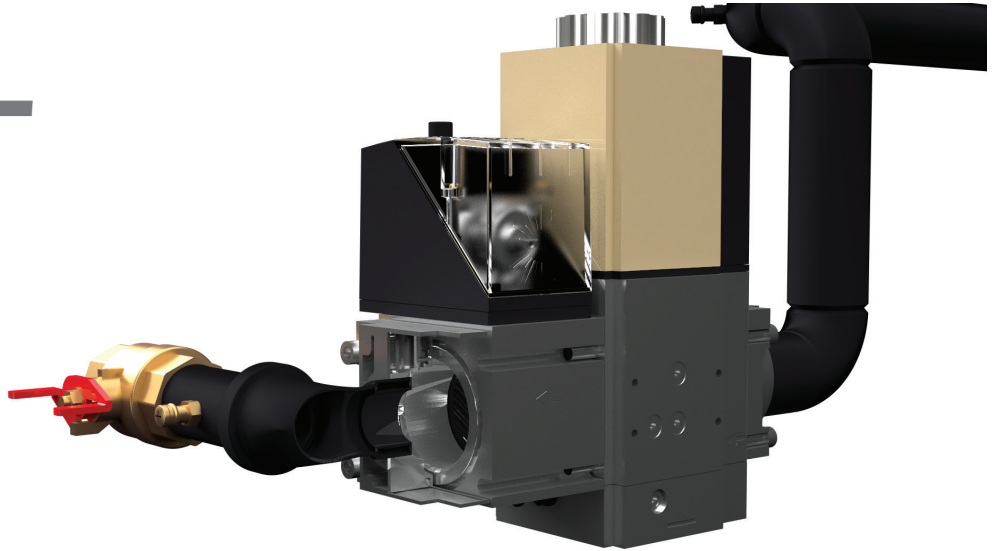


SUPPLEMENTAL INSTALLATION AND OPERATION MANUAL

HOT
2



Raypak O₂ Trim System



FOR YOUR SAFETY: Do not store or use gasoline or other flammable vapors and liquids or other combustible materials in the vicinity of this or any other appliance. To do so may result in an explosion or fire.

NOTE: This manual is supplemental for the XVers boilers, and addresses the specific differences between the XVers boilers configured with an O₂ Trim System and standard models. Please refer to the standard Installation and Operating Instruction manual specific to the XVers for installation requirements that are not related to the gas supply.

WHAT TO DO IF YOU SMELL GAS:

- Do not try to light any appliance.
- Do not touch any electrical switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.

A qualified installer, service agency or the gas supplier must perform installation and service.

This manual should be maintained in legible condition and kept adjacent to the boiler or in a safe place for future use.

Revision 2 reflects the following changes:

Revised SYSTEM DESCRIPTION text on page 4. Removed "NOTE: The O2 trim system is a factory-installed option" from SYSTEM DESCRIPTION on page 4. Revised "DDC circuit board" text on page 4. Added a new sentence "This option adds 30W to the power consumption..." on the last paragraph of page 5. Replaced title HMI SCREEN with DISPLAY SCREEN on page 6. Updated Tables A, B, C, and D on page 6. Added a new sentence "Only the optimum curve is provided for propane." on the User Control Setting on page 6. Revised Figure 7 title on page 6. Updated Figure 8, "O2 Trim System Wiring Diagram" on page 7. Replaced the Raypak ISO logo on the back cover page.

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1. WARNINGS

Pay Attention to these Terms

▲ DANGER	Indicates the presence of immediate hazards which will cause severe personal injury, death or substantial property damage if ignored.
▲ WARNING	Indicates the presence of hazards or unsafe practices which could cause severe personal injury, death or substantial property damage if ignored.
▲ CAUTION	Indicates the presence of hazards or unsafe practices which could cause minor personal injury or product or property damage if ignored.
CAUTION	CAUTION used without the warning alert symbol indicates a potentially hazardous condition which could cause minor personal injury or product or property damage if ignored.
NOTE	Indicates special instructions on installation, operation, or maintenance which are important but not related to personal injury hazards.

▲ WARNING: Do not use this boiler if any part has been under water. Immediately call a qualified service technician to inspect the boiler and to replace any part of the control system which has been under water.

▲ WARNING: Should overheating occur or the gas supply valve fail to shut off, do not turn off or disconnect the electrical supply to the boiler. Instead, shut off the gas supply at a location external to the boiler.

▲ WARNING: Risk of electrical shock. More than one disconnect switch may be required to de-energize the equipment before servicing.

2. SYSTEM DESCRIPTION

The optional O₂ trim system is composed of a circuit board, oxygen sensor, an actuator and valve, and inter-connecting wiring harnesses. This option is installed at the factory and is not offered for field installation.

The O₂ trim system monitors the oxygen level in the flue gas in the vent piping and if the O₂ level deviates from the target setpoint (operating curve), will modulate the actuator and valve in order to adjust the fuel gas flow to bring the O₂ level back to target setpoint.

In order to keep the flue gas O₂ level on target, the system compensates and adjusts under the following conditions:

- Partially blocked air inlet
- Variation of air inlet temperatures
- Weather variations, low and high pressure systems
- Fluctuations of the fuel heating values

In the event the system encounters any sort of error, error messages will be displayed and error lights will illuminate.

Refer to the Troubleshooting section for more information.

NOTE: Before starting the boiler, ensure the actuator stops are in the correct position. See **Figure 5**.

3. COMPONENTS

The O₂ trim system includes four main components:

1. **DDC circuit board** - The direct digital controller (DDC) board is the brains of the system, it modulates the actuator based on O₂ sensor readings and blower RPM. The DDC is located in a junction box on the side of the air box and has a cover for easy access to the controller. The DDC communicates with the touchscreen via Modbus. See **Figures 1 and 2**.
2. **Actuator and valve** - The main gas valve provides most of the fuel control. The actuator and valve provide partial fuel control (trim control). The actuator is downstream of the main gas valve. The valve is a modulating vertical shutter-style valve and is spring-loaded to fail open on loss of power or loss of signal. The actuator is a 24V-powered motor and responds to a 4 – 20mA input signal. The actuator drives a shaft counter-clockwise over 0 – 180° to move the vertical shaft of the valve with a 0 - 3.7 mm stroke. The actuator has adjustable minimum and maximum stops, but these stops **MUST** be at the 0° and 180° positions.

3. **O₂ sensor** - Installed in the vent piping to monitor flue gas (refer to the boiler's specific installation and operation manual), this wide-band lambda sensor provides O₂ measurement readings to the DDC board. The sensor has a warm-up period and is dependent on the initial temperature of the element. Actuation and gas trimming will not occur until the sensor is properly heated.
4. **Harnesses** - There are six (6) harnesses for the O₂ trim system inter-connecting O₂ components with the boiler's components. Refer to the Wiring Section.

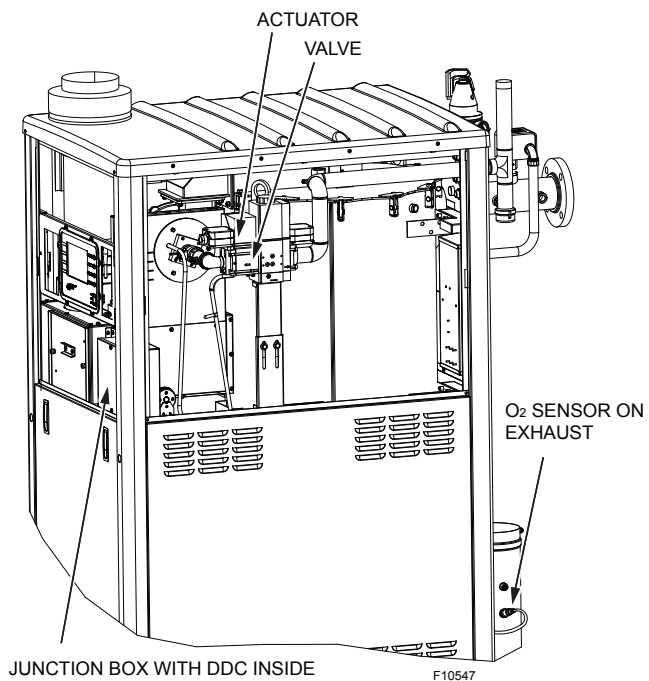


Figure 1. O₂ Trim System Components

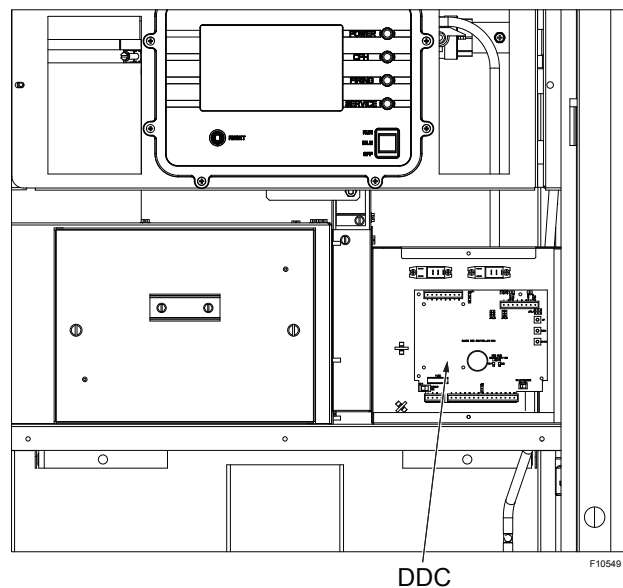


Figure 2. DDC Circuit Board Location with Cover Removed

4. INSTALLATION

- a. Install the vent with the O₂ sensor facing the boiler. Connect the O₂ sensor cable to the O₂ sensor. The O₂ sensor is installed in a tilted bung to prevent moisture build-up. See **Figure 3**.

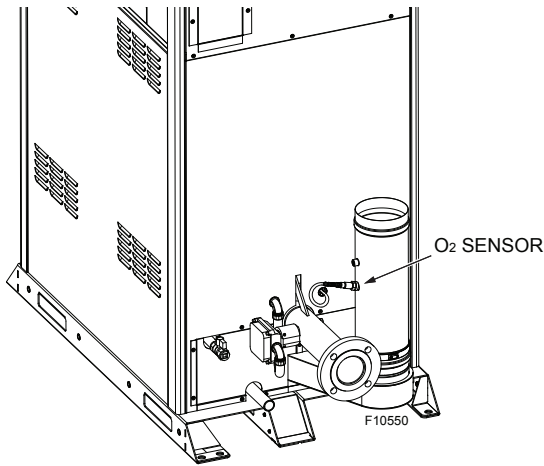


Figure 3. O₂ Sensor Location

5. PRE-START CHECK

⚠ WARNING: If you do not follow these instructions exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

Before starting the boiler, ensure the following:

1. O₂ sensor cable is connected to the O₂ sensor.
2. The DDC power switch is in the ON position. See **Figure 4**.
3. The maintenance switch is in the OFF position. See **Figure 4**.

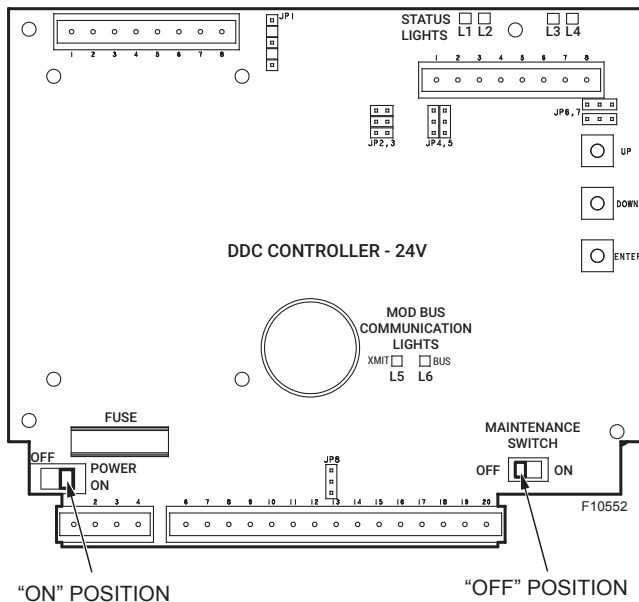


Figure 4. DDC Circuit Board

4. The actuator stops are in the correct position. See **Figure 5**.

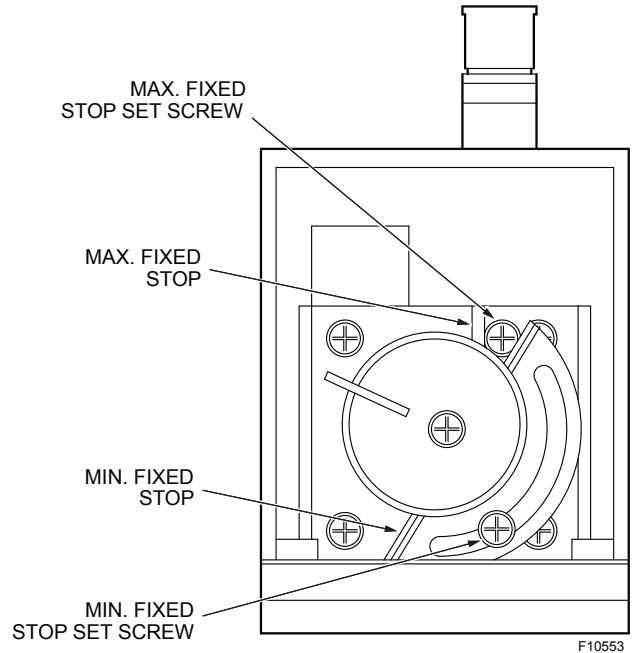


Figure 5. Actuator Stops

Refer to the boiler's installation and operation manual for further Pre-Start-up Check.

This option adds 30W to the power consumption of the unit, or 1/4 amp at 120VAC.

6. SEQUENCE OF OPERATION

- Once the boiler receives a call for heat (CFH), it will go through its normal sequence of operation. Refer to the boiler's installation and operation manual.
- The DDC is triggered "ON" when the boiler initiates the gas valve. The DDC has a short delay before it actually begins regulating. This allows the ignition cycle to complete.
- When the boiler has ignited and the delay has lapsed, the DDC will begin regulating the fuel gas based on the monitoring of the O₂ in the flue gas.
- In the event the boiler fails the ignition trial, the DDC's delay timer for regulation will restart.

NOTE: The boiler includes a manual shutter that will control the amount of gas being fed to the unit if the DDC is turned off.

While unit is running, CO₂/CO levels should be checked and verified. Refer to the following tables.

CO ₂ level ± 0.2%			
Models	Low fire	Mid fire	High fire
1756, 2006	8.0	8.8	8.9
All other models	8.0	8.9	8.9

Table A. Optimum for Natural Gas (Default)

CO ₂ level ± 0.2%			
Models	Low fire	Mid fire	High fire
1756, 2006	8.0	8.5	8.5
All other models	8.0	8.5	8.5

Table B. More Excess Air, Natural Gas

CO ₂ level ± 0.2%			
Models	Low fire	Mid fire	High fire
1756, 2006	8.0	8.9	9.3
All other models	8.0	9.2	9.3

Table C. Less Excess Air, Natural Gas

CO ₂ level ± 0.2%			
Models	Low fire	Mid fire	High fire
1756, 2006	9.3	10.2	10.3
All other models	9.3	10.3	10.3

Table D. Optimum Curve, Propane

7. DISPLAY SCREENS

There are two display screens related to the O₂ trim system:

1. Monitoring

Monitoring O₂ is on the boiler page (refer to your product's manual) and at a glance shows if the system is tracking the target O₂ curve (blue area) or if off target (red). See **Figure 7**. If in red zone, the boiler is operating in an undesirable zone and the situation should be monitored closely. The boiler's emission levels must be evaluated by a qualified service agent with a calibrated gas analyzer. Any current errors that have occurred are displayed on the boiler page. All previous errors are displayed in the boiler history log.

2. User Control Settings

The Settings page is accessible from the menu button. Adjust > Systems Settings > O₂ Trim Settings

This screen displays:

- Three different operating curves for the O₂ trim (only available for natural gas). Only the optimum curve is provided for propane.
- A graph of each operating curve with the current operating curve highlighted.

NOTE: Operating curve changes won't take place until the boiler returns to IDLE or the DDC board power is cycled.

- If DDC board power is cycled, O₂ reading will be zero until the O₂ sensor completes its warming period.

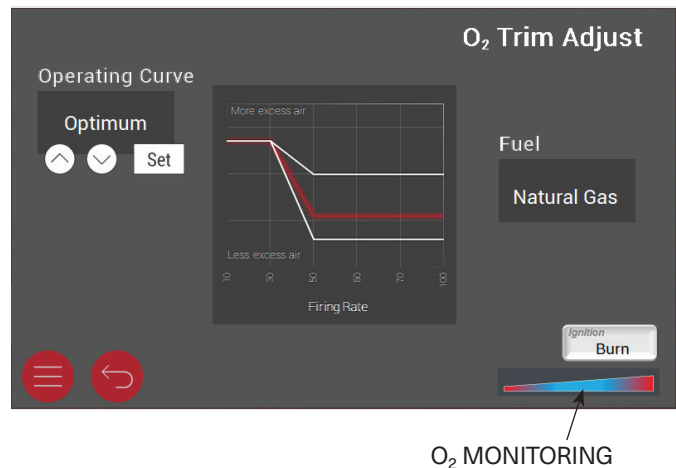


Figure 7. User Control Display Screen

8. SETTINGS

The factory setting for the O₂ trim system is the optimum operating curve. However, the user may manually adjust to operate on a curve with more or less excess air.

9. WIRING

There are six (6) harnesses for the O₂ trim system. See **Figure 8**.

1. Main gas valve
2. Power / Enable
3. Blower RPM
4. Modbus
5. Actuator
6. O₂ sensor

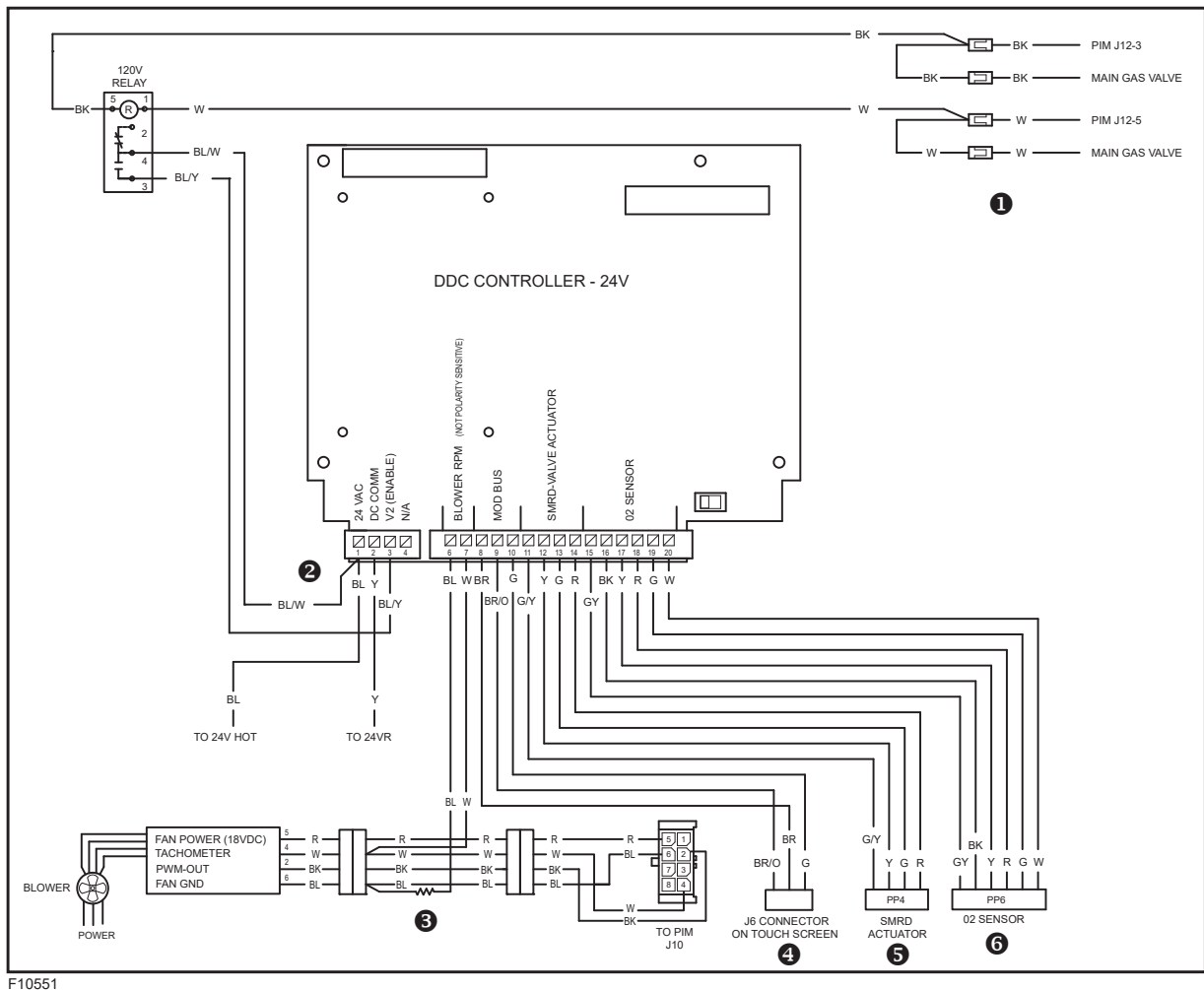


Figure 8. O₂ Trim System Wiring Diagram

10. TROUBLESHOOTING

NOTE: See Table A for corrective actions.

The DDC has two methods for communicating error messages:

1. Communication with the touchscreen (when equipped). Possible errors are:
 - a. **HO₂T - Loss of communication.** This can be caused by loss of power to the DDC or the modbus cable disconnected. Check wiring. If the DDC loses communication with the touchscreen, the O₂ trim system will continue to function normally. Modbus communication is only needed during initial commissioning.
 - b. **HO₂T - Blower RPM out of tolerance.** If the blower RPM is below or above your unit's operational range, the DDC stops regulating.
 - c. **HO₂T - Blower cable disconnected.**
 - d. **HO₂T - O₂ sensor HW fault.** O₂ sensor heater time-out or temperature guard-band fault.
 - e. **HO₂T - O₂ sensor disconnected.**
 - f. **HO₂T - Actuator output fault.**
 - g. **HO₂T - O₂ concentration out of tolerance.** O₂ reading is beyond set point tolerance in either direction.
 - h. **HO₂T - System fault.**

2. Light indicators from the control board:
 - L1** Power - orange light. Indicates the board is powered.
 - L2** Run - green light. Indicates the board is regulating.
 - L3** Alarm - red light. Major error.
 - L4** Out of tolerance - red light. O₂ reading is beyond set point tolerance in either direction.
 - L5** Blinking orange light in the middle of the board - DDC is communicating with the touchscreen
 - L6** Blinking green light in the middle of the board - Blinks together with the blinking orange light.

NOTE: When the unit is not running; if a clicking sound is coming from the DDC board, this indicates mis-wiring. Check all connections to the DDC board, and to the blower RPM, valve actuator, and O₂ sensor.

11. MAINTENANCE

Annually

The O₂ sensor calibration must be checked annually by comparing reading with a calibrated flue gas analyzer.

Connect the calibrated flue gas analyzer to the available flue gas test port on the exhaust plenum.

If the sensor reading varies by 1% O₂ more than the flue gas analyzer reading, inspect or replace the O₂ sensor.

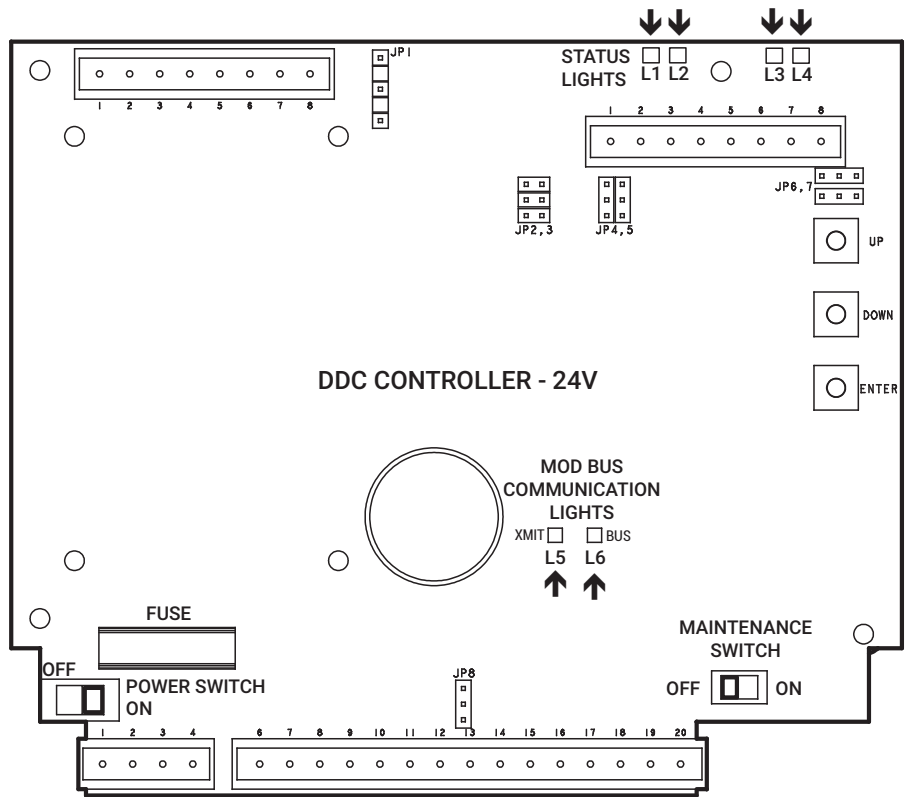


Figure 9. DDC Control Board Lights and Default Position of Switches

Problem	Cause	Solution
Loss of power – board is not powered. The boiler is not powered.	<ol style="list-style-type: none"> 1. Power / Enable connector is not installed or installed incorrectly. 2. The board is not functional. 	<ol style="list-style-type: none"> 1. Refer to the wiring diagram and reinstall correctly. Measure voltage between terminals 1 and 2 and confirm 24VAC. 2. Contact Raypak for assistance.
Loss of regulation – board is not regulating properly.	<ol style="list-style-type: none"> 1. Blower RPMs are lower than minimum boiler RPMs. 2. Blower RPMs are higher than maximum boiler RPMs. 3. Enable is not supplied to DDC. 4. Maintenance switch is ON. 5. Major error occurred. 	<ol style="list-style-type: none"> 1. The O₂ trim system will not regulate if the boiler RPMs are below the boiler's minimum or above the boiler's maximum. 2. If boiler is running normally, then verify blower RPM connector is installed correctly both to the DDC and at the blower. Cycle power to the DDC via its on/off switch. If issue is not resolved, contact Raypak for assistance. 3. Check wire diagram and check wiring for enable and the relays. 4. Switch maintenance switch to OFF and cycle power to the DDC via its on/off switch. 5. Refer to major error causes for resolution. if Alarm light is indicated.
Out of tolerance.	The DDC is unable to control due to external factors.	Check the air inlet, fuel gas pressure, BTU values, and exhaust vent. Also check that the blower RPM connector is connected.
Major Error - alarm light illuminated.	<ol style="list-style-type: none"> 1. Actuator disconnected. 2. O₂ sensor disconnected. 3. O₂ sensor fault. 4. Blower RPM disconnected. 5. Internal critical error. 	<ol style="list-style-type: none"> 1. If the boiler is running normally, check the position of the actuator. 2. If the actuator is nearly fully opened, this indicates the valve is disconnected. 3. Check connection at the DDC and check connection at the valve. Once reconnected, the boiler will regulate again. 4. To clear the red light, cycle power to the DDC via its on/off switch. 5. Refer to the O₂ sensor disconnected. 6. Refer to O₂ sensor fault. 7. Refer to blower RPM disconnected from above. 8. Refer to internal critical error.
Internal critical error.		<ol style="list-style-type: none"> 1. Cycle power to the DDC via its on/off switch. 2. If the error persists, contact Raypak for assistance.
O ₂ sensor disconnected.	If the boiler is running normally and the O ₂ sensor is lost (disconnected or sensor fault), the DDC will move the actuator to a nominal position specific for the boiler (refer to the boiler's specific installation and operation manual).	Check the position of the actuator then verify O ₂ sensor connection at the DDC and at the sensor. To clear the red light and begin regulation, cycle power to the DDC via its on/off switch.
O ₂ sensor fault.		Cycle power to the DDC via its on/off switch. If the error persists, replace O ₂ sensor. Raypak part number 652103.

Table E. O₂ Trim System Troubleshooting

If the DDC loses communication with the touchscreen, the O₂ trim system will continue to function normally. Modbus communication is only needed during initial commissioning. The touchscreen will show the error "loss of DDC", but will not shut the unit down.

12. START-UP CHECKLIST

This start-up checklist is to be completely filled out by the service technician starting up the XVers Boiler for the first time. All information may be used for warranty purposes and to ensure that the installation is correct. Additionally this form will be used to record all equipment operation functions and required settings.

GAS SUPPLY DATA

Regulator Model & Size _____ / _____ CFH
 Gas Line Size (in room) _____ In. NPT
 Length of Gas Line _____ Eq Ft
 Low Gas Pressure Setting _____ In. WC
 High Gas Pressure Setting _____ In. WC
 Gas Shut-Off Valve Type _____
 (Ball, Lube cock)
 Port _____ Std _____ Full

VISUAL INSPECTION OF COMPONENTS

Verify inspection was done and condition of components are in good working order with a "yes"
 Wiring Harness _____ Y/N
 Burner (flame) _____ Y/N
 Refractory (Visual) _____ Y/N
 Remote flame sense _____ Y/N
 Covers in place for outdoor _____ Y/N

VENTING

Vent Size: _____ Stack Height: _____
 Vent Material: _____ sketch vent on reverse side ***
 Vent Termination Type: _____
 Combustion Air Openings: Low _____ in²
 Ventilation Air High _____ in²

HO₂T

O₂ sensor cable is connected to the O₂ sensor _____
 DDC power switch is in the ON position _____
 Maintenance switch is in the OFF position _____
 Actuator stops are in the correct position _____

CLEARANCES

Front Clearance _____ In.
 Right Side Clearance _____ In.
 Left Side Clearance _____ In.
 Rear Clearance _____ In.
 Overhead Clearance _____ In.

ELECTRICAL

Voltage Supply (VAC) _____ No Load _____
 _____ Load _____
 Voltage -24 VAC _____ VAC
 Voltage Com to Ground _____ VAC
 Hot Surface Igniter _____ Ohms
 Auto High Limit Setting _____ deg F
 Manual Reset High-Limit Setting _____ deg F
 Operating Control Setting _____ deg F

Sketch plumbing on reverse side

WATER SUPPLY

Flow Rate in GPM or Delta T _____ If Avail
 Measure flow rate at full fire
 Pump Purge setting _____ Minutes
 Low Water Cutoff _____ Test
 Plumbing Size _____
 Pump Size: _____ (Boiler) Pump HP: _____
 Impeller trim _____ Pump Model _____
 Louvers _____ Screens _____

RAYMOTE

Wi-Fi signal available in boiler room _____
 Boiler provisioned with valid WiFi credentials _____
 Wi-Fi signal strength (RRS > -85) _____

EMISSIONS SETTINGS AND TEST INFORMATION

	(AT FULL FIRE)	(AT MIN. FIRE)
Blower Suction Pressure	_____ In. WC	_____ In. WC
Supply Gas Pressure	_____ In. WC	_____ In. WC
Verify stable pressure static and dynamic condition		
Manifold Gas Pressure	_____ In. WC	_____ In. WC

Nominal Factory Recommended Settings

See manual or card tag
 See manual or card tag
 See manual or card tag

The following measurements must be obtained with a Combustion Analyzer.

O ₂	_____ %	_____ %	See manual
CO	_____ PPM	_____ PPM	Less than 100 PPM
CO ₂	_____ %	_____ %	See manual

Model Number: _____

Serial Number: _____

*** Note: draw venting with details, such as extractors, barometric dampers, blast dampers or draft inducers

Site Elevation Above Sea Level _____ Ft.

Job Name _____

Address _____

Physical Location of Boiler: Indoors _____; Outdoors _____; Ground Level _____; Roof _____; Below Grade _____

Mechanical Contractor / Installer _____

Date and Time of Start-up _____ Print Name and Signature of Start-up Technician _____



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