

# **Commercial Gas Controller Diagnostics**

**(Combined Controller Diagnostics)**

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**FOR TRAINING PURPOSES ONLY.**  
Information is subject to change without notice.



# Commercial Gas Controller Diagnostics

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**Cycle Power means turn unit off, wait 1 minute, then turn on.**

## 1. AC Reversed

*Power supply to water heater has reversed polarity.*

The control has sensed the hot and neutral of the power supply are reversed.

Check for reversal of the Hot and Neutral. The control looks at the line neutral (or return) to verify that there is no voltage difference between neutral and safety ground. If there is leakage to safety ground or voltage on the neutral, due to power wiring, the fault could be thrown even if the units appears to be wired correctly.

## 2. Upper Probe Short (BTH series, not BTR/BTN)

*There is a problem with the upper probe.*

The control has sensed a shorted upper temperature probe.

Check for shorted or grounded upper probe wires (black wires in 4 pin connector). Check resistance of upper probe. If resistance is below 390 ohms, replace probe.

## 3. Lower Probe Short

*There is a problem with the lower probe.*

The control has sensed a shorted lower temperature probe.

Check for shorted or grounded lower probe wires (black wires in 2 pin connector). Check resistance of lower probe. If resistance is below 390 ohms, replace probe.

## 4. Upper Probe Open

*There is a problem with the upper probe.*

The control has sensed an open upper temperature probe.

Check all upper probe wiring connections (black wires in 4 pin connector). Check resistance of upper probe. If resistance is above 56,000 ohms, replace probe.

Typical reading for a good thermistor:

|       |       |       |       |
|-------|-------|-------|-------|
| 100°F | 5862Ω | 150°F | 2056Ω |
| 120°F | 3780Ω | 160°F | 1698Ω |
| 140°F | 2503Ω | 180°F | 1177Ω |

Thus, below 500Ω or above 35,000Ω would be out of range.

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## 5. Lower Probe Open

*There is a problem with the lower probe.*

The control has sensed an open lower temperature probe.

Check all upper probe wiring connections (black wires in 2 pin connector). Check resistance of lower probe. If resistance is above 56,000 ohms, replace probe. Check service connector pins and make sure they are connected.

## 6. Flame Probe Short

*The flame sensor is grounded.*

The control has sensed a grounded flame sense rod.

Ensure the flame sense rod is not touching the burner. Check for continuity between flame sense rod and wiring to ground.

One more note to add for this error, often if the flame rod is too close to the burner (bent into the burner) it may not appear to be shorted to the burner but it is so close that when the burner ignites, the flame rod is in the IR portion of the flame and the signal characteristics in that flame can make the CCB think it is shorted.

## 7. Flame Detect Error

*Flame detected out of sequence.*

The control has sensed a flame out of sequence.

The burner has not shut down properly. Check gas valve for 100% closure. If fault condition persists, shut off main gas supply valve.

Unless the gas valve is stuck open, which is a serious concern, this error usually will require the replacement of the CCB.

## 8. Energy Cut Out (ECO)

*Tank temperature is excessive. The water heater has been disabled.*

The control has sensed upper probe temperatures exceeding the maximum high limit (201°F).

Check upper probe ECO wiring connection (red wires in 4 pin connector). Check for improper piping conditions, and/or excessively high return loop temperatures. Check for scaled upper probe. Cool upper tank water temperature to below 160°F (70°C), and check continuity of ECO high limit switch in upper temperature probe. If ECO remains open at upper probe temperatures below 160°F (70°C), replace upper temperature probe.

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## **9. Low Gas**

*The supply gas pressure to the water heater is low.*

The control has sensed an open low gas pressure switch.

Verify that the low gas pressure switch connections and wiring (2 blue wires) are correct. Check gas pressure during all stages of operation of the water heater. Consider gas supply while other appliances are firing on a common gas supply. Refer to gas line sizing information contained in the owner's manual. Remove switch and check switch orifice for debris. If supply gas pressure remains above activation point for the low gas pressure switch during all stages of operation, replace switch.

## **10. Blocked Air Intake**

*The combustion air intake is restricted.*

The control has sensed an open blocked inlet air pressure switch.

Verify that that inlet air pressure switch connections are connected. Check air intake piping for restriction or excessive equivalent pipe length. Refer to owner's manual for maximum allowed air intake piping. If inlet air pressure sensed at the switch does not fall below the calibrated set point during operation but switch is open, replace switch.

## **11. Blocked Exhaust Event**

*The exhaust vent is blocked or restricted. Insure condensation hose is draining properly.*

The control has sensed an open blocked outlet air pressure switch.

Verify that the blocked exhaust pressure switch connections and wiring (2 red wires) are correct. Check condensation drain hose is draining properly. Check exhaust vent piping for restrictions or excessive equivalent pipe length. Refer to owner's manual for maximum allowed exhaust vent piping. If exhaust vent pressure sensed at the switch does not rise above the calibrated set point during operation but switch is open, replace switch.

## **12. Blower Prover Failure**

*The blower prover switch is closed out of sequence.*

The control has sensed a closed blower prover switch out of sequence.

Verify that the blower prover pressure switch connections and wiring (2 gray wires) are correct. Ensure pressure switch has not been bypassed (jumpered out). Consider infrequent high wind conditions for intermittent fault conditions. The blower prover switch is a normally open switch. If blower is not running and blower pressure switch remains closed, replace switch.

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## 13. Blower Prover Open

*The blower prover switch remains open after the blower has been energized.*

The control has sensed an open blower prover air pressure switch during operation.

Check air pressuring sensing tube. Verify that the tube is not kinked and is properly connected. Verify that the blower prover pressure switch connections and wiring (2 gray wires) are correct. Verify that blower is operating. Ensure blower and blower drive connections and wiring are correct. If pressure sensed at the blower prover switch is above the calibrated set point during blower operation and switch is open, replace the switch.

## 14. Igniter Current Error

*Igniter current has been detected out of sequence. Cycle power to water heater.*

Try cycling power to the unit. If the problem persists or will not reset, then replace the CCB.

## 15. Low Igniter Current

*Igniter current is low.*

The control has sensed low current to hot surface igniter (HSI).

Check for damaged or broken igniter element. Ensure igniter connections and wiring (2 brown wires) are correct. Replace igniter if damaged or broken. If it is not broken, check for 120 vac from control.

## 16. Ignition Failure

*The water heater has failed to ignite the burner.*

The control has not sensed proper flame sense signal to transition in heating mode.

Flame sense rod is possibly contaminated. Remove flame sense rod and clean with steel wool. Ensure flame rod connection and wiring are correct. Check for continuity between burner and earth ground. Ensure ground wire (green) to burner bolt is secure. Ensure gas valve is in the ON position. Check gas supply and manifold pressure during all stages of operation of the water heater. Consider gas supply while other appliances are firing on a common gas supply. Refer to gas line sizing information contained in the owner's manual. Check for restrictions in exhaust and heat exchanger.

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## **17. Gas Valve Error**

*Gas valve current has been detected out of sequence.*

This error code signifies the gas valve is bad or shorted. Please check the gas valve main solenoid for a short before replacing the CCB, especially if the installation is not new. (This error may be seen on a new install with a bad CCB but on an older unit probably would be a short in the gas valve.)

## **18. Gas Valve Failure**

*Gas valve has been energized. No current to gas valve has been detected.*

The control has sensed low current to the gas valve.

Ensure gas valve connection and wiring (2 yellow wires) are correct and connected. Check gas valve solenoid for continuity. If gas valve solenoid shows infinite resistance (open), replace gas valve.

This usually means the gas valve is bad. Replace the gas valve. This could also mean the gas valve is in the OFF position or the gas valve is not connected. Check the connections and settings before replacing the gas valve, especially if this is a new installation.

## **19. EEPROM Failure**

*Internal control failures have been detected. Cycle power to water heater.*

Try cycling power to the unit. If the problem persists or will not reset, then replace the CCB.

## **20. Hardware Failure**

*Internal control failures have been detected. Cycle power to water heater.*

Try cycling power to the unit. If the problem persists or will not reset, then replace the CCB.

## **21. RAM Failure**

*Internal control failures have been detected. Cycle power to water heater.*

Try cycling power to the unit. If the problem persists or will not reset, then replace the CCB.

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## 22. UIM Screen

*Internal control failures have been detected. Cycle power to water heater.*

Try cycling power to the unit. Check the cable between the UIM and CCB if the problem persists or will not reset, then replace the CCB.

## 23. Model Config Fail

*Internal control failures have been detected. Cycle power to water heater.*

This means the board has not been configured properly. The board will have to be replaced by a configured board from the factory, configured specifically for the unit it is installed on.

## 24. Power Supply Fail

*Control has detected a problem with the power supply.*

The control has sensed a problem with the incoming power supply.

Please ensure input power does not drop below 102 VAC anytime during heater operation.

These failures result when the power supply drops below 102 volts on the incoming power. Please check the incoming power to ensure that it is above 102 volts (at least) during the entire operation of the heater.

## 25. CCB Comm Error

*Internal control failures have been detected. Cycle power to water heater.*

Try cycling power to the unit. Check to ensure that the blue communication cable is not damaged and is securely plugged in both connections on the UIM and the CCB. If the problem persists or will not reset, then replace the CCB.

## 26. Communication Failure

*Communications between the user interface module and the central control board could not be established. Check communication cable.*

Check communication cable between the user interface module (UIM) and the central control board (CCB). The cable should be connected to J16 on the CCB.

Try cycling power to the unit. Check to ensure that the blue communication cable is not damaged and is securely plugged in both connections on the UIM and the CCB. If the problem persists or will not reset, then

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replace the UIM and then the CCB.

## **27. Low Anode Protection (Warning)**

*The power anodes are providing lower than anticipated protection. Contact the technical information center for further details. Contact information can be found in help under 'Contact Information'.*

This warning will be shown when the powered anodes can no longer balance the ionization in the water due to high steel exposure and high glass erosion. This can signify that the tank is at the end of its life, but no known, yet, determination can be made as to how long the tank will last after the powered anode protection is maxed out. (Place amp meter in series with anode rod. If current exceeds 40MA, this warning appears.)

## **28. No Anode Current (Warning)**

*The power anode(s) are not drawing any current.*

Ensure that the tank is completely full of water. Ensure connections and wiring to the anode(s) are correct.

Ensure the powered anodes are plugged in and the tank is completely full of water.

## **29. No Anode Voltage (Warning); On newer units, "No water detected in tank."**

*There may be no water in the tank or the powered anode(s) are shorted to earth/ground.*

Make sure tank is full of water. Check for continuity between powered anode(s) and wiring to ground. Ensure recessed area at the top of each anode (where wire connections are made) is dry and free of any moisture and standing water.

This fault can occur when the power anodes are shorted to ground. This could be water on the top connection of the anode or a tank jacket that is shorting out the spade terminal on the powered anode. Ensure the powered anode terminals and wiring are not shorted to earth ground anywhere.

## BTH - Series 100, 101

| Cyclone Xi Series 100/101         |                    |                    | BTH 120            | BTH 150 | BTH 199 | BTH 250            | BTH 300 | BTH 400            | BTH 500            | BTH 500            |
|-----------------------------------|--------------------|--------------------|--------------------|---------|---------|--------------------|---------|--------------------|--------------------|--------------------|
|                                   |                    |                    |                    |         |         |                    |         |                    | Series 100/101     | Series 104         |
| <b>Pressure Switches</b>          |                    |                    |                    |         |         |                    |         |                    |                    |                    |
| <b>Blower Prover Switch</b>       |                    |                    |                    |         |         |                    |         |                    |                    |                    |
| Switch Contacts N.O. N.C.         | N.O.               | N.O.               |                    |         |         |                    |         |                    | N.O.               | N.O.               |
| Activate on rise or fall in press | Rise               | Rise               |                    |         |         |                    |         | Rise               | Rise               | Rise               |
| Activation Pressure "WC           | .75"               | .75"               | .75"               |         |         | >.75"              |         | 1.0"               | 4.5"               | 1.0"               |
| Pressure Tolerance +              | ± .05"             | ± .05"             | ± .05"             |         |         | ± .05"             |         | ± .05"             | ± .05"             | ± .05"             |
| Actual Pressure During Fire       | 3.7"               | 3.75"              | 3.8"               |         |         | 5.8"               |         | 3.25"              | 5.6"               | 8.3"               |
|                                   |                    |                    |                    |         |         |                    |         |                    |                    | 3.75"              |
| <b>Blocked Exhaust Switch</b>     |                    |                    |                    |         |         |                    |         |                    |                    |                    |
| Switch Contacts N.O. N.C.         | N. C.              | N. C.              |                    |         |         |                    |         | N. C.              | N. C.              | N. C.              |
| Activate on rise or fall in press | Rise               | Rise               |                    |         |         |                    |         | Rise               | Rise               | Rise               |
| Activation Pressure "WC           | 1.2"               | .98" N/1.2" LP     | .98" N/2" LP       |         |         | 2.0"               |         | 1.15"              | 1.39"              | 1.77"              |
| Pressure Tolerance +              | ± .05"             | ± .05"             | ± .05"             |         |         | ± .05"             |         | ± .05"             | ± .05"             | ± .05"             |
|                                   |                    |                    |                    |         |         |                    |         |                    |                    |                    |
| <b>Blocked Inlet Switch</b>       |                    |                    |                    |         |         |                    |         |                    |                    |                    |
| Switch Contacts N.O. N.C.         | N. C.              | N. C.              |                    |         |         |                    |         | N. C.              | N. C.              | N. C.              |
| Activate on rise or fall in press | Fall               | Fall               |                    |         |         |                    |         | Fall               | Fall               | Fall               |
| Activation Pressure "WC           | -0.65" N/-0.85" LP | -0.65" N/-0.85" LP | -0.65" N/-0.85" LP |         |         | -0.85"             |         | -0.85"             | -1.25"             | -1.35"             |
| Pressure Tolerance +              | ± .05"             | ± .05"             | ± .05"             |         |         | ± .05"             |         | ± .05"             | ± .05"             | ± .05"             |
|                                   |                    |                    |                    |         |         |                    |         |                    |                    |                    |
| <b>Low Gas Pressure Switch</b>    |                    |                    |                    |         |         |                    |         |                    |                    |                    |
| Switch Contacts N.O. N.C.         | N.O.               | N.O.               |                    |         |         |                    |         | N.O.               | N.O.               | N.O.               |
| Activate on rise or fall in press | Rise               | Rise               |                    |         |         |                    |         | Rise               | Rise               | Rise               |
| Activation Pressure "WC           | 4.4" N/8.0" LP     | 4.4" N/8.0" LP     | 4.4" N/8.0" LP     |         |         | 4.4" N/8.0" LP     |         | 4.6" N/9.0" LP     | 4.6" N/9.0" LP     | 4.6" N/9.0" LP     |
| Pressure Tolerance +              | ± 0.4" N/± .05" LP | ± 0.4" N/± .05" LP | ± 0.4" N/± .05" LP |         |         | ± 0.4" N/± .05" LP |         | ± 0.4" N/± .05" LP | ± 0.4" N/± .05" LP | ± 0.4" N/± .05" LP |
|                                   |                    |                    |                    |         |         |                    |         |                    |                    |                    |
| <b>Minimum Flame Sense</b>        |                    |                    |                    |         |         |                    |         |                    |                    |                    |
| Flame Current @amp DC             | 0.7μamp            | 0.7μamp            |                    |         |         |                    |         | 0.7μamp            | 0.7μamp            | 0.7μamp            |
| Minimum Igniter Current           |                    |                    |                    |         |         |                    |         |                    |                    |                    |
| Igniter Current Amps AC           | 2.0amps            | 2.0amps            |                    |         |         |                    |         | 2.0amps            | 2.0amps            | 2.7 amps           |
| Ignitor Resistance Range          |                    |                    |                    |         |         |                    |         |                    |                    |                    |
| Ignitor Ohms at 77 deg            | 40-70ohms          | 40-70ohms          |                    |         |         |                    |         | 40-70ohms          | 40-70ohms          | 40-70ohms          |
| <b>VFD Voltage BTH 40/500</b>     |                    |                    |                    |         |         |                    |         |                    |                    |                    |
| Pre/Post Purge 1-10 VDC           | N/A                | N/A                |                    |         |         |                    |         | N/A                | 7.7 VDC            | 7.7 VDC            |
| Igniter Warmup 1-10 VDC           | N/A                | N/A                |                    |         |         |                    |         | N/A                | 9.1 VDC            | 5.48 VDC           |
| Heating Cycle 1-10 VDC            | N/A                | N/A                |                    |         |         |                    |         | N/A                | 9.8 VDC            | 10.1 VDC           |

**VFD Frequency BTH 400/500**

|                         |     |     |     |     |     |        |        |          |
|-------------------------|-----|-----|-----|-----|-----|--------|--------|----------|
| Pre/Post Purge Cycle HZ | N/A | N/A | N/A | N/A | N/A | 155 HZ | 155 HZ | 158.4 HZ |
| Igniter Warmup HZ       | N/A | N/A | N/A | N/A | N/A | 150 HZ | 181 HZ | 109.6 HZ |
| Heating Cycle HZ        | N/A | N/A | N/A | N/A | N/A | N/A    | 196 HZ | 200 HZ   |

**Exhaust/Blower Values**

|                    |         |         |         |         |         |         |         |         |
|--------------------|---------|---------|---------|---------|---------|---------|---------|---------|
| CFM                | 26      | 33      | 43      | 54      | 65      | 87      | 108     | 108     |
| C02                | 9.1     | 9.1     | 9.2     | 9.2     | 9.1     | 9.1     | 9.5     | 9.5     |
| Exhaust Temp Range | 130-140 | 130-140 | 130-140 | 130-140 | 130-140 | 130-140 | 130-140 | 130-140 |

**Maximum Gas Pressure**

|                 |          |          |          |          |        |        |        |        |
|-----------------|----------|----------|----------|----------|--------|--------|--------|--------|
| Natural in " WC | 10.5" wc | 10.5" wc | 10.5" wc | 10.5" wc | 11" wc | 11" wc | 11" wc | 11" wc |
| LP " WC         | 14" wc   | 14" wc   | 14" wc   | 14" wc   | 14" wc | 14" wc | 14" wc | 14" wc |

**Nominal Gas Pressure**

|                 |        |        |        |        |        |        |        |        |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|
| Natural in " WC | 7" wc  | 7" wc  | 7" wc  | 7" wc  | 7" wc  | 7" wc  | 7" wc  | 7" wc  |
| LP " WC         | 11" wc | 11" wc | 11" wc | 11" wc | 11" wc | 11" wc | 11" wc | 11" wc |

**Minimum Gas Pressure**

|                 |         |         |         |         |         |         |         |         |
|-----------------|---------|---------|---------|---------|---------|---------|---------|---------|
| Natural in " WC | 4.8" wc | 4.8" wc | 4.8" wc | 4.8" wc | 5.2" wc | 5.2" wc | 5.2" wc | 5.2" wc |
| LP " WC         | 11" wc  | 11" wc  | 8.5" wc | 8.5" wc | 11" wc  | 11" wc  | 11" wc  | 11" wc  |

**Manifold Pressure**

|                 |        |        |       |       |        |        |        |       |
|-----------------|--------|--------|-------|-------|--------|--------|--------|-------|
| Natural in " WC | 4" wc  | 4" wc  | 0" wc | 0" wc | 4" wc  | 4" wc  | 4" wc  | 0" wc |
| LP " WC         | 10" wc | 10" wc | 0" wc | 0" wc | 10" wc | 10" wc | 10" wc | 0" wc |

**Minimum Gas Supply Size**

|         |         |         |         |         |           |           |           |           |
|---------|---------|---------|---------|---------|-----------|-----------|-----------|-----------|
| Natural | 1/2"npt | 3/4"npt | 3/4"npt | 3/4"npt | 1 1/4"npt | 1 1/4"npt | 1 1/2"npt | 1 1/2"npt |
| Propane | 1/2"npt | 3/4"npt | 3/4"npt | 3/4"npt | 1 1/4"npt | 1 1/4"npt | 1 1/4"npt | 1 1/4"npt |

**Water Line Connections**

Outlet      1 1/2"npt

Inlet      1 1/2"npt

Tank Size in Gallons      60 gallons

BTU Input      120,000

Recovery GPH @ 80 □ Rise      173

60 gallons

100 gallons

100 gallons

130 gallons

130 gallons

300,000

399,900

499,900

720

582

720

720

720

Maximum equivalent feet of intake and vent pipe using 3" PVC is 50 feet (15.2m). Equivalent feet must include any 90° elbows (two 45° elbows equal one 90° elbow). Three inch diameter 90° elbows are equivalent to 5' (1.5m) of pipe.

Maximum equivalent feet of intake and vent pipe using 4" PVC is 120 feet (36.6m).

Equivalent feet must include any 90° elbows (two 45° elbows equal one 90° elbow). Four inch diameter 90° elbows are equivalent to 5' (1.5m) of pipe.

**VENTING TABLES BTH 120 - 250**

| Number of 90° Elbows | 3" Minimum | 3" Maximum | 4" Maximum | Number of 90° | 4" PVC | 6" PVC |
|----------------------|------------|------------|------------|---------------|--------|--------|
| ONE (1)              | 7          | 45         | 115        | ONE (1)       | 65'    | 115'   |
| TWO (2)              | 7          | 40         | 110        | TWO (2)       | 60'    | 110'   |
| THREE (3)            | 7          | 35         | 105        | THREE (3)     | 55'    | 105'   |
| FOUR (4)             | 7          | 30         | 100        | FOUR (4)      | 50'    | 100'   |
| FIVE (5)             | 7          | ---        | 95         | FIVE (5)      | 45'    | 95'    |
| SIX (6)              | 7          | ---        | 90         | SIX (6)       | 40'    | 90'    |

## BTN - Series 110

|                         | BTN Series 110  | 80              | 100             | 120             | 154             | 180             | 199C            | 199             | 200A            |
|-------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Tank Size               | 74              | 98              | 71              | 81              | 99              | 93              | 99              | 99              | 100             |
| BTU Input               | 80,000          | 98              | 120,000         | 154,000         | 180,000         | 199,000         | 199,000         | 199,000         | 199,000         |
| Ignition Type           | HSI (11-20ohms) |
| Blower Prover Switch    | -2.1            | -2.1            | -2.1            | -2.1            | -2.1            | -2.1            | -2.1            | -2.1            | -2.1            |
| Low Gas Switch          | 5.2             | 5.2             | 5.2             | 5.2             | 5.2             | 5.2             | 5.2             | 5.2             | 5.2             |
| Max Gas Pressure Nat    | 14              | 14              | 13.8            | 13.8            | 13.8            | 13.8            | 13.8            | 13.8            | 13.8            |
| Max Gas Pressure LP     | 14              | 14              | n/a             |
| Mini Gas Pressure Nat   | 5               | 5               | 5.6             | 5.6             | 5.6             | 5.6             | 5.6             | 5.6             | 5.6             |
| Mini Gas Pressure LP    | 11              | 11              | n/a             |
| Manifold Pressure Nat   | 4.5             | 4.5             | 3.5             | 3.5             | 3.5             | 3.5             | 3.5             | 3.5             | 3.5             |
| Manifold Pressure LP    | 10              | 10              | n/a             |
| Thermostat Temp Range   | 120-180         | 120-180         | 120-180         | 120-180         | 120-180         | 120-180         | 120-180         | 120-180         | 120-180         |
| Thermostat Differential | 4°              | 4°              | 4°              | 4°              | 4°              | 4°              | 4°              | 4°              | 4°              |
| ECO Open/Close          | ?               | ?               | 203°/193        | 203°/193        | 203°/193        | 203°/193        | 203°/193        | 203°/193        | 203°/193        |
| Gas Connection Size     | 1/2"            | 1/2"            | 3/4"            | 3/4"            | 3/4"            | 3/4"            | 3/4"            | 3/4"            | 3/4"            |
| Water Connection Size   | 1"              | 1 1/4"          | 1 1/2"          | 1 1/2"          | 1 1/2"          | 1 1/2"          | 1 1/2"          | 1 1/2"          | 1 1/2" or 2"    |
| Vent Diameter           | 4"              | 4"              | 5"              | 6"              | 6"              | 6"              | 6"              | 6"              | 6"              |

## ERROR CODES

| FLASH | DESCRIPTION                             | FLASH      | DESCRIPTION                              |
|-------|---|------------|--|
| 1     | System locked out                       | 6          | Reversed polarity                        |
| 2     | Blower prover closed on self diagnostic | 7          | Weak flame sense signal                  |
| 3     | Blower prover open                      | 8          | Ignitor not sensed - Heater not grounded |
| 4     | ECO cutout - Tank temp over 203deg      | CONT FLASH | Flame sensed out of sequence             |
|       |   | CONT ON    | Internal control board failure           |

|                         | BTN Series 110  | 250A            | 275A            | 310A            | 366A            | 400A            |
|-------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Tank Size               | 100             | 100             | 85              | 85              | 85              | 85              |
| BTUJ Input              | 250,000         | 275,000         | 310,000         | 366,000         | 390,000         | 390,000         |
| Ignition Type           | HSI (11-20ohms) |
| Blower Prover Switch    | -2.1            | -2.1            | -2.1            | -2.1            | -2.1            | -2.1            |
| Low Gas Switch          | 5.2             | 5.2             | 5.2             | 5.2             | 5.2             | 5.2             |
| Max Gas Pressure Nat    | 13.8            | 13.8            | 13.8            | 13.8            | 13.8            | 13.8            |
| Max Gas Pressure LP     | n/a             | n/a             | n/a             | n/a             | n/a             | n/a             |
| Mini Gas Pressure Nat   | 5.6             | 5.6             | 5.6             | 5.6             | 5.6             | 5.6             |
| Mini Gas Pressure LP    | n/a             | n/a             | n/a             | n/a             | n/a             | n/a             |
| Manifold Pressure Nat   | 3.5             | 3.5             | 3.5             | 3.5             | 3.5             | 3.5             |
| Manifold Pressure LP    | n/a             | n/a             | n/a             | n/a             | n/a             | n/a             |
| Thermostat Temp Range   | 120-180         | 120-180         | 120-180         | 120-180         | 120-180         | 120-180         |
| Thermostat Differential | 4°              | 4°              | 4°              | 4°              | 4°              | 4°              |
| ECO Open/Close          | 203°/193□       | 203°/193□       | 203°/193□       | 203°/193□       | 203°/193□       | 203°/193□       |
| Gas Connection Size     | 3/4"            | 3/4"            | 1"              | 1"              | 1"              | 1"              |
| Water Connection Size   | 1 1/2" or 2"    | 1 1/2" or 2"    | 1 1/2"          | 1 1/2"          | 1 1/2"          | 1 1/2"          |
| Vent Diameter           | 6"              | 6"              | 6"              | 6"              | 6"              | 6"              |

| ERROR CODES |   | DESCRIPTION |  |
|-------------|---|-------------|--|
| FLASH       | DESCRIPTION                             | FLASH       | DESCRIPTION                              |
| 1           | System locked out                       | 6           | Reversed polarity                        |
| 2           | Blower prover closed on self diagnostic | 7           | Weak flame sense signal                  |
| 3           | Blower prover open                      | 8           | Ignitor not sensed - Heater not grounded |
| 4           | ECO cutout - Tank temp over 203deg      | CONT FLASH  | Flame sensed out of sequence             |
|             |   | CONT ON     | Internal control board failure           |

## BTR - Series 118, 119, 120

| BTR Series 118/119        | 120     | series120 | 151     | 154     | 180     | 197     | 198     | 199     | 200A | 201     | Series 120 |
|---------------------------|---------|-----------|---------|---------|---------|---------|---------|---------|------|---------|------------|
| Tank Size                 | 71      | 32        | 81      | 81      | 100     | 100     | 81      | 100     |      | 32      |            |
| BTU Rating                | 120,000 | 150,000   | 154,000 | 180,000 | 199,000 | 199,000 | 199,000 | 199,000 |      | 199,000 | 199,000    |
| Ignition Type             | Spark   | HSI       | Spark   | Spark   | Spark   | Spark   | Spark   | Spark   |      | HSI     |            |
| Blower/Prover Switch      | N/A     | -2.5      | N/A     | N/A     | N/A     | N/A     | N/A     | N/A     |      | N/A     | -2.5       |
| Max Gas Pressure NT       | 14"     | 14"       | 14"     | 14"     | 14"     | 14"     | 14"     | 14"     |      | 14"     | 14"        |
| Max Gas Pressure LP       | 14"     | 14"       | 14"     | 14"     | 14"     | 14"     | 14"     | 14"     |      | 14"     | 14"        |
| Min Gas Pressure Nat      | 4.5"    | 4.5"      | 4.5"    | 4.5"    | 4.5"    | 4.5"    | 4.5"    | 4.5"    |      | 4.5"    | 4.5"       |
| Min Gas Pressure LP       | 11"     | 11"       | 11"     | 11"     | 11"     | 11"     | 11"     | 11"     |      | 11"     | 11"        |
| Manifold Gas Pressure Nat | 3.5"    | 3.5"      | 3.5"    | 3.5"    | 3.5"    | 3.5"    | 3.5"    | 3.5"    |      | 3.5"    | 3.5"       |
| Manifold Gas Pressure LP  | 10"     | 10"       | 10"     | 10"     | 10"     | 10"     | 10"     | 10"     |      | 10"     | 10"        |
| Thermostat Temp Range     | 120/180 | 120/185   | 120/180 | 120/180 | 120/180 | 120/180 | 120/180 | 120/180 |      | 120/180 | 120/185    |
| Thermostat Differential   | 4 deg   | 4 deg     | 4 deg   | 4 deg   | 4 deg   | 4 deg   | 4 deg   | 4 deg   |      | 4 deg   | 4 deg      |
| ECO Open/Close            | 203/120 | 203/120   | 203/120 | 203/120 | 203/120 | 203/120 | 203/120 | 203/120 |      | 203/120 | 203/120    |
| Gas Connection            | 1/2"    | 1/2"      | 1/2"    | 1/2"    | 1/2"    | 1/2"    | 1/2"    | 1/2"    |      | 1/2"    | 1/2"       |
| Water Connections Top     | 1 1/2"  | 1 1/2"    | 1 1/2"  | 1 1/2"  | 1 1/2"  | 1 1/2"  | 1 1/2"  | 1 1/2"  |      | 1 1/2"  | 1 1/2"     |
| Water Connections Side    | 1 1/2"  | 1 1/2"    | 1 1/2"  | 1 1/2"  | 1 1/2"  | 1 1/2"  | 1 1/2"  | 1 1/2"  |      | 2"      | 1 1/2"     |
| Vent Diameter             | 5"      | 6"        | 6"      | 6"      | 6"      | 6"      | 6"      | 6"      |      | 6"      | 6"         |

### WATER CONNECTIONS

TOP INLET AND OUTLET 1-1/2" on all models except BTR-251 and BTR-305, not equipped  
with top connections  
FRONT INLET AND OUTLET 2" on BTR-200, BTR-250, BTR-275 and BTR-400, 1-1/2" on all  
other models  
BACK INLET AND OUTLET 2" on BTR-198, BTR-200,

| BTR Series 118/119               | 250A   | 251A    | 275A    | 305A    | 365A    | 400A    | 500A    | 500A<br>Series120 |
|----------------------------------|--|---------|---------|---------|---------|---------|---------|-------------------|
| Tank Size                        | 100  | 65      | 100     | 65      | 85      | 100     | 85      | 85                |
| BTU Rating                       | 250,000  | 251,000 | 275,000 | 305,000 | 365,000 | 390,000 | 500,000 | 500,000           |
| Ignition Type                    | Spark  | Spark   | Spark   | Spark   | Spark   | Spark   | Spark   | HSI               |
| Blower Prover Switch             | N/A  | N/A     | N/A     | N/A     | N/A     | N/A     | N/A     | -2.4              |
| Max Gas Pressure NT              | 14"  | 14"     | 14"     | 14"     | 14"     | 14"     | 14"     | 14"               |
| Max Gas Pressure LP              | 14"  | 14"     | 14"     | 14"     | 14"     | 14"     | 14"     | 14"               |
| Min Gas Pressure Nat             | 4.5"   | 4.5"    | 4.5"    | 4.5"    | 4.5"    | 4.5"    | 4.5"    | 4.5"              |
| Min Gas Pressure LP              | 11"  | 11"     | 11"     | 11"     | 11"     | 11"     | 11"     | 11"               |
| Manifold Gas Pressure Nat        | 3.5"   | 3.5"    | 3.5"    | 3.5"    | 3.5"    | 3.5"    | 3.5"    | 3.5"              |
| Manifold Gas Pressure LP         | 10"  | 10"     | 10"     | 10"     | 10"     | 10"     | 10"     | 10"               |
| Thermostat Temp Range            | 120/180  | 120/180 | 120/180 | 120/180 | 120/180 | 120/180 | 120/180 | 120/180           |
| Thermostat Differential          | 4 deg  | 4 deg   | 4 deg   | 4 deg   | 4 deg   | 4 deg   | 4 deg   | 4 deg             |
| ECO Open/Close                   | 203/120  | 203/120 | 203/120 | 203/120 | 203/120 | 203/120 | 203/120 | 203/120           |
| Gas Connection                   | 1 1/2"   | 1 1/2"  | 1 1/2"  | 1 1/2"  | 1 1/2"  | 1 1/2"  | 1 1/2"  | 1 1/2"            |
| Water Connections Top            | 1 1/2"   | 1 1/2"  | 1 1/2"  | 1 1/2"  | 1 1/2"  | 1 1/2"  | 1 1/2"  | 1 1/2"            |
| Water Connections Side           | 2"   | 1 1/2"  | 1 1/2"  | 1 1/2"  | 1 1/2"  | 1 1/2"  | 1 1/2"  | 1 1/2"            |
| Vent Diameter                    | 8"   | 8"      | 8"      | 8"      | 8"      | 8"      | 8"      | 8"                |
| <b>ERROR CODES PRIOR TO 2010</b> |  |         |         |         |         |         |         |                   |
| <b>FLASH</b>                     | <b>DESCRIPTION</b>                             |         |         |         |         |         |         |                   |
| <b>FLASH</b>                     | No call for heat                               |         |         |         |         |         |         |                   |
| <b>OFF</b>                       | Power up - Internal check                      |         |         |         |         |         |         |                   |
| <b>FAST</b>                      | Normal startup                                 |         |         |         |         |         |         |                   |
| <b>HEARTBEAT</b>                 | Device in run mode                             |         |         |         |         |         |         |                   |
| <b>4SEC ON AND X FLASH</b>       | X = flame current to nearest uA                |         |         |         |         |         |         |                   |
| <b>2</b>                         | Pilot not detected during trial for ignition   |         |         |         |         |         |         |                   |
| <b>3</b>                         | Flame failed during run                        |         |         |         |         |         |         |                   |
| <b>4</b>                         | Flame sensed out of sequence                   |         |         |         |         |         |         |                   |
| <b>6</b>                         | Control internal error - Reset/Replace control |         |         |         |         |         |         |                   |
| <b>7</b>                         | Flame rod shorted to ground                    |         |         |         |         |         |         |                   |
| <b>8</b>                         | Low control voltage                            |         |         |         |         |         |         |                   |
| <b>ON</b>                        | Hardware error - Reset/Replace control         |         |         |         |         |         |         |                   |
| <b>ERROR CODES AFTER 2010</b>    |  |         |         |         |         |         |         |                   |
| <b>FLASH</b>                     | <b>DESCRIPTION</b>                             |         |         |         |         |         |         |                   |
| <b>FLASH</b>                     | No call for heat                               |         |         |         |         |         |         |                   |
| <b>OFF</b>                       | Power up - Internal check                      |         |         |         |         |         |         |                   |
| <b>FAST</b>                      | Startup - Flame sense calibration              |         |         |         |         |         |         |                   |
| <b>HEARTBEAT</b>                 | Normal operation                               |         |         |         |         |         |         |                   |
| <b>4SEC ON AND X FLASH</b>       | Pilot not detected during trial for ignition   |         |         |         |         |         |         |                   |
| <b>2</b>                         | Flame failed during run                        |         |         |         |         |         |         |                   |
| <b>3</b>                         | Flame sensed out of sequence                   |         |         |         |         |         |         |                   |
| <b>4</b>                         | Low control voltage (below 15.5VAC)            |         |         |         |         |         |         |                   |
| <b>6</b>                         | 5 minute retry delay                           |         |         |         |         |         |         |                   |
| <b>7</b>                         | 6th flame failure on call for heat             |         |         |         |         |         |         |                   |
| <b>8</b>                         | Flame sensed out of sequence - over 10 sec     |         |         |         |         |         |         |                   |
| <b>ON</b>                        | Hardware error - Reset/Replace control         |         |         |         |         |         |         |                   |

## BTH Parts - Series 120-250, 966-970

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|  |                             |                             |                             |                             |                             |                             |
|--|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| <b>BTH 120-250 966-970 Series Common parts</b> |                             |                             |                             |                             |                             |                             |
| <b>Control Board &amp; Display</b>             | BTH120966-970<br>9004250205 | BTH150966-970<br>9004250205 | BTH199966-970<br>9004250205 | BTH250966-970<br>9004250205 | BTH250966-970<br>9004250205 | BTH250966-970<br>9004250205 |
| Natural & LP                                   |                             |                             |                             |                             |                             |                             |
| <b>Igniter All Models</b>                      | 9004519205                  | 9004519205                  | 9004519205                  | 9004519205                  | 9004519205                  | 9004519205                  |
| <b>Blower Prover Switch Nat &amp; LP</b>       | 9005726215                  | 9005726215                  | 9005726215                  | 9005726215                  | 9005726215                  | 9005726215                  |
| <b>Gas Valve Nat</b>                           | 9004535205                  |                             |                             |                             | 9006285005                  | 9006285005                  |
| <b>Gas Valve LP</b>                            | 9006284005                  |                             |                             |                             | 9006286005                  | 9006286005                  |
| <b>Low Gas Pressure Switch Nat</b>             | 9003301205                  |                             |                             |                             | 9006256015                  | 9006256015                  |
| <b>Low Gas Pressure switch LP</b>              | 9004474215                  |                             |                             |                             | 9006255015                  | 9006255015                  |
| <b>Blocked Inlet</b>                           | 9004540215                  |                             |                             |                             |                             |                             |
| Natural  | 9006288015                  |                             |                             |                             | 9006288015                  | 9006288015                  |
| LP   | 9005972215                  |                             |                             |                             | 9006281015                  | 9006281015                  |
| <b>Blocked Outlet</b>                          |                             |                             |                             |                             |                             |                             |
| Natural  | 9005921215                  | 9005921215                  |                             |                             | 9006289015                  | 9006282015                  |
| LP   | 9004547215                  | 9004547215                  |                             |                             | 9006282015                  | 9006282015                  |
| <b>Blower</b>                                  | 9005840205                  | 9004539205                  |                             |                             | 9004539205                  | 9007234005                  |
| <b>VFD</b>                                     | N/A                         | N/A                         | N/A                         |                             | N/A                         | N/A                         |
| <b>Burner</b>                                  |                             |                             |                             |                             |                             |                             |
| Natural  | 9005303205                  | 9005168205                  |                             |                             | 9005302205                  | 9005304205                  |
| LP   | 9005740205                  | 9005305205                  |                             |                             | 9004607205                  | N/A                         |
| <b>Flame Rod</b>                               | 9005886215                  | 9005886215                  |                             |                             | 9005886215                  | 9005886215                  |
| <b>Cleanout Plate</b>                          | 9005797205                  | 9005797205                  |                             |                             | 9005797205                  | 9005797205                  |
| <b>Cleanout Gasket</b>                         | 9004099015                  | 9004099015                  |                             |                             | 9004099015                  | 9004099015                  |
| <b>Display</b>                                 | 9004249205                  | 9004249205                  |                             |                             | 9004249205                  | 9004249205                  |
| <b>Upper Probe</b>                             | 9004238215                  | 9004238215                  |                             |                             | 9004238215                  | 9004238215                  |
| <b>Lower Probe</b>                             | 9004241215                  | 9004241215                  |                             |                             | 9004241215                  | 9004241215                  |
| <b>Overlay</b>                                 | n/a                         | n/a                         |                             |                             | n/a                         | n/a                         |
| <b>Exhaust Elbow US Only</b>                   | 9007245005                  | 9007245005                  |                             |                             | 9007245005                  | 9007245005                  |
| <b>Burner/Igniter Gasket</b>                   | n/a                         | n/a                         |                             |                             | n/a                         | n/a                         |

## BTH Parts - Series 300-400, 970-975

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|  |                      |                      |     |            |
|--|----------------------|----------------------|-----|------------|
| <b>BTH 300-400 970-975 Series Common parts</b> |                      |                      |     |            |
| <b>Control Board</b>                           | BTH300<br>9004594205 | BTH400<br>9004594205 |     |            |
| Natural & LP                                   |                      |                      |     |            |
| <b>Igniter All Models</b>                      | 9006101205           | 9006101205           |     |            |
| <b>Blower Prover Switch Nat &amp; LP</b>       | 9004586215           | 9006002215           |     |            |
| <b>Gas Valve Nat</b>                           | 9004584205           | 9004584205           |     |            |
| <b>Gas Valve LP</b>                            | 9006086205           | 9006086205           |     |            |
| <b>Low Gas Pressure Switch Nat</b>             | 9004476215           | 9004476215           |     |            |
| <b>Low Gas Pressure switch LP</b>              | 9004474215           | 9004474215           |     |            |
| <b>Blocked Inlet</b>                           |                      |                      |     |            |
| Natural  | 9004596215           | 9006006215           |     |            |
| LP   | 9004596215           | 9006006215           |     |            |
| <b>Blocked Outlet</b>                          |                      |                      |     |            |
| Natural  | 9006007215           | 9006007215           |     |            |
| LP   | 9006088215           | 9006088215           |     |            |
| <b>Blower</b>                                  | 9004587205           | 9004587205           |     |            |
| <b>VFD</b>                                     | 9004588205           | 9004588205           |     |            |
| <b>Burner</b>                                  |                      |                      |     |            |
| Natural  | 9007265005           | 9007266005           |     |            |
| LP   | 9007265005           | 9007266005           |     |            |
| <b>Flame Rod</b>                               | 9004589215           | 9004589215           |     |            |
| <b>Cleanout Plate</b>                          | 9005797205           | 9005797205           |     |            |
| <b>Cleanout Gasket</b>                         | 9004099015           | 9004099015           |     |            |
| <b>Display</b>                                 | 9004593205           | 9004593205           |     |            |
| <b>Upper Probe</b>                             | 9004238215           | 9004238215           |     |            |
| <b>Lower Probe</b>                             | 9004241215           | 9004241215           |     |            |
| <b>Overlay</b>                                 | n/a                  | 9007245005           | n/a | 9007245005 |
| <b>Exhaust Elbow US Only</b>                   |                      |                      |     |            |
| <b>Burner/Igniter Gasket</b>                   | n/a                  | n/a                  | n/a | n/a        |

BTW Parts - Series 120-500

