



Instruction Sheet

PC700-2 Boiler Reset Control

102-097

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EFFECTIVE: March 1, 2004

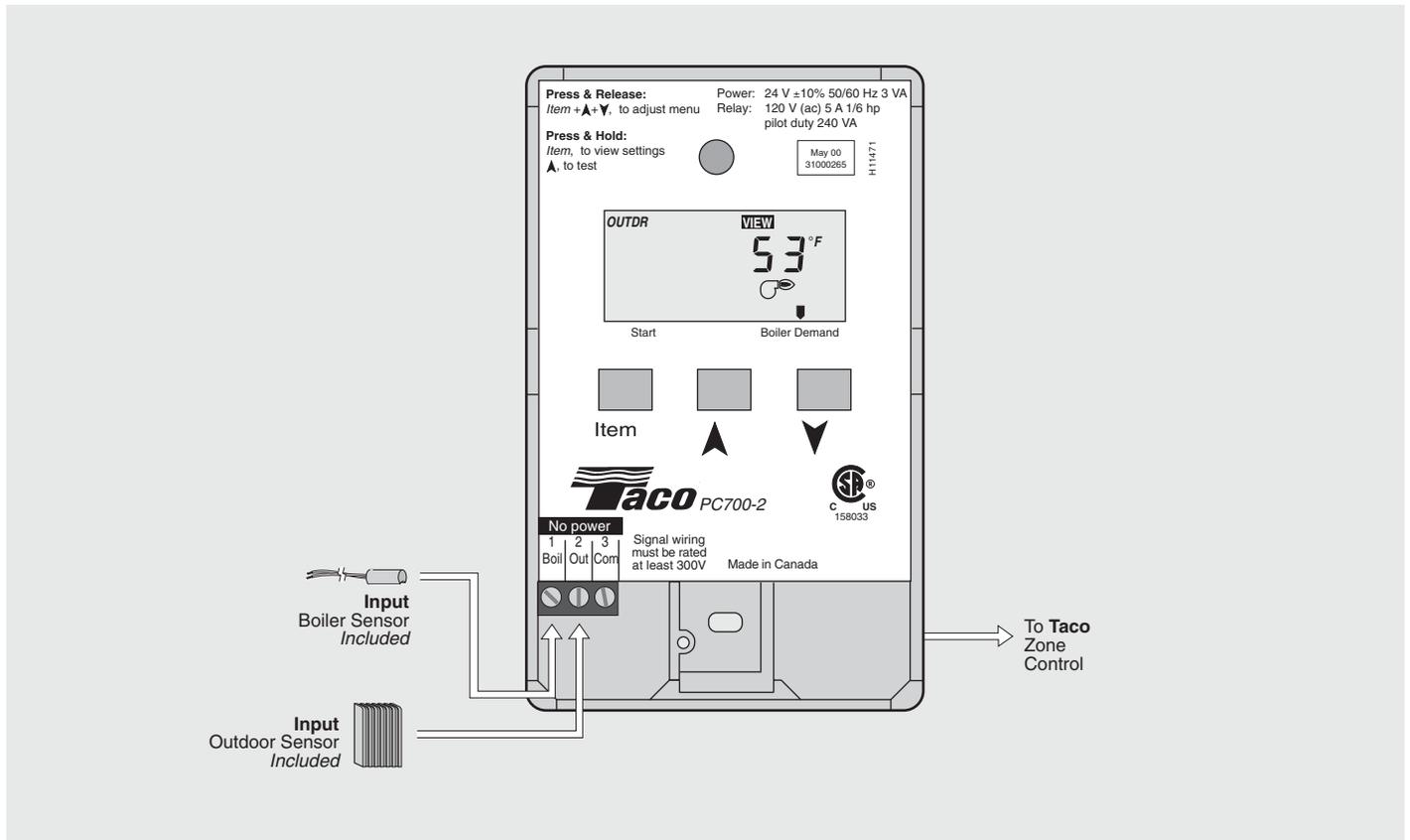
Plant ID# 9300-1055



The PC700-2 is a microprocessor-based control designed to regulate the supply water temperature of a single boiler, based on the outdoor temperature. A wiring harness is provided to be easily connected to the Taco Expandable (-EXP) Controls.

The PC700-2 includes functions such as automatic reset ratio calculation, Warm Weather Shut Down (WWSD), Minimum Boiler setting, 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.

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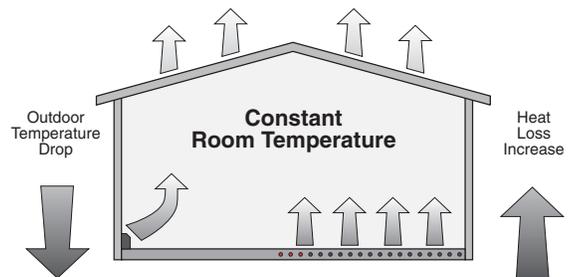


Control Strategy

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.

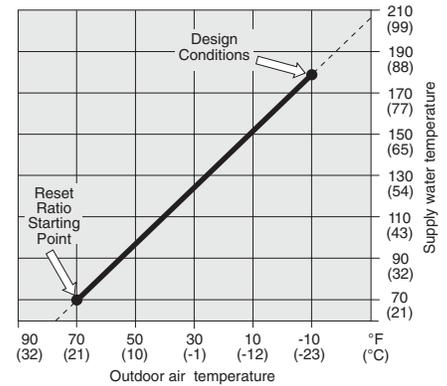


Reset Ratio

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 PC700-2 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 the 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)

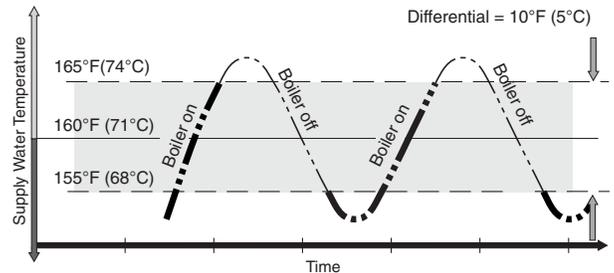
When the outdoor air temperature is warmer than the Warm Weather Shut Down setting, no additional heat is required in the building; therefore, the heating system can be shut down. This setting has no effect on the reset ratio calculation.

BOILER OPERATION

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

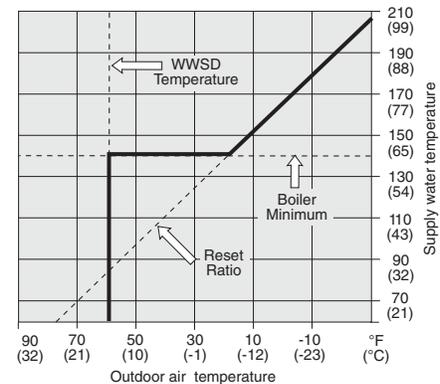
Differential

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.



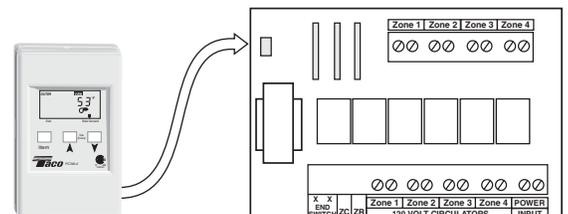
Sequence of Operation

POWERING UP THE CONTROL

After the PC700-2 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 PC700-2 obtains a boiler demand through the Taco Zone Control when a zone calls for heat. When the PC 700-2 receives a boiler demand, the *Boiler Demand* pointer is displayed in the LCD.



WARM WEATHER SHUT DOWN (WWSD)

When the outdoor temperature rises above the WWSD setting, the PC700-2 displays the WWSD segment and turns off the boiler. If a boiler demand from the Taco Zone Control is received, the boiler remains off. For applications where DHW is required, the DHW (priority) zone on the Taco Zone Control turns on the boiler.

BOILER OPERATION

While the PC700-2 has a boiler demand, the system supply water temperature is controlled by turning the boiler on and off. The PC700-2 calculates the target supply water temperature based on the outdoor temperature, and the settings that were entered.

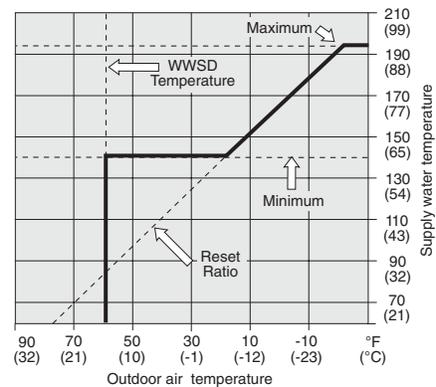
The boiler operates around a differential that is either manually set or automatically controlled by the PC700-2. The control includes a minimum on and off time for the heat source, in order to minimize short cycling. The automatic boiler differential increases system efficiency by adjusting to changing loads.

Maximum Boiler Supply

The PC700-2 does not allow the boiler target temperature to exceed the boiler design temperature setting plus 10°F (6°C) up to a maximum of 225°F (107°C). When operating at maximum temperatures, the control displays the MAX segment in the LCD when either the boiler supply or boiler target temperature is being viewed.

Minimum Boiler Supply

The PC700-2 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 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 the boiler supply or boiler target temperature is being viewed.



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 PC700-2 includes:

- PC700-2 Boiler Reset Control
- One Outdoor Sensor
- One Strap on Sensor
- Instruction Sheet

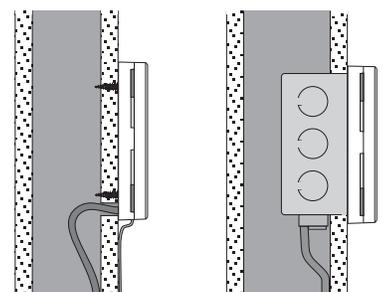
Replacement sensors are available from Taco, Inc. Strap on Sensor – 9300-2044RP Outdoor Sensor – 9300-2052RP

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

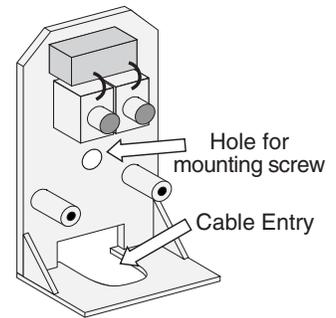
- Grasp the front cover by the fingertip grips on the top and bottom of the enclosure and pull the front cover off. Remove the wiring cover screw.
- The enclosure is either mounted flush onto a wall or it can be placed onto a 2" x 4" electrical box near the Taco Zone Control.
- The mounting holes in 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.

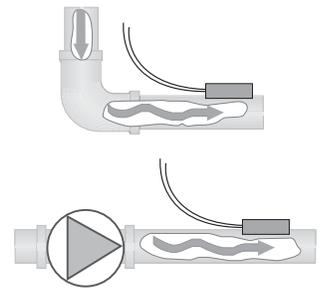
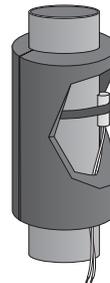
- Take the sensor cover off by sliding it upward relative to the sensor base.
- Use one round or pan head screw to attach the base of the sensor to the wall.
- The sensor is wall mounted and the wiring enters through the bottom of the enclosure. The hole for the cable entry must face downward in order 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 PC700-2 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

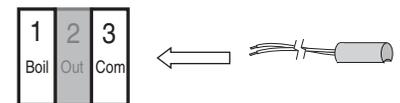
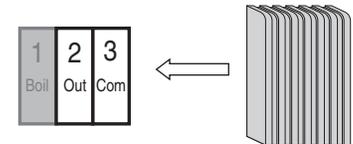
Do not apply power to these terminals as this will damage the control.

Outdoor Sensor

Connect the two wires from the Outdoor Sensor to the terminals *Out — Com* (2 and 3). The Outdoor Sensor measures the outdoor air temperature.

Boiler Sensor

Connect the two wires from the Boiler Sensor to the terminals *Boil— Com* (1 and 3). The Boiler Sensor measures the supply water temperature going from the boiler to the system.



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

Note: Radiant applications may require a mixing device in order to prevent flue gas condensation.

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 of 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:

$$\text{Differential} = \frac{\text{Btu/hr input}}{\text{System US GPM} \times 500} \quad \text{Example: } \frac{100,000 \text{ Btu/hr}}{20 \text{ US GPM} \times 500} = 10^\circ\text{F} (6^\circ\text{C})$$

When the adjustment is set to Ad (Auto Differential), the differential is continuously calculated by the control, and varies as the heating load changes. This function minimizes boiler short cycling, therefore increasing system efficiency.

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 adjustment is set to OFF, the control continues to provide a minimum boiler temperature even during warm outdoor temperatures.

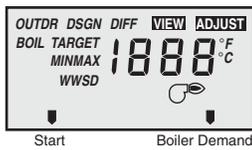
Control Adjustments

Boiler Start: _____
 Outdoor Start: _____
 Boiler Design: _____
 Outdoor Design: _____

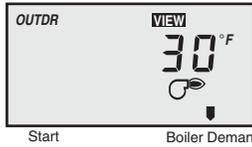
Boiler Minimum: _____
 Differential: _____
 WWSD: _____

POWER UP

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



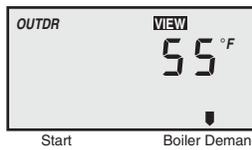
The control then automatically goes to operating mode, and displays the outdoor temperature.



VIEW MENU

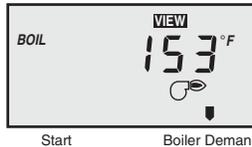
Outdoor Temperature

The outdoor temperature is displayed when the OUTDR element is turned on.



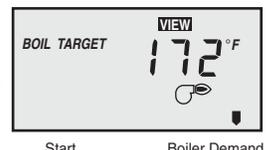
Boiler Temperature

Press and release the **Item** button until the BOIL element is displayed.



Boiler Target Temperature

Press and release the **Item** button until the BOIL TARGET element is displayed.



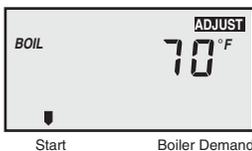
To view all control settings, the **Item** button may be pressed and held while in the View Menu. The control will then scroll through all the adjustable items.

ADJUST MENU

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

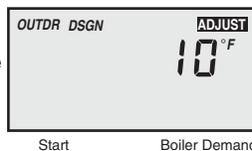
BOIL Start

Use the **▲** and **▼** buttons to set the desired boiler starting temperature.



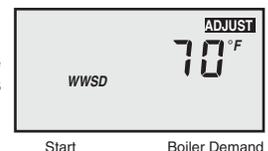
OUTDR DSGN

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



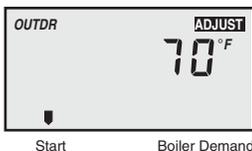
WWSD

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



OUTDR Start

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



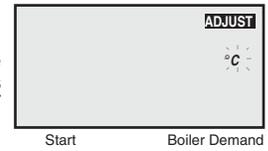
BOIL MIN

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



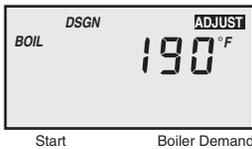
Units

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



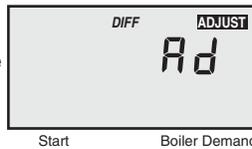
BOIL DSGN

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



DIFF

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



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

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 PC700-2. When the control displays an error message, identify the fault from the look-up table on page 7 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 PC700-2 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 boiler sensor fault occurs, the PC700-2 turns the boiler off and displays an error message.
- If an EEPROM fault occurs, the PC700-2 turns the boiler off until all the settings are verified. An error message is displayed.

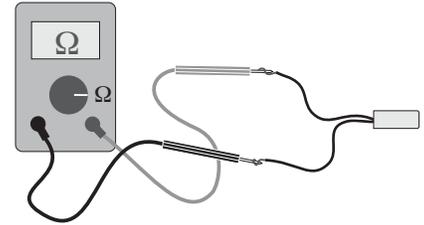
Adjustment of Settings

- 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 BOIL Start setting.
- If the boiler is cycling too often, increase the Differential setting or set control to Ad (Auto Differential).

Testing the Sensors

A good quality test meter capable of measuring up to 5,000 k Ω (1 k Ω = 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

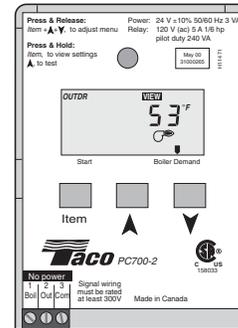
Whenever a fault is detected, an error message will be displayed to indicate the location of the problem.

EEPROM Read Error		Outdoor Sensor Open Circuit		Boiler Sensor Open Circuit	
Outdoor Sensor Short Circuit		Boiler Sensor Short Circuit		Refer to the troubleshooting section for operation details.	

Technical Data

PC700-2 Boiler Reset Control

Control	— Microprocessor PI control; This is not a safety (limit) control .
Packaged weight	— 1.3 lb. (580 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
Sensors	— NTC thermistor, 10 kΩ @ 77°F (25°C ±0.2°C) β=3892
included:	Outdoor Sensor M 2036 and Universal Sensor 071.
	<u>Factory</u>
<i>Boiler Start</i>	— 35 to 150°F (2 to 66°C) 70°F (21°C)
<i>Outdoor Start</i>	— 35 to 85°F (2 to 29°C) 70°F (21°C)
<i>Boiler Design</i>	— 70 to 220°F (21 to 104°C) 190°F (88°C)
<i>Outdoor Design</i>	— -60 to 32°F (-51 to 0°C) 10°F (-12°C)
<i>Boiler Minimum</i>	— Off, 80 to 180°F (Off, 27 to 82°C) 140 °F (60°C)
<i>Differential</i>	— Auto, 2 to 42°F (Auto, 1 to 24°C) Auto
<i>WWSD</i>	— 35 to 100°F, Off (2 to 38°C, Off) 70°F (21°C)
<i>Units</i>	— °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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