Ambient conditions	—	Indoor use only, 32 to 105°F (0 to 40°C), < 90% RH non-condensing.	
Power supply	—	Class 2, 24 V ±10% 50/60 Hz 3 VA (Powered by Taco -Exp Control)	
Relays	—	24 V (ac) 5 A 1/6 hp, pilot duty 240 VA	
DHW Demand	—	20 to 260 V (ac) 2 VA	
Sensors included:	—	NTC thermistor, 10 kΩ @ 77°F (25°C ±0.2°C) ß=3892 Outdoor Sensor M 2036 and Universal Sensor 071.	
Boiler Start	—	35 to 150°F (2 to 66°C)	70°F (21°C)
Outdoor Start	—	35 to 85°F (2 to 29°C)	70°F (21°C)
Boiler Design	—	70 to 220°F (21 to 104°C)	190°F (88°C)
Outdoor Design	—	-60 to 32°F (-51 to 0°C)	10°F (-12°C)
Boiler Minimum	—	Off, 80 to 180°F (Off, 27 to 82°C)	140°F (60°C)
Differential	—	Auto, 2 to 42°F (Auto, 1 to 24°C)	Auto
Interstage Delay	—	0:30 to 4:00 minutes	2:00 min.
WWSD	—	35 to 100°F, Off (2 to 38°C, Off)	70°F (21°C)
Units	—	°F, °C	°F



The installer must ensure that this control and its wiring are isolated and/or shielded from strong sources of electromagnetic noise. Conversely, this Class B digital apparatus complies with Part 15 of the FCC Rules and meets all requirements of the Canadian Interference-Causing Equipment Regulations. However, if this control does cause harmful interference to radio or television reception, which can be determined by turning the control off and on, the user is encouraged to try to correct the interference by reorienting or relocating the receiving antenna, relocating the receiver with respect to this control, and/or connecting the control to a different circuit from that to which the receiver is connected.

Do It Once. Do It Right.™

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