Service Manual for Mascot LX

Modulating Boilers - Model MLXH
Sizes 50, 75, 100, 150, 175, and 220 MBTU/h

Water Heaters - Model MLXC
Sizes 125, 150, and 175 MBTU/h

LAARS®
Heating Systems Company

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How to Use This Manual

How to Use the Troubleshooting Information

This manual is divided into five main sections:

Introduction -	How to Use This Manual, Safety Notes, Parts Identification
Section A -	Troubleshooting Instructions
Section B -	Troubleshooting Procedures
Section C -	Combustion Setup
Appendix -	Error Codes, Wiring Diagrams, etc.

Start the troubleshooting process using the charts in Section A. The instructions in Section A will lead you to more detailed procedures in Section B.

Section C covers possible combustion problems and the combustion setup procedure.

If the unit presents a Lockout message, you can get more information from the listing in Section App1 in the Appendix.

This manual covers two versions of the Mascot LX:

- The standard unit (MLXH), which produces hot water for central heat only. (This type of unit can also be connected to an indirect hot water tank.)
- The “Combi” unit (MLXC), which also produces domestic hot water using a built-in heat exchanger.

Contact Laars Technical Support if you can’t diagnose the problem using the information in this manual:

LAARS Product Support
Phone: (800) 900-9276
(603) 335-6300
Fax: (800) 335-3355

Identifying Your Unit

Model Designation -	M = Mascot
Series Designation -	LX = Laars Heat Exchanger
Usage -	H = Modulating Boiler C = Combination Boiler and Water Heater
Configuration -	W = Wall hung
Size -	50 - 220 MBH
Fuel -	N = Natural Gas P = Propane
Altitude -	A = 0’ - 10,000’
Revision -	1 = First
Options Code -	X = Standard L = Low water cutoff
Pump Options -	N = With pump

Finding Information in this PDF File

This manual includes a lot of detailed information, but none of this is very useful to you unless you can find it. We'd like to help you to find the information you need, quickly and easily.

There are three ways to locate information in this PDF* file.

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When you first open this file on your computer, it will display a list of "Bookmarks" along the left edge of the page. Scroll down the list until you see the item you want. When you click on that Bookmark, the PDF Reader will take you to that point in the manual. (If the Bookmarks do not appear, you can display them by clicking on the small tab in the middle of the left margin, and dragging toward the center of the screen.)

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The PDF reader includes several ways of locating information. From the line at the top of the screen, select Edit, then Find. Type in the item you want to find. The PDF Reader will take you to the first occurrence of that item. To go to the next occurrence, click on the right-arrow.

Table of Contents -
The Table of Contents is located at the beginning of the manual. (The bookmark for Contents will take you there.) Use this to identify the section of the manual you want to read, then use the Bookmarks to jump to that section. (You can also scroll through the PDF file to get to the section you want.)

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Please read this section before beginning any troubleshooting procedures.

If the information in this manual is not followed exactly, a fire or explosion may result, causing loss of life, personal injury, or property damage.

Necessary Training

This product must be installed and serviced by a professional service technician, qualified and/or licensed in hot water boiler and heater installation and maintenance. Any changes to safety-related configuration parameters must only be done by qualified and/or licensed burner/boiler operators and mechanics.

Carbon Monoxide Hazard

Improper installation and/or operation could create carbon monoxide gas in flue gases which could cause death, serious injury, or property damage. Improper installation and/or operation will void the warranty.

Fire or Explosion Hazard

Improper configuration can cause fuel buildup and explosion. Improper user operation may result in death, severe physical injury, or property damage. Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

What to Do If You Smell Gas

If any odor of gas is detected, or if the gas burner does not appear to be functioning in a normal manner, ***close the main gas shutoff valve***. The inlet gas pressure to the appliance must not exceed 13” w.c. (3.2 kPa).

- Do not try to light any appliance.
- Do not touch any electrical switch. Do not shut off the power switch. Do not use any phone in your building.
- Immediately call your gas supplier from a nearby phone. Follow the gas supplier’s instructions.
- If you cannot reach your gas supplier, call the fire department, your heating contractor, gas company, or factory representative.

DANGER

Electrical Shock Hazard

Electrical shock can cause severe injury, death or property damage. Only a professional technician, trained in electrical safety, should work on this unit. Whenever the troubleshooting procedures make this possible, turn off the power to the unit before working inside the cabinet. The only exceptions would be when it is necessary to test the voltages between the points listed in this manual.

This unit includes the following electrical hazard areas:

- Full line voltage is present behind the lower front panel. Be especially careful when working on the unit if this cover has been lowered. Always replace the cover when the service procedure is complete.

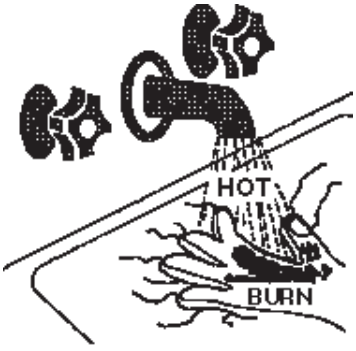
Before doing any work inside the unit, disconnect the power supply to prevent electrical shock or damage to the equipment. It may be necessary to turn off more than one power supply disconnect.

All electrical wiring is to be done in accordance with local codes, or in the absence of local codes, with: 1) The National Electrical Code ANSI/NFPA No. 70 - latest Edition, or 2) CSA STD. C22.1 “Canadian Electrical Code - Part 1.” This appliance must be electrically grounded in accordance with these codes.

WARNING

Hot Water Hazard

This unit can produce water which is hotter than 125°F (52°C). This can cause severe burns instantly or death from scalding. Always shut off the system and allow it to cool for one hour before opening any pipe connections that may contain hot water.



Children, disabled and elderly persons are at the highest risk of being scalded. See the Installation and Operating manual for instructions before setting the temperature at the Mascot LX unit.

For MLXC units - Adjust the outlet control (DHW setpoint or limit) or use temperature limiting valves to obtain a maximum water temperature of 125°F (52°C). Check local codes for details of the required mixing valves. Instruct all users to feel the water temperature before getting into the bath or shower.

The Mascot LX unit is protected against over-pressurization. A pressure relief valve is included with each Mascot LX unit.

The condensate water can be hot, and is also slightly acidic.

CAUTION

Capillary Tubes

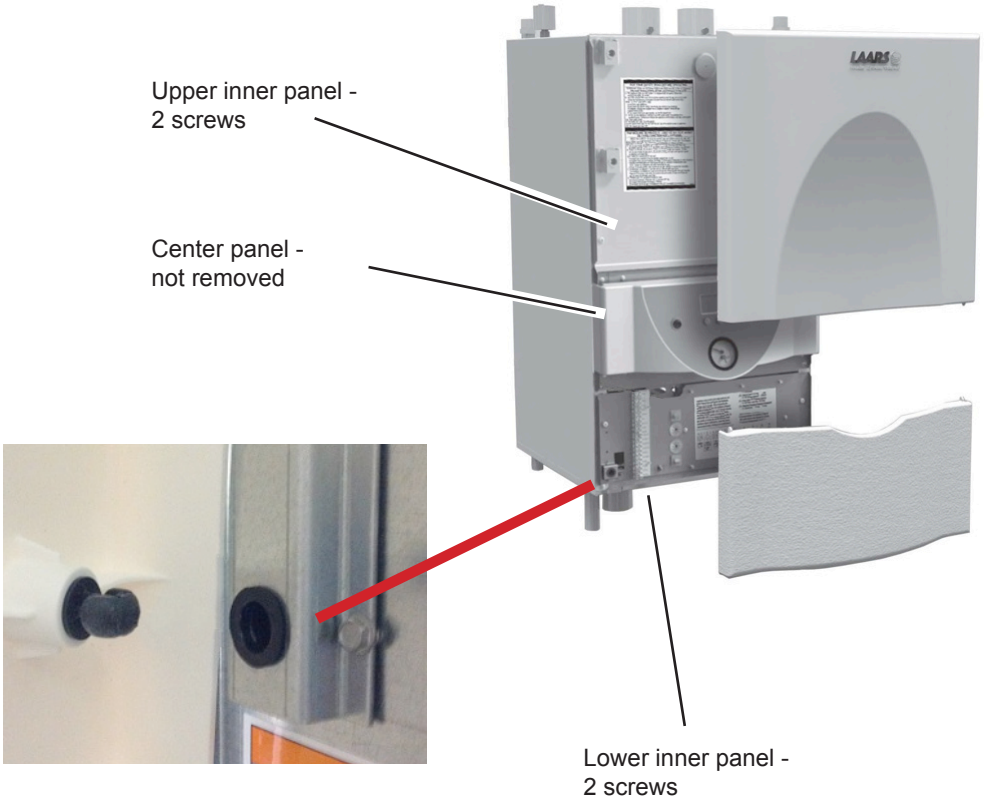
The temperature gauge on the front of the unit is connected to its sensor by a thin copper capillary tube. This tube is delicate, and can be damaged if it is bent sharply.

Installation Codes

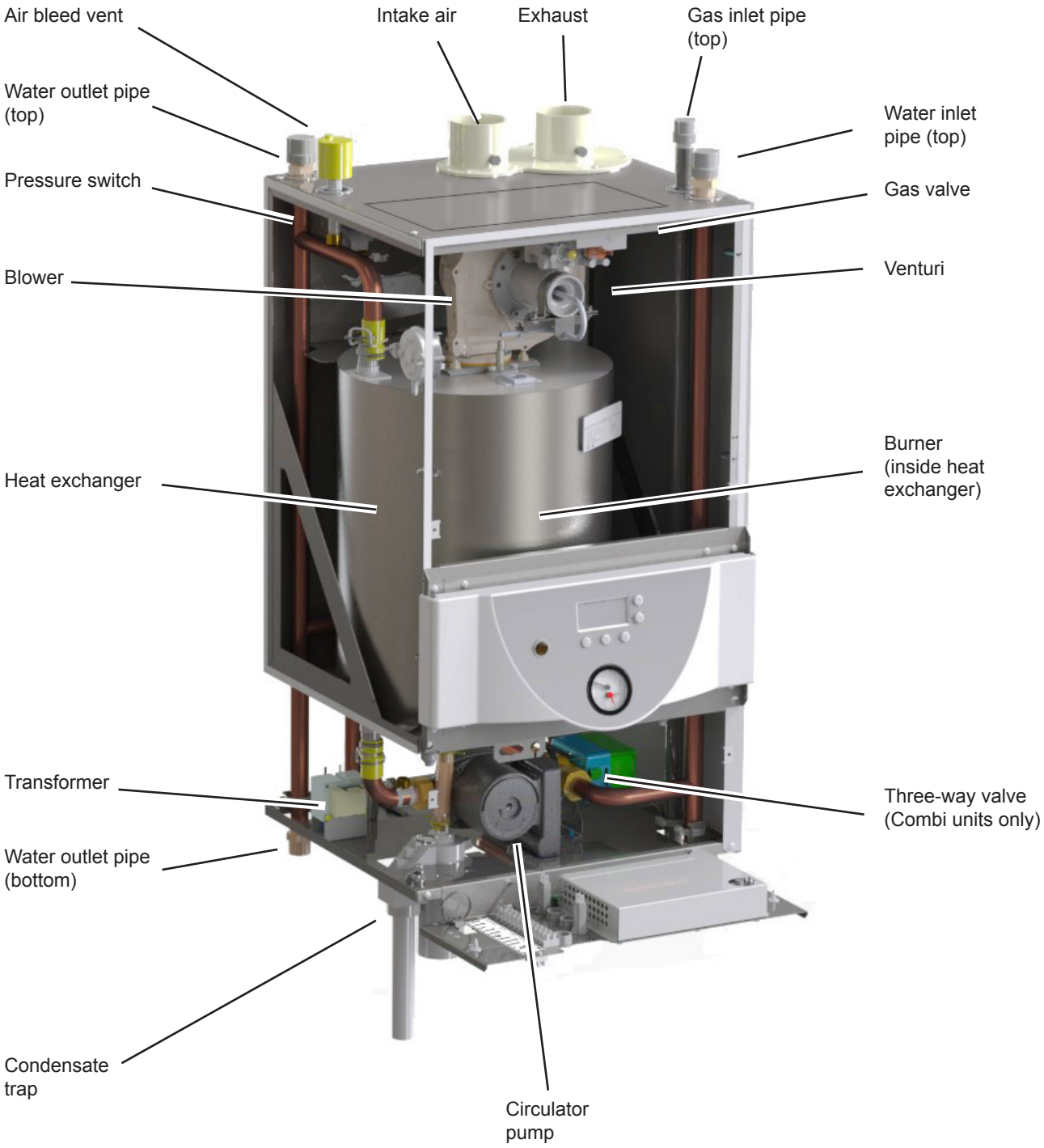
All installations must be made in accordance with 1) American National Standard Z223.1/NFPA54-Latest Edition “National Fuel Gas Code” or 2) CSA B149.1 “Natural Gas and Propane Installation Code” and with the requirement of the local utility or other authorities having jurisdiction. Such applicable requirements take precedence over the general instructions contained in this manual.

Removing the Covers

The upper and lower covers can be removed by pulling the part straight out and away from the unit. The center control panel cannot be removed.



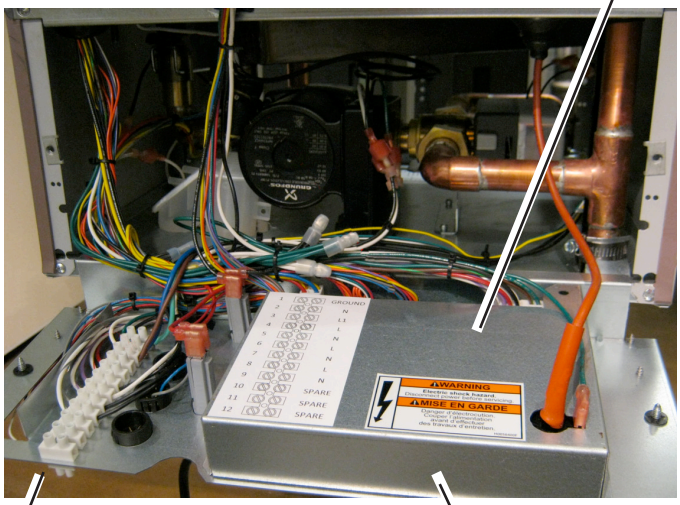
Part Locations



Sensor and Switch Locations

Access to Control Board

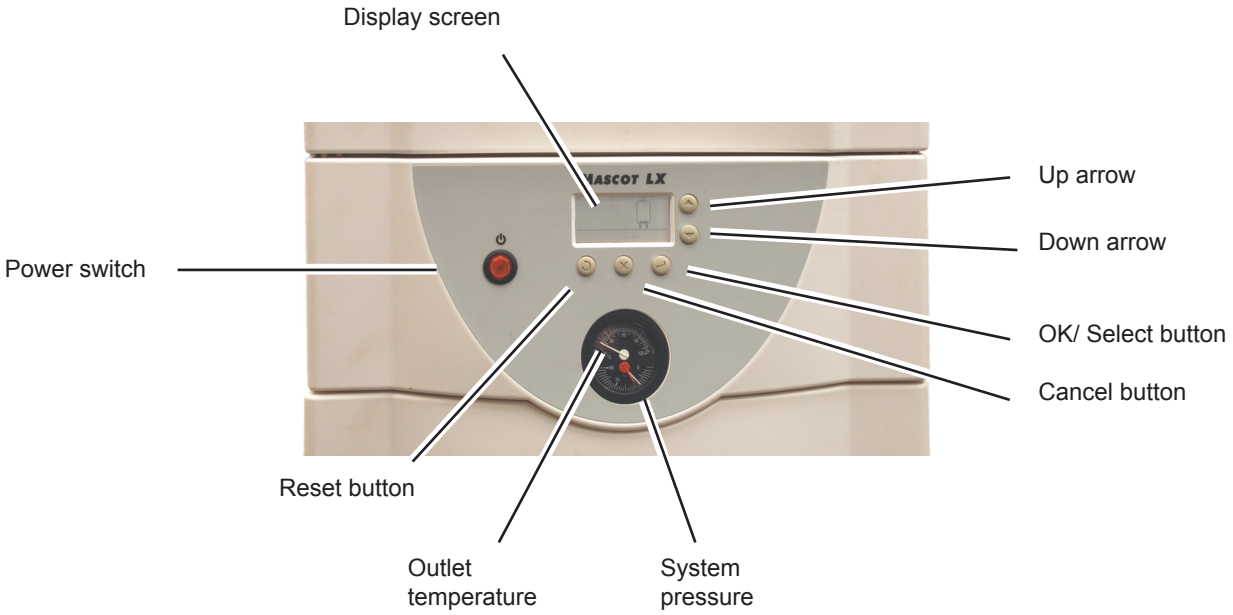
Lower metal panel folds down



High voltage terminal strip

The controller circuit board is located behind this cover.

Control Panel



Power switch -
This switches on power to the Mascot unit.

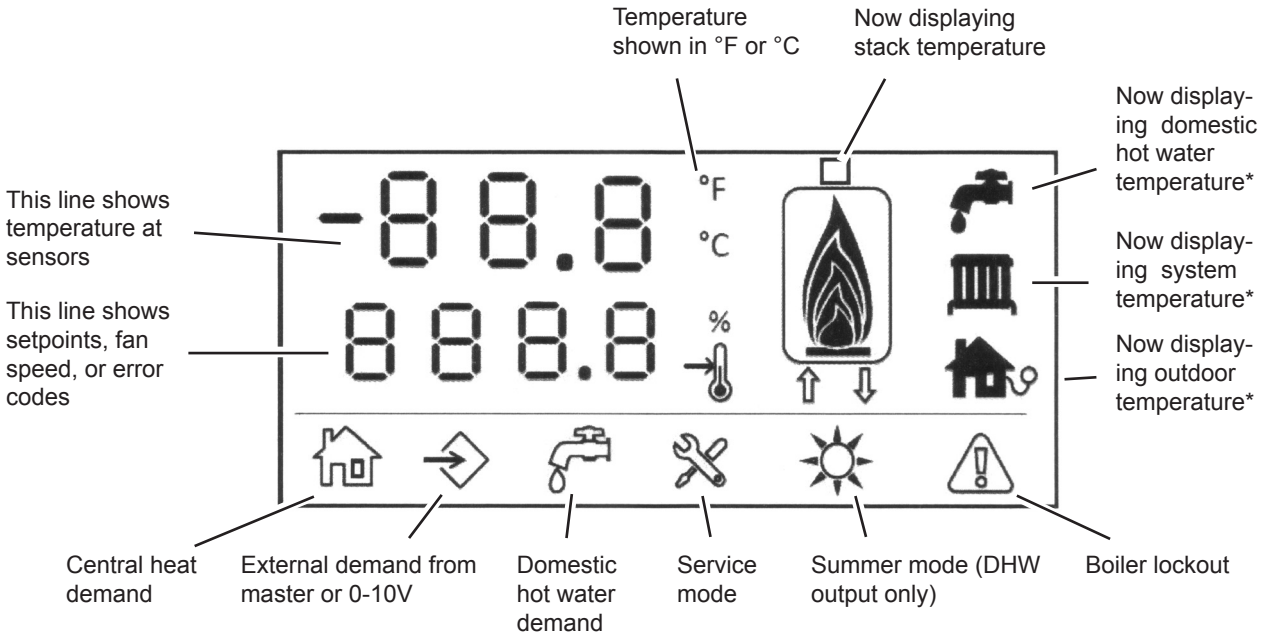
Up and Down arrows -
These can be used to step between display screens, or to change values used by the unit.

Reset button -
Use this to reset the controller after a lockout.

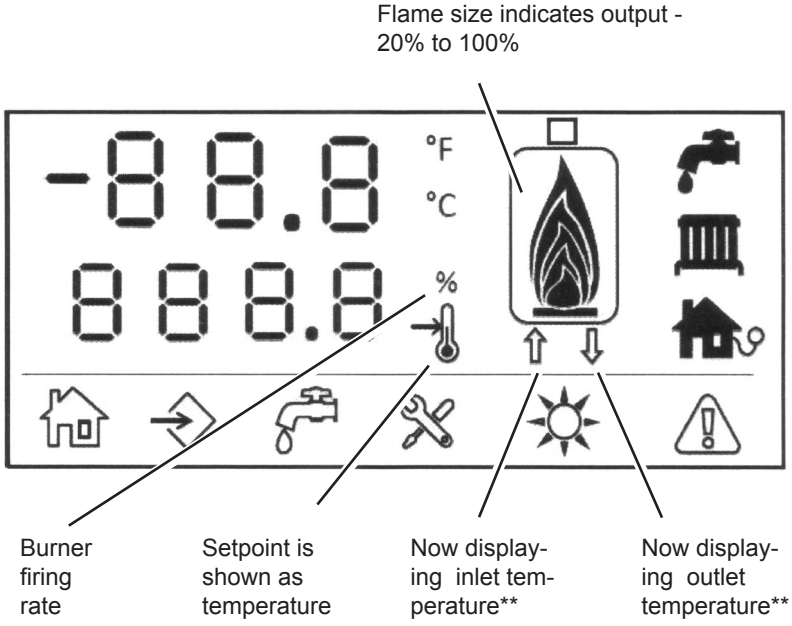
OK/ Select button -
Use this to select one of the options, or to Save a changed value.

Cancel button -
Use this to return to the previous function without saving a new value.

Temperature and pressure gauges -
These indicate the temperature and pressure at the water outlet. (The values shown here are not calculated by the SIT controller.)



* If the probe is present, the outline will be darkened. If the probe is reporting the current value, the center of the symbol will be filled in.



** If both arrow symbols are filled in, the unit is reporting “Delta T” - the difference between the outlet and the inlet temperatures.

Operating Displays

Operating Modes -

The control system uses four modes:

Operating Mode - While the unit is running, the controller will rotate between several standard displays.

User Mode - This mode allows the user to change some of the setpoints. To go to User Mode, press and hold the OK/Select button for one second.

Installer Mode - This allows the installer to change all of the parameters used to install and configure the boiler. To go to the Installer Mode, press and hold the OK/Select and Down buttons for five seconds. For details, see the Appendix.

Service Mode - This mode should only be used by technicians who have been trained in service procedures on the Mascot LX. For details, see Section C - "Combustion."

Operating Mode Displays -

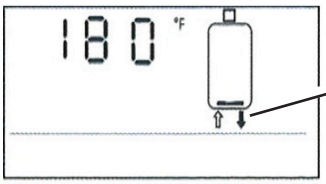
When the unit is operating normally, use the Up and Down buttons to rotate through the following functions:

- Outlet temperature - The setpoint for central heat is adjustable. Range 45°F - 189°F, default 130°F
* Inlet temperature
- Delta T (the difference between the outlet and inlet temperatures)
- Outdoor sensor (if the outdoor temperature sensor is installed
- Flue temperature
- Domestic hot water temperature (if this is a Combi model or is connected to an external tank). The setpoint is adjustable. Range 68°F - 189°F, default 120°F
- System temperature (if a System probe is installed). The setpoint is adjustable. Range 45°F - 189°F, default 130°F.
- Burner rate (if the burner is lit)

You can also use the Up and Down buttons to step through these displays. The following images show how to interpret these displays.

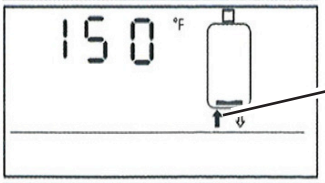
Operating Displays - Examples

Use the Up and Down buttons to cycle through the following screens:



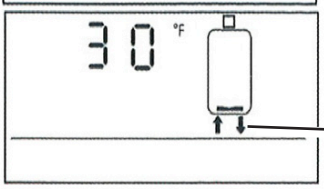
Outlet sensor temp. = 180°F

Outlet sensor



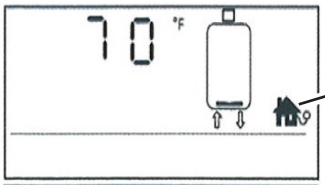
Inlet sensor temp. = 150°F

Inlet sensor



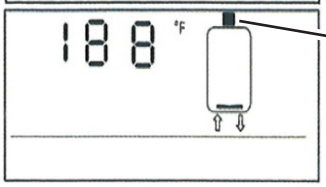
Delta T = 30°F
(difference between inlet and outlet temps.)

Indicates both inlet and outlet sensors



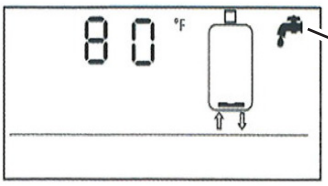
Outdoor temp. = 70°F

Outdoor temp. sensor



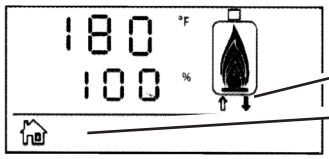
Flue temp. = 188°F

Flue temp. sensor



Domestic hot water temp. = 80°F

DHW temp. sensor

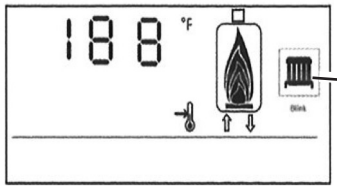


Central heat demand, temp. is 180°F at outlet sensor

Outlet sensor

Central heat demand

- or -

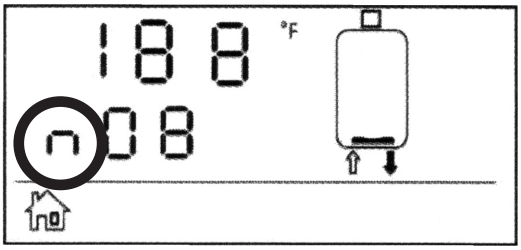


System temp. display, temp. is 188°F

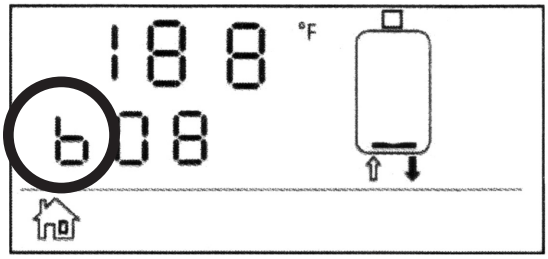
System temp. sensor

Notification, Blocking, Lockout, and Error Displays

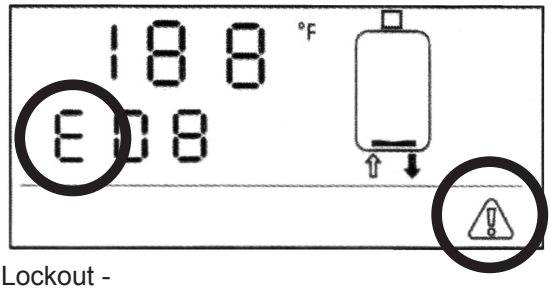
There are four other kinds of displays you may see while the unit is operating:



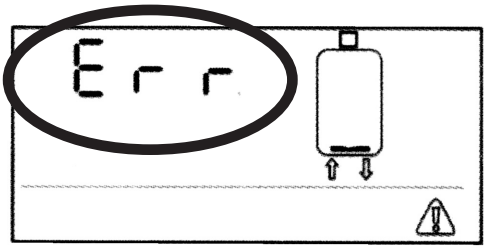
Note -
A “Notification” indicates a condition that is unusual, but will not prevent the unit from operating. For a list of Notification codes, see Section A3.



Blocking -
A “Blocking” code also indicates an unusual condition that will not prevent the unit from operating. During a “blocking” event, the unit is correcting itself or moving toward normal operation. For a list of Blocking codes, See Section App1 in the Appendix.



Lockout -
A “lockout” is a serious condition that will prevent the unit from operating. Usually the code will give you a good idea of the cause of the problem. Section App1 lists some troubleshooting suggestions based on the Lockout codes.



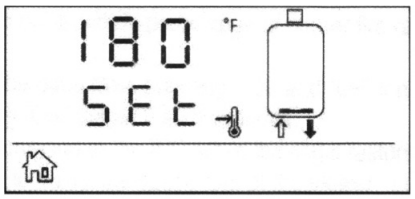
Error -
An “Error” display indicates a problem with the SIT control board. For instructions on replacing the board, see Section B30.

Changing Setpoints

While the unit is operating, you can change several of the setpoints:
- Central Heat setpoint or System setpoint
- Domestic Hot Water setpoint

This example shows how to change the Central Heat setpoint:

1. Wait until you see the display for the setpoint you want to change.
   - or -
   Press the Up and Down buttons to go to the display which includes the setpoint you want to change. (In this example, this will be the Central Heat display.)



2. Press the OK/Select button for one second to indicate that you want to change the set-point.

3. Use the Up and Down buttons to change the setpoint.

4. Press the OK/Select button to accept the new setpoint, or press Cancel to keep the old setpoint.

Changing Installer Settings -

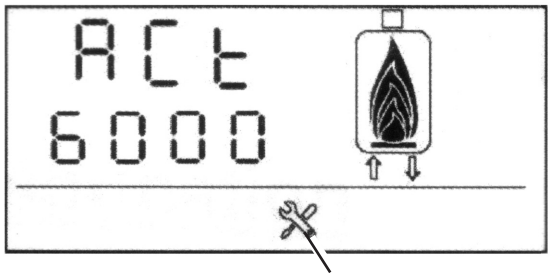
The SIT controller allows you to change a number of operating parameters using the Installer mode. Once a unit has been set up and operating normally, you should not need to change any of the Installer settings. These have been included for use during setup, or to handle special situations. For a complete list of Installer parameters, see Section App1 in the Appendix.

Here is the procedure for changing a setting:

1. To go to Installer mode, press the OK/Select and Down buttons at the same time for five seconds. You should see “U00” to indicate you have entered Installer mode.
2. Press OK/Select again. The display will blink.
3. Use the Up button to change the value to “15,” then press OK/Select again.
4. Use the Up and Down buttons to go to the parameter you want to change.
5. Press OK/Select to indicate you want to change that parameter. The display will blink.
6. Use the Up and Down buttons to change the value.
7. Press the OK/Select button to save the new value, or Cancel to leave the old value.
8. Press and hold OK/Select for 3 seconds to leave Installer mode.

Service Mode -

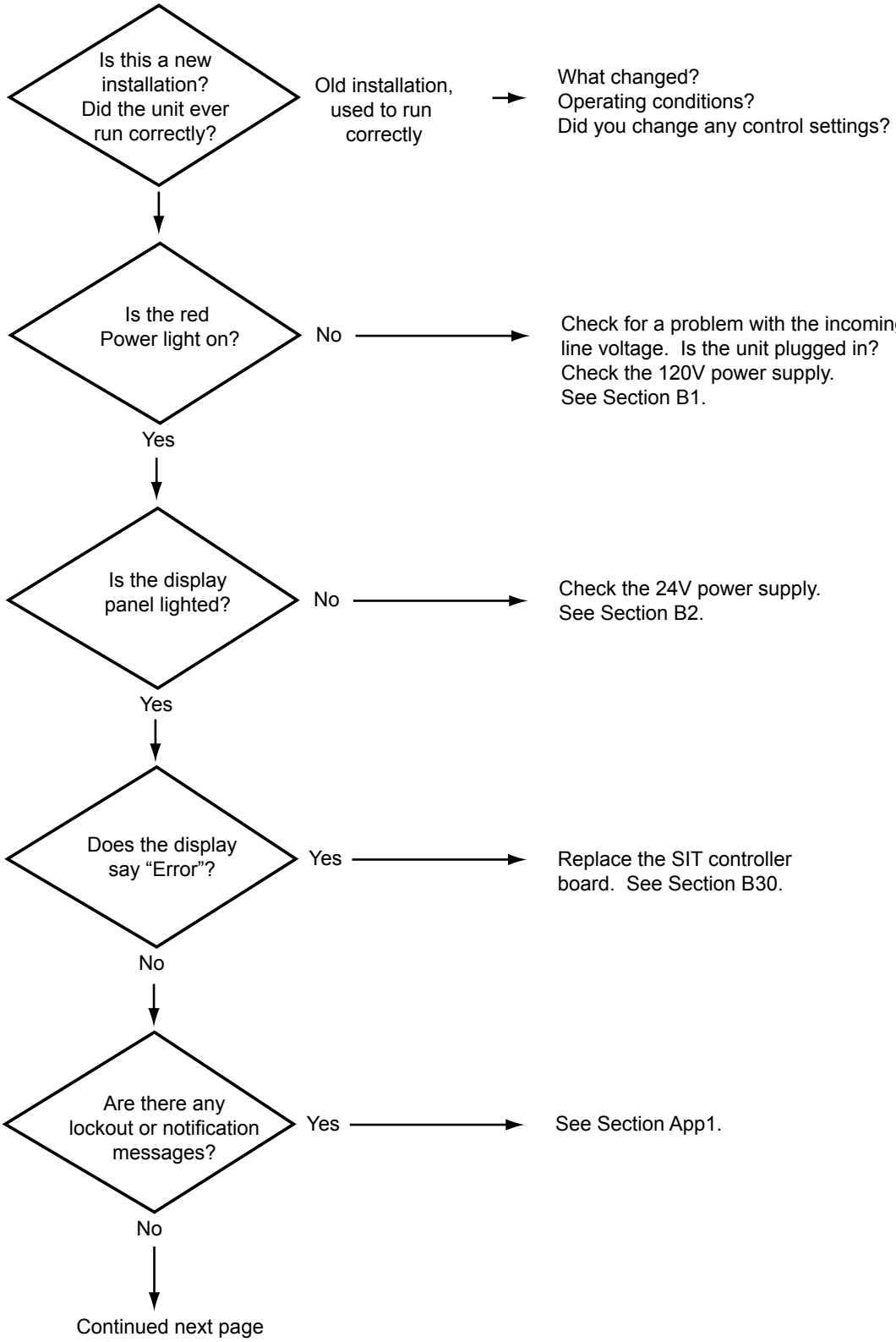
The Service mode should only be used by a technician who has been trained by Laars. Service mode is used to set the “high fire” and “low fire” conditions during CO_2 testing. For details, see Section C2.



Service mode symbol

Quick Checkout Procedure

A1



A1 Quick Checkout Procedure (continued)

Incoming gas pressure is OK?

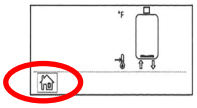
No → Adjust regulator. Check with gas company

Yes

Disconnect the Central Heat or System sensor and insert a jumper to create a permanent “Call For Heat.” (terminals 5 and 6 on the low voltage terminal strip)

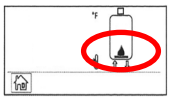
Does the Central Heat or System symbol light up?

No → Replace the SIT controller board. See Section B30.



Yes

The unit should try to fire. The smallest segment in the flame display should blink.



Boiler fires?

No → Check the direct spark ignition. See Section B16.

Yes

Does the pump start?

No → See Section B17 - “Pump Problems.”

Yes

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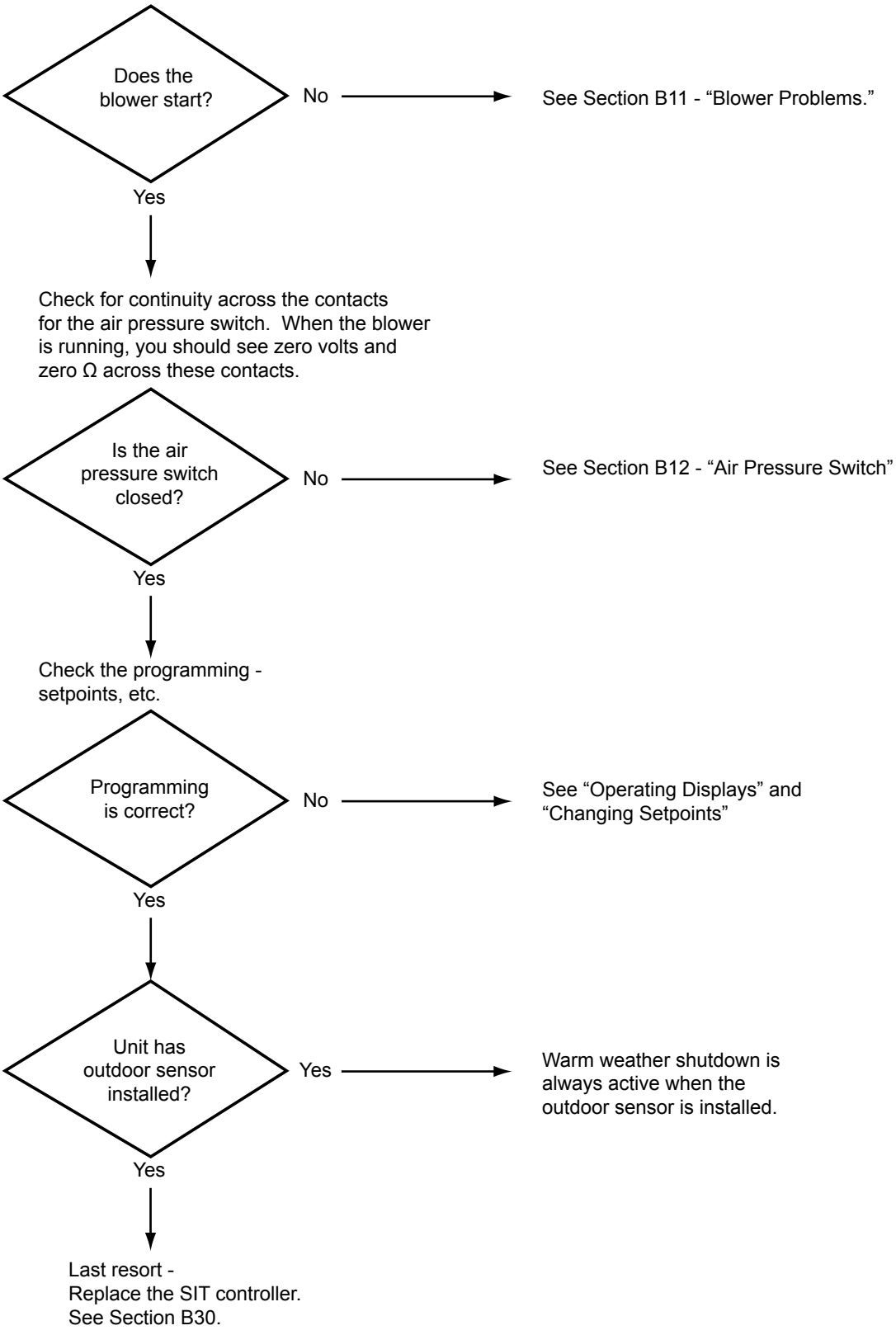

Does the blower start?
No
See Section B11 - “Blower Problems.”
Yes
Check for continuity across the contacts for the air pressure switch. When the blower is running, you should see zero volts and zero Ω across these contacts.
Is the air pressure switch closed?
No
See Section B12 - “Air Pressure Switch”
Yes
Check the programming - setpoints, etc.
Programming is correct?
No
See “Operating Displays” and “Changing Setpoints”
Yes
Unit has outdoor sensor installed?
Yes
Warm weather shutdown is always active when the outdoor sensor is installed.
Yes
Last resort - Replace the SIT controller. See Section B30.

A2 Lockout Codes

Many of the most serious trouble conditions on this unit will cause a “lockout,” and the controller will present a lockout code on the display. Often the lockout code will take you directly to the cause of the problem. After you have corrected the problem, press the Reset button to exit from the lockout.

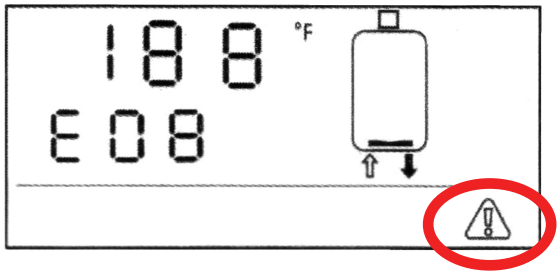


Fig. A2-1 Example of Lockout Screen

E001 – Memory error lockout

There has been a lockout due to a problem with the EEPROM memory in the control unit.

- Press the Reset button to try to cancel the lockout.
- Power down the unit, wait two minutes, then power on the unit again.
- If this does not restore normal operation, replace the SIT control board. See Section B30.

E002 – Fan speed error

There has been a lockout because the fan did not reach normal speed.

- Check for a blockage in the vent.
- Check the wiring to the blower. Disconnect the signal connection to the blower - the blower should run at full speed. See Section B11. If the blower reaches full speed, the blower itself is probably OK.
- If the blower does not reach full speed, remove the blower and check for free movement of the fan. Replace the blower if necessary.
- If the blower moves freely, replace the SIT control board. See Section B30.

E003 – Flame present when not expected (not in Run)

There has been a lockout because the controller detected a flame when the unit was not running.

- Check the wiring to the flame sensor.
- If the wiring is OK, replace the flame sensor. See Section B16.
- If this does not restore normal operation, replace the SIT control board. See Section B30.

E004 – Outlet auto-reset hi limit

There has been a lockout because the water outlet temperature sensor reported too high a temperature.

- Check the wiring to the water outlet temperature sensor.
- Check the sensor function, and replace it if necessary. See Section B4.
- If this does not restore normal operation, replace the control board. See Section B30.

E005 – Water pressure switch error

There has been a lockout because of the problem with the water pressure switch.

* Check the water supply to the unit. The switch will not close unless 5 psi of water pressure is present.
- Check the wiring to the system water pressure switch.
- If the wiring is OK, replace the switch. See Section B10.
- If this does not restore normal operation, replace the control board. See Section B30.

E006 – Safety switch – not used

E007 – Low water cutoff error

There has been a lockout because the optional low water cutoff switch reported a low-water condition or is open.

- Check the water supply.
- Check the LED's on the front of the optional low water cutoff switch. See Section B19. The system will present this error if the switch is open (low water condition.)
- Check the wiring to the low water cutoff switch.

- Check the switch function and replace the switch if necessary. See Section B19.
- If this does not restore normal operation, replace the SIT control board. See Section B30.

E008 – Field interlock error

- This indicates a problem with the control circuits outside the boiler.
- If the external circuits are OK, but the boiler does not restore normal operation, replace the SIT control board. See Section B30.

E009 – Blocked vent switch

There has been a lockout because the controller did not detect a normal airflow through the system.

- Check for a blockage in the vent.
- Check the wiring to the air pressure switch. See Section B12.
- Check the function of the switch. Replace the switch if necessary.
- If this does not restore normal operation, replace the SIT control board. See Section B30.

E010 – Blocked vent/ fan proving switch error

There has been a lockout because the controller did not detect a normal airflow through the system.

- Check for a blockage in the vent.
- Check the wiring to the air pressure switch. See Section B12.
- Check the function of the switch. The system will present this error if the switch is open (not enough air moving through the unit.) See Section B12 for instructions. Replace the switch if necessary.
- If this does not restore normal operation, replace the SIT control board. See Section B30.

E011 – Flame loss lockout

There has been a lockout because the controller detected three consecutive flame losses while the unit was trying to run.

- Check the wiring to the flame sensor. See Section B16.
- Remove and clean the flame sensor. Replace it if necessary. See Section B16.
- Check the wiring to the gas valve. See Section B13.
- Check for possible problems with the gas supply.
- If this does not restore normal operation, replace the SIT control board. See Section B30.

E012 – Lockout due to three consecutive failed ignitions

- Check the wiring to the flame sensor.
- Remove and clean the flame sensor. Replace it if necessary. See Section B16.
- Check the wiring to the gas valve. See Section B13.
- Check for possible problems with the gas supply.
- If this does not restore normal operation, replace the SIT control board. See Section B30.

E013 – Flue high temperature

The flue sensor reported a temperature above 195°F.

- Check for a blocked flue.
- Check the wiring to the flue safety sensor. See Section B8.
- Check for correct switch function and replace the switch if necessary.
- If this does not restore normal operation, replace the SIT control board. See Section B30.

E014 – Outlet high temperature (manual reset high limit)

- Check for a blocked flue.
- Check the wiring to the outlet water temperature sensor. See Section B4.
- An E014 error indicates that the system has reached the high limit and locked out. Did the system actually get that hot, or is there a problem with the sensor? Replace the sensor if necessary.
- If this does not restore normal operation, replace the SIT control board. See Section B30.

E015 – Flue sensor drift too high

The sensor used here is a dual sensor. The controller compares the signals from both sensors, and triggers an error if the difference between the two (the “drift”) is too great.

- Check the wiring to the sensor. See Section B8.
- Replace the sensor if necessary.

E016 – Outlet sensor drift too high

The sensor used here is a dual sensor. The controller compares the signals from both sensors, and triggers an error if the difference between the two (the “drift”) is too great.

- Check the wiring to the water outlet temperature sensor. See Section B4. An E018 error indicates that the sensor has failed.
- Check the sensor function and replace the sensor if necessary.

E017 – Flue sensor error

- Check the wiring to the sensor. See Section B8.
- Replace the sensor if necessary.

E018 – Outlet sensor error

- Check the wiring to the water outlet temperature sensor. See Section B4. An E018 error indicates that the sensor has failed.
- Check the sensor function and replace the sensor if necessary.

E019 – Inlet sensor error

- Check the wiring to the inlet water temperature sensor. See Section B3.
- Replace the sensor if necessary.

DU IN LOCKOUT -

You will see this if the system is in lockout, and you try to go to the Installer mode.

- Press the Reset button to exit from the lockout.

"Notification" codes indicate unusual conditions that do not cause the unit to lock-out. Some of these codes can be useful during troubleshooting.

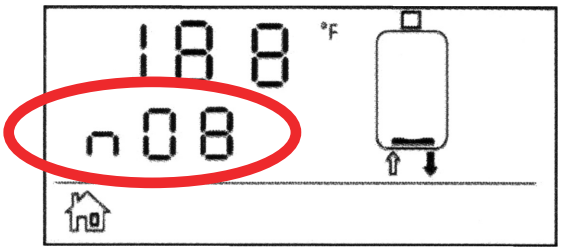


Fig. A3-1 Example of Notification Screen

N01 - Fan speed limited due to flue gradient not detected.

The flue sensor includes two sensor elements. The controller looks for the same reading from both. If the sensor readings are different, beyond a pre-set limit, the controller will present this Notification code. The boiler will continue to run at Low Fire. If this condition continues, the controller will present a Lockout message.

- Once the problem has been corrected, press Reset to remove the limitation.

N02 - Fan speed limited due to high temperature at outlet

This refers to a high water temperature at the water outlet.. The controller watches this input. If the sensor reading reaches a pre-set limit, the controller will present this Notification code. The boiler will continue to run at Low Fire. If this condition continues, the controller will present a Lockout message.

- Once the problem has been corrected, press Reset to remove the limitation.

N03 - Fan speed limited due to excessive delta T

This refers to a large difference between the water inlet and outlet temperatures. The controller watches these inputs. If the difference between the sensor readings reaches a pre-set limit, the controller will present this Notification code. The boiler will continue to run at Low Fire. If this condition continues, the controller will present a Lockout message.

- Once the problem has been corrected, press Reset to remove the limitation.

N04 - Fan speed limited due to high flue temperature

This refers to a high exhaust temperature in the flue.. The controller watches this input. If the sensor reading reaches a pre-set limit, the controller will present this Notification code. The boiler will continue to run at Low Fire. If this condition continues, the controller will present a Lockout message.

- Once the problem has been corrected, press Reset to remove the limitation.

Notification Codes (continued)

N05 - Domestic hot water sensor not present

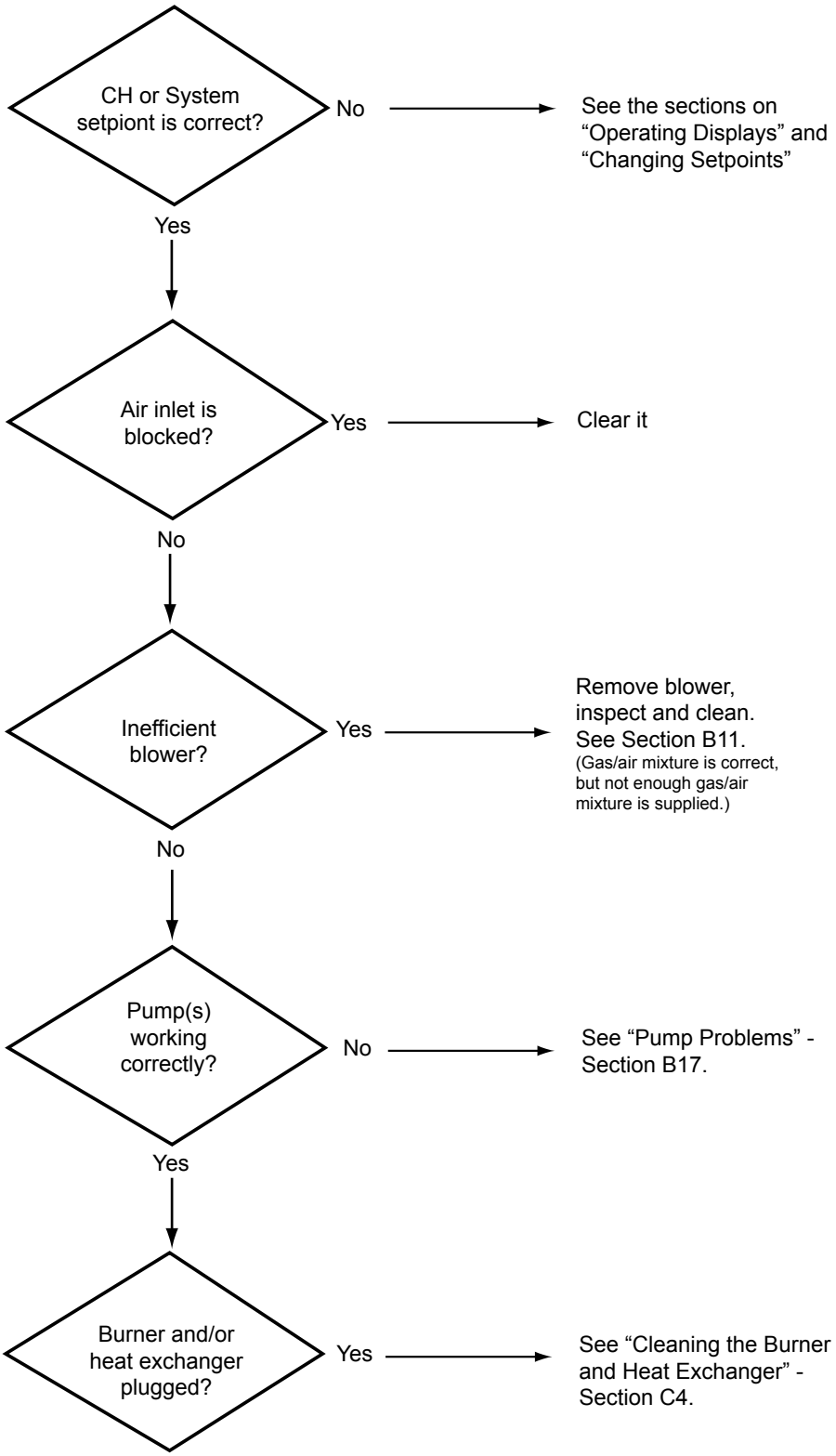
This may mean that the sensor is disconnected or not working. If this condition continues, the controller will present a Lockout message.

- Check for an input on terminals 9 and 10 on the low voltage terminal. If there is no input, check the domestic hot water temperature sensor and replace it if necessary. See Section B6.

N06 - Outdoor temperature sensor not present

This may mean that the sensor is disconnected or not working. If this condition continues, the controller will operate at a setpoint of 140°F or the value of Installer Parameter P62 (High Setpoint for Heat Curve), whichever is lower.

- Check for an input on terminals 1 and 2 on the low voltage terminal.
- If there is no input, check the outdoor temperature sensor and replace it if necessary. See Section B7.


CH or System setpiont is correct?
No
See the sections on "Operating Displays" and "Changing Setpoints"
Yes
Air inlet is blocked?
Yes
Clear it
No
Inefficient blower?
Yes
Remove blower, inspect and clean. See Section B11.
(Gas/air mixture is correct, but not enough gas/air mixture is supplied.)
No
Pump(s) working correctly?
No
See "Pump Problems" - Section B17.
Yes
Burner and/or heat exchanger plugged?
Yes
See "Cleaning the Burner and Heat Exchanger" - Section C4.

A5 Short-Cycling

There are several conditions that can cause short-cycling, and some of them can be caused by problems with the installation. The Mascot LX is a modulating boiler, so its input will decrease when there is a reduction in the heating load. This means that short-cycling is greatly reduced. If the heating load drops below the minimum input of the boiler for an extended period, the boiler will have a tendency to short cycle. This can be a symptom of improper control or piping layout. When in DHW mode under low load conditions, the boiler will normally cycle more often, but should not cycle frequently during call for central heating.

Short-cycling can occur if the piping in the hydronic loop is too small for the capacity of the boiler. To put this another way, the boiler is producing enough heat, but the surrounding system is too small to move the heat out of the boiler. The minimum firing rate on this unit is 20%. If the hydronic loop cannot accept at least that amount of heat, the unit may short-cycle. The solution to this problem is to use larger pipes in the primary (boiler) loop, or to install a buffer tank.

A similar situation can occur if the boiler is connected to an indirect DHW tank. If the output of the boiler is too large in relation to the size of the tank, the system may short-cycle. You may be able to correct this without changing the tank or piping. Be sure to use the aquastat on the indirect tank to provide the “call for heat.” You can also try lowering the DHW setpoint. If this does not work, you may have to change the DHW tank. The tank should be large enough to accept the output of the boiler when it is running at 20% of the maximum firing rate. The piping between the tank and the boiler must also be large enough to allow for adequate flow. Here’s the rule – ***The pipe diameter for the loop running to the tank must always be larger than the fittings on the tank.*** For example, if the fittings on the tank are ½” dia., you must use ¾” dia. or larger piping for the loop.

To check the control setting for “Anti-Cycling:”

- Press and hold the OK/Select and Down buttons for 5 seconds to go to Installer mode.
- Use the Up and Down buttons to go to P23 - Anti-Cycling Time. The default setting is 30 seconds.
- To make a change, press the OK/Select button. Use the Up and Down buttons to change the value. Press and hold the OK/Select button to save the new setting and leave Installer mode.

Unit is Noisy

A6

On systems using anti-freeze –

This can occur if the concentration of anti-freeze is too high. At concentrations above 35%, localized boiling can occur, and this can produce noise.

Some of the components in the boiler operate on 120V AC, including . . .

- Boiler pump
- System pump

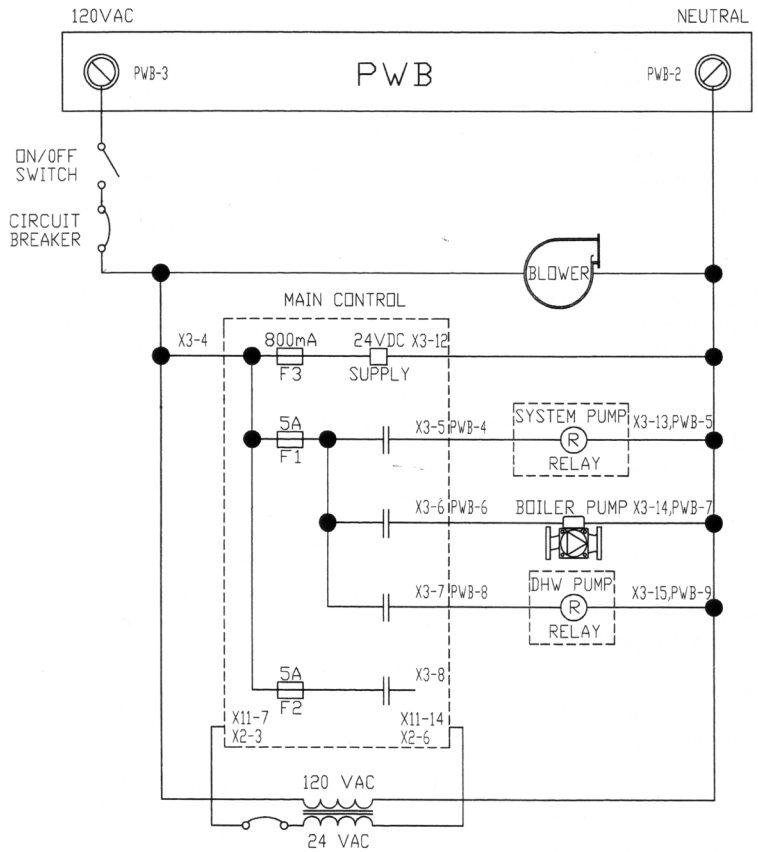
- and on “Combi” units (including Domestic Hot Water) -

- Domestic Hot Water pump
- Three-way valve

Figure B1-1 is a circuit diagram.

DANGER

Some of the parts inside the power box can carry full line voltage. This voltage can cause death or serious personal injury. Do not open this box or work inside unless you have been trained in safe electrical service techniques.



Important note: The maximum combined load on terminals PWB 4, 6, and 8 (the pump outputs) must not exceed 5 Amps.

Fig. B1-1 - 120V AC Power Distribution

Troubleshooting the 120V AC Power Supply (continued)

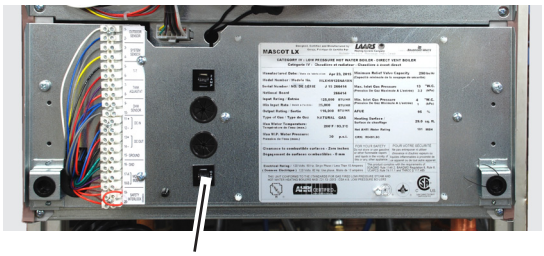


Fig. B1-2 - Circuit breaker for 120V AC (Shown with lower front cover removed)

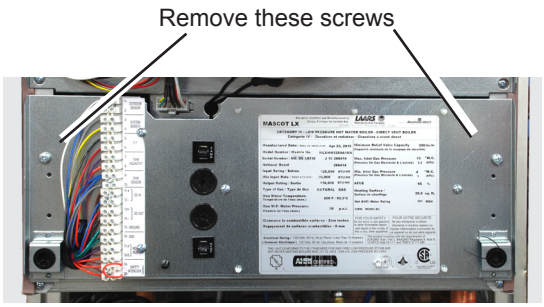


Fig. B1-3 - Opening the Lower Front Panel

Reaching the fuses on the control board -

1. Turn off the power switch on the front panel.
2. Remove the lower front panel.
3. Remove the two screws shown in Fig. B1-3.
4. The front panel is hinged. Swing it down.
5. You will notice a metal cover that protects the back of the control board. Disconnect the large red and small green wires for the direct spark ignition. See Fig. B1-4.
6. Remove the two screws that hold the metal cover in place.

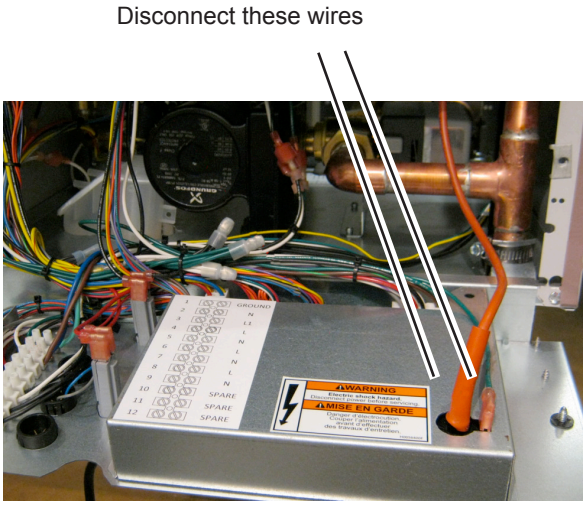


Fig. B1-4 - Removing the Metal Cover

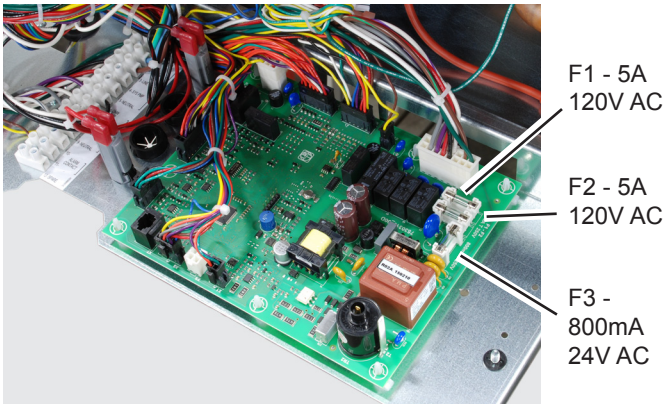


Fig. B1-5 - Fuses on Back of Control Board

Troubleshooting the 24V DC Power Supply

Many of the controls in the boiler operate on 24V, including:

- The SIT controller and display panel
- Most of the sensors and switches that provide inputs for the controller.

Figure B1-1 in the last section shows the power distribution system. A transformer develops 24V AC, which is later rectified to produce 24V DC.

There are two safety devices we should point out:

- A 2A circuit breaker for the 24V DC supply. This is mounted behind the lower front cover. See Fig. B2-1
- F3, an 800 mA fuse, located on the back of the control board. The instructions in Section B1 explain how to reach this fuse.

DANGER

Some of the parts inside the power box can carry full line voltage. This voltage can cause death or serious personal injury. Do not open this box or work inside unless you have been trained in safe electrical service techniques.

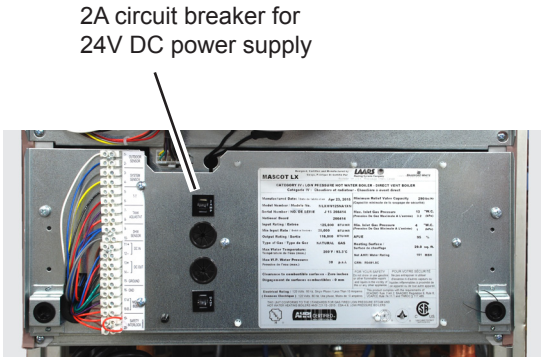


Fig. B2-1 - Circuit breaker for 24V DC (Shown with lower front cover removed)

B3 Inlet Water Temperature Sensor

The inlet water temperature sensor allows the control system to monitor the temperature of the water before it goes through the heat exchanger. The sensor uses an electronic device called a “thermistor.” For instructions on testing the sensor, see Section B9.

Replacement Procedure -

1. Turn off power to the system. Use the main disconnect switch mounted on the front panel.
2. Remove the lower front cover. The inlet water temperature sensor is mounted in the lower left corner of the unit. See Fig. B3-1.
3. Unplug the wiring connector (two wires). The connector is locked in place by a “squeeze tab.” Press on the tab to release the connector.
4. The sensor is held next to the exterior of the water pipe by a spring clip.
5. To test the sensor for accuracy, see Section B9.
6. To reassemble, reverse the process we have just described.

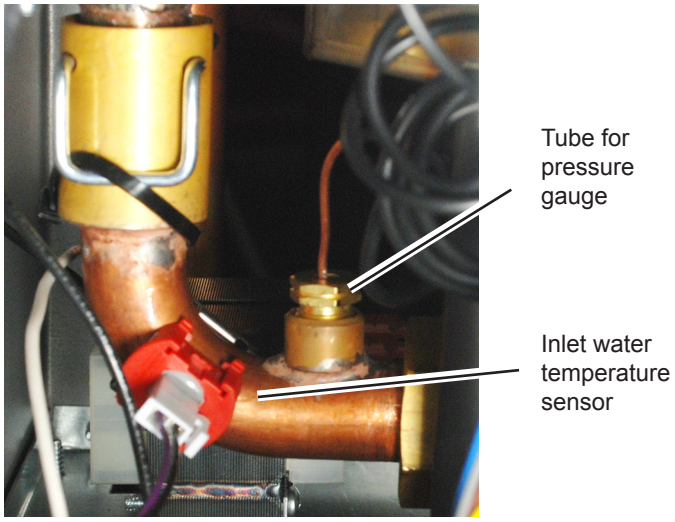


Fig. B3-1 - Inlet water temperature sensor (typical)

Outlet Water Temperature Sensor

The outlet water temperature sensor allows the control system to monitor the temperature of the water as it leaves the Mascot LX unit. A typical installation for the outlet water temperature sensor is shown in Fig. B4-1.

This sensor assembly includes two electronic devices called “thermistors.” The second sensor acts as the high water temperature safety limit. As long as the resistance readings from both sensors agree, the Mascot LX will continue to operate. If there is a large difference between the readings, or if one of the thermistors is “open” or “shorted,” the control system will shut down the Mascot LX unit.

For instructions on testing the assembly, see Section B9.

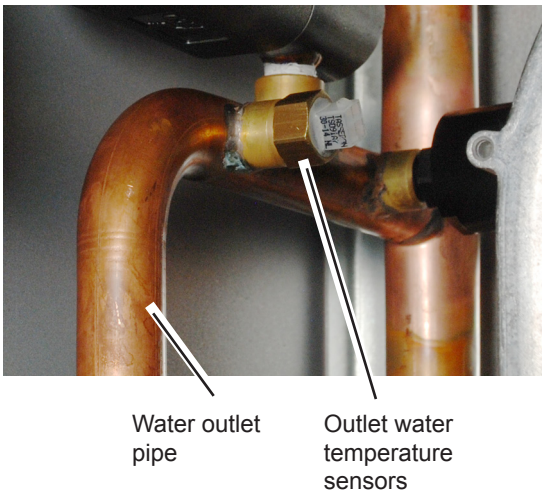


Fig. B4-1 - Outlet Water Temperature Sensor

Replacement Procedure -

Tools and equipment required:

- 17 mm wrench or crescent wrench
- Pipe dope or Teflon® tape

Procedure:

1. Turn off power to the unit. Use the main disconnect switch mounted on the front panel.
2. Isolate the boiler. Turn off the water shutoff valves located upstream and downstream of the unit.
3. Drain the boiler.
4. Remove the upper front cover. The outlet water temperature sensor is mounted in the upper left corner of the unit. See Fig. B4-1.
5. Unplug the wiring connector (four wires). The connector is locked in place by a “squeeze tab.” Press on the tab to release the connector.
6. Unscrew the sensor using the 17 mm wrench. Turn counter-clockwise to unscrew the part.
7. To test the part for accuracy, see Section B9.
8. To reassemble, reverse the process we have just described. Be sure to use pipe dope or Teflon tape on the threaded part of the sensor.

B5 System Sensor

The System sensor is mounted in the circulating loop, and provides the input for the CH (Central Heating) function. This type of sensor can fail in either an “open” or “shorted” condition, or may become inaccurate.

If the SIT controller detects a problem with the system sensor, it will present a fault message.

To check the sensor for accuracy, see Section B9.

B6 DHW Sensor

The DHW sensor is mounted in the DHW loop, and provides the input for the DHW (Domestic Hot Water) function. This type of sensor can fail in either an “open” or “shorted” condition, or may become inaccurate.

If the SIT controller detects a problem with the DHW sensor, it will present a “n05” fault message. For more information, see Section B25 or B27.

To check the sensor for accuracy, see Section B9.

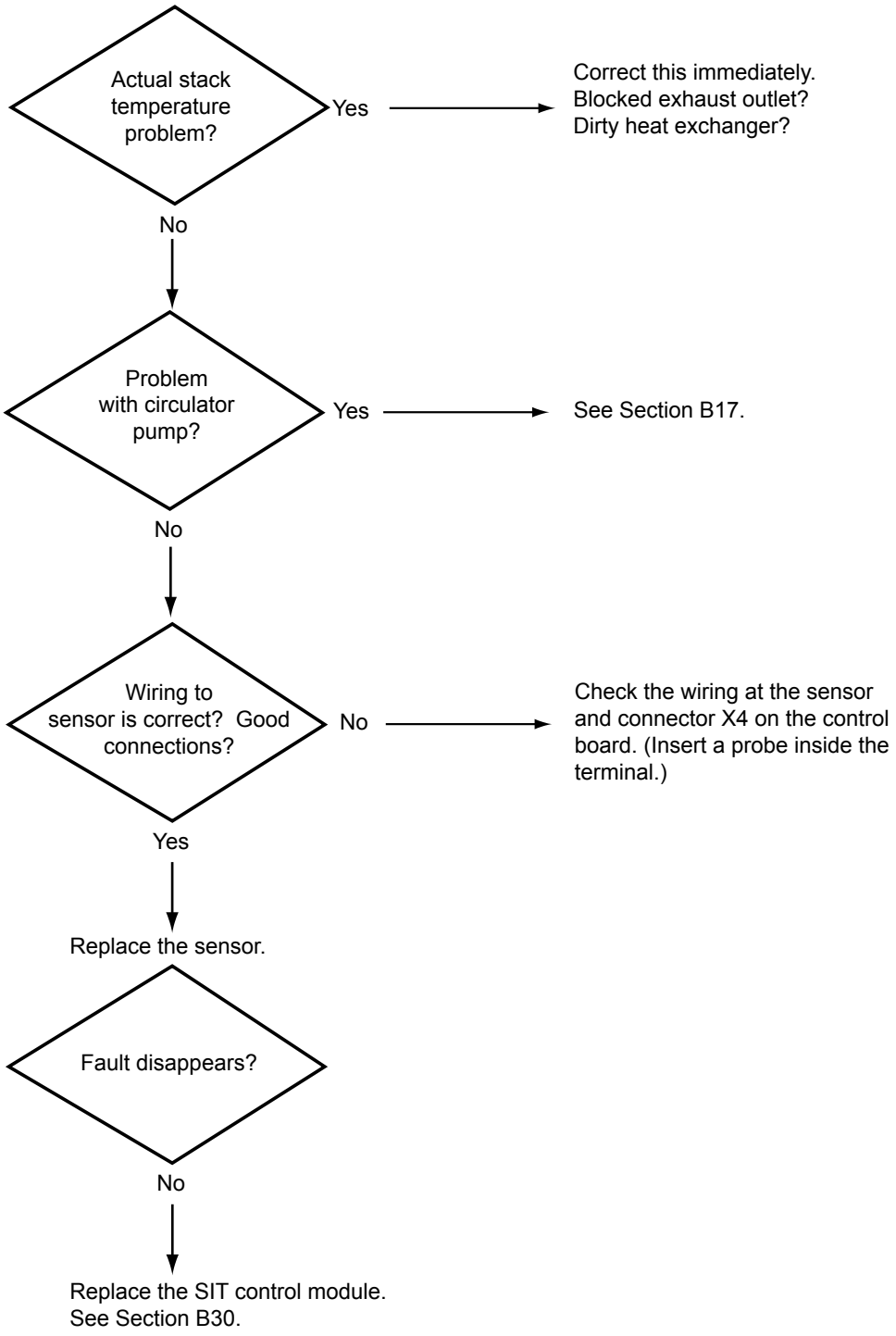
B7 Outdoor Sensor

The Outdoor sensor is mounted outside the heated space, and provides the input for the Outdoor Reset function. This type of sensor can fail in either an “open” or “shorted” condition, or may become inaccurate.

If the SIT controller detects a problem with the Outdoor sensor, the controller will operate at a setpoint of 140°F or the value of Installer Parameter P62 (High Setpoint for Heat Curve), whichever is lower.

For more information on Outdoor Reset, see Section B18. To check the sensor for accuracy, see Section B9.

Note - By default, the warm weather shutdown feature is always active when the outdoor sensor is installed.


Actual stack temperature problem?
Yes
Correct this immediately.
Blocked exhaust outlet?
Dirty heat exchanger?
No
Problem with circulator pump?
Yes
See Section B17.
No
Wiring to sensor is correct? Good connections?
No
Check the wiring at the sensor and connector X4 on the control board. (Insert a probe inside the terminal.)
Yes
Replace the sensor.
Fault disappears?
No
Replace the SIT control module.
See Section B30.

B8 cont. Flue Temperature and Flue Safety Sensors (continued)

The flue temperature and flue safety sensors will shut down the Mascot LX unit if the stack temperature rises above 195°F. This assembly is actually a “duplex” sensor - it includes two separate thermistors. The control system constantly compares the readings from the thermistors. If there is a large difference between the readings, or if one of the thermistors is “open” or “shorted,” the control system will shut down the Mascot LX unit, and display an “E015” error message.

Replacement Procedure:

1. Turn off power to the unit. Use the main disconnect switch on the front panel.
2. Turn off all gas valves supplying gas to the unit.
3. The stack temperature limit switch is mounted in the exhaust duct on the right side of the boiler. See Fig. B8-1. To get access to the switch, remove the upper front panel of the cabinet.
4. The sensor assembly is held in place by a “press fit” into a rubber grommet. Pull the sensor assembly straight out.
5. Unplug the wiring connector (four wires). The connector is locked in place by a “squeeze tab.” Press on the tab to release the connector.
6. To test the part for accuracy, see Section B9.
7. To reassemble, reverse the process we have just described.

Fig. B8-1 - Flue Temperature and Flue Safety Sensors

Testing the Temperature Sensors

The temperature sensors used in this unit are devices called “thermistors.” The electrical resistance across a thermistor drops as the temperature rises. The table below shows some typical resistance readings at different temperatures.

There are three temperature sensors mounted directly on the Mascot LX unit:

- Inlet water temperature sensor
- Combined outlet water temperature sensor and water temperature high limit (duplex sensor)
- Combined flue temperature and flue safety sensor (duplex sensor)

On a “Combi” unit which produces Domestic Hot Water (DHW), another sensor is mounted above the flat-plate water heater behind and below the unit:

- DHW high temperature limit sensor

Other sensors may be mounted at remote locations:

- System sensor
- DHW sensor (if installed)
- Sensor for Outdoor Reset function (if installed)

Each “duplex” sensor assembly actually uses two thermistors. The control module compares the readings of the two. If the difference (the “drift”) becomes greater than allowed, the controller declares a lockout and prevents the Mascot LX unit from firing.

To check a thermistor, unplug the sensor wires and check the resistance through the thermistor using a volt-ohmmeter. Note the temperature of the part, and check the resistance against the table. If there is an open-circuit or no resistance at all, replace the part.

The connector for a “duplex” sensor will include four pins. Two of these run to one thermistor, and two go to the other. You should see the same resistance reading on both of the thermistors in the assembly.

°F	±°F	Ohms
-22	1.6	176.1 kΩ
-4	1.6	96.7 kΩ
14	1.6	55.2 kΩ
32	1.6	32.6 kΩ
50	1.6	19.9 kΩ
68	1.6	12.5 kΩ
77	1.6	10.0 kΩ
86	1.6	8.0 kΩ
104	1.4	5.3 kΩ
122	1.4	3.6 kΩ
140	1.4	2.4 kΩ
158	1.6	1.7 kΩ
176	1.8	1.2 kΩ
194	2.0	912 Ω
212	2.2	674 Ω
230	2.5	506 Ω
248	2.7	384 Ω
266	2.9	296 Ω
284	3.1	230 Ω
302	3.2	181 Ω

Table B9-1 - Thermistor Resistance Chart

B10 Water Pressure Switch

The water pressure switch will not allow the Mascot LX unit to operate unless the water pressure is at least 5 p.s.i.

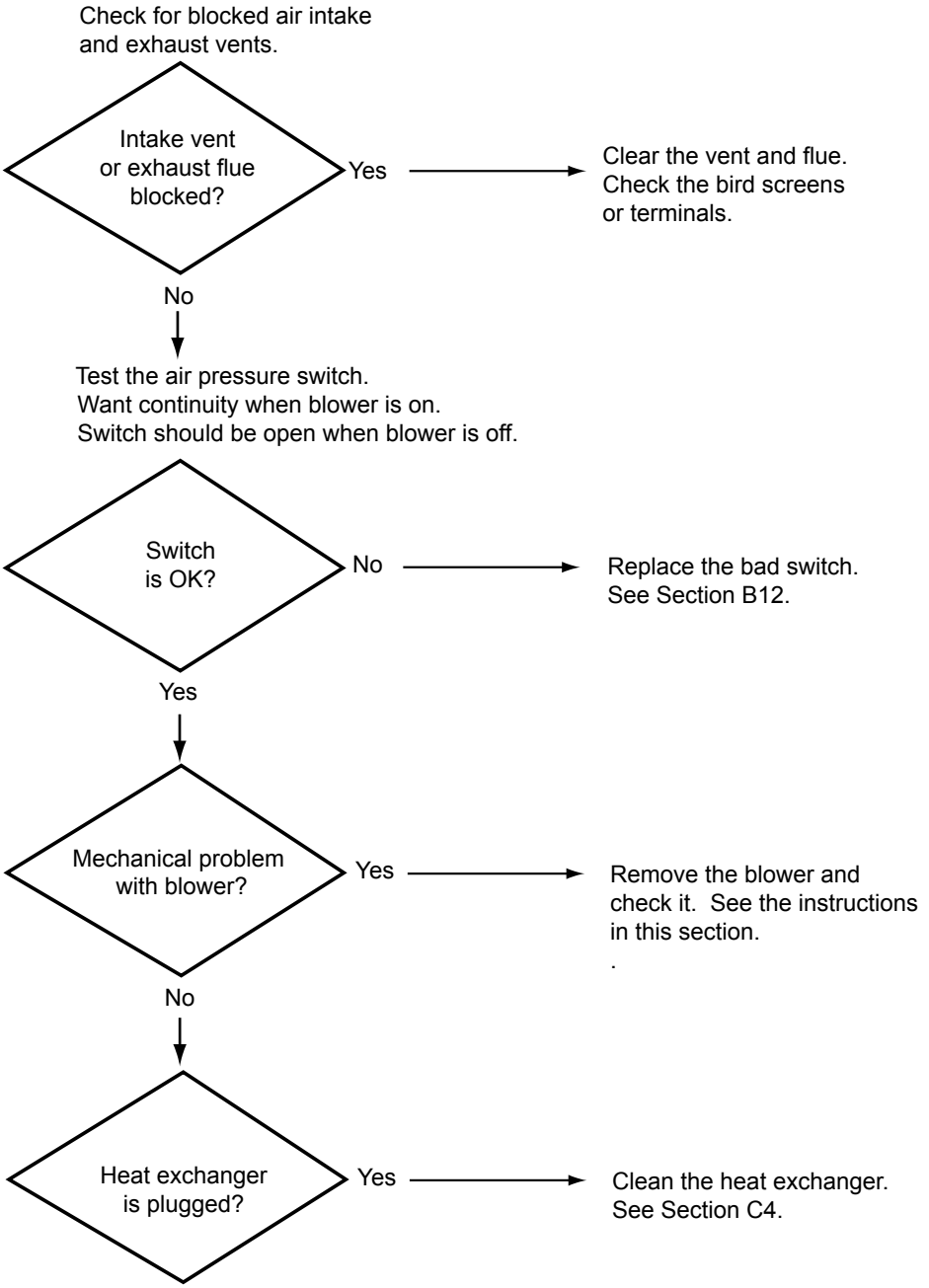
Tools and Equipment Required:

- 14 mm wrench
- Teflon® tape or pipe dope

Replacement Procedure:

1. Turn off power to the unit. Use the main disconnect switch on the front panel.
2. Turn off all gas valves supplying gas to the unit.
3. Isolate the boiler. Turn off the water shutoff valves located upstream and downstream of the unit.
4. Drain the boiler.
5. The water pressure switch is mounted in the upper left corner of the cabinet, as shown in Fig. B10-1. To get access to the switch, remove the upper front panel of the cabinet.
6. Unplug the wiring connector. The connector is locked in place by a “squeeze tab.” Press on the tab to release the connector.
7. Unscrew the sensor using the 14 mm wrench. Turn counter-clockwise to unscrew the part.
8. There is no practical way to test the part. If you suspect it is bad, replace it.
9. To reassemble, reverse the process we have just described. Be sure to use pipe dope or Teflon tape on the threaded part of the sensor.

Fig. B10-1 - Water Pressure Switch


Check for blocked air intake and exhaust vents.
Intake vent or exhaust flue blocked?
Yes
Clear the vent and flue. Check the bird screens or terminals.
No
Test the air pressure switch. Want continuity when blower is on. Switch should be open when blower is off.
Switch is OK?
No
Replace the bad switch. See Section B12.
Yes
Mechanical problem with blower?
Yes
Remove the blower and check it. See the instructions in this section.
.
No
Heat exchanger is plugged?
Yes
Clean the heat exchanger. See Section C4.

Blower Problems (continued)

Replacement Procedure -

1. Switch off the power switch on the front panel to turn off power to the machine.
2. Remove the upper front panel.
3. Turn off all manual gas valves connecting the boiler to the main gas supply line.
4. Disconnect the 120V and control signal connections from the blower.
5. Disconnect the wiring harness for the gas valve. It is held in place by a small Phillips-head screw.
6. Undo the two cap-head screws that support the end of the air line. This assembly hangs from the end of the Venturi. The air line runs to the air pressure switch. Once the assembly is free, swing the end of the air line out of the way to the left.
7. In order to remove the blower, you will need to get the spark rod and flame sensor out of the way. Remove these parts as shown in Fig. B11-2.
8. Loosen the union nut between the gas inlet pipe and the gas valve. Be careful not to drop the O-ring.
9. Remove the four nuts connecting the bottom of the blower to the combustion chamber. There are two sets of nuts here - remove the smaller (inner) ones.
10. At this point, you should be able to “roll” the blower assembly forward and out of the front of the unit. Note that the Venturi and gas valve remain connected to the blower.
11. To reassemble, reverse the steps listed above. After re-tightening the union in the gas line, check for gas leaks using a leak detection solution.

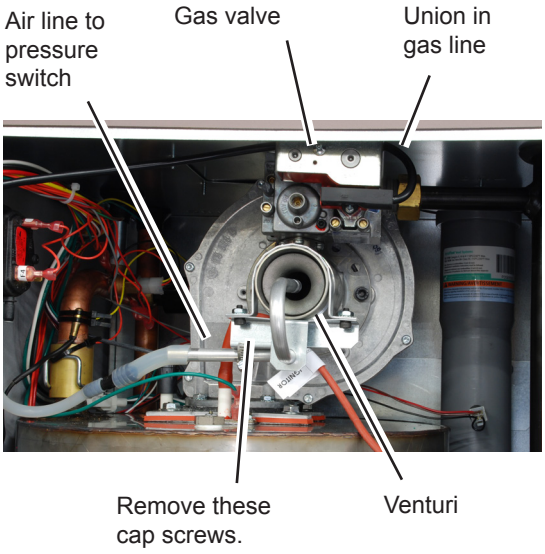


Fig. B11-1 - Upper part of cabinet (typical installation, front cover removed)

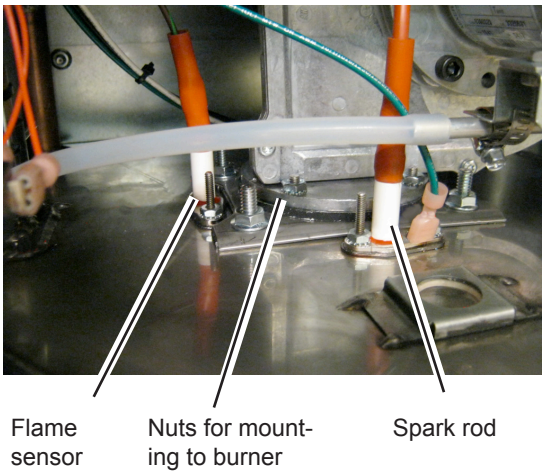
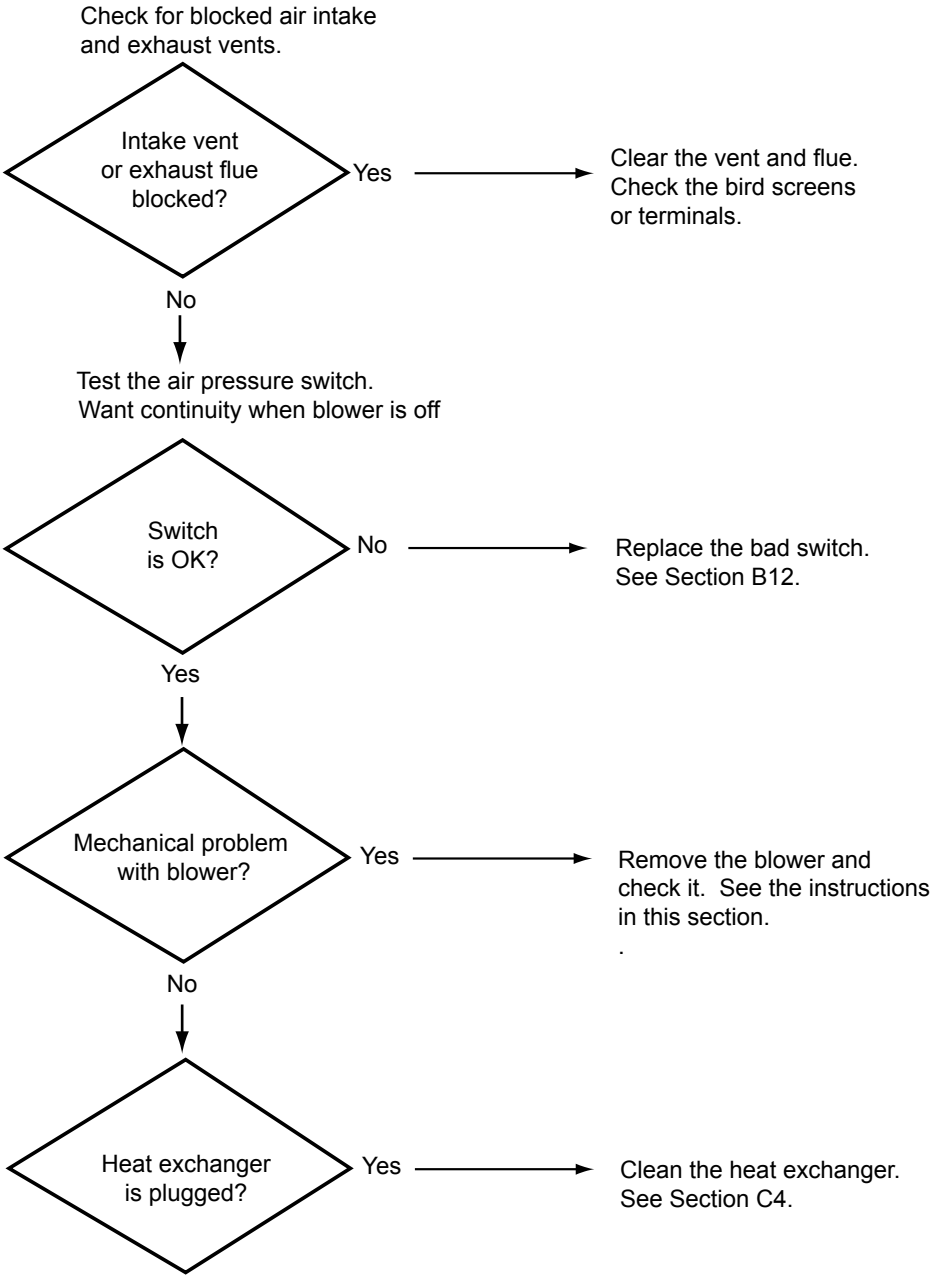


Fig. B11-2 - Detail view - Bottom of blower


Check for blocked air intake and exhaust vents.
Intake vent or exhaust flue blocked?
Yes
Clear the vent and flue. Check the bird screens or terminals.
No
Test the air pressure switch. Want continuity when blower is off
Switch is OK?
No
Replace the bad switch. See Section B12.
Yes
Mechanical problem with blower?
Yes
Remove the blower and check it. See the instructions in this section.
.
No
Heat exchanger is plugged?
Yes
Clean the heat exchanger. See Section C4.

B12 cont. Air Pressure Switch (continued)

This switch acts as a “fan proving” switch. The switch measures the difference in air pressure between the Venturi and the flue collector.

Because the switch is normally open (N.O.), you should see continuity across the switch contacts when the boiler is running, and no continuity when it is off.

Fig. B12-1 - Air pressure switch

Gas Valve

The modulating gas valve consists of a valve body that controls the on/off gas flow, and a pressure regulator. In combination with the Venturi, it provides the air/gas ratio control.

Tools and equipment required:

- Combination wrench set
- Allen wrench set
- Two pipe wrenches

Replacement procedure:

1. Switch off the power switch on the front panel to turn off power to the machine.
2. Remove the upper front panel.
3. Turn off all manual gas valves connecting the boiler to the main gas supply line.
4. Disconnect the wiring harness for the gas valve. It is held in place by a small Phillips-head screw.
5. Undo the two cap-head screws that support the end of the air line. This assembly hangs from the end of the Venturi. The air line runs to the air pressure switch. Once the assembly is free, swing the end of the air line out of the way to the left.
6. Loosen the union nut between the gas inlet pipe and the gas valve. Be careful not to drop the O-ring.
7. Separate the Venturi from the blower. Use an Allen wrench to remove the cap screws on the Venturi mounting plate. This will allow you to remove the gas valve and Venturi together.
8. You can separate the gas valve from the Venturi by pulling them apart while twisting slightly.
9. To reassemble, reverse the steps listed above. After re-tightening the union in the gas line, check for gas leaks using a leak detection solution.

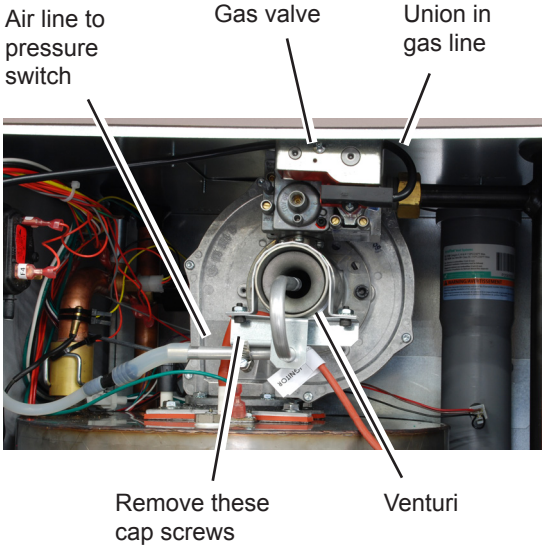


Fig. B13-1 - Upper part of cabinet (typical installation, front cover removed)

B14 Condensate Trap

Some operating conditions can cause small particles of mineral material to be formed in the heat exchanger and collect in the condensate trap. The drain can also be blocked if it is frozen or plugged with debris. If the water cannot drain freely, it can back up into the heat exchanger.

The trap on the Mascot LX has a removable cap, so it is easy to clean. Remove the cap and flush out this area at least once a year.

On a Mascot LX unit, the condensate trap is installed outside of the cabinet, so it should be easy to reach. Note that the condensate water can be hot. The water is also acidic, and can damage metal pipes. The center of the assembly includes a Nylon ball, which acts as a one-way check valve. If you remove the threaded part at the bottom of the assembly, be careful not to lose this ball.

Fig. B14-1 - Condensate trap assembly (typical)

If the system pressure exceeds the relief valve setting, the pressure relief valve is designed to open and release the excess pressure and water. Note - This type of valve is designed to relieve a limited number of times during its life cycle, so it is not a good idea to "test" the valve by tripping the small metal handle on top. Sometimes when this type of valve is opened, it will not re-seat correctly, causing a slow leak. If this happens, and the valve cannot be cleared, it must be replaced.

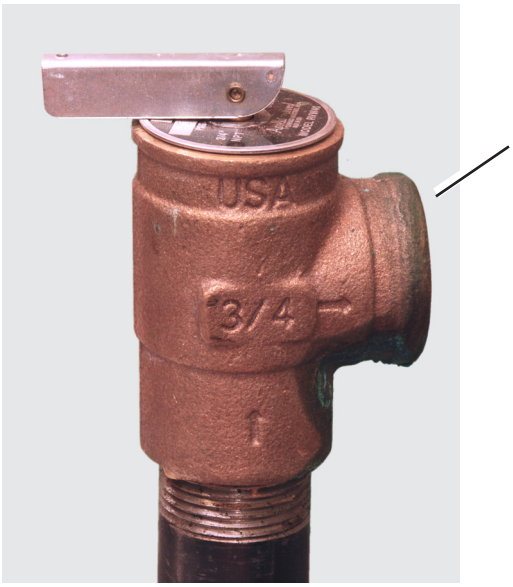


Fig. B15-1 - Pressure relief valve (typical)

Replacement Procedure -

Tools and equipment required:

- Plumber's torch, solder, and flux
- Two pipe wrenches
- Pipe dope or Teflon® tape

Procedure:

1. Turn off power to the system. Use the main disconnect switch mounted on the front panel.
2. The pressure relief valve is mounted on a separate "T" fitting attached to the outlet pipe unit.
3. Disassemble and remove the drain pipe.
4. Unscrew the valve from the water outlet pipe using the two pipe wrenches.
5. The replacement valve must be the correct size and capacity to match the size of the Mascot LX unit. Check the old valve for two important numbers:
   - The capacity of the old valve, listed in BTU
   - The relief pressure of the old valve, listed in p.s.i.

   These numbers will be marked on the body of the valve. Check for this before you get a replacement. The replacement valve must have ratings for both BTU and psi which ***are the same as or higher*** than the ratings on the old valve.
6. Wrap a piece of Teflon® tape around the threads on the end of the vertical pipe. Install the new valve using the two pipe wrenches.
7. Reassemble the drain pipe.

WARNING

Always re-install the drain pipe. If the pressure relief valve were to open without the drain pipe in place, the boiling water could shoot out, causing personal injury or property damage. Most plumbing codes call for the drain pipe to extend straight down to a point about 6" above the floor. Check your local code.

B16 Direct Spark Ignition

This boiler uses “direct spark ignition” to light the burner flame. The ignition system includes the spark rod, a ground rod, and a flame sensor. See Fig. B16-1. To light the burner, the SIT controller sends a high-voltage current to the spark rod and opens the gas valve. A spark jumps from the spark to the ground rod and lights the gas. The flame heats the flame sensor. The flame sensor generates a very small voltage (milli-Volts) to confirm that the gas is burning. If for some reason the flame sensor does not detect a flame within a very short time, the controller triggers a lockout.

This section of the boiler should not require much maintenance or troubleshooting. Table B16-1 shows the voltages you should see in the ignition system during normal operation.

Electrical Shock Hazard

While the burner is lighting, the controller will generate a high voltage between the spark rod and the ground rod. Use care when working around these parts or taking test readings.

Correct Clearances

To ensure easy and reliable firing, the clearance between the spark rod and the ground rod must be 3/16” (5 mm). See Fig. B16-1.

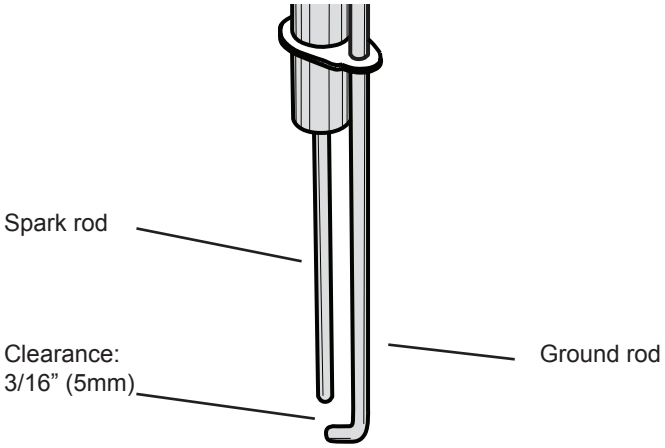


Fig. B16-1 - Correct clearance for spark rod

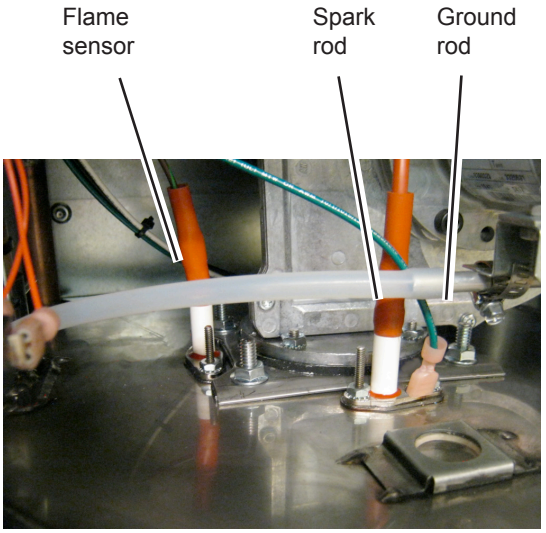


Fig. B16-2 - Connections for spark rod and flame sensor

Function	Observe when	Test points	Should observe this voltage
Open gas valve	Trying to light burner	#4-6 on X2 on SIT Y-BL wires to valve	24V AC
Creating spark	Trying to light burner	T2 on SIT	High voltage, see next page for test procedure
Flame sensor rod	Burner is lit	#10 on X3 on SIT to ground	±30 microamps

Table B16-1 - Normal voltages in ignition system

Spark Rod - Testing and Replacement

The spark rod should not create problems unless it is bent for some reason. The tip of the rod should be sharp and shiny. After long use, the tip of the rod may be partially burnt away. This could change the clearance between the spark and the ground rod, causing firing problems.

1. Shut off the main power supply to the unit. Use the switch on the front panel.
2. Turn off all gas valves connecting the unit to the main gas supply line.
3. Remove the upper front panel.
4. Carefully disconnect the large red wire running to the spark rod and the smaller wire running to the ground. See Fig. B16-2.
5. Remove the two screws holding the spark rod assembly in position. Now you can remove the assembly.
6. To test, lean the spark rod assembly against the top of the combustion chamber. Reconnect the large wire to the top of the assembly. Insert a jumper between terminals 5 and 6 on the low-voltage terminal strip to create a “call for heat”.

DANGER

Stand back and do not touch the spark rod assembly during this test - it will carry a dangerous high voltage.

7. When you power up the boiler you should see a bright blue spark between the spark rod and the ground rod. This indicates that the spark rod, ground rod, SIT controller, and gas pressure are all OK.
8. Power down the boiler again and check the clearance between the spark rod and the ground rod. See Fig. B16-3. The clearance should be 3/16” (5 mm).
9. If the assembly is damaged, replace it by reversing the instructions listed above. Remember to remove the jumper you installed to create the “call for heat.”

Flame Sensor - Cleaning and Replacement

Over time, the flame sensor can become tarnished or coated. This can affect the ability of the flame sensor to detect the flame, and eventually it will prevent the unit from firing. This problem will happen more quickly if the Mascot LX has been operating often at a low firing rate.

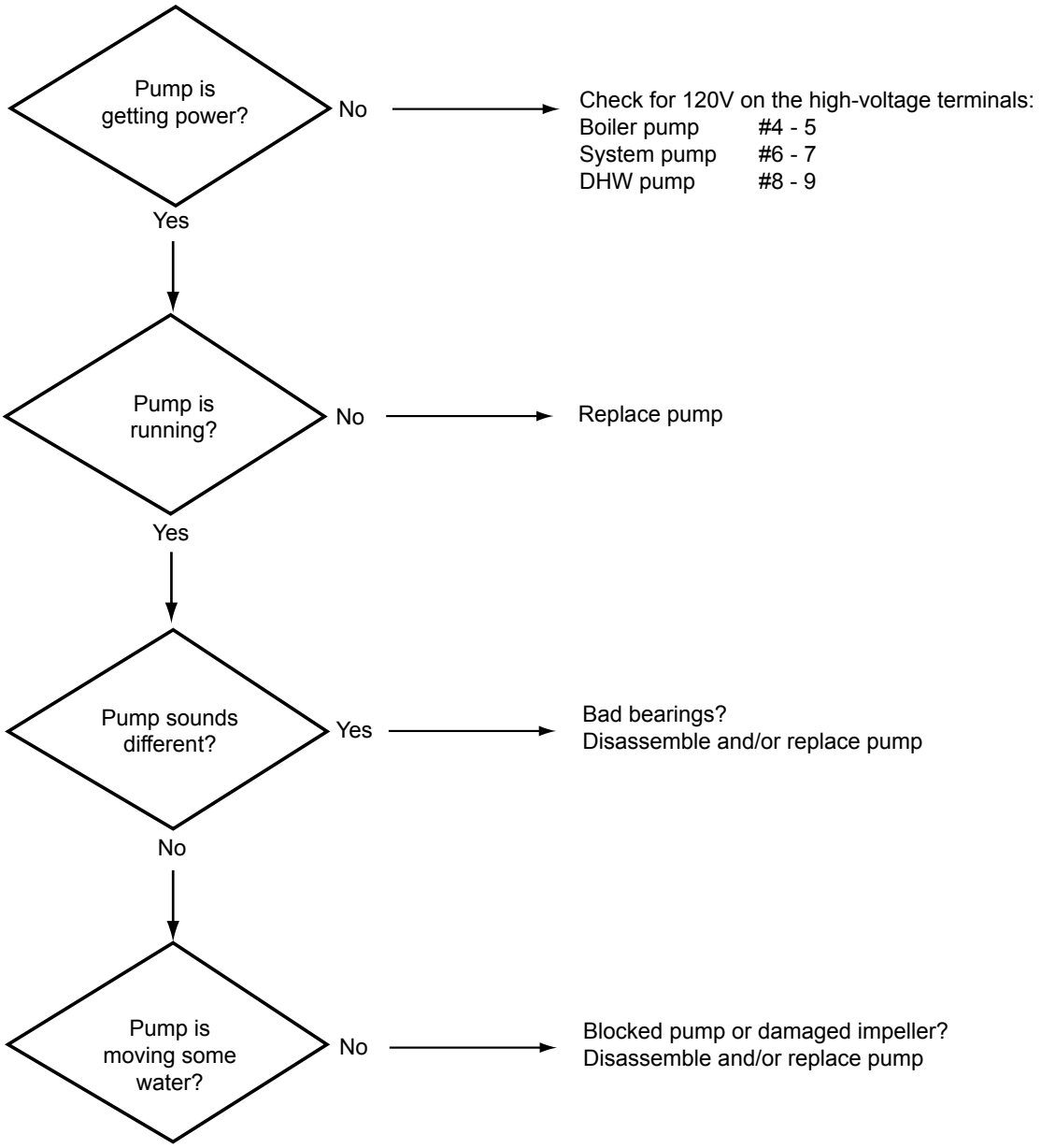
The surface of the flame sensor has a protective coating, so it must be cleaned carefully.

CAUTION

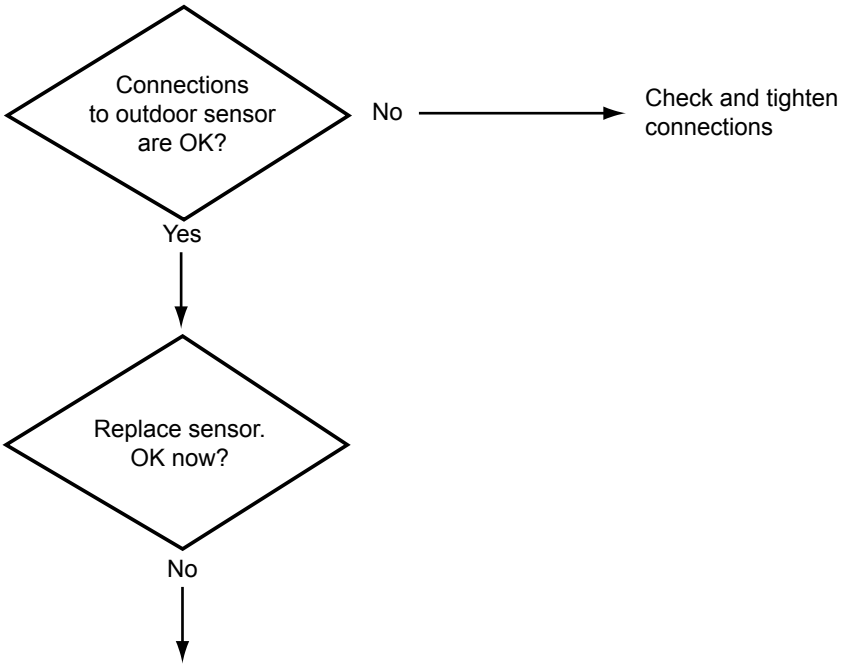
Do not use sandpaper, steel wool, or emery board to clean the flame sensor. These materials will clean the sensor, but they will also remove the protective coating. The sensor will work, but only for a short time.

1. Shut off the main power supply to the unit. Use the switch on the front panel.
2. Turn off all gas valves connection the unit to the main gas supply line.
3. Remove the upper front panel.
4. Carefully disconnect the large red wire running to the flame sensor. See Fig. B16-1.
5. Remove the two screws holding the flame sensor assembly in position. Now you can remove the assembly.
6. The best way to clean the sensor is to use a dollar bill. The paper used in the bill is just abrasive enough to clean the sensor correctly, without removing the protective coating.
7. To reassemble, reverse the instructions listed earlier. Be sure to insert the mounting gasket correctly.

B17 Pump Problems



N06 notification message -
“Outdoor sensor not present”?



Check the programming for Outdoor Reset.
Go to Installer Mode.
Check P61 through P64.
See the instructions which follow.

Outdoor Reset (continued)

About Outdoor Reset

The “outdoor reset” function allows the system to automatically use a lower setpoint for Central Heat when the outdoor temperature rises. This allows the unit to run more efficiently in warmer weather. Fig. B18-1 shows some different setpoints at different outdoor temperatures.

First, let’s see how the system behaves when outdoor reset is ***not*** turned on. Point “A” represents a cold day. The outdoor temperature is 20°F, and the control system is using a CH setpoint of 170°. Even on a much warmer day, with an outdoor temperature of 80°F, the CH setpoint is still the same - 170°. The unit will run correctly when it is set up this way, but the setup could be more efficient. At 80°F, the unit will fire occasionally at 100%, and do this for short periods of time. This is not the most efficient way for this unit to operate.

Now let’s say that the unit is using Outdoor Reset. At point “A”, the conditions are still the same - outdoor temperature 20°F, CH setpoint 170°. But using Outdoor Reset, you can set the controller to lower the CH setpoint as the outdoor temperature rises. (To put this another way, the SIT controller allows you to set the “slope” of the Outdoor Reset correction.) At point B, the outdoor temperature is 80°F. In this example we have set the controller to automatically lower the CH setpoint to 50°.

The SIT controller in the Mascot LX allows you to set the starting and stopping points for the Outdoor Reset correction. You can do this by changing some settings using the “Installer” mode.

Changing the Outdoor Reset Setpoints -

Go to the “Installer” mode:

1. Press and hold the OK/Select and Down buttons for 5 seconds to go to Installer mode.
2. Use the Up and Down buttons to go to the setting you want to change - P61 through P64 for Outdoor Reset.
3. To make a change, press the OK/Select button. Use the Up and Down buttons to change the value.
4. Press and hold the OK/Select button to save the new setting and leave Installer mode.

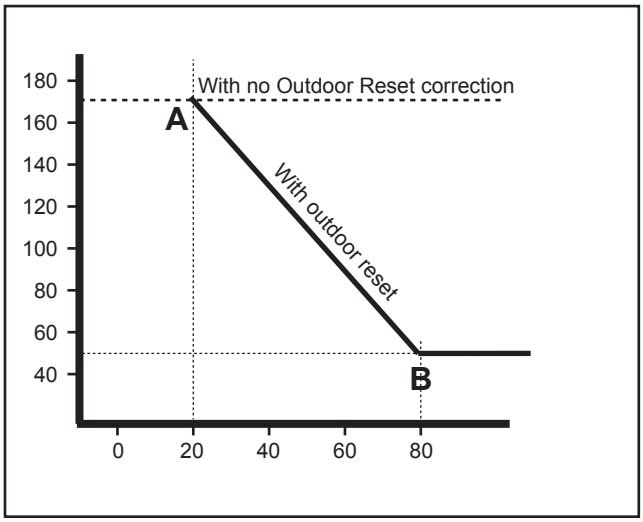


Fig. B18-1 - Setpoint Corrections Using Outdoor Reset

Starting Point for Outdoor Reset Correction -

We have shown this as point “A” on the chart.

P61 - Low Outdoor Temperature Setpoint (LOD)
This is the outdoor temperature where you want the Outdoor Reset correction to begin. In the example shown here, this would be 20°F. You could also start the Outdoor Reset correction at another temperature.

P62 - High Boiler Temperature Setpoint (HBT)
This is the boiler setpoint temperature at that outdoor temperature (point “A”). In this example, this would be 170°, but you could enter a different temperature.

End Point for Outdoor Reset Correction -

This is shown as point “B” on the chart.

P63 - High Outdoor Reset Temperature Setpoint (HOD)
This is the outdoor temperature where you want the Outdoor Reset correction to end. In this example, this is set to 80°F, but you could use another value.

P64 - Low Boiler Temperature Setpoint (LBT)
This is the boiler setpoint temperature at that outdoor temperature (point “B”.) We used 50° in this example.

- The warm weather shutdown feature is always active when the outdoor sensor is installed. See Installer Parameter P65 - Warm Weather Shutdown.”
- If the outdoor temperature sensor is disconnected or not working, you may see the message “N06 - Outdoor temperature sensor not working.” If this condition continues, the controller will operate at a setpoint of 140°F or the value of Installer Parameter P62, whichever is lower.

Low Water Cutoff Switch

The LED's on the front of the Low Water Cutoff unit provide some useful troubleshooting information. See Fig. B19-1.

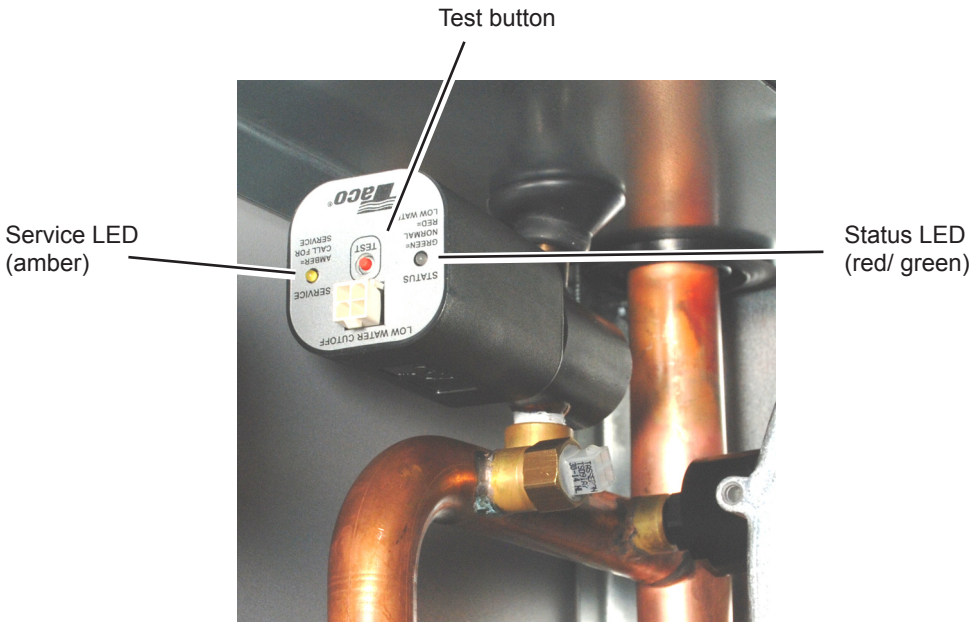


Fig. B19-1 - Controller for Low Water Cutoff

Status LED	Service LED	Condition	Necessary Action
Green	Off	Normal	
Red	Off	Low water condition	Check water source. See procedure below.
Green	Amber	Weak probe signal	Clean probe, or replace Low Water Cutoff. See the procedure on the next page.
Red	Amber	Low water condition and weak probe signal	Check water source. See procedure below. Clean probe, or replace Low Water Cutoff. See the procedure on the next page.
Blinking red	Off	Control failure	Reset the Low Water Cutoff. See the procedure on the next page. If necessary, replace the Low Water Cutoff.
Off	Off	No power to Low Water Cutoff	Check the power source and connections

Low Water Cutoff Switch (continued)

Checking for an Actual Low Water Condition

1. Check the water supply, water pressure, and auto makeup valve.
2. This controller can sometimes produce a false positive reading if the system uses ultra-pure water. Very pure water will not conduct electrical current, and will affect the reading from the probe.

Resetting the Low Water Cutoff

The Low Water Cutoff can be reset without removing it from the Mascot LX.

1. Remove the upper front panel on the Mascot LX.
2. Unplug the connector on the front of the Low Water Cutoff.
3. Wait 30 seconds.
4. Plug in the connector again.

Removing and replacing the unit

Tools and equipment required:

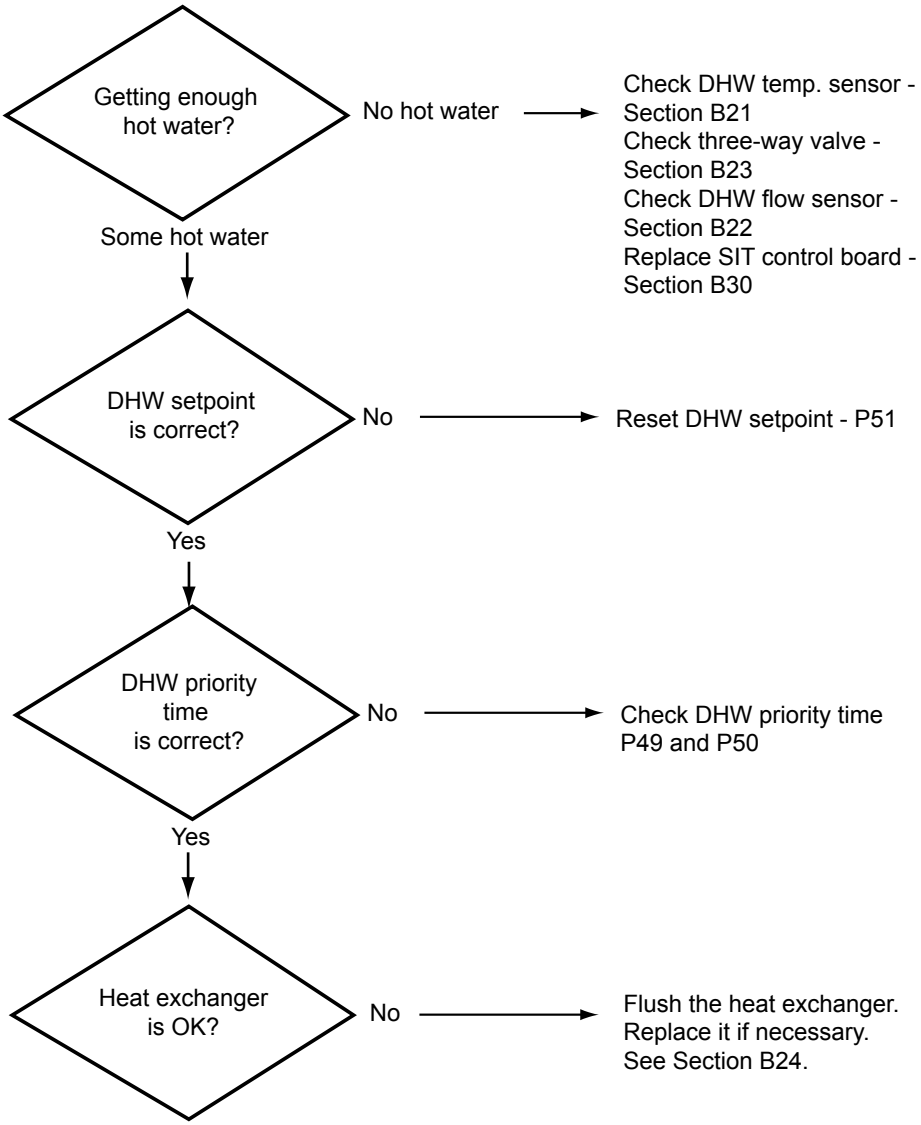
- Teflon® tape

1. Turn off power to the unit. Use the main disconnect switch on the front panel.
2. Isolate the boiler. Turn off the water shutoff valves located upstream and downstream of the unit.
3. Drain the boiler.
4. Remove the upper front panel on the unit.
5. Disconnect the wires running to the front of the unit.
6. Turn the assembly by counter-clockwise by hand to remove it. You should not need to use a wrench.
7. To reassemble, reverse the procedure we have just described. Keep these points in mind as you do this:
   - Use two or three wraps of Teflon® tape on the threaded part of the assembly. Do not use pipe dope or any other kind of sealant.
   - Start the thread carefully so you do not cross-thread the parts.
   - Hand-tighten only. Do not use a wrench.
   - Be sure the wiring connector is seated firmly.

Procedure - Cleaning the probe

Clean the probe whenever you see the amber signal on the Service LED.

1. Remove the low water cutoff as described above.
2. Clean the probe by wiping it with a clean cloth.
3. Replace the low water cutoff as described above.
4. If, after the probe is cleaned, the low water cutoff does not operate normally, replace the unit.


Getting enough hot water?
No hot water
Check DHW temp. sensor - Section B21
Check three-way valve - Section B23
Check DHW flow sensor - Section B22
Replace SIT control board - Section B30
Some hot water
DHW setpoint is correct?
No
Reset DHW setpoint - P51
Yes
DHW priority time is correct?
No
Check DHW priority time P49 and P50
Yes
Heat exchanger is OK?
No
Flush the heat exchanger. Replace it if necessary. See Section B24.

B21 DHW Temperature Sensor - Combi Units (MXLC)

The DHW temperature sensor allows the control system to monitor the temperature of the water before it goes to the Domestic Hot Water piping. The sensor uses an electronic device called a “thermistor.” For instructions on testing the sensor, see Section B9.

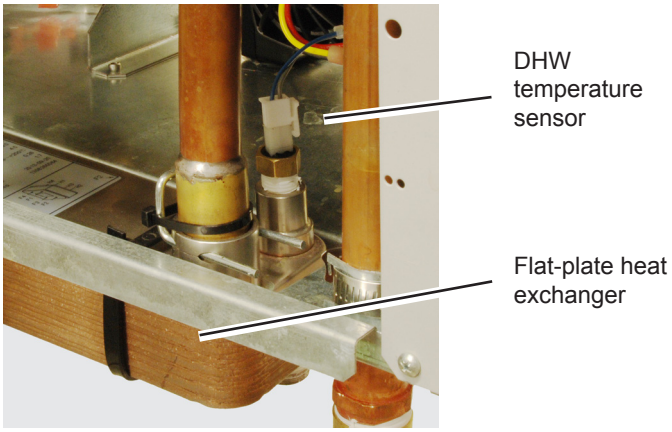


Fig. B21-1 - DHW High Temperature Limit Sensor

Tools and equipment required:

- Adjustable wrench or combination wrench set
- Pipe dope or Teflon® tape

Replacement procedure:

1. Turn off power to the system. Use the main disconnect switch mounted on the front panel.
2. Isolate the boiler. Turn off the water shutoff valves located upstream and downstream of the unit.
3. Drain the DHW piping.
4. Remove the rear cover. The DHW high temperature limit sensor is mounted in the lower right corner of the rear of the unit. See Fig. B21-1.
5. Unplug the wiring connector (two wires). The connector is locked in place by a “squeeze tab.” Press on the tab to release the connector.
6. Unscrew the sensor using a wrench. Turn counter-clockwise to unscrew the part.
7. To reassemble, reverse the process we have just described. Be sure to use pipe dope or Teflon® tape on the threaded part of the sensor.

DHW Flow Sensor (Hall Sensor) - Combi Units (MLXC)

The DHW flow sensor senses demand from the Domestic Hot Water piping. This unit includes a small paddle that turns as the water flows past. As the paddle turns, a magnet moves past a sensor and creates a signal for the controller in the Mascot LX. (This sensor uses a principle called the “Hall effect,” so this is sometimes called the “Hall sensor.”)

The output from this sensor is a series of pulses at very low voltage, so it is difficult to troubleshoot this type of unit using a Volt-Ohmmeter. This sensor tells the controller when there is a demand for domestic hot water. To test the sensor, open a hot water faucet in the domestic water system. The boiler should respond quickly. If it does not, the sensor may be bad.

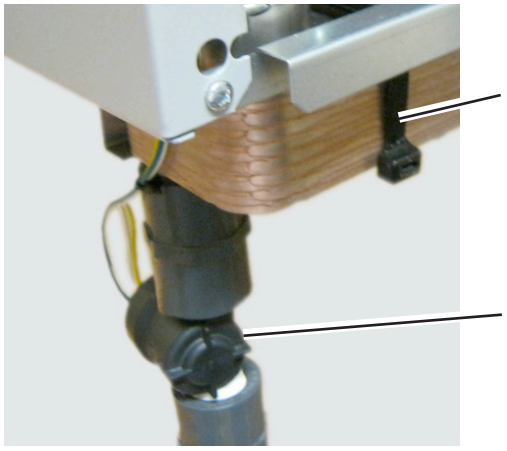


Fig. B22-1 - DHW Flow Sensor

Tools and equipment required:

- Adjustable wrench or combination wrench set
- Pipe dope or Teflon® tape

Replacement procedure:

1. Turn off power to the system. Use the main disconnect switch mounted on the front panel.
2. Isolate the boiler. Turn off the water shutoff valves located upstream and downstream of the unit.
3. Drain the DHW piping.
4. The DHW flow sensor is mounted in the lower rear of the unit. See Fig. B22-1.
5. Unplug the wiring connector (two wires). The connector is locked in place by a “squeeze tab.” Press on the tab to release the connector.
6. Unscrew the sensor using a wrench. Turn counter-clockwise to unscrew the part.
7. To reassemble, reverse the process we have just described. Be sure to use pipe dope or Teflon® tape on the threaded part of the sensor.

B23 Three-Way Valve - Combi Units (MLXC)

On a “Combi” unit (central heat plus domestic hot water), the three-way valve shifts the output flow between the CH and DHW functions.

Normally the system is set up to give priority to DHW. That is, when the DHW flow sensor detects a demand for hot water, the three-way valve is closed and the output of the Mascot LX is sent to the DHW piping. To send hot water to the CH system, the three-way valve is energized.

The priority and the timing can be changed using the Installer mode - parameters P49, P50, and P28.

P28 Domestic hot water demand blocks system pump enable/ disable

P49 Priority time for central heat over domestic hot water.

P50 Priority time for domestic hot water over central heat.

Normally, priority is given to the DHW function. When the unit receives a call for DHW, the priority time set by P50 begins (DHW over CH). If the call for DHW continues until that timer times out, the unit begins to send heat to the CH system and the timer set by P49 begins (CH over DHW).

Normally the valve is operated by a solenoid controlled by the SIT board. However, the valve also includes a manual actuating arm which can be helpful during troubleshooting. The table below outlines the valve function.

Valve position	Sends water to	Arm position
Not energized	DHW	Down
Energized	CH	Up

To test the valve, move the actuator arm to check for free motion. Insert a jumper between terminals 8 and 9 on the high-voltage terminal strip. The valve should actuate, and you should see the arm move.

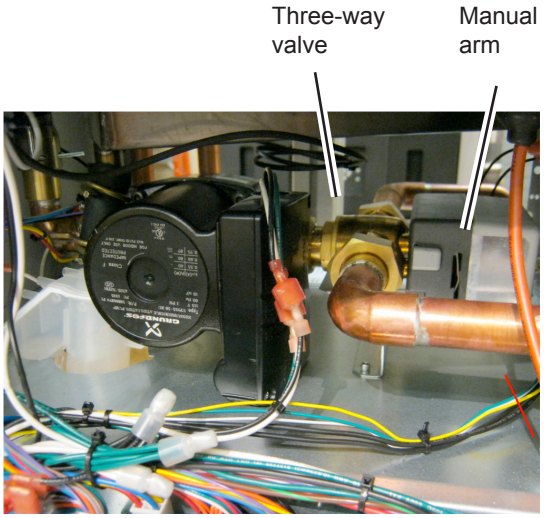


Fig. B23-1 - Three-way Valve

Tools and equipment required:

- Adjustable wrench

Replacement procedure:

1. Turn off the power switch on the front of the unit.
2. Shut off the gas supply to the unit.
3. Isolate the boiler and drain it.
4. Disconnect the two wires running to the back of the unit.
5. Using the wrench, undo the unions on each side of the valve.
6. Undo the union at the center of the assembly. At this point you will be able to remove the valve.
7. To reassemble, reverse the instructions listed above. Check for leaks after assembly.

On a “Combi” unit (central heat plus domestic hot water), the hot water is produced by a flat plate heat exchanger located under the rear of the unit. See Fig. B24-1.

Over time, the interior of the heat exchanger can become coated with a mineral buildup that reduces the heat transfer. In some cases it is possible to pump a cleaning solution through the exchanger and revive it. (Laars recommends straight white vinegar for this purpose.) If this does not improve the performance, the exchanger must be replaced.

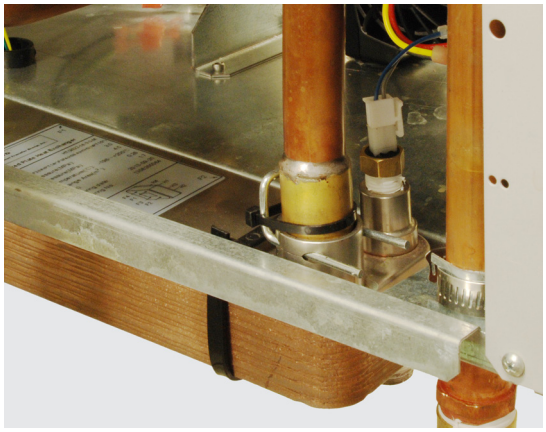


Fig. B24-1 - Flat Plate Water Heat Exchanger

Replacement Procedure:

The heat exchanger on this unit has been designed to be easy to replace. At each end of the assembly, the piping is connected by quick-disconnects. See Fig. B24-2. To remove one of the fittings, first cut the black Ty-Wrap. Next, pull out the metal locking pin. To reconnect, insert the locking pin, then install a new Ty-Wrap.

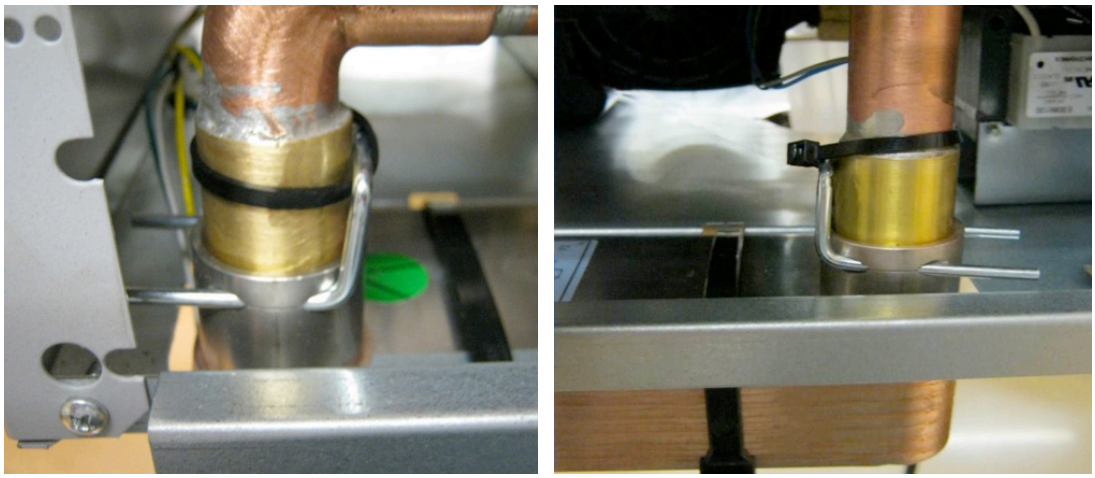


Fig. B24-2 - Quick-Disconnects for Heat Exchanger

B25 Hot Water Problems - Indirect Tank (MXLH)

The Mascot LX can be set up to service an “indirect” hot water tank. The heat for the indirect tank is supplied by a loop off of the main central heat loop, as shown in Fig. B25-1. The DHW loop has its own DHW pump. The control input can be provided by an aquastat (see Section B26) or a DHW sensor (see Section B27).

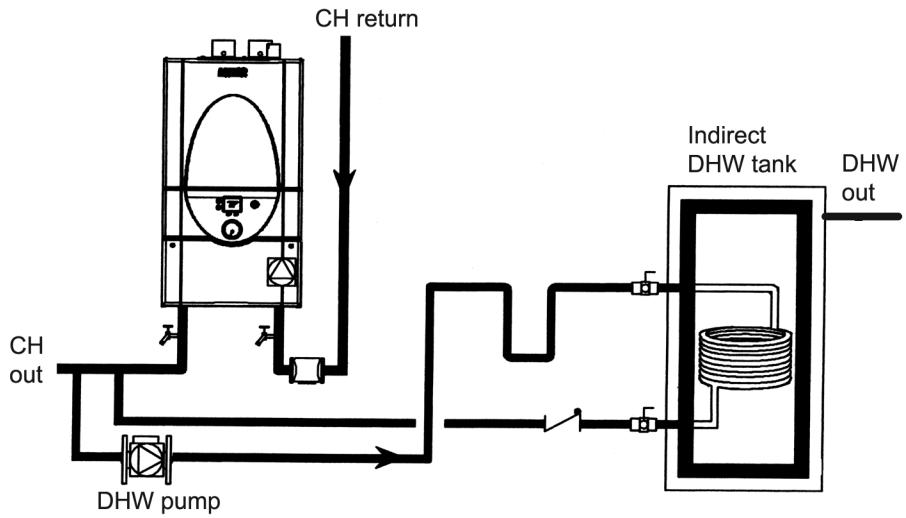
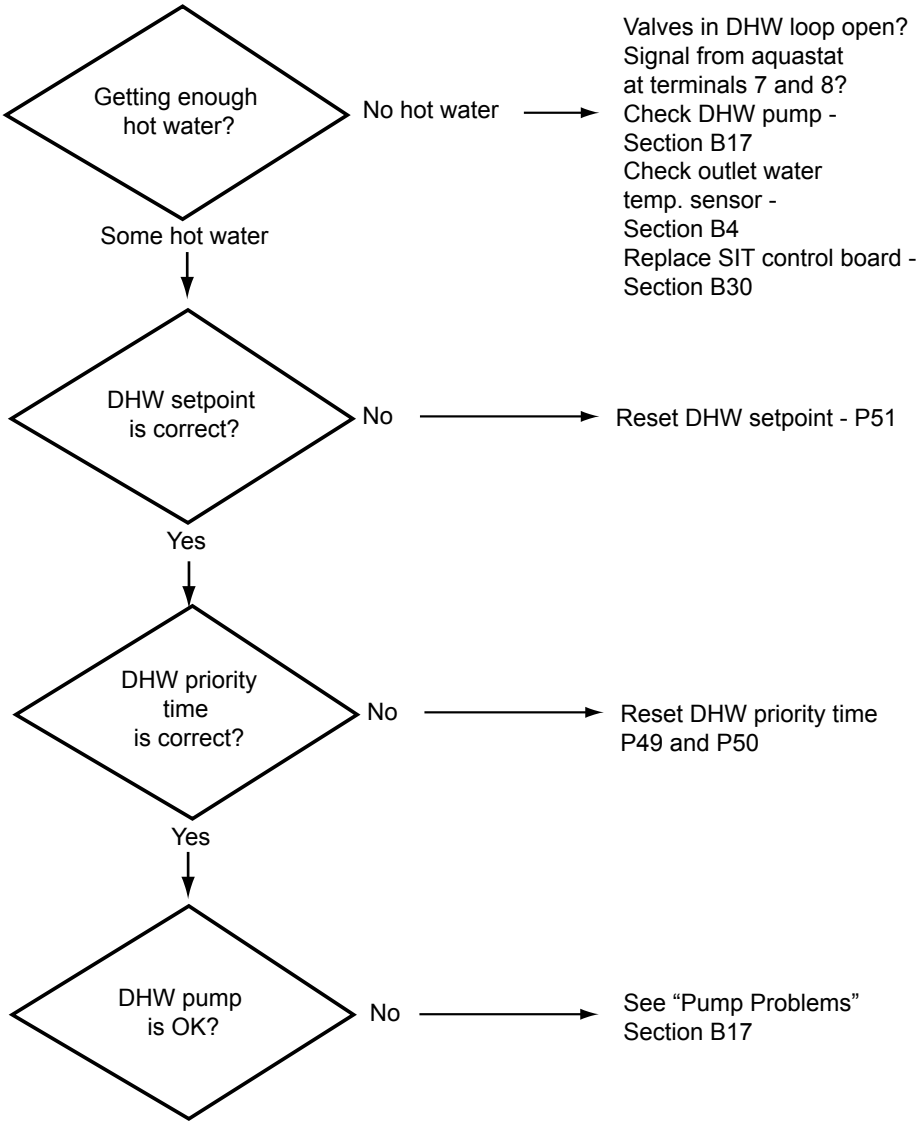
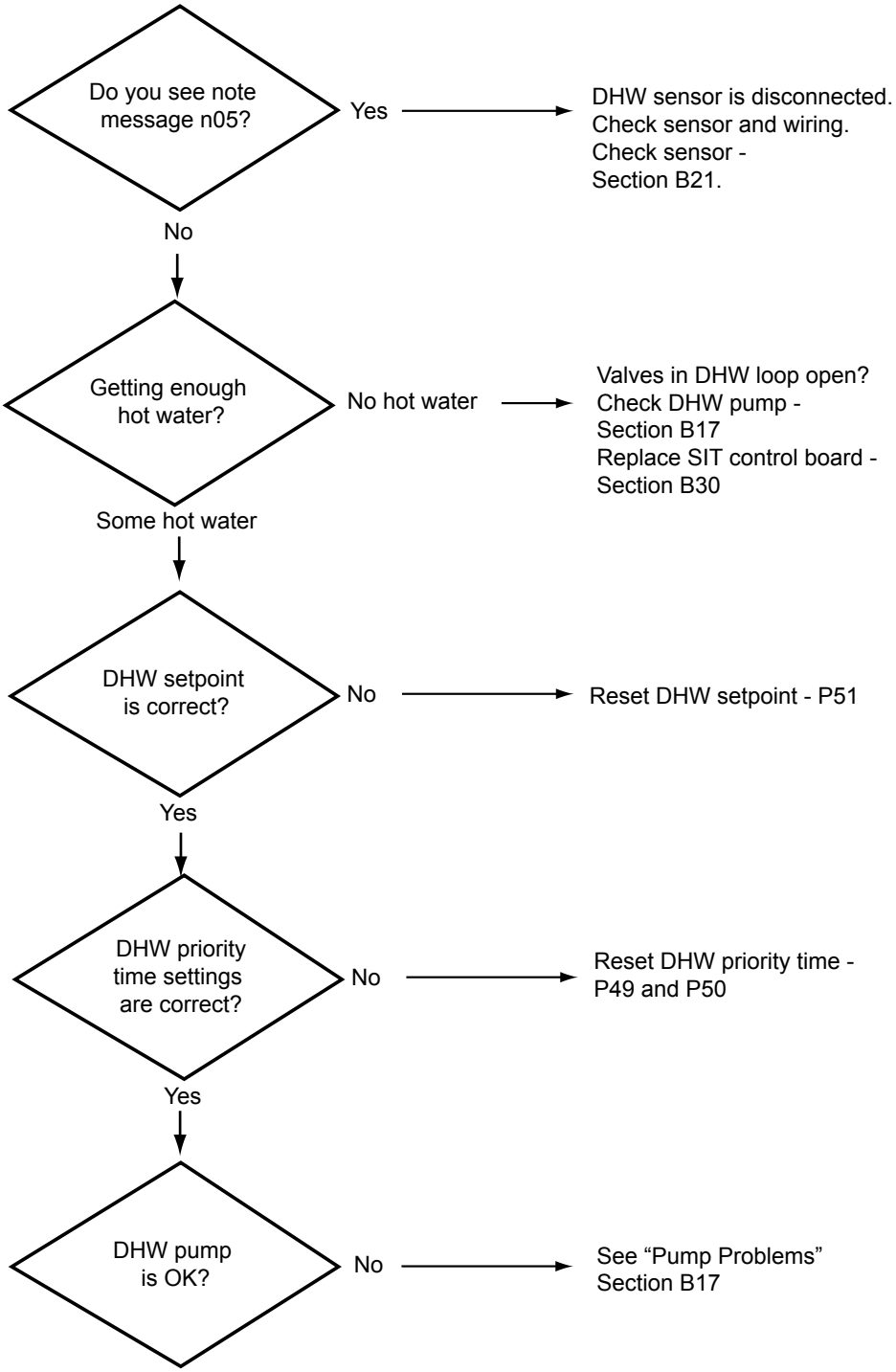


Fig. B25-1 - Arrangement for Indirect DHW Tank


Getting enough hot water?
No hot water
Valves in DHW loop open?
Signal from aquastat at terminals 7 and 8?
Check DHW pump - Section B17
Check outlet water temp. sensor - Section B4
Replace SIT control board - Section B30
Some hot water
DHW setpoint is correct?
No
Reset DHW setpoint - P51
Yes
DHW priority time is correct?
No
Reset DHW priority time P49 and P50
Yes
DHW pump is OK?
No
See “Pump Problems” Section B17

B27 Hot Water Problems - Indirect Tank with Sensor (MXLH)



Up to eight Mascot LX units can be set up in a “cascade.” To do this, the boilers must be “daisy-chained” together using Modbus.

Modbus Wiring -

The Modbus terminals are located on the low-voltage terminal strip: 17 = A, 18 = B, and 16 = ground. See Fig. B28-1.

The quality of the wiring is important. The wiring should be three-wire shielded cable with ground. The ground wire should be connected to a good chassis ground *at one end of the daisy chain only*. Wire terminal A on one boiler to terminal A on the next, and so on.

Modbus Address Auto Configuration -

To configure the control system, identify which boiler is going to be the “master” for the cascade. Go to Installer mode. Go to parameter P06 - “Cascade Address.” Set the address to “0”, and press and hold the OK/Select button. When “Auto Cfg” appears on the display, press OK/Select to start the auto configuration process. The controller will find all of the boilers connected to the system and assign Modbus addresses. When the auto configuration is complete, the display will say “boilr #”, where “#” is the number of boilers found on the cascade system.

Modbus Address Manual Configuration -

The Modbus addresses may also be configured manually. Identify which boiler is going to be the “master” for the cascade. On that boiler, go to Installer mode. Go to parameter P06 - “Cascade Address.” Set the address to “0.” Press OK/Select. (Do not press and hold OK/Select - that would trigger the auto configuration routine.)

On each of the other boilers, set up the Modbus address. Go to P06, set the address using a unique number, and press OK/Select.

Setting Cascade Setpoints -

The setpoints must be set up on each of the boilers. On each boiler, go to Installer mode. The three parameters are:

P07 Cascade Setpoint

P08 Cascade Off Hysteresis

P09 Cascade On Hysteresis

Be sure that the value for P09 is always higher than the value for P08.

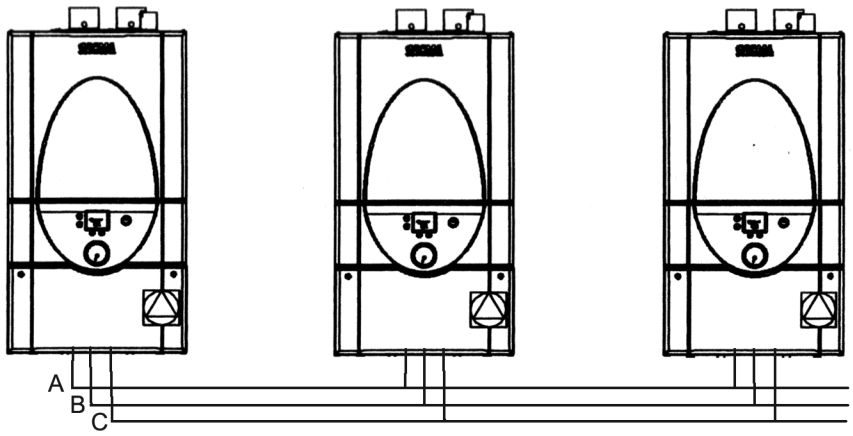


Fig. B28-1 - Modbus Connections

B29 External Modulation Control (BMS)

The Mascot LX can accept a 0 - 10V DC input so it can be controlled by a building management system or external modulating control. The Mascot can use the 0 - 10V signal to control modulation or fan speed, outlet temperature, or heat demand. The setup for each of these is slightly different.

External Modulation Enabled -

The external modulation control can be enabled or disabled using Installer mode:

P30 0 - 10V Input Enable/ Disable

External Modulation Scaling -

The maximum and minimum input signal levels can be set using Installer mode:

P31 BMS Voltage at Minimum

P32 BMS Voltage at Maximum

BMS Controls Modulation (Fan Speed) -

P25 0 - 10V to Power (enabled)

P33 On Threshold Voltage

P34 Off Hysteresis Voltage

P35 BMS Rate at Minimum Voltage

P36 BMS Rate at Maximum Voltage

This is the default 0 - 10VDC configuration. The external signal directly corresponds to fan speed or boiler power. In this mode, the call is initiated by the 0- 10V input based on parameters P33 and P34. The modulation power can also be scaled using P35 and P36.

BMS Controls Setpoint -

P25 0 to 10V to Power (disabled)

P37 BMS Temperature Setpoint at Minimum Voltage

P38 BMS Temperature Setpoint at Maximum Voltage

In this mode, the 0 - 10VDC input directly controls the boiler's output temperature. Note that for this setup, P25 must be disabled.

BMS Initiates Heat Demand -

P26 0-10V BMS Thermostat Demand (disabled)

P33 BMS On Volts

P34 BMS Demand Off Differential Voltage

This arrangement eliminates the need for a separate T-T call. This allows a heat demand to be created every time the 0 - 10V signal exceeds the value set for P33. The heat demand will remain until the 0 - 10V signal drops below the value set for P33 minus P34.

Replacing the SIT Control Board

The controller for this unit handles all of the control functions required for normal operation: operating temperature control, modulation of output (blower speed control), ignition control, pump control, outdoor reset, high limit control, and many other functions. This controller has proven to be very reliable.

A suggestion -
If the control system is not operating correctly, please "check out" all of the other possibilities before you replace the control board. Most service problems are caused by the sensors and devices that work with the controller, or by installation or setup problems. It is very rare for a problem to be caused by the controller itself.

Programs on the SIT Board and Display:

There are actually ***two*** copies of the program that controls this unit - one copy in the display, and another copy in the SIT board. If you replace just the SIT board, and leave the display in place, the program in the new "blank" SIT board will be copied over from the display. In the same way, if you replace just the display, the program will be copied over from the SIT board. This means that you do not have to order a special preprogrammed replacement part. However, if you replace ***both*** the display and the SIT board, ***both*** copies of the program will be lost. In this case, you will have to specify the serial number of the boiler when ordering the replacement parts.

Required Tools:

- Small flat screwdriver
- Phillips-head screwdriver
- Needle-nose pliers

Replacement Procedure:

1. Turn off the power switch on the front of the unit.
2. Shut off all manual gas valves to the unit.
3. Remove the lower front panel.
4. Remove the two screws shown in Fig. B30-1.
5. The front panel is hinged. Swing it down.

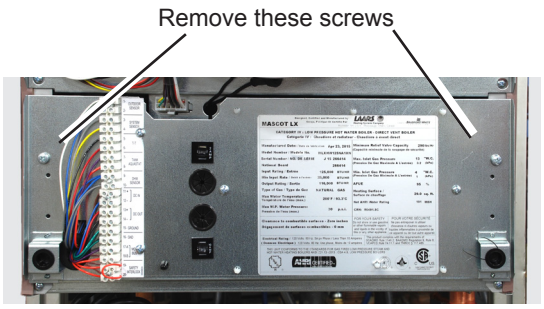


Fig. B30-1 - Opening the Lower Front Panel

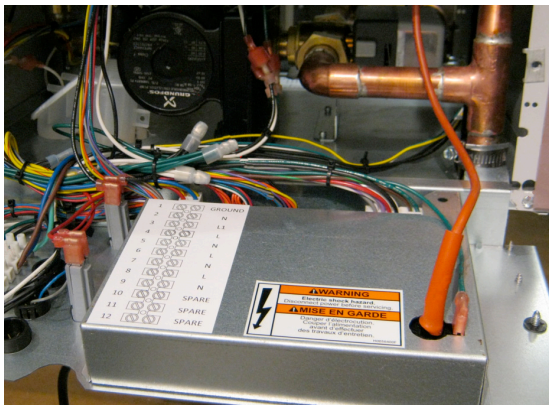


Fig. B30-2 - Removing the Metal Cover

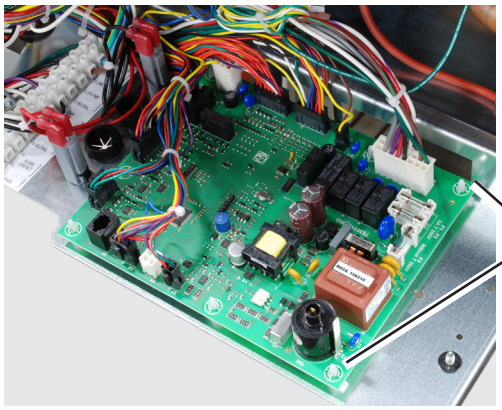


Fig. B30-3 - Standoffs Supporting Control Board

Replacing the SIT Control Board (continued)

6. You will notice a metal cover that protects the back of the control board. See Fig. B30-2. Disconnect the large red and small green wires for the direct spark ignition. Remove the two Phillips-head screws that hold the metal cover in place, then remove the cover.

7. Carefully unplug each of the wiring connectors from the control board. Each connector is held in place by a small tab. Press in on the tab to release the connector. You will need a small screwdriver to release some of the connectors in the back. Be careful not to damage the wires by pulling on them.

8. The control board is supported on a set of six stand-offs. See Fig. B30-3. The easiest way to release the board is to work with the *lower* part of each standoff first - the part below or behind the board.

   With a pair of needle-nose pliers, press the two tabs together to release each standoff. After you have done this for all six standoffs, you will be able to remove the board.

   Once the board is free, you can use the pliers to squeeze the top of each standoff so you can remove it from the board.

9. To replace the board, repeat the steps listed above in the reverse order. Replace all of the connectors in their proper locations. Replace the standoffs on the new board. The connectors are keyed, so you cannot insert them backwards.)

The Mascot LX should be inspected at least once a year by a qualified service technician.

1. Clear the area around the unit. Remove anything that could burn, and any flammable liquids.
2. Make a quick visual check of the inside of the unit. Look for anything that is “out of the ordinary,” especially signs of corrosion or moisture. Check for loose wires, discoloration of parts, leaks, or any other signs of trouble. Be sure to check the following areas:
    - Control box
    - Gas valve
    - Sensors and switches
    - Condensate trap
    - Pump
    - Three-way valve (Combi units)
3. Clean the condensate trap. See Section B14. If the unit has a condensate neutralizer, be sure it is working.
4. Check the vent system, including the joints. Clean the screens on the terminals.
5. Clean the burner and combustion chamber. See Section C4.
6. Do a combustion analysis to check the CO_2 at maximum and minimum output. See Section C2.

About Correct Combustion

When the unit is firing, the gas valve must always supply the correct amount of gas to match the amount of air going through the burner. The ratio of gas to air remains constant, but the control module adjusts the blower speed to adjust for changes in heat load. If the ratio of gas to air is not correct, this will cause poor combustion, and this can cause several different problems:

- Poor combustion can cause the unit to produce carbon monoxide, and this may lead to personal injury or death.
- Poor combustion will make the unit run less efficiently, and cause it to use more gas than necessary.
- Poor combustion can cause maintenance problems, including sooty exhaust and a fouled heat exchanger. Eventually this can reduce the life of the unit.

Before the unit leaves the factory, it is test-fired and the combustion settings are adjusted. However, once the unit is installed, the airflows (air inlet and exhaust) will be different, because of the different arrangements of the inlet and exhaust piping. This is why the combustion settings must be re-set after installation. (For the setup procedure, see the instructions in the following sections.)

Depending on the gas/air mixture, the burner can operate in three different ways:

- When the burner is burning correctly (correct gas and air mixture), enough air is available to combine with the gas, and the flame produces CO_2 ("carbon di-oxide") and H_2O (water). ("Carbon di-oxide" includes two oxygen atoms attached to every carbon atom.)
- When the burner cannot get enough air, the flame is "starved" for air. The flame continues to burn, but since enough oxygen is not available the result is CO ("carbon mon-oxide"). ("Carbon mon-oxide includes just one oxygen atom attached to each carbon atom.) This is dangerous because carbon mon-oxide can replace the oxygen in the air you are trying to breathe. This is the reason for the warnings we have included in this manual.
- Another kind of problem can happen if the flame has too much air for the amount of gas supplied. In this case, the extra air cools the flame temperature. The flame lifts off of the burner surface, and begins to produce too much CO.

Of course, the main concern is that bad combustion is potentially dangerous, but bad combustion can also cause maintenance problems in the unit. A "sooty" flame can eventually create enough soot to plug up the heat exchanger. So the goal is to set up the burner so that it is always producing the correct amount of CO_2, and the minimum amount of CO. To do this, you use two adjustments on the gas valve: the high- and low-fire CO_2 adjustment screws.

C2 Combustion Adjustment Procedure

⚠ DANGER

Improper adjustment may lead to poor combustion quality, increasing the amount of carbon monoxide produced. Excessive carbon monoxide levels may lead to personal injury or death.

Equipment required:

- Combustion analyzer
- 2.5 mm Allen wrench
- 4 mm Allen wrench

Replacement procedure:

1. Create an active “Call For Heat” signal so the unit is always firing. On the low voltage terminal strip, insert a jumper between terminals 3 and 4. See Fig. C2-1.
2. Take the controller to Service mode. Press and hold the OK/ Select button and the Up buttons for five seconds.
3. The next job is to measure the CO_2 and O_2 in the flue products at High Fire. To do this, the Mascot LX must be forced go to High Fire. Use the Up arrow to increase the firing rate to 100%. (All of the segments in the flame image will be lighted.) Figure C2-2 shows the type of display you should see.
4. The CO_2 readings should be between the values shown in Table C2-1. If the CO_2 is not within the range shown, you must make some adjustments. Remove the upper front panel so you can reach the gas valve shown in Fig. C2-3.

   To adjust the high fire CO_2, locate the high fire adjuster screw shown in Fig. C2-3. Use the 2.5 mm Allen wrench. Slowly make adjustments in 1/16 of a revolution increments until the CO_2 is within the range shown in the table.

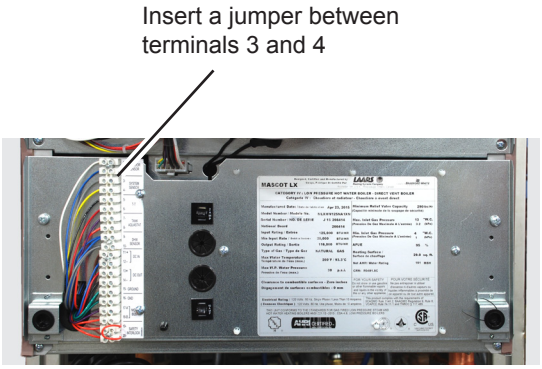


Fig. C2-1 - Jumper location for “call for heat”

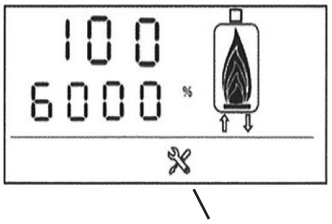


Fig. C2-2 - Control display during “high fire”

5. Next you need to measure the CO_2 and O_2 in the flue products at Low Fire. Use the Down arrow to reduce the firing rate to 20%. You can also use the OK/Select button to toggle between high fire and low fire. (At low fire, only the smallest segment in the flame image will be lighted.)

   The CO_2 readings should be between the values shown in Table C2-1. If the CO_2 is not within the range shown, you must make some adjustments. To adjust the Low Fire CO_2, use the 4 mm Allen wrench to turn the Low Fire adjuster screw shown in Fig. C2-3. Slowly make adjustments in 1/16 of a revolution increments until the CO_2 is within the range shown in the table.

Gas Type	High Fire CO_2	Low Fire CO_2
Natural	8.9% to 9.9%	0.5% lower than high fire CO_2
Propane	9.9% to 10.9%	0.5% lower than high fire CO_2

Table C2-1 - CO_2 Range

6. The adjustment you just made for the Low Fire setting could affect the High Fire setting, so you need to re-check the High Fire setting. Press the Up arrow to go back to the 100% firing rate. The CO_2 should still be at about the same level listed in Table C2-1. If the CO_2 is not correct, repeat the steps listed above.
7. Use the Down arrow to go back to 20% firing, and re-check the CO_2 during Low Fire.
8. Once the CO_2 values are correct for both High Fire and Low Fire, leave the Service mode. Press and hold the OK/ Select button for 5 seconds.
9. Remember to remove the “call for heat” jumper from the low-voltage terminal strip.

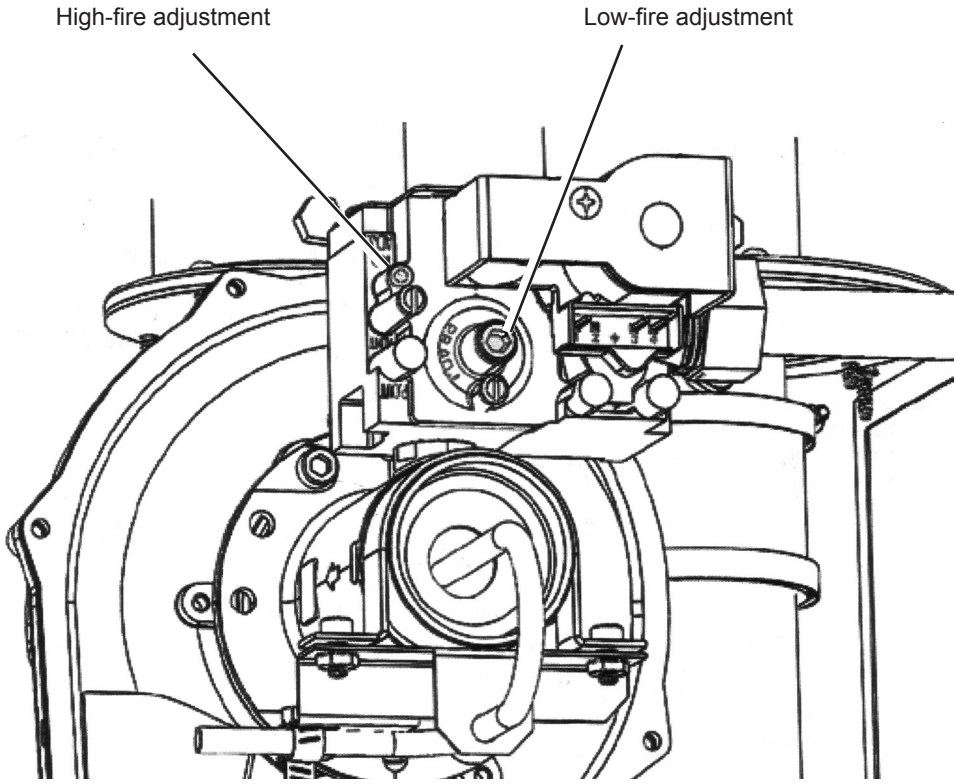
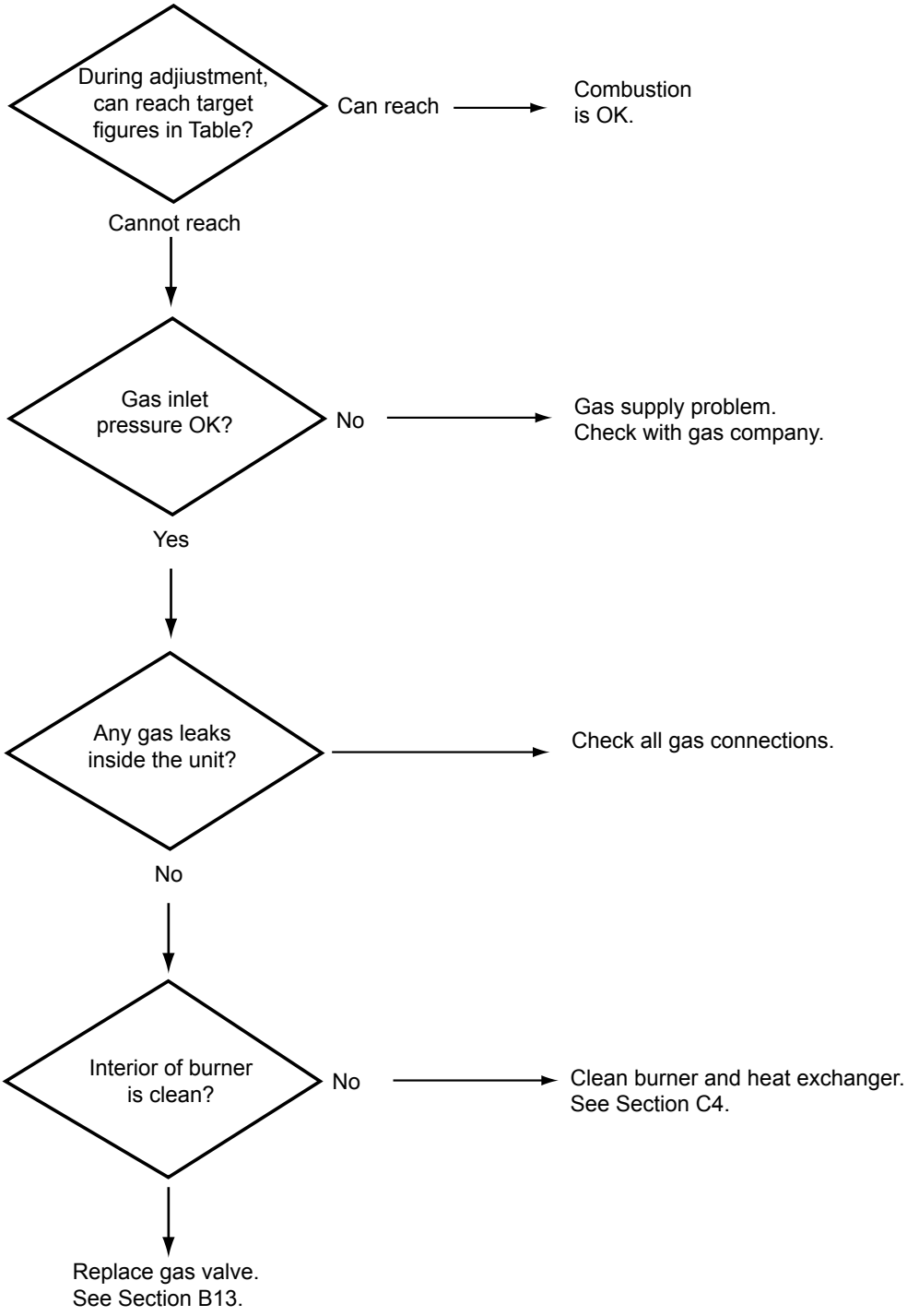


Fig. C2-3 - High- and low-fire adjustments on gas valve


During adjiustment, can reach target figures in Table?
Can reach
Combustion is OK.
Cannot reach
Gas inlet pressure OK?
No
Gas supply problem. Check with gas company.
Yes
Any gas leaks inside the unit?
Check all gas connections.
No
Interior of burner is clean?
No
Clean burner and heat exchanger. See Section C4.
Replace gas valve. See Section B13.

Cleaning the Burner and Heat Exchanger

If black carbon soot is allowed to build up on the internal surfaces of the heat exchanger, this can affect the efficiency and/or smoothness of operation of the unit. The possible causes include: incomplete combustion, combustion air problems, venting problems, or short-cycling.

Laars recommends the unit be inspected once a year, and cleaned if necessary. If a condensing boiler is operated consistently at high temperatures, it may need to be cleaned more often.

As part of the cleaning process, you will need to remove the blower.

WARNING

Black carbon soot buildup on a dirty heat exchanger can be ignited by a random spark or flame. To prevent this from happening, dampen the soot deposits with a wet brush or fine water spray before servicing the heat exchanger.

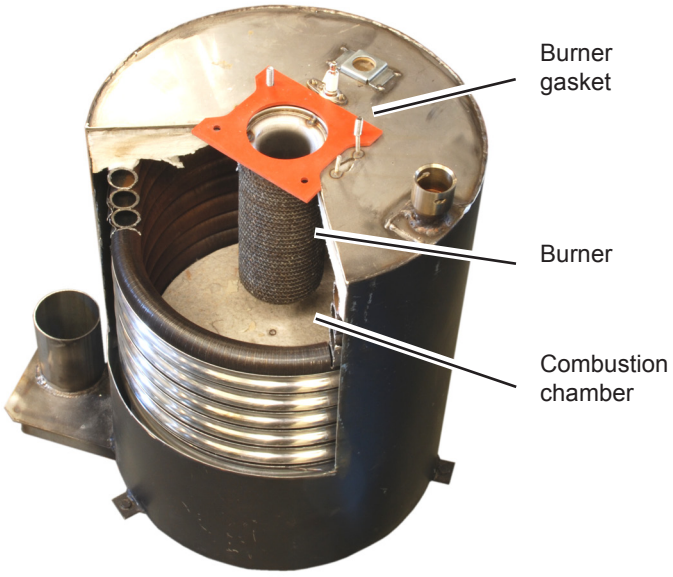


Fig. C4-1 - Burner and combustion chamber

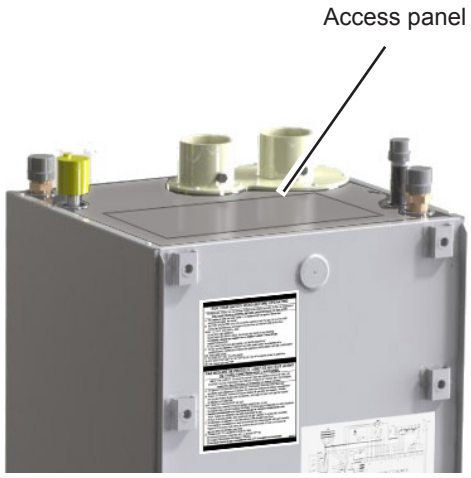


Fig. C4-2 - Access panel on top of unit

Tools required:

- Compressed air
- Non-detergent glass cleaner (i.e. Windex ®)
- Power drill
- Soft brush on a long shaft
- Furnace vacuum (i.e. SootMaster ®)
- Drain hose (approx. 6')
- Pump-type garden sprayer
- White vinegar

Cleaning procedure:

1. Turn off the power to the unit using the switch on the front panel.
2. Shut off all gas supply valves to the unit.
3. Remove the hose at the outlet of the condensation trap, and attach a longer hose. Run the free end of the hose into a different container – not into the drain normally used for the condensate.

Cleaning the Burner and Combustion Chamber (continued)

4. To reach the burner and combustion chamber, start by removing the blower as described in Section B11.
5. Remove the burner gasket.
6. With the blower removed, the small panel on the top of the unit will allow access to the end of the burner. See Fig. C4-2. Lift the burner up and away from the combustion chamber.
7. Check the burner and clean it if necessary. Blow compressed air from the outside of the burner into the center. Wipe the inside of the burner clean with glass cleaner.

   A dirty burner may be an indication of improper combustion or dirty combustion air. Determine the cause and correct it.
8. Clean the inside of the heat exchanger by brushing away light accumulations of soot and debris. Use a power drill and a brush with soft bristles.

CAUTION

Do not use a metal brush – this could damage the surfaces of the heat exchanger tubes or the refractory material.

Be careful not to damage the white refractory material at the top and bottom of the heat exchanger.

9. Once the tubes have been brushed clean, rinse the tubes and combustion chamber. In the garden sprayer, make a mixture of water with a small amount of white vinegar. Use the sprayer to flush all of the debris out of the bottom of the flue collector. The debris will flow into the longer hose you installed on the condensate trap, and into the separate container. (Do not flush the debris into the normal condensate drain line.)

CAUTION

Failure to rinse the debris from the heat exchanger and temporary drain line may lead to a clogged condensate line, trap, or neutralizer. If a condensate pump is included in the system, this may be damaged by the debris, and this could cause property damage.

10. After cleaning, replace the parts on the unit in the reverse order of the instructions listed above. Be careful to replace the burner gasket. Do not re-use the burner gasket if it is damaged.

    When replacing the burner, be sure the flange is aligned with the mating surface. Both parts are keyed so they will fit correctly.
11. Remove the temporary hose connected to the condensate trap, and re-connect the condensate drain line.

LOCKOUT CODES

Code	Description
E001	Memory error lockout
E002	Fan speed error
E003	Flame present when not in Run
E004	Outlet auto-reset high limit
E005	Water pressure switch error
E006	Not used
E007	Low water cutoff error
E008	Field interlock error
E009	Blocked vent switch
E010	Blocked vent/ fan proving switch error
E011	Lockout due to three consecutive flame losses during Run
E012	Lockout due to three consecutive failed ignitions
E013	Flue high temperature
E014	Outlet high temperature (manual reset high limit)
E015	Flue sensor drift too high
E016	Outlet sensor drift too high
E017	Flue sensor error
E018	Outlet sensor error
E019	Inlet sensor error

BLOCKING CODES

Code	Description
b01	General - setpoint reached, etc.
b02	Anti short cycling
b03	Outlet temperature too high
b04	Delta T (inlet to outlet) temperature difference too high
b05	Flue temperature too high
b06	Line voltage too low

Appendix 1 - SIT Parameter Codes (continued)

NOTIFICATION CODES

n01	Fan speed limited due to flue gradient not detected
n02	Fan speed limited due to outlet temperature
n03	Fan speed limited due to Delta T (inlet to outlet temperature difference)
n04	Fan speed limited due to flue temperature
n05	Domestic hot water sensor not present (Combi boiler only). Hot water call will be blocked.
n06	Outdoor sensor not present

INSTALLER MODE PARAMETERS

Parameter	Description	Default	
P01	Service notification months	12	
P02	Service notification hours since last service	8760	
P03	Service notification cycles	500	
P04	Timeout for service mode	180	
P05	Modbus timeout	10 sec.	
P06	Cascade address and configuration	1	
P07	Cascade temperature set point	180°F	
P08	Cascade temperature offset	10°F	
P09	Cascade temperature hysteresis from offset	20°F	
P10	Minimum power percentage before a cascade boiler is switched off	30%	
P11	Minimum time a bic must remain on or off	30 sec.	
P12	Minimum next on time	60 sec.	
P13	Maximum kBtu of this unit	125	
P14	Maximum kBtu of Slave 1	0	
P15	Maximum kBtu of Slave 2	0	
P16	Maximum kBtu of Slave 3	0	
P17	Maximum kBtu of Slave 4	0	
P18	Maximum kBtu of Slave 5	0	
P19	Maximum kBtu of Slave 6	0	
P20	Maximum kBtu of Slave 7	0	
P21	Power at which next boiler is switched on	90%	
P22	Power at which next boiler is switched off	35%	
P23	Anti short cycling time	30 sec.	
P24	Anti cycling dropoff temperature on s2	10°F	
P25	0 - 10V to Power (fan speed)	Enabled	
P26	0 - 10V to outlet setpoint	Disabled	
P27	Alarm contact configuration	Enabled	
P28	Domestic hot water demand blocks system pump enable/ disable	Disabled	
P29	System pump always on enable/ disable	Disabled	
P30	0 - 10V input enable/ disable	Enabled	

Appendix 1 - SIT Parameter Codes (continued)

Parameter	Description	Default	
P31	Building management system voltage at minimum	2VDC	
P32	Building management system voltage at maximum	10VDC	
P33	On threshold voltage	1VDC	
P34	On hysteresis voltage	0.5VDC	
P35	Building management system rate at minimum voltage	20%	
P36	Building management system rate at maximum voltage	100%	
P37	Building management system temperature setpoint at minimum voltage	70°F	
P38	Building management system temperature setpoint at maximum voltage	180°F	
P39	Postcirculation time for central heat pump	30 sec.	
P40	Postcirculation time for domestic hot water pump	30 sec.	
P41	Postcirculation time for system pump	30 sec.	
P42	Summer kick timer for central heat pump	20 sec.	
P43	Summer kick timer for domestic hot water pump	20 sec.	
P44	Summer kick timer for system pump	20 sec.	
P45	Delta T setpoint for central heat pump speed control	20°F	
P46	Minimum output voltage for central heat pump output	3.5VDC	
P47	Differential maximum fan speed for hot water demand	0 rpm	
P48	Differential maximum fan speed for central heat demand	0 rpm	
P49	Priority time for central heat over domestic hot water	0 min.	
P50	Priority time for domestic hot water over central heat	50 min.	
P51	Hot water tank setpoint	180°F	
P52	Stop hot water tank demand offset	0°F	
P53	Start hot water tank demand offset	6°F	
P54	Block hot water demand offset (Combi units only)	12°F	
P55	Unblock hot water demand offset (Combi units only)	20°F	
P56	Minimum user setting hot water setpoint	60°F	
P57	Maximum user setting hot water setpoint	140°F	

Parameter	Description	Default	
P58	Frost protection start pump temperature	45°F	
P59	Frost protection start burner temperature	37°F	
P60	Frost protection stop burner hysteresis	5°F	
P61	Low outdoor air temperature for heat curve (LOD)	25°F	
P62	High setpoint for test curve (HBT)	180°F	
P63	High outdoor air temperature for heat curve (HOD)	70°F	
P64	Low setpoint for heat curve (LBT)	120°F	
P65	Outside temperature disabling central heat demand (WWSD)	90°F	
P66	Outside temperature disabling central heat hysteresis	5°F	
P67	TH1 shift heat curve	0°F	
P68	Boost function time	0 sec.	
P69	Boost function temperature step per period	0°F	
P70	Minimum user setting central heat setpoint	32°F	
P71	Maximum user setting central heat setpoint	190°F	
P72	Block offset central heat demand	10°F	
P73	Block hysteresis central heat demand	20°F	

App2 Appendix 2 - Ignition and Firing Sequence

This is the basic operating sequence of the boiler whether there is a hydronic or domestic hot water call for heat.

1. The unit receives a call for heat.
2. The boiler pump and the system pump start. Once the fan reaches operating speed, the blower begins a pre-purge for 10 seconds.
3. After the pre-purge, the direct spark and gas valve activate, and the unit starts a four-second trial for ignition.
4. The unit fires and runs at a reduced rate of 45% for 10 seconds.
5. After the reduced rate time has ended, the flame signal is compared with a pre-set standard. If the flame is adequate, the unit goes to normal operation. It will modulate based on the system load and the control setpoints.
6. When the call for heat ends, or the set point is reached, the gas valve closes, and the flame goes out.
7. The fan continues to run in post-purge for 11 seconds.

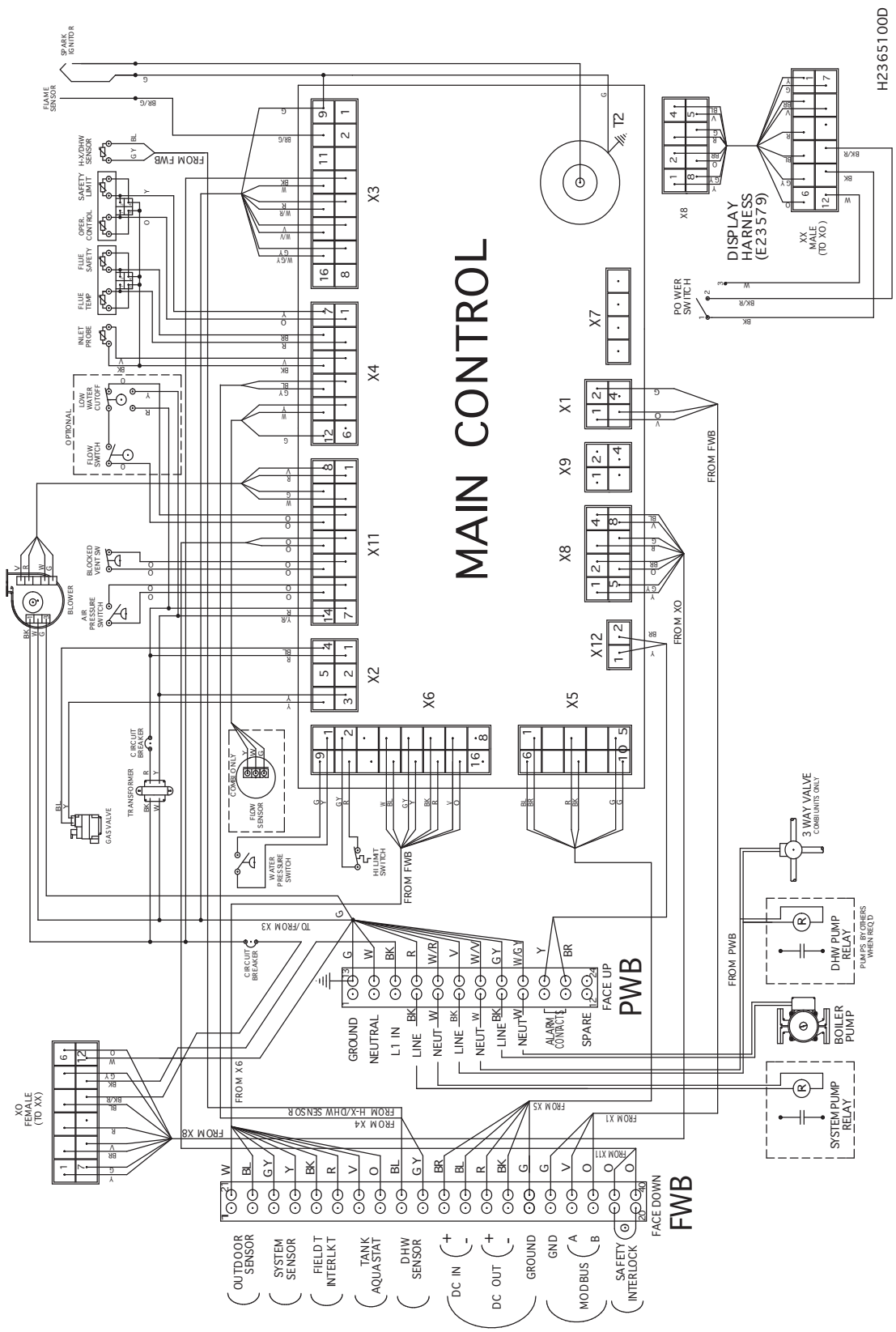


Fig. App3-1 - Wiring Diagram

Appendix 3 - Wiring Diagrams (continued)

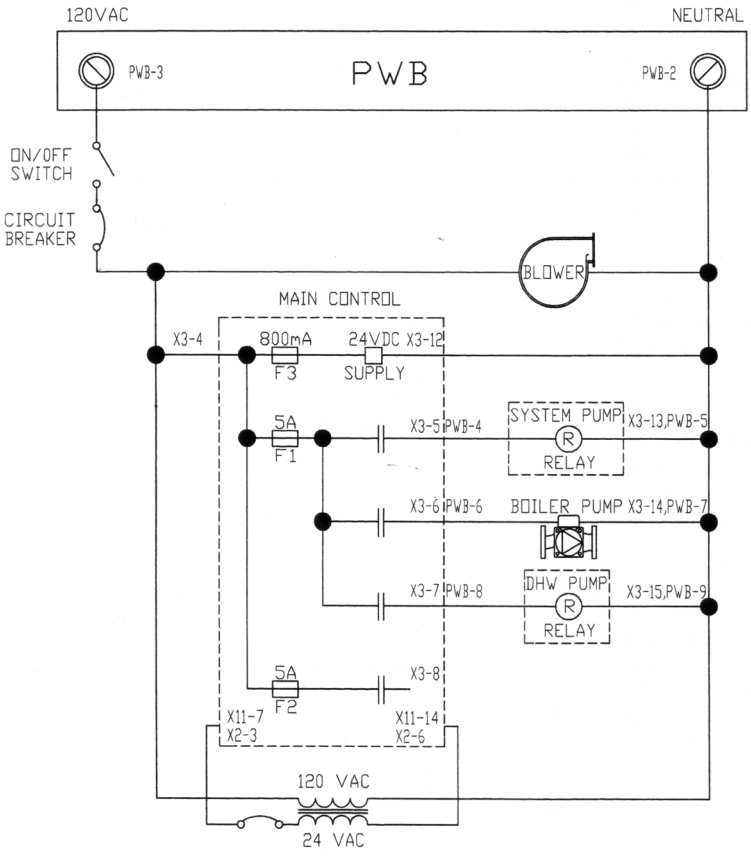


Fig. App3-2 - 120V Wiring Diagram

High voltage field connections -
(located behind the inside lower panel)

Low voltage field connections -
(located on the front of the inside lower panel)

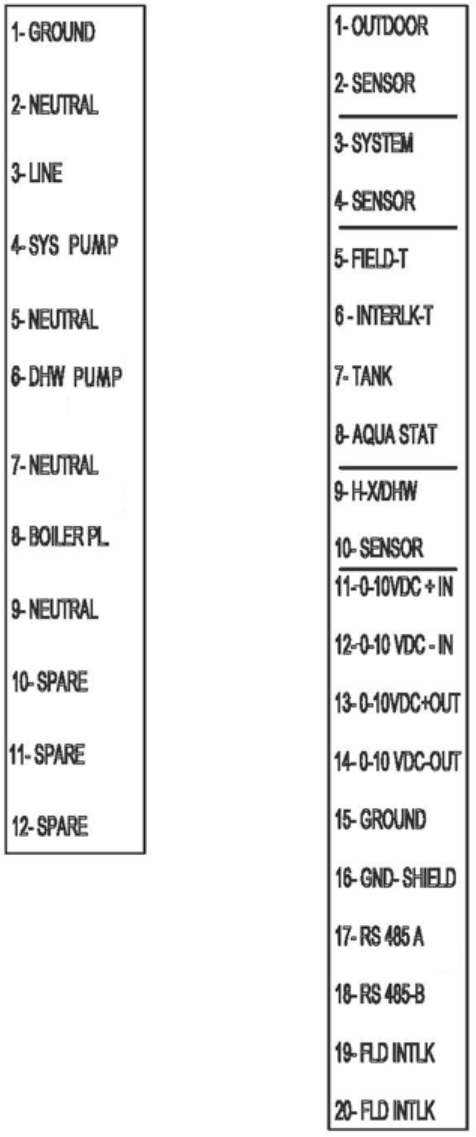


Fig. App3-3 - Terminal Connections

App4 Appendix 4 - Gas Conversion Procedure

In this section we will explain how to change the unit from natural gas to propane operation, or from propane to natural gas. It is not necessary to change any parts or orifices. However, you must be careful to label the unit showing the correct type of gas.

1. Remove the upper and lower front covers.

2. Find the location where the gas supply line enters the unit. Place the Propane Gas sticker over the Natural Gas sticker (or vice-versa).

3. The rating plate sticker is located behind the center door panel. Fill out the gas conversion sticker, Place it beside the rating plate sticker.

4. Confirm that the gas supply is on.

5. Start the boiler. Use the lighting procedure shown on the inside front cover or side of the unit.

6. With a combustion analyzer, check the CO_2 levels at both maximum and minimum input. See Section C2.

DANGER

Serious injury or death could occur if the CO_2 levels are not adjusted properly.

7. Close the front covers.

DANGER

This conversion shall be installed by a qualified service agency in accordance with the manufacturer's instructions and all applicable codes and requirements of the authority having jurisdiction. If the information in these instructions is not followed exactly, a fire, explosion, or production of carbon monoxide may result, causing property damage, personal injury, or loss of life. The qualified service agency is responsible for the proper and complete installation. The installation is not proper and complete until the operation of the converted appliance is checked as specified in the manufacturer's instructions.

Fig. App4-1 - Natural Gas Sticker

Fig. App4-2 - Propane Gas Sticker

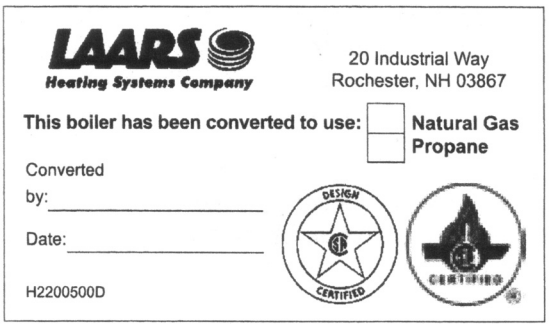


Fig. App4-3 - Gas Conversion Sticker

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