SAFETY PRECAUTIONS AND ABBREVIATIONS

Safety Precautions

It is essential to read and understand the following safety precautions before attempting to operate the equipment. Failure to follow these precautions may result in damage to equipment, serious personal injury, or death. A complete understanding of this manual is required before attempting to start-up, operate or maintain the equipment. The equipment should be operated only by personnel who have a working knowledge and understanding of the equipment.

The following symbols are used throughout this manual:

⚠️ WARNING
This symbol indicates a potentially hazardous situation which, if not avoided, could result in serious personal injury, or death.

⚠️ CAUTION
This symbol indicates a potentially hazardous situation which, if not avoided, could result in damage to the equipment.

Note: This symbol indicates information that is vital to the operation of this equipment.

Abbreviations

Following is an explanation of the abbreviations, acronyms, and symbols used in this manual.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>AC</td>
<td>Alternating Current</td>
</tr>
<tr>
<td>AR</td>
<td>Automatic Reset</td>
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<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
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<tr>
<td>ASTM</td>
<td>American Society of Testing and Materials</td>
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<tr>
<td>BHP</td>
<td>Boiler Horsepower</td>
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<tr>
<td>BTU</td>
<td>British Thermal Unit</td>
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<tr>
<td>°C</td>
<td>Degrees Celsius</td>
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<tr>
<td>CFH</td>
<td>Cubic Feet per Hour</td>
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<tr>
<td>Cu Ft</td>
<td>Cubic Feet</td>
</tr>
<tr>
<td>DC</td>
<td>Direct Current</td>
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<tr>
<td>°F</td>
<td>Degrees Fahrenheit</td>
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<tr>
<td>FM</td>
<td>Factory Mutual</td>
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<tr>
<td>FS</td>
<td>Flame Safeguard</td>
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<tr>
<td>ft</td>
<td>Feet</td>
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<tr>
<td>GPM</td>
<td>Gallons per Minute</td>
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<tr>
<td>Hd</td>
<td>Head</td>
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<tr>
<td>Ht</td>
<td>Height</td>
</tr>
<tr>
<td>HTB</td>
<td>High Turndown Burner</td>
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<tr>
<td>HZ</td>
<td>Hertz</td>
</tr>
<tr>
<td>In H₂O</td>
<td>Inches of Water</td>
</tr>
<tr>
<td>IRI</td>
<td>Industrial Risk Insurance</td>
</tr>
<tr>
<td>Lb</td>
<td>Pound</td>
</tr>
<tr>
<td>LWCO</td>
<td>Low-Water Cut-Off</td>
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<tr>
<td>M</td>
<td>Million</td>
</tr>
<tr>
<td>MFD</td>
<td>Micro-Farad</td>
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<tr>
<td>MR</td>
<td>Manual Reset</td>
</tr>
<tr>
<td>NEC</td>
<td>National Electric Code</td>
</tr>
<tr>
<td>No.</td>
<td>Number</td>
</tr>
<tr>
<td>pH</td>
<td>Measure of the degree of acid or base of a solution</td>
</tr>
<tr>
<td>P/N</td>
<td>Part Number</td>
</tr>
<tr>
<td>PPM</td>
<td>Parts Per Million</td>
</tr>
<tr>
<td>PR</td>
<td>Program Relay</td>
</tr>
<tr>
<td>psi</td>
<td>Pounds Per Square Inch</td>
</tr>
<tr>
<td>SAE</td>
<td>Society of Automotive Engineers</td>
</tr>
<tr>
<td>scfh</td>
<td>Standard Cubic Feet per Hour</td>
</tr>
<tr>
<td>T</td>
<td>Temperature</td>
</tr>
<tr>
<td>TC</td>
<td>Temperature Control</td>
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<tr>
<td>TI</td>
<td>Temperature Gauge</td>
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</table>
TO: Owners, Operators and/or Maintenance Personnel

This operating manual presents information that will help to properly operate and care for the equipment. Study its contents carefully. The unit will provide good service and continued operation if proper operating and maintenance instructions are followed. No attempt should be made to operate the unit until the principles of operation and all of the components are thoroughly understood. Failure to follow all applicable instructions and warnings may result in severe personal injury or death.

It is the responsibility of the owner to train and advise not only his or her personnel, but the contractors' personnel who are servicing, repairing or operating the equipment, in all safety aspects.

Cleaver-Brooks equipment is designed and engineered to give long life and excellent service on the job. The electrical and mechanical devices supplied as part of the unit were chosen because of their known ability to perform; however, proper operating techniques and maintenance procedures must be followed at all times. Although these components afford a high degree of protection and safety, operation of equipment is not to be considered free from all dangers and hazards inherent in handling and firing of fuel.

Any "automatic" features included in the design do not relieve the attendant of any responsibility. Such features merely free him of certain repetitive chores and give him more time to devote to the proper upkeep of equipment.

It is solely the operator’s responsibility to properly operate and maintain the equipment. No amount of written instructions can replace intelligent thinking and reasoning and this manual is not intended to relieve the operating personnel of the responsibility for proper operation. On the other hand, a thorough understanding of this manual is required before attempting to operate, maintain, service, or repair this equipment.

Because of state, local, or other applicable codes, there are a variety of electric controls and safety devices which vary considerably from one boiler to another. This manual contains information designed to show how a basic burner operates.

Operating controls will normally function for long periods of time and we have found that some operators become lax in their daily or monthly testing, assuming that normal operation will continue indefinitely. Malfunctions of controls lead to uneconomical operation and damage and, in most cases, these conditions can be traced directly to carelessness and deficiencies in testing and maintenance.

It is recommended that a boiler room log or record be maintained. Recording of daily, weekly, monthly and yearly maintenance activities and recording of any unusual operation will serve as a valuable guide to any necessary investigation.

Most instances of major boiler damage are the result of operation with low water. We cannot emphasize too strongly the need for the operator to periodically check his low water controls and to follow good maintenance and testing practices. Cross-connecting piping to low water devices must be internally inspected periodically to guard against any stoppages which could obstruct the free flow of water to the low water devices. Float bowls of these controls must be inspected frequently to check for the presence of foreign substances that would impede float ball movement.

The waterside condition of the pressure vessel is of extreme importance. Waterside surfaces should be inspected frequently to check for the presence of any mud, sludge, scale or corrosion.

The services of a qualified water treating company or a water consultant to recommend the proper boiler water treating practices are essential.

The operation of this equipment by the owner and his or her operating personnel must comply with all requirements or regulations of his insurance company and/or other authority having jurisdiction. In the event of any conflict or inconsistency between such requirements and the warnings or instructions contained herein, please contact Cleaver-Brooks before proceeding.

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**WARNING**

DO NOT OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS YOU FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL.

DO NOT ALLOW OTHERS TO OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS THEY FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL.

FAILURE TO FOLLOW ALL APPLICABLE WARNINGS AND INSTRUCTIONS MAY RESULT IN SEVERE PERSONAL INJURY OR DEATH.
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CHAPTER 1
GENERAL

A. Major Components .......................... 1-1
B. Installation/Startup Requirements ........... 1-2
C. Major Field Installation Tasks ............... 1-2

The Cleaver-Brooks Fuel Air Ratio Control System is a microprocessor-based parallel positioning combustion control system. The system represents a value-added replacement of mechanical cam and linkage assemblies. The system controls up to four actuators to maintain optimum fuel/combustion air ratio and flue gas recirculation (if so equipped) on a boiler/burner package.

A. Major Components

1. Fuel Air Ratio Controller (P/N 833-2801)
Controls the relationship between fuel, air flow and flue gas recirculation (FGR), if used. The controller (see Figure 1-1) is panel mounted and works in conjunction with the boiler’s modulating control to drive the parallel positioning actuators according to the commissioned profiles. The controller works in conjunction with the boiler’s flame safeguard to shutdown the boiler if any fuel air ratio faults occur. Refer to Appendix A for complete details.

2. Controller Subbase (P/N 833-2802)
The controller is inserted into the wiring subbase. The subbase allows wiring of the control system before installation of the controller. Refer to Appendix B for detail information.

3. Parallel-Positioning Actuators (minimum of 2, no more than 4) (P/N 945-216)
The actuators (see Figure 1-2) operate the air damper, gas and/or oil modulation valve(s), and the FGR valve based on the controller’s signals. Appendix C has complete details of the actuator.

4. Pressure or Temperature Control
The controller requires a 4-20 milliamp firing rate input signal from the boiler. This can be supplied from a Cleaver-Brooks Solid-State Pressure Control (817-2428, 2429, 2430) on steam or a temperature controller (P/N 817-2924), or equivalent, for hot water boilers.
5. Software (P/N 985-125)

**WARNING**

Improper configuration and operation can result in system damage, personal injury or death. Proper software and boiler-burner training and experience are required.

The control system software, used with a PC or laptop computer, enables setup, commissioning and operation of the Fuel Air Ratio Control System. Initial configuration along with any adjustments and/or modifications to such items as ignition, purge, and FGR settings are made using this software. Complete details of the software can be found in Appendix D.

6. Mounting hardware and other accessories

The actuators require mounting and interface hardware to transfer the motion of the actuator to the air, fuel and FGR control valves. Depending on the various boiler controls and options, the electrical circuitry may contain additional relays, switches and/or other devices to provide for an overall boiler control system.

Each unit will include a unique wiring schematic tailored to the options covered on the boiler-burner package.

B. Installation/Startup Requirements

- An IBM compatible PC capable of running Windows 95, 98, or ME, an RS-232 to RS-485 converter (P/N 985-126), and proper combustion test instrumentation.
- A service person trained on both the fuel air ratio controller commissioning and Cleaver-Brooks burner set-up.
- Free and easy access to oil and gas modulating valves (to mount actuators). New valve stem and packing recommended for oil installations.
- Boiler access, including down time and operating time, to install, wire and set-up control.

C. Major Field Installation Tasks

- Disassembly of existing linkage.
- Installation of actuators, brackets & linkage.
- Install Controller.
- Replace Modulating/Operating Control.
- Gas-Oil Switch, Manual-Auto Switch, Manual Flame Control (5k ohm Potentiometer P/N 836-783), rewire or replace as required.
- Setup (or Commissioning) with configuration software (985-125).
CHAPTER 2
INSTALLATION
Models CB, CBLE, CBW

A. General ................................................. 2-1
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C. Install Gas Butterfly Valve Actuator Assembly . . 2-5
D. Fuel Oil Controller Actuator Assembly ............ 2-5
E. FGR Valve Actuator Assembly ....................... 2-6

![WARNING]
Do not operate, service, or repair this equipment until you fully understand all applicable sections of this manual. Do not allow others to operate, service, or repair this equipment until they fully understand all applicable sections of this manual. Failure to follow all applicable warnings and instructions may result in severe personal injury or death.

A. General
Prior to the removal of the jackshaft and associated linkage, take measurements of the high-fire and low-fire positions of the respective valves and/or dampers. These measurements will be used when configuring the Fuel Air Ratio Controller.

1. Rotary Air Damper: Note the angle of the damper arm at both high-fire (Figure 2-1) and at low-fire (Figure 2-2).

![Figure 2-1. Rotary Air Damper (High Fire)]

2. Gas Butterfly Valve: Permanently mark the valve shaft, so as to provide an indication of valve position after the actuator has been mounted (the slot at the end of the shaft will not be visible with the actuator in place (Figure 2-3). As an alternative, a collar with a setscrew can be placed on the shaft with the setscrew aligned with the slot in the shaft (Figure 2-4).

![Figure 2-2. Rotary Air Damper (Low Fire)]

3. Fuel Oil Controller: Note the height of the top surface of the oil valve stem above the base of the bearing bracket at both high-fire and low-fire (Figure 2-5).

![Figure 2-3. Gas Butterfly Valve (High Fire)]

4. FGR Valve: Take note of the positions of the stop screws on the over-travel mechanism – these stops, as well as the valve position indicator arm, can be left in position to aid in actuator configuration (Figure 2-6).

![Figure 2-4. Gas Butterfly Valve (Low Fire)]

5. Power should be disconnected from the boiler at this time. Close off any gas and/or oil supply to the boiler.

6. Remove the mod motor, jackshaft, bearing supports, linkage arms, and cams from the front head. The gas valve
and FGR valve over-travel mechanism must also be removed. Remove all wiring between the mod motor and control panel. The remaining dampers and valves should be checked to verify that they are in good operating condition. If any parts are not operating properly, they should be replaced at this time.

7. Connect wiring between the controller sub-base and the burner control panel per wiring diagram/instructions. Preliminary wiring to each actuator can be run from the controller sub-base. Line voltage wiring should be run separately from the 5-wire low-voltage shielded cable (P/N 826-103).

**Note:** When installing an actuator, power should remain disconnected until the actuator is mounted in place and final wiring connections are made.

### B. Install Air Damper Actuator Assembly

Proceed as follows:

1. Disconnect power to the boiler.

2. Refer to Figures 2-7, 2-8, or 2-9, based on your boiler diameter for mounting location of the air actuator and support (P/N 85-3242). Drilling and tapping may be required as shown. Use the support as a template to ensure the marked holes will match the support, and no nearby interference exists that would impede the mounting of the actuator or motion of its linkage. Mount the bracket to the head at this location with 5/16-18 x 1" capscrews (P/N 868-150) and lockwashers (P/N 952-97).

3. Place a mark on the 1/2" diameter shaft (P/N 74-530) at 7/16" from the end closest to the hole in the shaft. Insert the marked end first into the actuator support. Slide one set collar (P/N 824-6), then the actuator arm (P/N 2-401), then another set collar onto the shaft. Continue to slide the shaft into the actuator support until the mark is in line with the inner bushing (see Figure 2-10). Tighten each set collar against the inner and outer shaft support bushings respectively, to prevent axial movement, while allowing free rotation of the shaft. Next, position the linkage arm
Figure 2-7. Air Damper Actuator Mounting (48" CB)

Figure 2-8. Air Damper Actuator Mounting (60" CB/CBLE/CBW)

Figure 2-9. Air Damper Actuator Mounting (60" LE and 78" – 96" CB/CBLE/CBW)
and insert the roll pin to secure to shaft. Be sure the shaft turns freely – slight resistance is acceptable – and that the linkage arm is not obstructed by anything attached to the front head.

4. Attach one end of the air damper link to the actuator arm. (If necessary, assemble the air damper link which consists of 3/8" rod with threaded ends, rod ends, jam nuts & rod end inserts.) Attach the other end to the outermost hole in the damper arm. The actuator arm should be set below horizontal, approximately 10-30° maximum at the damper closed position. The actuator arm should travel at least 60° but not more than 90° from damper closed to damper open. Ensure that there is no binding of the linkage or interference with other parts.

5. Mount the Actuator (P/N 945-216) to the actuator support by sliding the actuator hub over the shaft and attaching the anti-rotation tab to the support with a 1/4-20 x 1-1/2" socket head cap screw (P/N 868-215), 1/4" lock washer (P/N 952-92) and 1/4" pipe-spacer (P/N 57-1651). Do not tighten the actuator hub set screws at this time. Figure 2-11 shows a mounted actuator.

6. Remove the actuator cover, connect power and communications wiring to the actuator. (5-wire shielded cable (P/N 826-103) should be grounded at the Controller Sub-base, not at the Actuator.) Supply power to the actuator.

7. With it’s cover removed, (see Figure 2-12) use the actuator manual buttons (one labeled CW & one labeled CCW), to turn the actuator hub counter-clockwise (CCW) until it reaches the actuator end-stop, then turn the actuator hub clockwise (CW) about 5° off of the end-stop. Next, rotate the linkage arm CCW until the Air Damper opens to the damper end-stop. Now tighten the actuator hub’s (4) set screws on the shaft to 60 inch-lbs.

8. With the manual actuator buttons, run the air damper closed to the damper end-stop and back to full open. The actuator, connecting linkage, and air damper should operate smoothly without interference. If not, make adjustments as necessary. Adjustments to the actuator rotation can easily be made by loosening the actuator hub set screws, then rotating the actuator hub with the manual buttons to the proper position, and re-tightening. Keep in mind that the limits of travel of the actuator/damper assembly is established during commissioning when
configuring the Actuator with the Fuel Air Ratio Controller Commissioning software.

C. Install Gas Butterfly Valve Actuator Assembly

Proceed as follows:

1. Disconnect power to the boiler.
2. Attach the mounting bracket for the actuator to the gas butterfly valve in the position that best suits the valve location, access space, and wiring requirements. Do not tighten mounting bracket screws at this time.
3. Attach indicator collar to the butterfly valve shaft to provide an indication of valve position — the slot at the end of the shaft will not be visible with the actuator mounted. Align collar long set screw to correspond to the slot in the shaft. (Refer back to Figure 2-3 if necessary.)
4. Mount the actuator (P/N 945-216) by placing the actuator hub over the valve shaft. If the valve shaft is less than 1/2” diameter, use the appropriate self-centering shaft reducer or shaft adapter included in the Gas Valve Actuator Mounting Kit (P/N 880-967 or -968). Attach the anti-rotation tab to the mounting bracket with a 1/4-20 x 1” socket head capscrew (P/N 868-213), lockwasher (P/N 952-92) and 1/4” pipe-spacer (P/N 57-1653) or washer. Do not tighten any screws at this time.
5. Connect wiring to the actuator. Supply power.
6. Using the actuator manual buttons, rotate the actuator hub in the direction of closed travel of the valve until it reaches the actuator end-stop. Then reverse the actuator hub about 5° off the end-stop.
7. Rotate the valve shaft to the closed position, then reposition the actuator to align the actuator with the valve shaft. Partially tighten the actuator hub’s (4) set screws on the shaft. (Make note of the closed travel direction)
8. Tighten the anti-rotation screw to the mounting bracket.
9. Tighten the screws holding the mounting bracket to the valve.
10. Finally, tighten the actuator hub’s (4) set screws to 60 inch-lbs.
11. With the manual actuator buttons, rotate the gas butterfly valve open and closed to check for smooth operation. Readjust as necessary.

D. Fuel Oil Controller Actuator Assembly

Proceed as follows:

1. Disconnect power to the boiler.
2. Remove the oil valve stem and spring. (Make note of the direction for low fire). Remove the jackshaft and oil cam bearing support bracket. (It is recommended that the valve stem and valve stem packing be replaced at this time – Call your local, authorized Cleaver-Brooks parts representative for the proper replacement parts to fit you’re specific application – always use genuine Cleaver-Brooks parts.)
3. Install Fuel Oil Controller Actuator Support (P/N 85-3241) in place of the old jackshaft support. Ensure proper positioning of the replacement support bracket gasket (P/N 32-1295). Position the actuator support to avoid interference, utilizing the slotted holes in the base. Fasten with 5/16-18 x 7/8” capscrews (P/N 868-152) and lockwashers (P/N 952-97). Be sure to securely fasten the replacement 7/8-14NF externally threaded packing nut (P/N 51-121), which is part of the stem packing replacement kit (P/N 656-7207) into the new actuator support base.
4. If a replacement is unavailable, the existing packing nut from the old jackshaft bearing support bracket may be reused and installed into the new base. Remove the cam follower (roller wheel) from the existing oil valve stem by tapping out the pin with a small punch. Replace the wheel with the new Link (P/N 67-881) and tap the pin through the hole in the link and the oil valve stem. Add the jam nut (P/N 869-22) and rod-end ball joint (P/N 883-17) to the threaded end of link.
5. Insert the oil valve stem into the controller.
6. Insert the 1/2” diameter shaft (P/N 74-529) into the actuator support. Slide the set collar, then the Linkage Arm (P/N 2-400), then the other set collar onto the shaft. Slide the shaft the rest of the way until it protrudes out the back end of the actuator support about 1/4”. Tighten each set collar against the inner and outer shaft support bushings, respectively, to prevent axial movement while allowing free rotation of the shaft.
7. Position the linkage arm on the shaft, approximately centered between the set collars. Tighten the arm’s set screws to 60 inch-lbs.
8. Place the bushing insert (P/N 10-288) into the rod-end so that the spacer is between the linkage arm and the rod end. Fasten the link to the arm with a 1/4-20 x 1-1/2”capscrew (P/N 868-139) and nut (P/N 869-234). The linkage arm should be about 50° to 60° below horizontal with the oil valve stem at the low-fire position — the top surface of the oil valve stem should be approximately 3-1/2” above the base of the actuator support (see Figure 2-13).
9. Mount the Actuator (P/N 945-216) to the actuator support by sliding the actuator hub over the shaft and attaching the anti-rotation tab to the support with a 1/4-20 x 1-1/2” socket head capscrew (P/N 868-215), lockwasher (P/N 952-92), and 1/4” pipe-spacer (P/N 57-1651). Do not tighten the coupling set screws at this time.
10. Connect wiring to the Actuator. (Shielded cable should be grounded at the controller sub-base, not at the actuator.) Supply power to the actuator.

11. Using the actuator manual buttons (one labeled CW & one labeled CCW), turn the actuator hub counterclockwise (CCW) until it reaches the actuator end-stop, then turn the actuator hub clockwise (CW) about 5° off of the end-stop. Next, rotate the linkage arm CCW to raise the oil valve stem to the high-fire position (top of the oil valve stem is about 2-1/8" above the actuator support base). The linkage arm should be about 15° to 20° above horizontal at this point; if not, adjust the length of the Link Assembly (P/N 67-880) accordingly. Now tighten the actuator hub’s (4) set screws on the shaft to 60 inch-lbs.

12. Using the manual actuator buttons, run the fuel oil controller closed to slightly below the low-fire position and back to slightly above the high-fire position. The actuator, connecting linkage, and fuel oil controller should operate smoothly without interference. If not, make adjustments as necessary. Adjustments to the actuator rotation can easily be made by loosening the actuator hub set screws, then rotating the actuator hub with the manual buttons to the proper position, and retightening. Keep in mind that the limits of travel of the actuator/controller assembly is established during commissioning when configuring the actuator with the Fuel Air Ratio Controller software.

E. FGR Valve Actuator Assembly

Proceed as follows:

1. Disconnect power to the boiler.

2. On the existing FGR valve over-travel mechanism, the existing stop screws and position indicator arm may be used as a reference for the minimum and maximum positions of the FGR valve (Refer back to Figure 2-6 as necessary).

3. Lay out the location of a hole 4-1/2" straight down from the horizontal centerline of the FGR valve shaft protruding through the front head. Use a #7 drill and tap 1/4-20. This hole will be used to secure the anti-rotational tab of the actuator to the head.

4. Mount the Actuator (P/N 945-216) directly to the front head by sliding the actuator hub over the FGR valve shaft, which protrudes through the front head. Attach the anti-rotation tab to the front head with a 1/4-20 x 2-1/2" socket head cap screw (P/N 868-678), lockwasher (952-92) and 1/4" pipe-spacer (P/N 57-1652). Do not tighten the actuator hub set screws at this time (see Figure 2-14.).

5. Connect wiring to the actuator. (Shielded cable should be grounded at the controller sub-base, not at the actuator.) Supply power to the Actuator.

6. Using the actuator manual buttons (one labeled CW & one labeled CCW), turn the actuator hub counterclockwise (CCW) until it reaches the actuators end-stop, then turn the actuator hub clockwise (CW) about 5° off of the end-stop. Next, rotate the FGR valve shaft CCW until the indicator arm hits the low-fire (right side) stop screw. Now tighten the actuator hub’s (4) set screws on the shaft to 60 inch-lbs.

7. Using the manual actuator buttons, run the FGR valve open and closed to the respective stop screws to check for smooth operation. To maximize FGR valve travel, back off both stop screws about one thread. If there is any evidence of binding of the FGR valve or linkage, turn the stop screw(s) back in until the binding disappears.
CHAPTER 3
INSTALLATION
Models CBE, CEW, FLX
(F and G Series ProFire Burner)

A. Air Damper ................................. 3-1
B. Oil Control Valve ......................... 3-2
C. Gas Butterfly Valve Actuator Assembly 3-2

A. Air Damper

Proceed as follows:

1. Prior to the removal of the damper motor and associated linkage, take measurements of the high-fire and low-fire positions of the respective valves and/or dampers. These measurements will be used when configuring the Fuel Air Ratio Controller.

2. Remove the air inlet box access cover. Remove damper motor and bracket. Remove the coupling from the end of the air damper shaft. (As an option, the shaft can be removed and reversed). This option requires cutting the shaft down from the end to which the linkages were attached. Note – If cutting the shaft down, ensure that at least 1-1/2” is available to stick out of the end of the air box after cutting to allow for mounting of the actuator.

3. Once the shaft is readied, mount the air actuator bracket to the air inlet box. Use the bracket as a template to drill the holes into the air inlet box.

4. Mount the bracket with 1/4-20 x 1-1/2”socket head capscrews (P/N 868-215), lockwashers (P/N 952-92) and nuts (P/N 869-21).

5. Mount the shaft adapter to the actuator, and tighten the set screws to 60 inch-lbs. With the damper in the closed position, slide the actuator onto the air damper shaft. Mount the actuator to the bracket at the anti-rotation tab with a 1/4-20 screw, nut, and lockwasher.

6. Apply power to the actuator.

7. With the actuator cover removed (see Figure 2-12), drive the actuator counter-clockwise to the end stop position. Back off 5°. Position the damper at the low fire position and tighten the set screws on the shaft adapter to 60 inch-lbs.

8. Drive the damper to the full open and closed positions to verify operation using the CCW and CW buttons on the actuator. The actuator, connecting linkage, and air damper should operate smoothly without interference. If not, make adjustments as necessary. Adjustments to the actuator rotation can easily be made by loosening the actuator hub set screws, then rotating the actuator hub with the manual buttons to the proper position, and re-tightening. Keep in
mind that the limits of travel of the actuator/damper assembly is established during commissioning when configuring the Actuator with the Fuel Air Ratio Controller Commissioning software.

9. Install the air inlet access box cover.

B. Oil Control Valve

Proceed as follows:
1. Note the high and low fire positions of the oil control valve.
2. Remove the linkage and arm. Leave the valve position indicator.
3. Remove two face plate screws. Mount oil control valve bracket (P/N 085-3241) to the oil control valve using two 8-32 x 1/2" screws with lockwashers.
4. Mount the shaft adapter to the oil control valve shaft (P/N 868-213).
5. Slide the actuator over the adapter and mount it to the bracket at the anti-rotation tab using a 1/4-20 x 1" screw, nut, and lockwasher.
6. Apply power to the actuator.
7. Drive the actuator to the closed position using the CCW or CW buttons on the actuator. Back off about 3°. Rotate the oil control valve to the low fire position. Tighten the set screws to 60 inch-lbs.
8. Drive the actuator to the full open and closed positions to verify operation. The actuator and connecting linkage should operate smoothly without interference. If not, make adjustments as necessary. Adjustments to the actuator rotation can easily be made by loosening the actuator hub set screws, then rotating the actuator hub with the manual buttons to the proper position and retightening. Keep in mind that the limits of travel of the actuator assembly is established during commissioning when configuring the Actuator with the Fuel Air Ratio Controller Commissioning software. Figure 3-1 shows the air and oil actuators mounted.

C. Gas Butterfly Valve Actuator Assembly

Proceed as follows:
1. Disconnect power to the boiler.
2. Attach the mounting bracket for the actuator to the gas butterfly valve in the position that best suits valve location, access space, and wiring requirements. Do not tighten the mounting bracket screws at this time.
3. If not already done, place a permanent mark at the base of the butterfly valve shaft to provide an indication of valve position – the slot at the end of the shaft will not be visible with the Actuator mounted. (Refer back to Figure 2-5 if necessary.)
4. Mount the Actuator (P/N 945-216) by placing the actuator hub over the valve shaft. If the valve shaft is less than 1/2” diameter, use the appropriate self-centering
shaft reducer or shaft adapter included with the Gas Valve Actuator Mounting Hardware. Attach the anti-rotation tab to the mounting bracket with a 1/4-20 x 1" socket head cap screw (P/N 868-213), lock washer (P/N 952-92) and 1/4" flat washer. Do not tighten any screws at this time.

5. Connect wiring to the actuator. Apply power to the unit.

6. Using the actuator manual buttons, rotate the actuator hub in the direction of closed travel of the valve until it reaches the actuator end-stop. Then reverse the actuator hub about 5° off the end-stop.

7. Rotate the valve shaft to the closed position, then after positioning the actuator, partially tighten the actuator hub set screws on the shaft.

8. Tighten the anti-rotation screw to the mounting bracket.

9. Tighten the screws holding the mounting bracket to the valve.

10. Finally, tighten the actuator hub using four set screws to 60 inch-lbs.

11. With the manual actuator buttons, rotate the gas butterfly valve open and closed to check for smooth operation. Readjust as necessary.
CHAPTER 4
SETUP and PARTS

Setup

Once the hardware has been installed you are ready to begin the commissioning process. The controller will need to be connected to a computer that has the software configuration tool (P/N 985-125) loaded. The connection to the computer consists of an RS232 to RS485 converter (P/N 985-126).

Please refer to Appendix D for detailed instructions of the commissioning process.

Parts

When ordering parts, please provide the part number, a complete description and the quantity required. Also include all boiler data including model, serial number, size, fuel series and whether it is low NOx. Use only Genuine Cleaver-Brooks parts from your local authorized Cleaver-Brooks representative.

Refer to Figure 4-1 and Tables 4-1 thru 4-5 for the parts list breakdown for models CB, CBLE and CBW boilers.

Refer to Figures 4-2, 4-3, and 4-4 and Tables 4-6 thru 4-11 for the parts list breakdown for models CBE, CEW and FLX boilers.
### Table 4-1: Assembly Breakdown - Models CB/CBLE/CBW

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PART NO.</th>
<th>DESCRIPTION</th>
<th>USED ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Table 4-2</td>
<td>Actuator Assembly, Air Damper *</td>
<td>All</td>
</tr>
<tr>
<td>2</td>
<td>Table 4-3</td>
<td>Actuator Assembly, Gas Butterfly Valve*</td>
<td>200,400,700 Fuel Series</td>
</tr>
<tr>
<td>3</td>
<td>269-00016</td>
<td>Actuator Assembly, Fuel Oil Controller*</td>
<td>100,101,200,400,600 Fuel Series</td>
</tr>
<tr>
<td>4</td>
<td>Table 4-4</td>
<td>Stem Assembly, Oil Valve</td>
<td>100,101,200,400,600 Fuel Series</td>
</tr>
<tr>
<td>5</td>
<td>269-00017</td>
<td>Actuator Assembly, IFGR Valve*</td>
<td>Low NOx</td>
</tr>
<tr>
<td>6</td>
<td>Table 4-5</td>
<td>Pressuretrol Controller</td>
<td>Steam</td>
</tr>
<tr>
<td>7</td>
<td>826-00097</td>
<td>Shielded Cable, 2-Conductor</td>
<td>Steam</td>
</tr>
<tr>
<td>8</td>
<td>859-00089</td>
<td>Plug, Pipe, SQ.HD. 1/4&quot;NPT, 300#M.I</td>
<td>Steam</td>
</tr>
<tr>
<td>9</td>
<td>833-02801</td>
<td>Fuel Air Ratio Controller</td>
<td>All</td>
</tr>
<tr>
<td>10</td>
<td>833-02802</td>
<td>Subbase, Fuel Air Ratio Controller</td>
<td>All</td>
</tr>
<tr>
<td>11</td>
<td>836-00783</td>
<td>Potentiometer, Manual, 5k Ohm</td>
<td>All</td>
</tr>
<tr>
<td>12</td>
<td>817-02924</td>
<td>Controller, Temperature, Digital</td>
<td>Hot Water</td>
</tr>
<tr>
<td>13</td>
<td>826-00097</td>
<td>Shielded Cable, 2-Conductor</td>
<td>Hot Water</td>
</tr>
<tr>
<td>14</td>
<td>832-01983</td>
<td>Thermocouple, Type-J</td>
<td>Hot Water</td>
</tr>
<tr>
<td>15</td>
<td>937-00772</td>
<td>Well, Thermocouple</td>
<td>Hot Water</td>
</tr>
<tr>
<td>16</td>
<td>950-00414</td>
<td>Wire, Thermocouple, Type-J</td>
<td>Hot Water</td>
</tr>
<tr>
<td>17</td>
<td>826-00103</td>
<td>Shielded Cable, 5-Conductor</td>
<td>All</td>
</tr>
</tbody>
</table>

* Actuator Only use 945-216.
### Table 4-2: Actuator Assembly, Air Damper

<table>
<thead>
<tr>
<th>ASS'Y NO.</th>
<th>BOILER SIZE / MODEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>269-00020</td>
<td>48&quot; CB</td>
</tr>
<tr>
<td>269-00021</td>
<td>60&quot; CB/ CBW</td>
</tr>
<tr>
<td>269-00022</td>
<td>60&quot;-78&quot; LE</td>
</tr>
<tr>
<td>269-00023</td>
<td>78&quot; CB/CBW</td>
</tr>
<tr>
<td>269-00024</td>
<td>96&quot; CB/LE/ CBW</td>
</tr>
</tbody>
</table>

### Table 4-3: Actuator Assembly, Gas Butterfly Valve

<table>
<thead>
<tr>
<th>ASS'Y NO.</th>
<th>VALVE SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>269-00018</td>
<td>1-1/2&quot; Thru 2&quot;</td>
</tr>
<tr>
<td>269-00019</td>
<td>2-1/2&quot; Thru 4&quot;</td>
</tr>
</tbody>
</table>

### Table 4-4: Stem Assembly, Oil Valve

<table>
<thead>
<tr>
<th>ASS'Y NO.</th>
<th>BOILER SIZE / MODEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>024-00093</td>
<td>50-60 HP (#2 OIL)</td>
</tr>
<tr>
<td>024-00094</td>
<td>50-60 HP (#6 OIL)</td>
</tr>
<tr>
<td>024-00095</td>
<td>70-80 HP</td>
</tr>
<tr>
<td>024-00096</td>
<td>100 HP</td>
</tr>
<tr>
<td>024-00097</td>
<td>100A, 125A, 125, 150, 125S, 150S HP</td>
</tr>
<tr>
<td>024-00098</td>
<td>175A, 175S, 200 HP</td>
</tr>
<tr>
<td>024-00099</td>
<td>250-350 HP</td>
</tr>
<tr>
<td>024-00100</td>
<td>400 HP</td>
</tr>
<tr>
<td>024-00101</td>
<td>500-700 HP</td>
</tr>
<tr>
<td>024-00102</td>
<td>800 HP</td>
</tr>
</tbody>
</table>

### Table 4-5: Pressuretrol Controller

<table>
<thead>
<tr>
<th>PART NO.</th>
<th>DESIGN PRESSURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>817-02428</td>
<td>0-15 PSI</td>
</tr>
<tr>
<td>817-02429</td>
<td>16-150 PSI</td>
</tr>
<tr>
<td>817-02430</td>
<td>151-300 PSI</td>
</tr>
</tbody>
</table>
Figure 4-2. Burner Detail - “F” and “G” Series (component location)

Figure 4-3. Burner Detail - “D” and “LND” Series (component location)
**Figure 4-4. Pressure and Temperature Controls**

### Table 4-6: Assembly Breakdown - Model CBE/CEW/FLX

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PART NO.</th>
<th>DESCRIPTION</th>
<th>USED ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Table 4-7</td>
<td>Actuator Assembly, Air Damper</td>
<td>All*</td>
</tr>
<tr>
<td>2</td>
<td>Table 4-8</td>
<td>Actuator Assembly, Gas Butterfly Valve</td>
<td>200,400,700 Fuel Series*</td>
</tr>
<tr>
<td>3</td>
<td>Table 4-9</td>
<td>Actuator Assembly, Oil Metering Valve</td>
<td>100,101,200,400,600 Fuel Series*</td>
</tr>
<tr>
<td>4</td>
<td>Table 4-10</td>
<td>Actuator Assembly, FGR Control Valve</td>
<td>Low NOx*</td>
</tr>
<tr>
<td>5</td>
<td>Table 4-11</td>
<td>Pressuretrol Controller</td>
<td>Steam</td>
</tr>
<tr>
<td>6</td>
<td>826-00097</td>
<td>Shielded Cable, 2-Conductor</td>
<td>Steam</td>
</tr>
<tr>
<td>7</td>
<td>859-00089</td>
<td>Plug, Pipe, SQ.HD. 1/4&quot;NPT, 300#M.I.</td>
<td>Steam</td>
</tr>
<tr>
<td>8</td>
<td>833-02801</td>
<td>Fuel Air Ratio Controller</td>
<td>All</td>
</tr>
<tr>
<td>9</td>
<td>833-02802</td>
<td>Subbase, Fuel Air Ratio Controller</td>
<td>All</td>
</tr>
<tr>
<td>10</td>
<td>836-00783</td>
<td>Potentiometer, Manual, 5k Ohm</td>
<td>All</td>
</tr>
<tr>
<td>11</td>
<td>817-02924</td>
<td>Controller, Temperature, Digital</td>
<td>Hot Water</td>
</tr>
<tr>
<td>12</td>
<td>826-00097</td>
<td>Shielded Cable, 2-Conductor</td>
<td>Hot Water*</td>
</tr>
<tr>
<td>13</td>
<td>832-01983</td>
<td>Thermocouple, Type-J</td>
<td>Hot Water</td>
</tr>
<tr>
<td>14</td>
<td>937-00772</td>
<td>Well, Thermocouple</td>
<td>Hot Water</td>
</tr>
<tr>
<td>15</td>
<td>950-00414</td>
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<td>Hot Water</td>
</tr>
<tr>
<td>16</td>
<td>826-00103</td>
<td>Shielded Cable, 5-Conductor</td>
<td>All</td>
</tr>
</tbody>
</table>

* Actuator Only use 945-216
### Table 4-7: Actuator Assembly, Air Damper

<table>
<thead>
<tr>
<th>ASS'Y NO.</th>
<th>BURNER MODEL - SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>269-00026</td>
<td>F/G - 1/2</td>
</tr>
<tr>
<td>269-00027</td>
<td>F/G - 3/4</td>
</tr>
<tr>
<td>269-00028</td>
<td>D/LND - (42-105)</td>
</tr>
<tr>
<td>269-00048</td>
<td>D/LND - (145-420)</td>
</tr>
</tbody>
</table>

### Table 4-8: Actuator Assembly, Gas Butterfly Valve

<table>
<thead>
<tr>
<th>GAS BUTTERFLY VALVE SIZE</th>
<th>ASS'Y NO. BY VALVE MANUFACTURER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ECLIPSE</td>
</tr>
<tr>
<td>1-1/2&quot;</td>
<td>269-00029</td>
</tr>
<tr>
<td>2&quot;</td>
<td>269-00030</td>
</tr>
<tr>
<td>2-1/2&quot;</td>
<td>269-00031</td>
</tr>
<tr>
<td>3&quot;</td>
<td>269-00032</td>
</tr>
<tr>
<td>4&quot;</td>
<td>269-00033</td>
</tr>
<tr>
<td>DUAL VALVES</td>
<td>269-00046</td>
</tr>
</tbody>
</table>

### Table 4-9: Actuator Assembly, Oil Metering Valve

<table>
<thead>
<tr>
<th>OIL VALVE STYLE</th>
<th>ASS'Y NO. BY BURNER TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F/G</td>
</tr>
<tr>
<td>1</td>
<td>269-00039</td>
</tr>
<tr>
<td>2</td>
<td>269-00040</td>
</tr>
</tbody>
</table>

### Table 4-10: Actuator Assembly, FGR Control Valve

<table>
<thead>
<tr>
<th>SIZE</th>
<th>ASS'Y NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>6&quot;</td>
<td>269-00043</td>
</tr>
<tr>
<td>8&quot;</td>
<td>269-00044</td>
</tr>
<tr>
<td>10&quot;</td>
<td>269-00045</td>
</tr>
</tbody>
</table>

### Table 4-11: Pressuretrol Controller

<table>
<thead>
<tr>
<th>PART NO.</th>
<th>DESIGN PRESSURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>817-02428</td>
<td>0-15 PSI</td>
</tr>
<tr>
<td>817-02429</td>
<td>16-150 PSI</td>
</tr>
<tr>
<td>817-02430</td>
<td>151-300 PSI</td>
</tr>
</tbody>
</table>
Appendix A

Fuel Air Ratio Controller
APPLICATION

The 833-02801 Fuel Air Ratio Controller uses the latest microprocessor-based technology to simultaneously control up to four actuators. The device, when used with the Cleaver Brooks Universal Parallel Positioning Actuators, represents a value-added replacement of mechanical cam and linkage assembly controlling the relationship between fuel, airflow and flue gas recirculation (if used) on a power burner. The Cleaver Brooks Fuel Air Ratio System consists of the 833-02801 Fuel Air Ratio Controller, 833-02802 Universal Wiring Subbase and commissioning software.

The 833-02801 Fuel Air Ratio Controller, with one communications port, provides communications capabilities similar to those found in the CB780/CB784 SERIES controls.

FEATURES

- Fast burner setup via PC or laptop.
- Fuel, air, FGR profile download capability.
- Two independent fuel profiles with or without FGR.
- 7 to 24 point profiles.
- Programmable behaviors of all actuators during Purge and Standby.
- Programmable behavior of nonselected fuel actuator.
- Independent lightoff and minimum modulation positions.
- Wide power voltage input range (50/60 Hz); two models cover global applications.
- Auto/Manual input.
- Manual mode firing rate input.
- Pluggable controller to wiring subbase.
- Multipurpose communications port.
- Field-configurable device.
- Integrated boiler shock protection algorithms:
  - Water temperature low fire hold.
  - Stack temperature low fire hold.
  - FGR and low fire hold.
- Selectable FGR hold based on stack temperature.
- Programmable behavior of FGR actuator during purge.
- Maximum modulation limit capability.
- Remote reset input.
- Automated actuator endpoint seeking process.
- UL/cUL Approved, CSD-1 and NFPA acceptable.
- Infrared communications output.

CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
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</tr>
<tr>
<td>Features</td>
<td>1</td>
</tr>
<tr>
<td>Specifications</td>
<td>2</td>
</tr>
<tr>
<td>Installation</td>
<td>3</td>
</tr>
<tr>
<td>Wiring</td>
<td>3</td>
</tr>
<tr>
<td>Operation</td>
<td>6</td>
</tr>
<tr>
<td>Checkout and Troubleshooting</td>
<td>8</td>
</tr>
</tbody>
</table>
Nonvolatile memory stores operating history and current lockout and alarm status.

Six light-emitting diodes (LED) provide:
- System status.
- Fault information.
- Status of four actuator channels.

**Safety Features**

- Class C operating software system.
- Fail-safe feedback potentiometer circuitry.
- Curve verification algorithms.
- Step size enforcement during commissioning.
- Point plausibility algorithms.
- Password protected.
- Weld-resistant algorithm for LCI-LCO contact set.
- Dual time base.
- Built-in self-test and safety relay circuits.
- Component anti-swap protection.
- Off curve checking algorithm.

**SPECIFICATIONS**

**Model:**
833-02801 Fuel Air Ratio Controller, consisting of a four-channel actuator drive Input/Output (I/O) and hardware interface for a variety of burner controllers.

**Electrical Ratings:**
- **Input Power:**
  - 100 to 120 Vac (+10/-15%), 50/60 Hz (±10%), 10VA maximum.
- **Outputs:**
  - Limit/Control OUT (LCO):
    - 120 Vac, 8.0A run, 42A inrush (UL).
    - 120 Vac, 6.0A run; 26A inrush (CE).
  - Alarm (ALR):
    - 120 Vac, 1A pilot duty (UL).
    - 120 Vac, 1.0A at PF = 0.4, 6A inrush (CE).
  - High Fire (HFP):
    - 120 Vac, 1A pilot duty (UL).
    - 120 Vac, 1A at PF = 0.4, 6A inrush (CE).
  - Light-Off Position:
    - 120 Vac, 1A pilot duty (UL).
    - 120 Vac, 1A at PF = 0.4, 6A inrush (CE).
- **A-1, F1-1, F2-1, FG-1:**
  - Source: 4.25 to 5.25V minimum at 5 mA (counterclockwise [CCW] drive command).
  - Sinking: 0 to 0.6V maximum at -5 mA (Clockwise [CW] drive command).
- **A-2, F1-2, F2-2, FG-2:**
  - Source: 4.25 to 5.25V minimum at 5 mA (Clockwise [CW] drive command).
  - Sinking: 0 to 0.6V maximum at -5 mA (Counterclockwise [CCW] drive command).
- **Inputs:**
  - Limit/Control In (LCI)
    - 120 Vac, 8A run, 42A inrush (UL).
    - 120 Vac, 6A run, 26A inrush (CE).
  - Fuel 1 Select (FS1):
    - 120 Vac at 2 mA (UL/CE).
  - Fuel 2 Select (FS2)
    - 120 Vac at 2 mA (UL/CE).
  - Remote Reset (RR): 5V at 5 mA.
- **Feedback Potentiometer input (per channel):**
  - CW: 5 Vdc at 1 mA.
  - S: 5 Vdc at 1 mA.
  - CCW: 5 Vdc at 1 mA.

**Environmental Ratings:**
- **Temperature Range:**
  - Ambient: -40°F to +140°F (-40°C to +60°C).
  - Storage: -40°F to +150°F (-40°C to +65°C).
- **Humidity:**
  - 5 to 95 percent relative humidity, noncondensing.
- **Vibration:**
  - 0.0 to 0.5g continuous (V2 level).

**Mounting:**
Mounts on Universal Subbase.

**Accessories:**
- Three-Pin Electrical Connector (RS-485).
**Dimensions:** See Fig. 1.

**Weight:** 12oz (0.35 kg).

**Approvals:**
Underwriters Laboratories Inc. (UL)(cUL):
  Component Recognized; File Number MH17367.
Factory Mutual (FM): Pending.
CSD-1 and NFPA: Acceptable.

**Required Components:**
833-02802 Universal Wiring Subbase.
Universal Parallel Positioning Actuators
  (number as required by application).
Fuel Air Ratio Software Configuration Tool.

**INSTALLATION**

**When Installing This Product...**

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced service technician.
4. After installation is complete, check out product operation as provided in these instructions.

**WARNING**

Electrical Shock Hazard.
Can cause serious injury or death.
Disconnect power supply before installation. More than one disconnect can be required to remove line voltage power completely.

**Location**

Mount the 833-02801 Fuel Air Ratio Controller on the 833-02802 Universal Wiring Subbase. The subbase is secured to a panel by four number 8 screws. Secure the 833-02801 Fuel Air Ratio Controller to the subbase by tightening the two captive screws.

**WIRING**

All wiring for the 833-02801 Fuel Air Ratio Controller is connected to the 833-02802 Universal Wiring Subbase. There is no direct wiring to the controller. Tables 1 and 2 provide the 833-02801 Fuel Air Ratio Controller input and output terminal descriptions, respectively. Table 3 provides the 833-02801 Fuel Air Ratio Controller maximum field wiring lengths. A block hookup diagram for the Universal Parallel Positioning Actuator Actuator is shown in Fig. 2 and a typical wiring diagram is shown in Fig. 4.

**Earth Ground**

Earth ground is required for proper operation of the Fuel Air Ratio system. Earth ground provides a connection between the subbase and the control panel of the equipment. The earth ground must be capable of conducting enough current to blow the fuse or breaker in the event of an internal short.

1. Use wide straps or brackets to provide minimum length, maximum surface area ground conductors. If a leadwire must be used, use 14 AWG copper wire.
2. Make sure that mechanically tightened joints along the ground path are free of nonconductive coatings and protected against corrosion on mating surfaces.

**Shield Ground**

Connect the shield ground of the Universal Parallel Positioning Actuator(s), Remote Reset, Manual Potentiometer, Controller 4-to-20 mA and Auxiliary 4-to-20 mA inputs to the earth ground strip provided in the 833-02802 Universal Wiring Subbase. Connect the shield at the controller end only. See Fig. 2.
<table>
<thead>
<tr>
<th>Name (Abbreviation)</th>
<th>Terminal Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground (G)</td>
<td>2</td>
<td>Earth ground.</td>
</tr>
<tr>
<td>Line Power (L1)</td>
<td>1</td>
<td>Line Voltage Power: 100 to 120 Vac, 50/60 Hz (833-02801 Fuel Air Ratio Controller A), 10 VA maximum power consumption. NOTE: The Fuel Air control must be on the same phase as the burner control.</td>
</tr>
<tr>
<td>Power Supply Neutral</td>
<td>3</td>
<td>Power Supply Neutral.</td>
</tr>
<tr>
<td>High Fire (HF)</td>
<td>10</td>
<td>Purge Position is activated by line voltage ac signal. Upon activation of the input, 833-02801 Fuel Air Ratio Controller commands the air damper to the programmed purge position. NOTE: LF and HF may not be energized at the same time. Operation will be halted if the condition is introduced and will not start if the condition exists at power up.</td>
</tr>
<tr>
<td>Main Valve (MV)</td>
<td>11</td>
<td>Main Valve Input, activated by line voltage ac signal. Activation of this input releases the 833-02801 Fuel Air Ratio Controller to position all actuators to the programmed position curve. Maximum values same as High Fire. Improper insertion of the main valve input during the sequence can cause lockouts, recycles or initiates holds.</td>
</tr>
<tr>
<td>Auto/Manual (AM)</td>
<td>4</td>
<td>Auto/Manual Input, activated by line voltage ac signal. Activation of this input during the Modulate phase of the RUN state changes the input control variable from the CMA(+/-) to the MNC input. Maximum values same as High Fire.</td>
</tr>
<tr>
<td>Low Fire (LF)</td>
<td>12</td>
<td>Low Fire is activated by line voltage ac signal. Upon activation, 833 02801 Fuel Air Ratio Controller commands the air damper to the Light-Off position in addition to causing the selected fuel actuator to move to the light-off position. Maximum values same as High Fire. NOTE: LF and HF may not be energized at the same time. Operation will be halted if the condition is introduced and will not start if the condition exists at power up.</td>
</tr>
<tr>
<td>Limit/Ctrl In (LCI)</td>
<td>13</td>
<td>Line voltage input that signals limits are satisfied and that a demand exists to run the burner. Provides power to energize Burner Control. Voltage present equates to function selected.</td>
</tr>
<tr>
<td>Controller Input (CmA+)</td>
<td>39</td>
<td>Firing Rate input: 4 to 20 mA positive input from temperature or pressure controller.</td>
</tr>
<tr>
<td>Controller Input (CmA-)</td>
<td>40</td>
<td>Firing Rate input: 4 to 20 mA negative input from temperature or pressure controller.</td>
</tr>
<tr>
<td>Manual Ctrl (MNC)</td>
<td>35/36</td>
<td>Use for manual control potentiometer. Resistance range: 0 to 5000 ohms, ±10%. 4500 ohms or more equates to the 20 mA controller input. Use linear interpolation for all other values. Programmable also as the maximum modulation limit, if so configured.</td>
</tr>
<tr>
<td>Fuel 1 Select (FS1)</td>
<td>5</td>
<td>Line voltage input that selects fuel 1 when activated. Voltage present equates to function selected.</td>
</tr>
<tr>
<td>Fuel 2 Select (FS2)</td>
<td>6</td>
<td>Line voltage input that selects fuel 2 when activated. Voltage present equates to function selected.</td>
</tr>
<tr>
<td>Feedback Air Damper (CW)</td>
<td>17</td>
<td>Provides position feedback for the Air actuator: (CW) Clockwise rotational endpoint of the feedback potentiometer.</td>
</tr>
<tr>
<td>(S)</td>
<td>18</td>
<td>(S) Variable resistance signal from potentiometer.</td>
</tr>
<tr>
<td>(CCW)</td>
<td>19</td>
<td>(CCW) Counterclockwise rotational endpoint of the feedback potentiometer.</td>
</tr>
<tr>
<td>Feedback Fuel 1 (CW)</td>
<td>22</td>
<td>Provides position feedback for the Fuel 1 Actuator: (CW) Clockwise rotational endpoint of the feedback potentiometer.</td>
</tr>
<tr>
<td>(S)</td>
<td>23</td>
<td>(S) Variable resistance signal from potentiometer.</td>
</tr>
<tr>
<td>(CCW)</td>
<td>24</td>
<td>(CCW) Counterclockwise rotational endpoint of the feedback potentiometer.</td>
</tr>
<tr>
<td>Feedback Fuel 2 (CW)</td>
<td>27</td>
<td>Provides position feedback for the Fuel 2 Actuator: (CW) Clockwise rotational endpoint of the feedback potentiometer.</td>
</tr>
<tr>
<td>(S)</td>
<td>28</td>
<td>(S) Variable resistance signal from potentiometer.</td>
</tr>
<tr>
<td>(CCW)</td>
<td>29</td>
<td>(CCW) Counterclockwise rotational endpoint of the feedback potentiometer.</td>
</tr>
<tr>
<td>Feedback FGR (CW)</td>
<td>32</td>
<td>Provides position feedback for the FGR Actuator: (CW) Clockwise rotational endpoint of the feedback potentiometer.</td>
</tr>
<tr>
<td>(S)</td>
<td>33</td>
<td>(S) Variable resistance signal from potentiometer.</td>
</tr>
<tr>
<td>(CCW)</td>
<td>34</td>
<td>(CCW) Counterclockwise rotational endpoint of the feedback potentiometer.</td>
</tr>
<tr>
<td>Temperature Sensor (XmA+)</td>
<td>37</td>
<td>Configurable Sensor Input: 4 to 20 mA positive input from temperature sensor. For the temperature input application the endpoints are programmable from -40°F to +140°F. Minimum span must exceed 100°F.</td>
</tr>
<tr>
<td>Temperature Sensor (XmA-)</td>
<td>38</td>
<td>Configurable Sensor Input: 4 to 20 mA negative input from temperature sensor.</td>
</tr>
<tr>
<td>Remote Reset (RR)</td>
<td>35/38</td>
<td>Remote Reset Input. A cycled contact on this terminal indicates a reset condition. Retrieval of fault codes is possible using this input.</td>
</tr>
</tbody>
</table>
### Table 2. 833-02801 Fuel Air Ratio Controller Output Terminal Description

<table>
<thead>
<tr>
<th>Name (Abbreviation)</th>
<th>Terminal Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limit/Control OUT (LCO)</td>
<td>14</td>
<td>Line voltage output that signals limits are satisfied and that a demand exists to run the burner and Fuel Air Ratio Controller is operational. Provides power to energize Burner Control.</td>
</tr>
<tr>
<td>Alarm (ALR)</td>
<td>7</td>
<td>Alarm Output.</td>
</tr>
<tr>
<td>High Fire Proven (HFP)</td>
<td>8</td>
<td>High Fire Proven normally open contact is activated when the HF input terminal has been energized and the Fuel Air Ratio Controller has successfully moved the air/fuel damper (and FGR, if so configured) to the programmed Purge Position.</td>
</tr>
<tr>
<td>Low Fire Proven (LFP)</td>
<td>9</td>
<td>Low Fire Proven normally open contact is activated when the LF input terminal has been energized and the Fuel Air Ratio Controller has successfully moved the Air, selected fuel, and FGR damper to the programmed Light-Off Position.</td>
</tr>
<tr>
<td>A-1</td>
<td>15</td>
<td>A-1: Output when combined with A-2 is used to modulate the Air damper. The resultant push-pull current flow of the two outputs causes the motor to advance, reverse, or hold.</td>
</tr>
<tr>
<td>A-2</td>
<td>16</td>
<td>A-2: Output when combined with A-1 is used to modulate the Air damper. The resultant push-pull current flow of the two outputs causes the motor to advance, reverse, or hold.</td>
</tr>
<tr>
<td>F1-1</td>
<td>20</td>
<td>F1-1: Output when combined with F1-2 is used to modulate the Fuel 1 valve. The resultant push-pull current flow of the two outputs causes the motor to advance, reverse, or hold.</td>
</tr>
<tr>
<td>F1-2</td>
<td>21</td>
<td>F1-2: Output when combined with F1-1 is used to modulate the Fuel 1 valve. The resultant push-pull current flow of the two outputs causes the motor to advance, reverse, or hold.</td>
</tr>
<tr>
<td>F2-1</td>
<td>25</td>
<td>F2-1: Output when combined with F2-2 is used to modulate the Fuel 2 valve. The resultant push-pull current flow of the two outputs causes the motor to advance, reverse, or hold.</td>
</tr>
<tr>
<td>F2-2</td>
<td>26</td>
<td>F2-2: Output when combined with F2-1 is used to modulate the Fuel 2 valve. The resultant push-pull current flow of the two outputs causes the motor to advance, reverse, or hold.</td>
</tr>
<tr>
<td>FG-1</td>
<td>30</td>
<td>FG-1: Output when combined with FG-2 is used to modulate the FGR damper. The resultant push-pull current flow of the two outputs causes the motor to advance, reverse, or hold.</td>
</tr>
<tr>
<td>FG-2</td>
<td>31</td>
<td>FG-2: Output when combined with FG-1 is used to modulate the FGR damper. The resultant push-pull current flow of the two outputs causes the motor to advance, reverse, or hold.</td>
</tr>
</tbody>
</table>

### Table 3. 833-02801 Fuel Air Ratio Controller Maximum Wiring Lengths

<table>
<thead>
<tr>
<th>Terminal Name</th>
<th>Wiring Length (Maximum)</th>
<th>Wire Type</th>
<th>Minimum/Maximum Wire Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground (G)</td>
<td>Short as possibleab</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>Line Power (L1)</td>
<td>No Restrictionbc</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>Power Supply Neutral L2 (N)</td>
<td>No Restrictionb</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>High Fire (HF)</td>
<td>100 Feet</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>Modulate (MOD)</td>
<td>100 Feet</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>Low Fire (LF)</td>
<td>100 Feet</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>Limit/Control IN (LCI)</td>
<td>No Restrictionb</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>Controller input (CmA+)</td>
<td>1000 Feetd</td>
<td>Belden 9502, 2-conductor, 100% shield coverage, 300V 80C (UL 2464, CSA PCC FT 4) or equivalent.</td>
<td>18 to 24 AWG</td>
</tr>
<tr>
<td>Manual Ctrl (MNC)</td>
<td>10 Feetd</td>
<td>Belden 9502, 2-conductor, 100% shield coverage, 300V 80C (UL 2464, CSA PCC FT 4) or equivalent.</td>
<td>18 to 24 AWG</td>
</tr>
<tr>
<td>Fuel 1 Select (FS1)</td>
<td>No Restrictionb</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>Fuel 2 Select (FS2)</td>
<td>No Restrictionb</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>Actuator Interface (A1, F1-1, F2-1, FG-1)</td>
<td>100 Feetd</td>
<td>Belden 9535, 5-conductor, 100% shield coverage, 300V 80C (UL 2464, CSA PCC FT 4) or equivalent.</td>
<td>18 to 24 AWG</td>
</tr>
<tr>
<td>Configurable Sensor (XmA+)</td>
<td>1000 Feetd</td>
<td>Belden 9535, 2-conductor, 100% shield coverage, 300V 80C (UL 2464, CSA PCC FT 4) or equivalent.</td>
<td>18 to 24 AWG</td>
</tr>
<tr>
<td>RS485 DDL Commissioning port</td>
<td>1000 Feetd</td>
<td>Belden 9535, 2-conductor, 100% shield coverage, 300V 80C (UL 2464, CSA PCC FT 4) or equivalent.</td>
<td>18 to 24 AWG</td>
</tr>
</tbody>
</table>

abUse wide straps or brackets to provide minimum length, maximum surface area ground conductors. If a leadwire must be used, use 14 AWG copper wire. Make sure that all mechanically tightened joints along the ground path are free of nonconductive coatings and protected against corrosion on mating surfaces.
bcFollow local and NEC 1 codes.
bdImplies no limitations beyond voltage (current times resistance) drop considerations versus wire size constraints.
ecnRequires ground shield at controller end. See Fig. 2, 4.
dGround shield to digital ground terminal C at controller end and and PC or laptop end.
OPERATION

The 833-02801 Fuel Air Ratio Controller provides communication capabilities similar to those found in the CB780/CB784 SERIES equipment. Fault annunciation is available through a connection to the communication data output (DDL). Operating history is kept in nonvolatile memory as is the current lockout status.

The Fuel Air Ratio Commissioning Software tool is necessary for the field commissioning prior to operation. Refer to the configuration software help screens for commissioning procedures.

The 833-02801 Fuel Air Ratio Controller tracks the firing rate input value and drives the Universal Parallel Positioning Actuators according to the commissioned profile and maintains the relative programmed positions.

**WARNING**

Explosion Hazard.
Improper configuration can cause fuel buildup and explosion.
The Fuel Air Ratio Commissioning Software is to be used only by experienced and/or licensed burner-boiler operators and mechanics.

Operators of this software may move fuel and/or air actuators to positions that can create hazardous burner conditions. Improper user operation can result in property loss, physical injury or death.

The 833-02801 Fuel Air Ratio Controller must go through an Initiate state whenever the fuel select switch is changed.

The 833-02801 Fuel Air Ratio Controller has the following operating states:

1. Non-Configured State. The controller is shipped from the factory in this condition and will not respond to any input other than the DDL port (configuration tool port).

2. Commissioning State. The controller enters this state once communications with a configuration tool is established. Actuators are placed in pseudo-manual control mode during this state. Commands from the configuration software increment or decrement motor positions. The 833-02801 Fuel Air Ratio Controller write the values for the valve and damper positions, as a function of firing rate, during this state.

3. Initiate State. This state exists for a minimum of ten seconds after an internally- or externally-initiated reset. The 833-02801 Fuel Air Ratio Controller performs internal checks during this state.

4. Standby State. This state occurs whenever the LCI input (terminal 13) is not active. All actuators move to the Programmed Standby Stop Position (PSTP) or return to the light-off position, except for the FGR actuator, which moves to the closed position.

5. Processing Demand State. The 833-02801 Fuel Air Ratio Controller enters this state when the LCI has just become active. The 833-02801 Fuel Air Ratio Controller makes sure the firing rate command inputs are valid before advancing to the next state.

6. Run State. The 833-02801 Fuel Air Ratio Controller enters this state when the LCI input is active. The high fire or low fire command from the burner control causes the air actuator and the FGR actuator (if configured) to drive to the purge or light-off positions, respectively. The selected fuel, air and FGR actuators track the firing rate input versus the programmed profile once the main valve terminal is energized.

7. Lockout State. The 833-02801 Fuel Air Ratio Controller enters this state when critical internal faults are detected. The controller retains the lockout state via nonvolatile memory. To exist this state, press the reset button.

8. Alarm Initiate State. Essentially an Initiate state, except that the alarm terminal is energized. A controller will remain in this state as long as the fault exists. The 833-02801 Fuel Air Ratio Controller will automatically restart once the fault is removed. The user may restart the system by pressing the Reset button.

Normal operating sequence for the 833-02801 Fuel Air Ratio Controller is: Initiate (ac power up or internal or external reset), Standby, Processing Demand and Run. The Non-Configured State may also occur.

An LED status panel provides visual status of the operating condition of the 833-02801 Fuel Air Ratio Controller and associated components. See Fig. 3. Table 4 provides the LED condition and meaning. Table 5 provides the Channel Status LED condition and meaning.

At power up, all LED will automatically turn on to verify operation.

If all LED remain on, make sure one fuel select input is made, not two or zero.

![Fig. 2. 833-02801 Fuel Air Ratio Controller/Universal Parallel Positioning Actuator hookup block diagram.](image-url)

![Fig. 3. 833-02801 Fuel Air Ratio Controller LED status panel.](image-url)
Table 4. 833-02801 Fuel Air Ratio Controller Status LED Blink Patterns.

<table>
<thead>
<tr>
<th>Power (Green) LED State</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Always Off</td>
<td>Control has failed, or has no power.</td>
</tr>
<tr>
<td>Always On</td>
<td>Control cannot run or communicate until a critical fault has been corrected. This state occurs at each power up or reset. Control is in the Initiate State or Alarm Initiate State or Alarm Hold State. Check that only one fuel has been selected, or that HF and LF are not active at the same time. If HF and LF are active at the same time, the red LED will also be on.</td>
</tr>
<tr>
<td>1 short blink every interval</td>
<td>Control is in Postpurge or Standby State.</td>
</tr>
<tr>
<td>2 short blinks every interval</td>
<td>Control is in a low voltage condition.</td>
</tr>
<tr>
<td>3 short blinks every interval</td>
<td>Control is in the non-configured state.</td>
</tr>
<tr>
<td>4 short blinks every interval</td>
<td>Control is in the commissioning state.</td>
</tr>
<tr>
<td>Steady medium blink</td>
<td>Control is in the Run State.</td>
</tr>
<tr>
<td>Steady fast blink</td>
<td>Control is in manual mode.</td>
</tr>
</tbody>
</table>

A red LED, normally off, indicates a Lockout State when lit.

Table 5. 833-02801 Fuel Air Ratio Controller Channel Status LED Blink Patterns.

<table>
<thead>
<tr>
<th>Motor (Amber) LED State</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Always Off</td>
<td>Actuator is not being commanded to move or is not configured.</td>
</tr>
<tr>
<td>On</td>
<td>Actuator is in motion.</td>
</tr>
<tr>
<td>1 short blink every interval</td>
<td>Actuator Failure: Failed timing plausibility check.</td>
</tr>
<tr>
<td>2 short blinks every interval</td>
<td>Actuator Failure: Failed actuator ID process.</td>
</tr>
<tr>
<td>3 short blinks every interval</td>
<td>Actuator Failure: Analog/Digital reading of potentiometer out of range.</td>
</tr>
<tr>
<td>4 short blinks every interval</td>
<td>Actuator Failure: Potentiometer failure—wiper resistance.</td>
</tr>
<tr>
<td>Medium speed blink</td>
<td>Actuator Warning: Wiper resistance high.</td>
</tr>
</tbody>
</table>

A The four amber motor LED provide status for the individual Universal Parallel Positioning Actuator Actuators; e.g., Motor 1 LED is Air Actuator Status, Motor 2 LED is Fuel 1 Actuator Status, Motor 3 LED is Fuel 2 Status, and Motor 4 LED is FGR Actuator Status.

**Manual Operation**

Place the 833-02801 Fuel Air Ratio Controller in a manually commanded firing rate condition by applying a line voltage signal to terminal 4. The 833-02801 Fuel Air Ratio Controller will derive the desired firing rate control position by the value of the resistance set at terminal 36. A 200-ohm value equals minimum modulation; 4500 ohms equals maximum modulation. Linear interpolation exists for all other values.
Commissioning Process
The primary tasks to be accomplished by the commissioning process are as follows:
1. Establish the endpoints of each actuator within the system.
2. Establish the purge position.
3. Establish the lightoff position.
4. Establish minimum and maximum modulation positions.
5. Establish a fuel, air, FGR mixture profile for up to 20 points between the minimum and maximum modulation points for each fuel source within the system.

The commissioning process requires the use of the Fuel Air Ratio Commissioning Software running on a laptop or PC with an operating system of Windows 95, 98 or 2000. Additional minimum requirements include a Pentium® class processor, or equivalent, with 16 megabytes of RAM and a one gigabyte hard drive with 100 megabytes of free hard drive memory. The PC or laptop must have a RS232-to-RS485 converter to communicate with the 833-02801 Fuel Air Ratio Controller. Fig. 4. shows the 985-126 RS485 to RS232 Port Expander and the hookup information.

The 833-02801 Fuel Air Ratio Controller requires the presence of one of the Fuel Select inputs to start communications with the Fuel Air Ratio Commissioning Software. Additional wiring interface requirements include that HF and LF command inputs cannot be activated at the same time.

NOTE: A stack gas analyzer is required to commission the Fuel Air Ratio Control System.

CHECKOUT AND TROUBLESHOOTING

Fault Codes
The 833-02801 Fuel Air Ratio Controller is designed so that only an unrecoverable internal related fault will cause lockout. The 833-02801 Fuel Air Ratio Controller will recycle when specific external problems are detected and then cleared.

When the 833-02801 Fuel Air Ratio Controller locks out, obtain the fault code (a repeating series of blinks from the POWER LED) by pressing and holding the Reset button or using a laptop in monitor or commissioning mode. To interpret the LED flashes, for example, a Fault 11 would be one slow blink and one fast blink, while a Fault 67 would be six slow blinks followed by seven fast blinks.

See Table 8 for fault codes and descriptions.

Abbreviation Definitions.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCI</td>
<td>Limit Control Input</td>
</tr>
<tr>
<td>HF</td>
<td>High Fire Input</td>
</tr>
<tr>
<td>LF</td>
<td>Low Fire Input</td>
</tr>
<tr>
<td>MV</td>
<td>Main Valve Input</td>
</tr>
<tr>
<td>LCO</td>
<td>Limit Control Output</td>
</tr>
<tr>
<td>HFP</td>
<td>High Fire Proved</td>
</tr>
<tr>
<td>LFP</td>
<td>Low Fire Proved</td>
</tr>
<tr>
<td>FS1</td>
<td>Fuel Select Channel 1</td>
</tr>
<tr>
<td>FS2</td>
<td>Fuel Select Channel 2</td>
</tr>
<tr>
<td>ALM</td>
<td>Alarm</td>
</tr>
<tr>
<td>ILK</td>
<td>Interlock</td>
</tr>
<tr>
<td>DMD</td>
<td>Demand</td>
</tr>
<tr>
<td>COM</td>
<td>Common</td>
</tr>
<tr>
<td>MNC</td>
<td>Manual Control</td>
</tr>
</tbody>
</table>

Fig. 5 provides a standard block hookup diagram for the 833 02801 Fuel Air Ratio Controller and associated equipment.

Fig. 4. 985-126 Port Expander to 833-02801 Fuel Air Ratio Controller hookup.
Fig. 5. Hookup block diagram—833-02801 Fuel Air Ratio Controller and associated equipment.

NOTE: Shields on MNC (terminal 36, 38) and RESET (35, 38) also go to earth ground terminal on the subbase.
### Table 6. Fault Listings and Descriptions.

<table>
<thead>
<tr>
<th>Fault/BlinK Code</th>
<th>Description</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Device is operating properly.</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>MV input energized at an improper time.</td>
<td>Reset control. Check Burner Control Interface wiring and correct error. This error causes the device to remain in initiate state at power up.</td>
</tr>
<tr>
<td>14</td>
<td>HF and LF are energized at the same time.</td>
<td>Reset control. Check Burner Control Interface wiring and correct error. This error causes the device to remain in initiate state at power up.</td>
</tr>
<tr>
<td>15</td>
<td>Transition to the requested Burner Control input state is not allowed from the current state. E.g. Standby to Modulate is not allowed.</td>
<td>Reset control. Check wiring to burner control and/or burner control operation. NOTE: Moving a CB780/CB784 Run/Test switch to Test will induce this fault during commissioning mode.</td>
</tr>
<tr>
<td>21</td>
<td>Internal error—Time Base.</td>
<td>Reset control(^a)</td>
</tr>
<tr>
<td>22</td>
<td>Internal error—Safety relay.</td>
<td>Reset control(^a)</td>
</tr>
<tr>
<td>23</td>
<td>Internal error—Safety relay.</td>
<td>Reset control(^a)</td>
</tr>
<tr>
<td>24</td>
<td>Internal error—Time storage.</td>
<td>Reset control(^a)</td>
</tr>
<tr>
<td>25</td>
<td>Internal error—Limited move.</td>
<td>Reset control(^a,c)</td>
</tr>
<tr>
<td>26</td>
<td>Internal error—Targeted move.</td>
<td>Reset control(^a,c)</td>
</tr>
<tr>
<td>27</td>
<td>Internal error—LVD.</td>
<td>Reset control(^a)</td>
</tr>
<tr>
<td>28</td>
<td>Internal error—ISR check.</td>
<td>Reset control(^a)</td>
</tr>
<tr>
<td>31</td>
<td>Internal fault—A2D Range.</td>
<td>Reset control(^a)</td>
</tr>
<tr>
<td>32</td>
<td>Internal fault—A2D cross-matching error.</td>
<td>Reset control(^a)</td>
</tr>
<tr>
<td>33</td>
<td>Internal fault—LCO Drive.</td>
<td>Reset control(^a)</td>
</tr>
<tr>
<td>34</td>
<td>Internal fault—LCO/I Feedback.</td>
<td>1. Reset control(^b). 2. Terminal 14 has voltage present from external source; correct wiring error. 3. Make sure that short does not exist at terminal 14. Control will need replacement if a sustain fault code 34 exists after steps 1, 2 and 3 are performed.</td>
</tr>
<tr>
<td>35</td>
<td>Internal fault—</td>
<td>Reset control(^a)</td>
</tr>
<tr>
<td>36</td>
<td>Fuel selection error.</td>
<td>1. Check wiring through fuel select switch. Only one fuel can be selected at any one time. This error causes the device to remain in initiate state. 2. No fuel selected. Correct by selecting fuel.</td>
</tr>
<tr>
<td>37</td>
<td>Fault—HFP or LFP output.</td>
<td>Verify correct wiring to burner control; specifically check wiring at LFP and HFP.</td>
</tr>
<tr>
<td>38</td>
<td>Internal Fault—Memory curve.</td>
<td>Reset control(^a)</td>
</tr>
<tr>
<td>39</td>
<td>Internal Fault—AC sampling.</td>
<td>Reset control(^a)</td>
</tr>
<tr>
<td>41</td>
<td>Feedback potentiometer Interface circuit fault—Air.</td>
<td>Verify correct wiring of potentiometer(^a)</td>
</tr>
<tr>
<td>42</td>
<td>Feedback potentiometer Interface circuit fault—Fuel 1.</td>
<td>Verify correct wiring of potentiometer(^a)</td>
</tr>
<tr>
<td>43</td>
<td>Feedback potentiometer Interface circuit fault—Fuel 2.</td>
<td>Verify correct wiring of potentiometer(^a)</td>
</tr>
<tr>
<td>44</td>
<td>Feedback potentiometer Interface circuit fault—FGR.</td>
<td>Verify correct wiring of potentiometer(^a)</td>
</tr>
<tr>
<td>45</td>
<td>Feedback potentiometer wiper resistance problem—Air.</td>
<td>Check for loose potentiometer wiring(^a,c)</td>
</tr>
<tr>
<td>46</td>
<td>Feedback potentiometer wiper resistance problem—Fuel 1.</td>
<td>Check for loose potentiometer wiring(^a,c)</td>
</tr>
<tr>
<td>47</td>
<td>Feedback potentiometer wiper resistance problem—Fuel 2.</td>
<td>Check for loose potentiometer wiring(^a,c)</td>
</tr>
</tbody>
</table>
Table 6. Fault Listings and Descriptions. (Continued)

<table>
<thead>
<tr>
<th>Fault/BlindK Code</th>
<th>Description</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>Feedback potentiometer wiper resistance problem—FGR.</td>
<td>Check for loose potentiometer wiring. b,c</td>
</tr>
<tr>
<td>49</td>
<td>Feedback potentiometer total resistance problem—Air.</td>
<td>Check for loose potentiometer wiring. b,c</td>
</tr>
<tr>
<td>51</td>
<td>Feedback potentiometer total resistance problem—Fuel 1.</td>
<td>Check for loose potentiometer wiring. b,c</td>
</tr>
<tr>
<td>52</td>
<td>Feedback potentiometer total resistance problem—Fuel 2.</td>
<td>Check for loose potentiometer wiring. b,c</td>
</tr>
<tr>
<td>53</td>
<td>Feedback potentiometer total resistance problem—FGR.</td>
<td>Check for loose potentiometer wiring. b,c</td>
</tr>
<tr>
<td>54</td>
<td>Internal memory function problem—Air.</td>
<td>Repeat actuator ID on-line process.</td>
</tr>
<tr>
<td>55</td>
<td>Internal memory function problem—Fuel 1.</td>
<td>Repeat actuator ID on-line process.</td>
</tr>
<tr>
<td>56</td>
<td>Internal memory function problem—Fuel 2.</td>
<td>Repeat actuator ID on-line process.</td>
</tr>
<tr>
<td>57</td>
<td>Internal memory function problem—FGR.</td>
<td>Repeat actuator ID on-line process.</td>
</tr>
<tr>
<td>58</td>
<td>Stuck Reset button.</td>
<td>Turn off remote reset switch; check operation of controller reset button.</td>
</tr>
<tr>
<td>61</td>
<td>Actuator(s) not reaching lightoff point.</td>
<td>Check for actuator wiring problems or stuck valves or dampers. Place controller in standby and use actuator manual keys to verify actuator travel.</td>
</tr>
<tr>
<td>65</td>
<td>Internal memory fault.</td>
<td>Reset control. a</td>
</tr>
<tr>
<td>66</td>
<td>Internal Initialization Error.</td>
<td>Reset control. a</td>
</tr>
<tr>
<td>67</td>
<td>Fuel actuator off curve (selected fuel type).</td>
<td>Check for stuck fuel actuator and/or proper shielding on actuator interface.</td>
</tr>
<tr>
<td>68</td>
<td>FGR actuator off curve.</td>
<td>Check for stuck FGR actuator and/or proper shielding on actuator interface.</td>
</tr>
<tr>
<td>69</td>
<td>Air actuator off curve.</td>
<td>Check for stuck air actuator and/or proper shielding on actuator interface.</td>
</tr>
<tr>
<td>71</td>
<td>Verifies that the Air actuator accepted the offline, online, move counter-clock-wise and move clock-wise commands. Furthermore, all potentiometer tests must be successfully passed to bring an actuator online.</td>
<td>Check wiring of actuator, verify correct ID is being used. Watch actuator LED to verify that the actuator is being brought online. A fast flash in the actuator equals offline status, while a one-second flash equals online status.</td>
</tr>
<tr>
<td>72</td>
<td>Verifies that the Fuel 1 actuator accepted the offline, online, move counter-clock-wise and move clock-wise commands. Furthermore, all potentiometer tests must be successfully passed to bring an actuator online.</td>
<td>Check wiring of actuator, verify correct ID is being used. Watch actuator LED to verify that the actuator is being brought online. A fast flash in the actuator equals offline status, while a one-second flash equals online status.</td>
</tr>
<tr>
<td>73</td>
<td>Verifies that the Fuel 2 actuator accepted the offline, online, move counter-clock-wise and move clock-wise commands. Furthermore, all potentiometer tests must be successfully passed to bring an actuator online.</td>
<td>Check wiring of actuator, verify correct ID is being used. Watch actuator LED to verify that the actuator is being brought online. A fast flash in the actuator equals offline status, while a one-second flash equals online status.</td>
</tr>
<tr>
<td>74</td>
<td>Verifies that the FGR actuator accepted the offline, online, move counter-clock-wise and move clock-wise commands. Furthermore, all potentiometer tests must be successfully passed to bring an actuator online.</td>
<td>Check wiring of actuator, verify correct ID is being used. Watch actuator LED to verify that the actuator is being brought online. A fast flash in the actuator equals offline status, while a one-second flash equals online status.</td>
</tr>
<tr>
<td>75</td>
<td>Internal memory fault.</td>
<td>Reset control. a</td>
</tr>
<tr>
<td>76</td>
<td>Internal checksum error.</td>
<td>Reset control. a</td>
</tr>
<tr>
<td>82</td>
<td>Actuator secondary fault.</td>
<td>Check actuator wiring. See Channel LED for actuator.</td>
</tr>
<tr>
<td>83</td>
<td>Air actuator nonresponsive.</td>
<td>Check actuator wiring and stuck damper/valve. c</td>
</tr>
<tr>
<td>84</td>
<td>Fuel 1 actuator nonresponsive.</td>
<td>Check actuator wiring and stuck damper/valve. c</td>
</tr>
<tr>
<td>85</td>
<td>Fuel 2 actuator nonresponsive.</td>
<td>Check actuator wiring and stuck damper/valve. c</td>
</tr>
<tr>
<td>86</td>
<td>FGR actuator nonresponsive.</td>
<td>Check actuator wiring and stuck damper/valve. c</td>
</tr>
<tr>
<td>87</td>
<td>Internal math error.</td>
<td>Reset control. a</td>
</tr>
</tbody>
</table>
Table 6. Fault Listings and Descriptions. (Continued)

<table>
<thead>
<tr>
<th>Fault/Blinc Code</th>
<th>Description</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>91</td>
<td>The 4 to 20 mA firing rate input is below 3 mA, Out of Range—Low. (Actuators return to or remain at the minimum modulation point with the alarm on; the control remains operational only to the extent that Minimum Modulation firing operation is allowed.)</td>
<td>Check CmA+- input (Terminals 39 and 40) for proper operation polarity and range. The input must be within 3.0 mA to 21.0 mA. The voltage at this terminal must be within 0.7 to 5.0 Vdc, respectively. Conditional Alarm—Alarm output is energized; controller continues to run.</td>
</tr>
<tr>
<td>92</td>
<td>The manual potentiometer rate input is higher than an allowable range, i.e., Out of Range—High. (The actuators move to the maximum modulation point with alarm ON; control will remain operable, yet when MANUAL MODE is selected, maximum modulation and alarm output shall occur.) Auto mode operation is not affected.</td>
<td>The Manual potentiometer is out of range high. Make sure a 5000 ohm (+–10%) potentiometer is being used and wiring to it is correct. Shielded cable is recommended. Conditional Alarm—Alarm output is energized; controller continues to run.</td>
</tr>
<tr>
<td>93</td>
<td>The auxiliary 4-20 mA input must be below 3.0 mA when configured for use. (The actuators return or remain at the minimum modulation point with alarm ON; the control will remain operable only to the extent that Minimum Modulation firing operation is allowed.)</td>
<td>Check XmA+- input (Terminals 37 and 38) for proper operation polarity and range. The input must be within 3.0 mA to 21.0 mA. The voltage at this terminal must be within 0.7 to 5.0 Vdc respectively. Conditional Alarm—Alarm output is energized; controller continues to run.</td>
</tr>
<tr>
<td>94</td>
<td>After LCO is set by the 833 02801 Fuel Air Ratio Controller, the Burner Control must provide a Lightoff or Purge request within 20 seconds. (Controller remains in a processing demand condition indefinitely waiting for valid inputs on the LF, MV and HF inputs; the alarm is sounded after the 20-second period expires.)</td>
<td>Check burner control interface wiring and burner control operation (Terminals 10, 11, 12). The 833 02801 Fuel Air Ratio Controller is waiting for a command via these terminals. Conditional Alarm—Alarm output is energized; controller continues to run.</td>
</tr>
</tbody>
</table>

*a* It is possible that a random external electrical noise has caused a fault checking algorithm to be detected. Resetting the control will allow recalculation of the fault and, if it is not a hard failure, the device will continue to operate. If the condition will not clear, the device must be replaced.

*b* Check ac waveform; severe noise on ac lines can corrupt sampling of ac signals.

*c* Verify actuator total resistance and wiper measurements; check the ability of the actuator to travel full stroke using the manual override buttons in the actuator. Verify input power to the actuator. If actuator is not functioning, replace the actuator.

*d* Verify a short does not exist at terminal 14. The control will need replacement if a sustained fault code 34 exists after the noted items 1 and 2 have been performed. Fuse line voltage power to control system with type SC15 fuse or fuse Limit Input (terminal 13) with type SC5 fuse.

*e* Conditional Alarm. Causes the alarm output to be energized, the system may still be operating but requires attention in order to modulate or to proceed with the light off sequence. The actuators would be positioned at lightoff point, minimum modulation point or maximum modulation point, dependent on what the particular fault is and when the fault is introduced, relative to the 833-02801 operating state.

**Wiring Checkout and Error Faults**

The commissioning and monitoring tools provides an effective means of an indirect status reading of all line voltage inputs and outputs. Use these tools to confirm wiring. The commissioning tool and monitoring tool environments require that a single fuel select input to be active before proceeding with communications between the tool and controller. Further, simultaneous HF and LF commands from the burner are not allowed and will preclude communications with the tools.

The act of bringing actuators successfully “on-line” verifies the initial wiring between the controller and actuators. See error codes 71 through 74 and/or 54 through 57 for details. Other wiring problems occurring between the actuators and controller, after commissioning, may be annunciated by fault codes 41 through 53 or 61,67,68,69 or 82 through 86.

Burner control wiring interface problems are annunciated by fault codes 13, 14, 15, 34, 37.

The 833-02802 Universal Wiring Subbase is partitioned into a line voltage section and a low voltage section. Utilize shielded cabling on all low voltage wiring. Keep the earth ground cable shield short as possible for all interface wiring as illustrated by Figure 2.
Appendix B

Wiring Sub Base
Fuel Air Ratio Universal Wiring Subbase

APPLICATION

The 833-02802 Fuel Air Ratio Universal Wiring Subbase is for the 833-02801 Fuel Air Ratio Controller. The wiring subbase provides terminals for field wiring. Terminals located on the 833-02801 Fuel Air Ratio Controller engage the wiring subbase contacts to make electrical connections.

The wiring subbase is panel-mounted.

FEATURES

• Quick-mount wiring subbase for 833-02801 Fuel Air Ratio Controllers.
• Allows wiring of control system before installation of controller.
• Panel-mounted.
• NEMA 1 enclosure.

Contents

Application ................................................................. 1
Features ................................................................. 1
Specifications ......................................................... 2
Installation ............................................................. 3
Wiring ................................................................. 3
Checkout .............................................................. 3
SPECIFICATIONS

Weight: 10 oz (0.28 kg).

Dimensions: See Fig. 1.

Enclosure: NEMA 1.

Approvals:
Underwriters Laboratories Inc. (UL).
Canadian Standards Association (CSA): Pending.
European Community (CE): Pending.
Factory Mutual (FM): Pending.
INSTALLATION

When Installing This Product...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced, Flame Safeguard service technician.
4. Disconnect the power supply before beginning installation to prevent electrical shock and equipment damage. More than one disconnect can be involved.
5. All wiring must comply with applicable local electrical codes, ordinances and regulations.
6. All line voltage wiring must be NEC Class 1 in the U.S.
7. After installation is complete, checkout product operation as provided in these instructions.

WARNING

Electrical Shock Hazard.
Can cause serious injury or death.
Disconnect power supply before beginning installation to prevent electrical shock and equipment damage. More than one disconnect can be involved.

Follow the equipment manufacturer instructions, if available. Otherwise, proceed as follows.

Mounting

NOTE: For installation dimensions, see Fig. 1.

1. Place the subbase in a location within the ambient temperature rating of the 833-02801 Fuel Air Ratio Controller. Refer to the appropriate 833-02801 Fuel Air Ratio Controller instructions, form number 65-0253. Be sure to allow adequate clearance for service, installation and access to electrical field connections.
2. Place the subbase on the panel and mark the location of the four mounting holes.
3. Insert the mounting screws, using four number 8 screws (purchased separately), tightened securely.

WIRING

1. Refer to equipment manufacturer wiring information and 833-02801 Fuel Air Ratio Controller specifications for correct subbase wiring.
2. Provide overload protection and disconnect means as required. Disconnect the power supply from the main disconnect before beginning installation to prevent electrical shock and equipment damage. More than one disconnect can be involved.
3. All wiring must comply with appropriate electrical codes, ordinances and regulations. In the U.S. use NEC Class (Line Voltage) wiring.
4. Recommended grounding practices:
   a. Each 833-02801 Fuel Air Ratio Controller will have an earth ground terminal that must be grounded to the metal control panel with wire as short as practical. Each ground wire must be capable of carrying a fault current equal to the rating of the protective fuse; a number 14 copper conductor is adequate.
   b. The earth ground provides a connection between the subbase and the control panel or the equipment. The earth ground wire must be capable of conducting a current to blow the fuse or breaker in event of an internal short circuit. The 833-02801 Fuel Air Ratio Controller needs a low impedance ground connection to the equipment frame which, in turn, needs a low impedance connection to earth ground. Connections must be made with minimum length conductors that have maximum surface area. Wide straps or brackets are preferred rather than leadwires. Be careful to ensure that mechanically tightened joints along the ground path, such as pipe or conduit threads or surfaces held together with fasteners, are free of nonconductive coatings and have corrosion-protected mating surfaces.
5. Make sure that loads do not exceed terminal ratings; refer to the labels on the 833-02801 Fuel Air Ratio Controller, or ratings in the 833-02801 Fuel Air Ratio Controller Specifications.
6. Check the power supply circuit. The voltage and frequency tolerance must match those of the 833-02801 Fuel Air Ratio Controller. Do not connect the Fuel Air Ratio Controller/Subbase to a power supply circuit that is subject to line voltage variations, such as would occur with on-off switching of heavy loads. A separate power supply may be required for the 833-02801 Fuel Air Ratio Controller. Add the required disconnect means and overload protection.
7. Check all wiring circuits and complete a static checkout according to the 833-2801 Fuel Air Ratio Controller specifications before installing the 833-02801 Fuel Air Ratio Controller on the subbase.
8. Install the 833-02801 Fuel Air Ratio Controller on the subbase.
9. Restore power to the panel.

IMPORTANT

Make sure no subbase wiring is projecting beyond the terminal blocks. This could interfere with proper mounting of the 833-2801 Fuel Air Ratio Controller. Tuck wiring in against the back of the subbase so that it does not interfere with the terminals or contacts of the 833-02801 Fuel Air Ratio Controller or the wiring Subbase.

CHECKOUT

After installation, perform a complete checkout of the system. Follow information supplied by equipment manufacturer and instructions furnished with the 833-02801 Fuel Air Ratio Controller (form number 65-0253).
Appendix C
Parallel Positioning Actuator
APPLICATION

The 945-00216 Universal Parallel-Positioning Actuator provides 100 lb-in. torque, pulse-width-modulating (PWM) control of combustion air dampers, butterfly gas valves, oil modulation valves, and flue gas recirculation systems. The actuator includes a precision feedback potentiometer and integral power supply capable of direct line voltage connection. The 945-00216 Universal Parallel Positioning Actuator is part of the Fuel Air Ratio Control System, and must be used with the 833-02801 Fuel Air Ratio Controller.

FEATURES

• Universal power supply input.
• Password protected with an eight-digit hexadecimal identification signal.
• 100 lb-in. (11.3 Nm) torque.
• Includes integral position feedback potentiometer.
• Separate wiring compartment between line voltage power wiring and low voltage control.
• Direct coupling shaft interface mounting.
• Couples directly to a 1/2 in. (13 mm) shaft with no additional parts required.
• Couples directly to 5/16 in. (8 mm) and 3/8 in. (9 mm) shafts using available self-centering shaft reduction accessories.
• Shaft coupler assembly available for shafts larger than 1/2 in.
• Bracket Accessory Kit available for mounting to Cleaver Brooks Butterfly Gas Valves.
• Visual indication of actuator position.
SPECIFICATIONS

Model: 945-00216 Universal Parallel-Positioning Actuator. Medium torque electronic actuator with a precision feedback potentiometer and integral power supply capable of direct line voltage connection.

Dimensions: See Fig. 1.

Electrical Ratings:
Power Input: 100 to 240 Vac +10% -15%, 50/60 Hz.
Maximum Power Consumption: 15 VA.

*IMPORTANT*
Device must be hardwired.

Temperature Range:
Ambient: -40°F to +140°F (-40°C to +60°C).
Storage: -40°F to +150°F (-40°C to +66°C).

Humidity Range at 95°F [35°C]: 5 to 95 percent relative humidity, noncondensing.

Vibration: 0.0 to 0.5g continuous (V2 level).

Control Signal (at 5 mA current):
Drive Clockwise: Minimum 4.25 Vdc differential between DR1-DR2.
Drive Counterclockwise: Maximum -4.25 Vdc differential between DR1-DR2.

NOTE: Actuator does not respond until the 8-digit ID signal from the 833-02801 Fuel Air Ratio Controller is passed via DR1-DR2.

Actuator Stroke: 95° nominal ± 3°, mechanically limited.

Output Hub Position Accuracy: ±0.1°.

Torque Ratings at Rated Voltages:
Lift and Hold Minimum: 100 lb-in. (11.3 Nm).
Breakaway Minimum: 100 lb-in. (11.3 Nm).
Stall Minimum: 100 lb-in. (11.3 Nm).
Stall Maximum: 150 lb-in. (17 Nm).

Actuator Design Life (at 100 lb-in.):
Full-Stroke Cycles: 100,000 minimum.
Repositions: 2,000,000 minimum.

Feedback Potentiometer: Total Resistance: 5000 ohms ±10%.

Actuator Timing (90° Travel):
Standard: 24 to 30 seconds.
Derated Cold-Start Timing (from -40°F to -20°F (-40°C to -29°C)): 150 seconds maximum.

Noise Rating: 55 dBA maximum at 1m during normal operation.

Mounting:
Mounts directly on 1/2 in. (13 mm) round or square shaft. With proper accessories, mounts to 5/16 in. and 3/8 in. (8 mm, 10 mm) round or square shafts; 9/16 in., 5/8 in., and 3/4 in. (14 mm, 16 mm, and 19 mm) round shafts.

*IMPORTANT*
Tighten hub setscrews to a torque of 60 lb-in.
±10 lb-in.

Position Indicator: Visible with cover on device.


Accessories:
201391 Shaft Adapter for 3/8 in. round or square shaft.
32003167-001 Shaft Adapter for 5/16 in. round or square shaft.
32003168-001 Shaft Adapter for 3/4 in. diameter round shaft.
32003168-002 Shaft Adapter for 5/8 in. diameter round shaft.
32003168-003 Shaft Adapter for 9/16 in. diameter round shaft.
32003396-001 Butterfly Valve Mounting Bracket for 1-1/2 in. and 2 in. valves.
32003396-002 Butterfly Valve Mounting Bracket for 2-1/2 in., 3 in. and 4 in. valves.

Fig. 1. Universal Parallel Positioning Actuator dimensions in in. (mm).

INSTALLATION

When Installing this Product...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced service technician.
4. After installation is complete, check out product operation as provided in these instructions.

Mounting the Universal Parallel Positioning Actuator

The Universal Parallel Positioning Actuator mounts on a 1/2 in. horizontal or vertical shaft. Using the self-centering shaft reducer (see Accessories), the actuator can be mounted on a 5/16 in. or a 3/8 in. shaft. For shafts larger than 1/2 in., adapters are available for 5/8 in., 3/4 in., and 9/16 in.

CAUTION

Equipment Damage Hazard.
Lateral forces on actuator hub will damage actuator.
Ensure actuator is mounted with shaft centered in actuator hub.

1. Place the actuator over the shaft, see Fig. 2.
2. Position and seat the actuator.
3. Rotate the shaft to match the actuator position.
4. Install the mounting bracket accessory (not included), if needed. See Fig. 3.
5. Partially tighten hub setscrews to ensure actuator seats firmly against mounting bracket with shaft centered in hub.
6. Tighten the anti-rotation bolt to the torque recommendation for the selected bolt/nut.
7. Tighten the hub setscrews against the shaft to a torque of 60 lb-in.

Mounting the Universal Parallel Positioning Actuator on the Firing Rate Gas Valve.

WARNING

Explosion Hazard and Electrical Shock Hazard.
Can cause explosion, serious injury or death.
1. Turn off gas supply before starting installation.
2. Disconnect power supply for valve actuator before beginning installation and wiring. More than one disconnection can be involved.
3. Attach the mounting bracket for the Universal Parallel Positioning Actuator (supplied with the Firing Rate Gas Valve) in the position that best suits the valve location, access space and wiring requirements.
4. Place the short end of the Firing Rate Gas Valve drive stem in the top of the Firing Rate Gas Valve drive so that the rectangular portion of the drive stem is inside the valve drive.
5. Mount the Universal Parallel Positioning Actuator on the Firing Rate Gas Valve and secure the actuator to the mounting bracket with the supplied screws.
6. Wire the Universal Parallel Positioning Actuator per the instructions in the Wiring section.
7. Restore power to the system.

Location

CAUTION

Actuator Damage Hazard.
Deteriorating vapors and acid fumes can damage the actuator metal parts.
Install actuator in areas free of acid fumes and other deteriorating vapors.
WIRING

⚠️ WARNING
Electrical Shock Hazard.
Can cause serious injury or death.
Disconnect power supply before installation.

All wiring must comply with local electrical codes, ordinances and regulations. The Universal Parallel Positioning Actuator is designed for use with a Class 2 power supply for low voltage. Voltage and frequency of the transformer must correspond with the characteristics of both the actuator and the power supply.

Preparation
Use OEM-supplied 1/2 in. conduit connectors in the low- and line- voltage base openings; the motor has separate line- and low-voltage wiring compartments. Use Belden 9535, 5-conductor, 100% shield coverage, 300V, 80°C (UL2464, CSA PCC FT4), or equivalent for low voltage wiring.

Wiring Procedures

**IMPORTANT**
Device must be hardwired.

1. Remove the cover from the actuator.
2. Pull back the snap-locks while opening the low-voltage compartment. See Fig. 5.
3. Wire the low-voltage circuit to the 833-02801 Fuel Air Ratio Controller. See Fig. 6 for typical wiring connections.
4. Close the low-voltage compartment.
5. Wire the line-voltage circuit. See Fig. 6 for typical wiring connections.
6. Replace the cover on the actuator.

---

**Fig. 3. Mounting the Universal Parallel Positioning Actuator.**

**Fig. 4. Mounting the Universal Parallel Positioning Actuator with mounting bracket accessory.**

**Fig. 5. Opening Universal Parallel Positioning Actuator low-voltage wiring compartment.**

**Fig. 6. Typical Universal Parallel Positioning Actuator wiring.**
OPERATION

The 945-00216 Universal Parallel-Positioning Actuator is designed to operate combustion air dampers, butterfly gas valves, oil modulation valves, and flue gas recirculation systems requiring up to 100 lb-in. torque. A 833-02801 Fuel Air Ratio Controller operates the actuator.

The actuator has a position indicator that shows shaft position. As the indicator moves with the shaft, it provides an angular representation of the shaft position.

IMPORTANT

When the cover is removed and replaced, the position indicator will not operate until manually rotated clockwise to engage it. An audible click indicates the position indicator is engaged.

NOTE: While installing the actuator, the hub can be manually driven using the push buttons located under the cover. The buttons are labeled CW and CCW. To use them, the only required wiring connections are L1, L2, and GND. However, after the device is installed and wired to the 833 02801 Fuel Air Ratio Controller, do not use these buttons for anything but troubleshooting.

Password Protection (ID Signal)

Before using the actuator, the ID signal must be set. See the software interface instructions for details. After this signal is set, the 833-02801 Fuel Air Ratio Controller sends the signal to operate the actuator. Until the appropriate ID signal is sent, the actuator is offline and responds only to its own ID signal.

(See Table 1.)

Table 1. On-Board LED Indications.

<table>
<thead>
<tr>
<th>LED</th>
<th>Online</th>
<th>Configured</th>
<th>Meaning</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast Blink</td>
<td>No</td>
<td>Yes</td>
<td>Awaiting ID signal.</td>
<td>Responds only to ID signal.</td>
</tr>
<tr>
<td>Slow Blink</td>
<td>Yes</td>
<td>Yes</td>
<td>ID signal recognized.</td>
<td>Monitors signals for operation or offline commands.</td>
</tr>
<tr>
<td>Steady On</td>
<td>No</td>
<td>No</td>
<td>Actuator has failed.</td>
<td>Return actuator to factory.</td>
</tr>
</tbody>
</table>

CHECKOUT AND TROUBLESHOOTING

Checkout

Refer to the 833-02801 Fuel Air Ratio Controller literature (form 65-0253) for system checkout.

Troubleshooting

If the actuator does not operate properly during Checkout, perform the following troubleshooting steps. Perform these steps before replacing the actuator:

1. Check the actuator label to make sure the power and control signal requirements are correct for the application.
2. Check for the presence of 120-240 Vac at the actuator (L1) and (L2) connections when the actuator should be driving. If the voltage is not present or is low, check the power supply.
3. Ensure actuator stroke matches stroke of damper or valve.
   a. Remove the cover.
   b. Press the button labeled CW. The actuator should drive the device clockwise.
   c. Press the button labeled CCW. The actuator should drive the device counterclockwise.
4. If the actuator operates properly, check the controller for proper output signals.
5. If the actuator does not drive, remove power, disconnect the actuator hub, and try to turn the shaft clockwise and counterclockwise. If the shaft turns freely throughout the 90-degree stroke and the actuator is installed properly, replace the actuator.
6. If the shaft does not turn freely for the full 90 degrees, check for binding. If necessary, adjust mounting to prevent binding.
7. If the device shaft does not turn freely, fix or replace the device.
8. If the device shaft turns, reconnect the actuator and wiring and drive the actuator hub clockwise and counterclockwise. If the actuator does not drive, replace the actuator.
9. If the actuator and device shaft turn freely, remount the actuator to the device according to instructions in the Installation section. Make sure the actuator does not bind and that the actuator and device are both at the same clockwise or counterclockwise end stop when assembled. Hook up the wires and repeat the Checkout procedures. Troubleshoot if necessary.
Appendix D

Port Expander
APPLICATION

The 985-126 Port Expander provides a direct or cable (RS-232, DB9) connection to the serial port of a laptop or PC. It also provides an RS-485 connection to the 833-02801 Fuel Air Ratio Controller.

SPECIFICATIONS

Dimensions: See Fig. 1.

Weight: 1.5 oz (42 g).

Ambient Temperature Ratings:
Operating: -40°F to +140°F (-40°C to + 60°C)
Storage: -40°F to +150°F (-40°C to +66°C).

INSTALLATION

When Installing This Product...
1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings in the instructions and on the product to make sure the product is suitable for your application.
3. The installer must be a trained, experienced flame safeguard technician.
4. After installation is complete, check out product operation as provided in these instructions.

IMPORTANT

The laptop/PC RS-232 port must be a serial port (DB9 connection).

Connect the 985-126 Port Expander as shown in Fig. 2.

- Wire type: Belden 8760 shielded wire or equivalent, 3-conductor, 100% shield coverage, 300V, 80°C (UL2464, CSA PCCFT4, 18 to 24 AWG).
- RS-232 (DB9) PC connection can be either direct or RS-232 (DB9) cable.

Fig. 1. 985-126 Port Expander dimensions in in. (mm).

Fig. 2. Connecting the 985-126 Port Expander to the 833-02801 Fuel Air Ratio Controller and the laptop/PC.
TROUBLESHOOTING

If the 985-00125 Software does not connect to the 833-02801 Cleaver-Brooks Fuel Air Ratio Controller, perform the following steps:

1. Check the laptop/PC communications serial port settings for proper configuration.
2. Check connections/wiring of the port expander to the laptop/PC and the 833-02801 Cleaver-Brooks Fuel Air Ratio Controller.
Appendix E

Software Configuration Tool
Software License Advisory

This document supports software that is proprietary to Cleaver Brooks and/or to third party software vendors. Before software delivery, the end user must execute a software license agreement that governs software use. Software license agreement provisions include limiting use of the software to equipment furnished, limited copying, preserving confidentiality, and prohibiting transfer to a third party. Disclosure, use, or reproduction beyond that permitted in the license agreement is prohibited.
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INTRODUCTION

The 985-00125 Software Configuration Tool reduces burner setup time by letting you create a burner modulation curve (profile) for the burner that allows for safe and efficient operation at all points along the modulation curve. The software uses a wizard-like process to assist you through the commissioning process. It also lets you save curves in standard PC files so that you can commission similar systems rapidly and safely. Once the burner is commissioned, real-time monitoring of the system can be done via the monitoring tool.

The software can be used on systems with one or two fuels and on systems with or without flue gas re-circulation (FGR).

The information in this user guide is also available on-line, see “Getting Help,” below.

REQUIREMENTS

The minimum system requirements for using the 985-00125 Software Configuration Tool are as follows:

a. PC or laptop with a Pentium® processor running Windows® 95, Windows 98, Windows ME or Windows 2000.
   b. 16 MB of RAM
   c. 1G hard drive with 100 MB of free memory.
   d. RS232 Serial Port (DB9).

Before commissioning a burner with the 985-00125, you will also need the following equipment:

a. A calibrated stack gas analyzer.
   b. An RS232 to RS485 converter.

SAFETY FEATURES

This software incorporates many features that are designed to guide you safely through the commissioning process. Safety, however, is your responsibility.

This software should only be used by experienced and/or licensed boiler operators and mechanics.

Read all documentation carefully and respond appropriately to all error messages.

Be aware that as you command the software to open and close actuators, the software is designed to prevent you from opening or closing them too rapidly. When any of the system actuators is below 20% of its full open position, the 833-02801 effectively limits any actuator from traveling more than three degrees without moving the other actuators in the system. When all the actuators are over 30% of their full open position, the limit increases to 10 degrees.

WARNING

Explosion Hazard. Improper configuration can cause fuel buildup and explosion.

Operators of this software may move fuel and/or air actuators to positions that can create Hazardous burner conditions. Improper user operation may result in PROPERTY LOSS, PHYSICAL INJURY or DEATH.

The 985-00125 Software Commissioning Tool is to be used only by experienced and/or licensed boiler operators and mechanics.

GETTING HELP

In addition to referring to this manual, you can get on-line help when using the software by pressing the HELP button on any of the screens. You can then use the table of contents of the help system to open topics or use the search function to find information.

INSTALLING THE HARDWARE

Use the following instructions to install the system hardware:

— 65-0253 833-02801A,B ControLinks™ Controller.
— 65-0254 ML7999A ControLinks™ Actuator.
— 65-0225 Q7999A Wiring Subbase.

INSTALLING THE SOFTWARE

To install the software, follow the directions provided in the CD-ROM booklet. If those instructions are not available proceed as follows:

1. Start Windows™
2. Insert the CD-ROM in your CD-ROM drive.
3. Press the Windows Start button.
4. Enter D:\setup (assuming your CD-ROM drive is your D: drive), and press OK.
5. Follow the installation directions as they are displayed. An on-line help file and this user guide will be installed along with the configuration software. A printed copy of this User Guide (form number 65-0257) can be ordered from Cleaver Brooks, Inc. by calling 1- 800 — 468 – 1502
6. When updating or removing 985-00125 software, perform an uninstall of the old software.

Once installed, the 985-00125 software can be used to configure and monitor the 833-02801A, B ControLinks™ Controller.
**BEFORE YOU BEGIN**

Before you begin to commission a system:

1. Read this guide to understand how the program operates.
2. Review the “Commissioning Process” and “Creating an Air/Fuel Ratio Curve - Example” sections so that you have a clear understanding of the commissioning process.

**STARTING THE PROGRAM**

To start the program, proceed as follows:

Double-click the “FuelAir 985-00125” icon on your desktop.

OR

1. Press the Windows Start button.
2. Select “Fuel Air Wizard 985-00125.”
3. Select “FuelAir 985-00125.”

**THE COMMISSIONING PROCESS**

Commissioning a burner using the 985-00125 Software Configuration Tool requires the following general steps:

1. Connecting the 833-02801 to the communications port of your PC, and logging onto the software with a password. This prevents unauthorized users from modifying the modulation curve.
2. Specifying the base configuration: one or two fuels, with or without an FGR.
3. Selecting system parameters such as Low Fire Hold.
4. Specifying the characteristics of the actuators and setting the valve/damper end points for those actuators.
5. Creating a modulation curve (profile) for each fuel and verifying it from maximum to minimum modulation. (While you are commissioning the system, you must monitor the burner operation with appropriate safety instrumentation to verify the modulation curve.)

Refer to “Creating an Air/Fuel Ratio Curve - Example” for a detailed example of how a system should be commissioned.

**Commissioning Overview**

The following table provides a step-by-step overview of how a system is commissioned. A detailed example of how to commission a system is described in “Creating an Air/Fuel Ratio Curve—Example”.

The Notes column in the table provide references to detailed information when completing the more complex operations.

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>On the Intro screen, press Commission.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>On the Connect to Fuel/Air Controller screen, perform the following steps:</td>
<td></td>
</tr>
<tr>
<td>2.a.</td>
<td>Enter your password.</td>
<td>The 985-00125 requires you to enter your own password. The factory default password is “password.”</td>
</tr>
<tr>
<td>2.b.</td>
<td>Select or verify the communications port to which the 833-02801 Cleaver-Brooks Fuel Air Ratio Controller is connected.</td>
<td></td>
</tr>
<tr>
<td>2.c.</td>
<td>Press Next button.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>On the Select Base Configuration screen, perform the following steps:</td>
<td></td>
</tr>
</tbody>
</table>
| 3.a. | Select the base configuration. | The choices are:
  - Unconfigured; selecting this option takes the device back to a factory state.
  - Single Fuel.
  - Single Fuel with FGR.
  - Dual Fuel.
  - Dual Fuel with FGR. |
<p>| 3.b. | Select an actuator to configure: AIR, Fuel 1, Fuel 2, or FGR. | There may not be a button for each actuator. |
| 4    | On the Set Actuator Endpoints screen, perform the following steps: | |
| 4.a. | Select the Direction of Closed Travel: Clockwise or Counterclockwise. | |
| 4.b. | Select the Actuator’s Valve or Damper Type: Fixed Stops or Continuous Rotation. | The Auto Endpoint Seek function is only enabled when the Fixed Stop option is selected. |</p>
<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.c.</td>
<td>Enter the KEY (serial number) of the Actuator.</td>
<td>Manually move the actuator to a midspan position to allow the ID unlocking algorithm to function properly. Please make sure that all eight digits are entered correctly. You can confirm an actuator has been successfully brought on-line by noting its flash rate has changed from a rapid flash to a slow flash, i.e., 1 blink/second.</td>
</tr>
<tr>
<td>4.d.</td>
<td>Press Set Configuration.</td>
<td></td>
</tr>
<tr>
<td>4.e.</td>
<td>Press Auto Seek Open or Auto Seek Close.</td>
<td>Press here for information on which to select first.</td>
</tr>
<tr>
<td>4.f.</td>
<td>If necessary, press Open or Close to adjust the actuator position.</td>
<td></td>
</tr>
<tr>
<td>4.g.</td>
<td>Press Lock Position.</td>
<td></td>
</tr>
<tr>
<td>4.h.</td>
<td>Repeat steps 4.e. through 4.g. to set the Open/Close position of the other actuators in your system.</td>
<td></td>
</tr>
<tr>
<td>4.i.</td>
<td>Press Next.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>On the Create Fuel Ratio Curve screen, press the Fuel 1 or Fuel 2 button.</td>
<td>If you selected “Single Fuel” in the base configuration (step 3.a.), only one Fuel button appears.</td>
</tr>
<tr>
<td>6</td>
<td>On the Create Profile screen, perform the following steps:</td>
<td>See System Parameters. The 833-02801 Cleaver-Brooks Fuel Air Ratio Controller automatically moves the air actuator to a 62% open position.</td>
</tr>
<tr>
<td>6.a.</td>
<td>Switch the external burner demand switch (power LCI terminal 13) and then press Start Light Off Sequence.</td>
<td></td>
</tr>
<tr>
<td>6.b.</td>
<td>Press Open and/or Close for Fuel and Air and the FGR (if present, and configured to follow purge) to move the cursor to the “Air Purge” point of the burner.</td>
<td>The 833-02801 Cleaver-Brooks Fuel Air Ratio Controller automatically moves the air actuator to a 62% open position.</td>
</tr>
<tr>
<td>6.c.</td>
<td>Press Air Purge.</td>
<td>A “P” will be displayed. The 833-02801 Cleaver-Brooks Fuel Air Ratio Controller energizes its HFP output (terminal 10) which, in turn, allows the burner control to start the purge time.</td>
</tr>
<tr>
<td>6.d.</td>
<td>press the Open and Close buttons for Fuel and Air and the FGR (if present) to move the cursor to the Light Off point of the burner.</td>
<td>The air damper automatically moves to a 25% open position, while the fuel actuator remains at the closed position plus one degree. When used with CB780/784 burner controls, you have 240 seconds to perform this action, otherwise the burner control locks out.</td>
</tr>
<tr>
<td>6.e.</td>
<td>Press Light Off.</td>
<td>An “L” is displayed on the profile, and the 833-02801 Cleaver-Brooks Fuel Air Ratio Controller energizes the LFP output (terminal 8), which allows the burner control to light off the system. The burner should light. Press here for troubleshooting information.</td>
</tr>
<tr>
<td>6.f.</td>
<td>Press Open and Close for Fuel and Air and the FGR (if present) to move the cursor to the Minimum Modulation point for the burner.</td>
<td>Press here for information on using the flat line Wizard for the FGR.</td>
</tr>
</tbody>
</table>
| 6.g. | Press Min Modulation. | An “m” will be displayed on the profile. 

**NOTE:** The min modulation point may be higher or lower than the Light Off point. |
<p>| 6.h. | Press Open and Close for Fuel and Air and the FGR (if present) to move the cursor to the next desired fuel air mixture point. | The 833-02801 Cleaver-Brooks Fuel Air Ratio Controller enforces slope limitations of 1 to 8 and 8 to 1 (in degrees) with the exception of Flat Line or Negative FGR capability. The cursor changes from a cursor to a diamond when you have moved out of the range of allowable slopes. You are not allowed to enter points when a diamond shape is present. With Cleaver-Brooks Fuel Air Ratio Controller release 1.4 or greater, the FGR actuator may have negative slopes (maximum negative slope of 1 to 5) anywhere within the modulation band. |</p>
<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
<th>Notes</th>
</tr>
</thead>
</table>
| 6.i. | Press Intermediate. | A dot will be displayed on the profile and a line will connect the minimum modulation point and the first intermediate point. Entering a new Maximum Modulation point causes any pre-existing Maximum Modulation point to change to an intermediate point. This technique of entering each new intermediate point as the new “temporary” Maximum Modulation point has an advantage, which is apparent under light boiler load conditions. You are able to use the move along the curve commands during the next lightoff sequence and you can more quickly reach the firing rate point that the system was at prior to going out because of low demand. For gas systems in which the gas pressure has not been adjusted to match the burner rated btu capability, you should use the Maximum Modulation replacement technique to rough in a curve until maximal air flow is obtained. The gas flow may then be adjusted to set the maximum firing rate. You can then delete all points and immediately re-enter another maximum modulation point.  

Or press Maximum Modulation. with Rev 1.4 (or greater) controllers, you can alternatively place a maximum modulation point in place of an intermediate point as long as a span of 17 degrees exists between the minimum and maximum modulation points. |
| 6.j. | Repeat steps 6.h. and 6.i. until you have created at least six intermediate points along the profile. | For gas systems in which the gas pressure has not been adjusted to match the burner rated btu capability, you can use the Maximum Modulation replacement technique to rough in a curve until maximal air flow is obtained. The gas flow may then be adjusted to set the maximum firing rate. You can then delete all points and immediately re-enter another maximum modulation point. This may save you some time by not requiring you to successively delete invalid intermediate points due to gas pressure change. |
| 6.k. | Press Open and Close for Fuel and Air and the FGR (if present) to move the cursor to the Maximum Modulation point for the burner. | For gas systems in which the gas pressure has not been adjusted (to match the burner rated btu capability), you can use the Maximum Modulation replacement technique to rough in a curve until maximal air flow is obtained. The gas flow may then be adjusted to set the maximum firing rate. You can then delete all points and immediately re-enter another maximum modulation point. This may save you some time by not requiring you to successively delete invalid intermediate points due to gas pressure change. |
| 6.i. | Press Max Modulation. | An “M” will be displayed on the profile and a line will connect it to the intermediate points. The 833-02801 requires reverification of any verified curve segments after setting the maximum modulation point. |
| 6.m. | Press Move to Next Lower position until the cursor reaches the next lower point on the profile. Alternatively, you can add intermediate points as the effective firing rate is lowered. Jump back to 6h if the temporary intermediate points were deleted in 6k. | The line segment turns color to indicate the curve has been walked (verified). NOTE: The 985-00125 requires you to enter at least three points (inclusive of the min and max modulation points) in order to use the “Move Along the Curve” buttons. |
| 6.n. | Repeat step 6.m. until you have moved along the curve from top to bottom. | The profile is now complete and operational. The 833-02801 Cleaver-Brooks Fuel Air Ratio Controller requires reverification of any line segment after the maximum modulation point has been altered. |
| 6.o. | If you wish to save the profile you have just created to your PC, press Save Profile. | You must insure that the purge point is within the minimum and maximum modulation points before finishing the profile. The purge point can be moved while the burner is firing by simply using the move along the curve commands and pressing Purge at the desired level or at the purge point definition period during the next startup sequence. |
| 7 | When you are through with the profile, press Finish. | The Monitor screen appears. You have successfully commissioned the 833-02801 Cleaver-Brooks Fuel Air Ratio Controller. |
PROGRAM OPERATION

Because the 985-00125 ControLinks™ Software Configuration Tool operates like a wizard, you cannot open screens randomly. You must step through them one at a time, and provide the information necessary for one before you can move on to another. The screen descriptions are provided below so that you can understand the purpose of each and view the selections, parameters, and information that is available or required on each.

Screen Descriptions
The 985-00125 ControLinks™ Software Configuration Tool screens include the following:

a. Cleaver Brooks Fuel/Air Ratio Controller Commissioner 985-00125, referred to as the “Intro” screen.
b. Connect to Fuel/Air Controller.
c. Select Base Configuration.
d. Set XXXX Actuator Endpoints, where XXXX is either Air or Fuel or FGR (Serial Number).
e. Create Fuel/Air Ratio Curve.
f. Create/Modify Profile Curve for Fuel X, where X is either 1 or 2.
g. Monitor (This screen is not part of the commissioning process, but allows you to monitor a system after it has been commissioned.)

Intro Screen
The Intro screen (Fig. 1) is used to select one of the following actions:

• Commission the system.
• Monitor the system.

You can perform the following actions from this screen:

1. Begin to commission a new system.
2. Modify the commissioning of an existing system.
3. Monitor the status of a commissioned system.
4. Verify the version number of the 985-00125 software.
   a. Commission Press to start commissioning a new system or modify/review the commissioning settings of an existing system.
   b. Monitor Press to monitor the status of a commissioned system.
   c. Help Press to display the help system.
   d. Exit Press to exit the program.

Connect to Fuel/Air Controller Screen
The Connect to Fuel/Air Controller screen (Fig. 2) is used to:

• Protect the system from unauthorized users.
• Connect the 833-02801 to the software. Refer to the 833-02801A,B ControLinks™ Controller specification sheet (Form No. 65-0253).

You can perform the following actions from this screen:

1. Enter your password to access the commissioning function of the program.
2. Select the PC communications port the 833-02801 is connected to.
3. Change the password.
NOTE: The password has to have a minimum of four and a maximum of 15 characters.

4. Verify the version number of the firmware residing on the 833-02801.
   a. **Commissioning Password** Before you can connect to the system, you must enter a valid password here. See Fig. 3 and 4.

NOTE: The first time you use the system, enter the password ‘Password’ and then press Connect. A message will display that you must change the default password. Change the password, as described in “How to Change the System Password.” A message will then display asking you to reconnect using the new password. Press the Prev button, then the Next button to return to this screen and enter your new password and press Connect.

b. **Connect** Press after you have entered a valid password and selected the PC Comm Port. (Fig. 5) See “How to Connect to the PC Comm Port.”

c. **New Password** Enter your new password in this field. See “How to Change the System Password.”

d. **Change Password** Press to change your password.

e. **PC Comm Port** Select the communications port that the 833-02801 is connected to. See “How to Connect the 833-02801” in the specification sheet.

f. **Help** Press to display the help system.

g. **Exit** Press to exit the program. Valid changes will be saved.

h. **Prev** Press to return to the Intro screen.

i. **Next** Press to move to the next screen, Select Base Configuration. You cannot move to this screen until you have properly connected to the 833-02801.

---

**Select Base Configuration Screen**

The Select Base Configuration screen (Fig. 6) is used to:

- Identify the configuration of the system you want to commission, for example, dual fuel system with a FGR or a single fuel system, etc.
- Begin configuration of the actuators.
- Allow the user to set System Parameters.
You must perform the following actions from this screen:

1. Select base configuration for the system.
2. Select and configure all actuators within the base configuration.
3. Go to the System Parameters screens to set system parameters or view the default system parameters.

NOTE: Depending on the number of actuators physically connected to the 833-02801, some of the selections on this screen may be grayed out. For example, if you have a single fuel system and only two actuators, you can only select “Unconfigured” or “Single Fuel.”

   a. **Base Configuration**
      - **Unconfigured**—This is the initial (default) option. You can select this option to erase the current configuration.
      - **Single Fuel**—Select if you want to configure only one fuel actuator and one air actuator.
      - **Single Fuel with FGR**—Select if you want to configure a fuel actuator, an air actuator, and an FGR actuator.
      - **Dual Fuel**—Select if you want to configure two fuel actuators and one air actuator.
      - **Dual Fuel with FGR**—Select if you want to configure two fuel actuators, one air actuator, and an FGR actuator.

   b. **Air**
      - **Fuel 1**
      - **Fuel 2**
      - **FGR**

      (1) Press a button to configure the actuator. (If you selected ‘Single Fuel’ or ‘Single Fuel with FGR’ in the Base Configuration, the Fuel 2 button is not displayed. If you selected ‘Single Fuel’ or ‘Dual Fuel’ in the Base Configuration, the FGR button is not displayed.) When you press a button, the **Set Actuator Endpoints** screen is displayed. When the actuator has been configured, the word “Configured” is displayed next to the appropriate button. See Fig. 7.

**Fig. 7. Base Configuration for Dual Fuel with FGR.**

**Set Air/Fuel Actuator Endpoints Screen (Fig. 8)**

The Set Air/Fuel Actuator Endpoints screens (there is one screen for each actuator) are used to:

- Identify the configuration of each actuator in the system. This prevents actuator and/or controller replacement without recommissioning the system and verifying safe operation.
- Set the maximum open and closed positions for each actuator.
- You can perform the following actions from these screens:
  - Enter the actuator configuration information including: direction of travel, actuator type, and KEY (serial number).
  - Set the maximum open and closed positions for each actuator.

⚠️ **CAUTION**

Operating Condition Hazard. Wrong actuator information can cause an unsafe operating condition. Use caution when selecting this setting. If you enter the wrong direction of travel, you may create an unsafe condition later in the commissioning process.

1. **Actuator Configuration:**
   - **Direction of Closed Travel**—Select the direction that the actuator travels to close, either **Clockwise** or **Counterclockwise**. See Fig. 9.
   - **Actuator Type**—Select the type of actuator, either **Fixed Stops** or **Continuous rotation**.
   - **Serial Number**—Enter the serial number of the actuator you are configuring. The serial number can be found on the ML7999 actuator body in two places under the label “KEY.” The “key” is made up of eight
numbers, the first four numbers represent the date code of manufacture for the actuator. When you attempt to set the configuration, the software writes the serial number to the actuator to verify your entry. If you enter the wrong number, you will receive an error message.

d. If you change an actuator in a commissioned system, you cannot run the system until you have entered the new KEY (serial number) of the actuator, set the maximum open and closed positions and re-verify the existing curve (or set and verify a new curve) for the system.

2. Set Configuration (Fig. 12):
   • Press this button after you have selected the direction of closed travel, actuator type, and entered the KEY (serial number). The software verifies the serial number and stores the configuration information. If the serial number you entered and the device serial number do not match, you will receive an error message.

NOTE: You must resend the KEY (serial number) anytime you revise the closed direction setting or change the type of end-stop selection.

3. Set Maximum Closed Position/Set Maximum Open Position:
   • Press one of these buttons to manually open or close the actuator the number of degrees indicated in the slide bar (from 1 to 10). You can also use the function keys indicated next to the buttons (F1, F2, F5 or F6) to perform the same actions. Each time you press the Open or Close key, the 833-02801 receives a command to execute the move command, the interface is essentially locked out until the command has been completed. See Fig. 11 and 12.
4. **Auto Seek Open/Closed:**
   - Press one of these buttons to let the software automatically locate the maximum open or maximum closed position of the actuator. The actuators are moving in a limited torque mode. Therefore the time required to move from one end of travel to the other is extended by approximately a factor of three. You can speed up this activity by opening the actuator cover and pressing the CW or CCW buttons.

5. **Lock/Unlock Position:**
   - After you have set the maximum open or closed positions for the actuator, ‘lock’ in the settings by pressing the Lock Position button. Once you press the Lock Position button, the button redisplays as Unlock Position. To change the position settings once the Lock Position button has been pressed, you must press the Unlock Position button.
   - **Help** Press this button to display the help system.
   - **Exit** Press this button to exit the program. Valid changes will be saved.
   - **Prev** Press this button to return to the Select Base Configuration screen without completing this screen.
   - **Next** Press this button to move to return to the Select Base Configuration screen. You cannot move to the next screen until you have completed the actions required on this screen. See Fig. 13 and 14.

Fig. 11. Set Maximum Air Open Position.

Fig. 12. Set Maximum Air Closed Position.

Fig. 13. Air Configured.
**System Parameters Screen**

**SYSTEM PARAMETERS**

1. Press to set system parameters. System parameters let you choose advanced features that use the auxiliary 4-20mA input such as: low fire hold and/or FGR holds, configure actuator positions during standby, configure the position of the non-selected fuel actuator, configure action of the FGR actuator during purge, adjust the postpurge timing parameter, and select a maximum firing rate limit via the manual potentiometer input.

2. See “System Parameters Screen” below.

3. Setting these parameters is optional. If you do not set system parameters, the default values will be used. See “Default System Parameters” for the default value/setting for each parameter.

**NOTE:** The selection of Xma (auxiliary mA) operation system parameters result in a common attribute between the operation of both fuel selections. For example, selecting low fire hold will apply to both fuels.

**e. Help** Press to display the help system.

**f. Exit** Press to exit the program. Valid changes will be saved.

**g. Prev** Press to return to the Connect to Fuel/Air Controller screen.

**h. Next** Press to move to the next screen, Create Fuel Ratio Curve.

**NOTE:** You cannot move to Create Fuel Ratio Curve screen until all of the actuators have been configured.

**NOTE:** You do not have to set any of these system parameters. Default values/positions are defined. If you want to review system parameter settings or add/modify them. Press System Parameters on the Select Base Configuration screen.

If you make changes to the system parameters, they are not saved until you press *Finish* on the second system parameters screen.

System parameters you can set include:

- Stack or boiler water temperature sensor operating parameters.
- Controller timing (postpurge time).
- Auto/manual maximum firing rate option via the manual potentiometer input.
- Program standby positions and non-selected fuel position.
- FGR behavior during purge.
  
  **a. Xma Operation**

  **(Auxiliary mA input)**

  Select an operation from the dropdown list:

  1. Disabled means this input is ignored.
  2. Low Fire Hold—Selecting this option field enables an algorithm that protects the boiler from thermal shock. Upon successful progression to modulation, the 833-02801 holds the burner at the light off point until the auxiliary temperature input exceeds the programmed threshold. The Low Fire Hold function re-enables once the temperature input falls below the threshold minus the differential. Use of this function requires an auxiliary linearized temperature transducer. You must match the programmed high and low temperature range points to that of the transducer; all other values are determined in a linear interpolated manner ranging from 4.0mA to 20.0mA. The maximum temperature range is -40°F to 1400°F respectively. The minimum span is 100°F.
  3. FGR Hold—Selecting this option field enables an algorithm that holds the FGR damper closed until the stack temperature has reached a programmed threshold. After successful progression to modulation, the 833-02801 holds the FGR closed until the auxiliary temperature input exceeds the programmed threshold. The FGR function re-enables once the temperature input falls below the threshold minus the differential. Use of this function requires an auxiliary linearized temperature transducer. You must match the programmed high and low temperature range points to that of the transducer; all other values are determined in a linear interpolated manner ranging from 4.0mA to 20.0mA. The maximum temperature range is -40°F to 1400°F respectively. The minimum span is 100°F.
  4. FGR and Low Fire Hold—Selecting this option field enforces both of the above actions.

  **a. Max (20ma)** This field lets you set the maximum sensing range of the transducer. The maximum value must be between -40 and 1400 degrees F.

  **b. Min (mA)** This field lets you set the minimum sensing range of the transducer. The minimum must be less than the maximum by at least 100 degrees F.
c. **Threshold** This field lets you set the threshold temperature at which you want the low fire hold or FGR hold or Low fire and FGR hold to be released. The threshold temperature must be less than the maximum.

d. **Differential** This field lets you set the differential temperature at which the system will revert to a hold condition. The threshold must be set lower than the threshold but greater than the minimum.

5. **Controller Timing**
a. **Postpurge Timeout**—Use the dropdown list to select how long the system should wait at the postpurge position once the postpurge state has been detected. It is important that the postpurge timeout time be at least as long as the burner control time, especially when the air damper is configured to close while in standby.

6. **Auto/Manual Switch** Select either Normal or Maximum Firing Rate Limit. When the Maximum Firing Rate Limit is selected, the 833-02801 (when in auto mode) reads the value of the manual potentiometer input and does not allow modulation beyond its interpreted value. The manual potentiometer input equates 0 to 500 ohms as a 4mA firing rate input and 4500 ohm or greater as a 20mA input; all other values are determined by linear interpolation. The behavior during manual switch setting is not affected, i.e., the firing rate input is derived directly from the potentiometer value and the controller mA input is ignored.

7. **Program Standby Position** Lets you set the position of the actuators when the controller is in the standby position. For each actuator, select Closed, Lightoff, or Open. If you select Open, you must enter a value in the appropriate field to indicate how wide the actuator should be opened (percent of maximum open value).

8. **Program Non Selected Fuel Position** Lets you set the position of the fuel actuator of the fuel that is not currently being used. Select Closed, Lightoff, or Open. If you select Open, you must enter a value in the appropriate field to indicate how wide the actuator should be opened (percent of maximum open value).

9. **FGR Behavior During Purge** Lets you set the position of the FGR actuator during the purge cycle. The options are **Remain Closed** or **Follow FGR Curve to Purge Position**.

### Default System Parameters
The default values/settings for each system parameter are shown in Table 2. See also Fig. 15 and 16.

#### Table 2. Default Values/Settings for System Parameters.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Xma Operation</strong></td>
<td></td>
</tr>
<tr>
<td>Operation</td>
<td>Disabled</td>
</tr>
<tr>
<td>Max 20 mA</td>
<td>NA</td>
</tr>
<tr>
<td>Min (4 mA)</td>
<td>NA</td>
</tr>
<tr>
<td>Threshold</td>
<td>NA</td>
</tr>
<tr>
<td>Differential</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Controller Timing</strong></td>
<td></td>
</tr>
<tr>
<td>Postpurge Time</td>
<td>30 seconds</td>
</tr>
<tr>
<td><strong>Automanual Switch</strong></td>
<td></td>
</tr>
<tr>
<td>Automanual Switch</td>
<td>Normal Mode</td>
</tr>
<tr>
<td><strong>Program Standby Position</strong></td>
<td></td>
</tr>
<tr>
<td>Fuel Selection 1</td>
<td>Closed</td>
</tr>
<tr>
<td>Air</td>
<td>Closed</td>
</tr>
<tr>
<td>FGR</td>
<td>Closed</td>
</tr>
<tr>
<td><strong>Fuel Selection 2</strong></td>
<td></td>
</tr>
<tr>
<td>Fuel</td>
<td>Closed</td>
</tr>
<tr>
<td>Air</td>
<td>Closed</td>
</tr>
<tr>
<td>FGR</td>
<td>Closed</td>
</tr>
<tr>
<td><strong>Program Non-Selected Fuel Position</strong></td>
<td></td>
</tr>
<tr>
<td>Fuel Selection 1</td>
<td>Closed</td>
</tr>
<tr>
<td>Fuel Selection 2</td>
<td>Closed</td>
</tr>
<tr>
<td>Fuel Selection 2</td>
<td>Closed</td>
</tr>
<tr>
<td>Fuel Selection 1</td>
<td>Closed</td>
</tr>
</tbody>
</table>
Create Fuel Ratio Curve Screen

The Create Fuel Ratio screens are used to:

- Select which fuel is to be configured. (If your base configuration has only one fuel, the Fuel 1 button is all that is available.)
- Identify whether fuel/air ratio curves are configured.

You can perform the following actions from these screens (see Fig. 17):

1. **Fuel 1/Fuel 2**: Press the appropriate button to indicate the fuel for which you want to create a fuel ratio curve. (If you have only one fuel, only a Fuel 1 button is displayed. ‘Configured’ means a curve already exists, ‘Not Configured’ means the profile must be created or changed and validated.)

2. **Help**: Press this button to display the help system.

3. **Exit**: Press this button to exit the program. Valid changes will be saved.

4. **Prev**: Press this button to return to the Select Base Configuration screen.

5. **Next**: This button is not available on this screen. Press the Fuel 1 or Fuel 2 button to proceed to the Create Profile screen.
Create/Modify Profile Curve for Fuel Screen
The Create/Modify Profile Curve for Fuel 1 or Fuel 2 screens (Fig. 18) are used to:

1. Create modulation curves for the burner.
2. Identify whether fuel/air ration curves are configured.

You can perform the following actions from this screen:

- Enter points on the graph to indicate the Air Purge position, Light Off position, Maximum and Minimum modulation positions, and intermediate positions for the actuators for the specified fuel (Fuel 1 or Fuel 2). See Fig. 19.
- Create a curve that provides safe and efficient operation of the burner from minimum to maximum modulation.
- Verify the profile that was created.
- Load a file from your PC that contains a curve (profile) to use as a starting point for constructing a profile for this burner.
- Save the profile you created to a file on your PC for reference or future use. Fig. 20 through 31 illustrate creating the profile curve.

2. Outputs/Inputs:
   - The 833-02801 outputs and inputs are displayed on the screen and their current state is noted. See “Outputs and Inputs” for a description.

3. Firing Rate:
   - This window displays the current value of input firing rate (from the pressure or temperature controller). Once the minimum and maximum modulation positions are entered, the window also provides a visual indication if over-firing (the current load demand) of the system occurs during the commissioning process. When the color of the ‘mA value’ is blue, it indicates an under firing condition exists. When the color of the ‘mA value’ is red, it indicates your commanded firing rate exceeds the present input demand needs (over-firing).

4. Save Position:
   - After positioning the actuator(s), press the appropriate button to save the point on the graph.
   - Intermediate—Press to save positions on the curve that are between the max and min modulation points. A point is displayed on the graph each time you press this button. You need at least 6 intermediate points between the max and min modulation points on a curve for a valid profile.
   - Light Off—Press to save the light off position on the graph. An ‘L’ is displayed on the graph to indicate the lightoff point. Only one light off point is allowed per curve.
   - Max Modulation—Press to save the maximum modulation position on the graph. An ‘M’ is displayed on the graph to indicate the maximum modulation point. Only one maximum modulation point is allowed per curve.
d. Min Modulation—Press to save the minimum modulation position on the graph. An ‘m’ is displayed in the graph to indicate the minimum modulation point. Only one minimum modulation point is allowed per curve.

e. Air Purge—Press to save the air purge position on the graph. A ‘P’ is displayed on the graph to indicate the air purge point. Only one air purge point is allowed per curve.

5. Delete Positions:
   a. Delete Position—Press to delete an intermediate point on the curve. To delete the point, you must position the cursor on the point.
   b. Delete All Positions—Press to delete ALL positions on the curve, including the light off, air purge, max and min modulation points. Use this button ONLY when you want to start creating the curve from the beginning.

6. Start Lightoff Sequence:
   - Stop Modulation:
     - This button serves a dual purpose. Press this button after you have positioned the actuators (as shown by the cursor) to the light off position. Pressing this button activates the burner controller lightoff sequence. If the lightoff sequence is successful, this button then displays Stop Modulation. If the lightoff sequence fails, the Status window indicates the problem.
     - If you want to stop the system at any time during the commissioning process, use the Stop Modulation button.

7. Move Along Curve:
   - Move to Next Higher Position—
   - Move to Next Lower Position—
     - Press these buttons to move the cursor along the curve to a previously set position. Use these buttons to reposition the cursor or to ‘walk the curve’ and verify system operation. As the curve is verified, the color of the curve changes.

NOTE: The 985-00125 requires you to enter at least 3 points (inclusive of the min and max modulation points) to use the “Move Along the Curve” buttons.

8. Load/Save Profile to File:
   - Load Profile—Press this button to load an existing profile curve (from a file saved on your PC or disc). When you press the button, a File Search window opens and you can navigate to the directory and filename of the file you want to load. Press Okay to load the profile in the file. The profile will be displayed in red. You must ‘walk the curve’ to verify system operation with the curve.
   - Save Profile—Press this button to save the curve you have created to a file on your PC or disc. When you press the button, a File search window opens and you can navigate to the directory you want to save the file in. Use a descriptive filename for the file. The extension (.prf) is automatically added when you press Save to save the profile.

NOTE: The curve is saved in the 833-02801 as you create it. Saving the profile to a file is only necessary to provide a backup copy of the profile or to use it as a base for creating a curve for a similar system in another location.

9. Configuration Information:
   - Config Info—Press this button to view the system configuration information.
   - Save to file—Press this button (.txt).
   - Save—Press this button to save the system configuration you have created to a file on your PC or disc. When you press the button, a File search window opens and you can navigate to the directory you want to save the file in. Use a descriptive filename for the file. The extension (.txt) is automatically added when you press Save to save the profile.
10. **Status:**
   - This window displays status and error information as you create the profile. It cannot be edited.

11. **Help:**
    - Press to display the help system.

12. **Exit:**
    - Press to exit the program. Valid changes will be saved.

13. **Prev:**
    - Press to return to the *Create Fuel Ratio Curve* screen.

14. **Next:**
    - This button is not available on this screen. It is grayed out.

15. **Finish:**
    - Press to save the profile you have created. The *Finish* button is grayed out until you complete the profile. After you press this button, the *Monitor* screen is displayed. You can exit the program from there.

---

**Fig. 22. Save Configuration Information.**

**Fig. 23. Setting Lightoff point.**

**Fig. 24. Establishing Lightoff Point for the Curve.**
Fig. 25. Setting maximum modulation point.

Fig. 26. Establishing Maximum Modulation Point for the Curve.

Fig. 27. Verifying an Intermediate Point.

Fig. 28. Verifying an Intermediate Point on the Curve.
Monitor Screen

The Monitor screen (Fig. 32) is used to:

- Monitor the burner controlled by an 833-02801.
- Review alarms that were generated during run cycles.
- You can perform the following action from this screen:
  - View various parameters of the system including: the current positions of the Air, Fuel and FGR actuators; the status of the system, on/modulating/lockout/alarm etc.; historical list of alarms.
- 1. Fuel Selection:
  - Identifies which fuel is currently in use, Fuel 1 or Fuel 2.
- 2. Fuel:
  - Displays the current position of the fuel actuator.
- 3. Air:
  - Displays the current position of the air actuator.
- 4. FGR:
  - Displays the current position of the FGR actuator (if present).
- 5. Firing Rate:
  - Displays the current firing rate position (in milliamps).
- 6. Aux Temperature Input:
  - Displays the current temperature reading from the auxiliary input. If the function is disabled, the value indicates “disabled”.
- 7. Status:
  - Indicates system status, for example, manual modulation, air purge, lightoff sequence, etc.
- 8. Cycle:
  - Indicates the current cycle of the system, with one being the first call-for-heat cycle since the system was commissioned.
- 9. Active Alarm:
  - Indicates if the system is in an Alarm state.

Fig. 29. Verifying Minimum Modulation Point.

Fig. 30. Verifying Minimum Modulation Point on the Curve.

Fig. 31. Fuel 1 Configured; Fuel 2 Not Configured.
10. **Alarm History:** Displays all alarms that have been generated. The dropdown box displays the cycle the alarm occurred in and the alarm type.

11. **Inputs/Outputs:**
   - All Outputs and Inputs are displayed and their current state is noted. See Outputs and Inputs for a description.

12. **Help:**
    - Press this button to display the help system.

13. **Finish:**
    - Press this button after you are through monitoring the system to return to the Intro screen.

**OPERATING PROCEDURES**

This section describes procedures for the various operations you will have to perform when using the 985-00125 Software Configuration Tool to commission a burner.

The 985-00125 works like a wizard. As you progress through the screens, use this section to answer specific questions as to how to perform required actions.

The process of commissioning a system is described in detail in “Creating an Air/Fuel Ratio Curve - Example.”

---

### How to Change the System Password

To change the system password, proceed as follows:

1. Enter the current password in the **Commissioning Password** field. (The factory default password is “password.”)
2. Press **Connect.** The system must be connected in order to change the password.
3. Enter a new password in the **New Password** field.

   **NOTE:** Your new password requires a minimum of four (4) characters and a maximum of 15 characters.

4. Press **Change Password.**
5. Return to the **Commissioning Password** field and enter your new password to proceed.

   **NOTE:** The password is not case sensitive. Make sure you write down your new password before you press **Change Password.** Once you have pressed this button you cannot enter the system without the password.

### How to Connect to the PC Comm Port

To connect to the PC communications port, proceed as follows:

1. Refer to your PC manual to determine the location of your communications ports.
2. Connect the RS232 to RS485 conversion cable from the 833-02801 to the appropriate communications port of your PC.
3. Enter your password in the **Commissioning Password** field. (The factory default password is “password.”)
4. Press the appropriate radio button (**COM1, COM2**, etc.) on the **Connect to Fuel/Air Controller** screen.
5. Press **Connect.** If you selected the correct communications port and the 833-02801 is properly connected, you will see the word “Connected” displayed next to the **Connect** button.

   If you get an error while connecting, refer to Troubleshooting.

### How To Set the Actuator Maximum Open/Closed Positions

To set the maximum open and closed positions for the actuator, proceed as follows:

1. Look at the open and closed positions displayed on the screen. (If no number is displayed, press **Open** or **Close** so that a number is displayed.)

   Typically the position of one maximum is closer to its end point than the other. For example, the open position reading might be “85.3 Degrees” and the closed position reading might be “40.2 Degrees.” Since the actuator will be fully open at approximately 100 degrees, it will take less time to move it to its maximum open position than its maximum closed position. You will note that the readings are initially in percentage of potentiometer travel.

   **NOTE:** The system must exhibit at least 15 degrees of travel from open to closed.
2. Press Auto Seek Open or Auto Seek Closed based on your observation in Step 1. The controller automatically opens (or closes) the actuator to its maximum open (or closed) value.

3. When the actuator has been driven to its maximum position, visually verify its position and use the Open or Close buttons to manually adjust the maximum position if necessary. Press the Lock Position button for the endpoint once the appropriate position has been achieved and verified.

4. Repeat Steps 2 and 3 for the other maximum position.

5. When the maximum open and closed values are set where you want them and you have pressed Lock Position buttons for both positions, the Next button will be available.

6. Press the Next button. This will return you to the Select Base Configuration screen to configure another actuator. After all actuators are configured, press the Next button again to display the Create Fuel Ratio Curve screen.

How to Verify the Profile -- Walking the Curve

‘Walking the Curve’ means to verify the profile you have just completed. You can ‘walk’ a partial curve, however, you must have successfully entered minimum and maximum modulation points and one additional point, such as light off or an intermediate point. If you modify a point on a profile you must ‘walk’ the section of the curve connecting the new point to points that have already been verified (walked).

To walk the curve:

1. Position the cursor at one end of the profile that needs to be verified.

2. Press either the Move to Next Higher Position button or the Move to Next Lower Position button. As you reach a new point, the line changes color (red to blue). To verify the transition lines between points (or points themselves), you should allow sufficient time for the combustion system to stabilize before accepting the fuel/air and FGR ratios.

After each point move, carefully monitor the oxygen sensor for unsafe conditions or inefficient combustion. Make adjustments to the curve shape or add points as necessary. When you have completely walked the curve, the entire profile is one color and the Finish button is operational.

How to Delete a Position on the Profile

Points on the curve can be deleted individually. For example if you want a new fuel/FGR mixture at a predefined air point, simply position the actuators near the point of interest (until the Delete Point button is highlighted), and pressing Delete Point. Pressing this button removes all data relative to the point of interest. If you want to add a new point between two existing points (and it is not on the existing curve), move the cursor to the appropriate stop and add the new point by pressing the Intermediate button.

If you decide the entire curve you created is not usable, press Delete All Positions button. This will clear the display and let you start over.

How to Load an Existing Profile

If you are responsible for commissioning a number of burner systems with similar characteristics, you may want to create and save one profile and then load it when you commission another system. (Or you may want to save the current profile so that you have a copy of it in case an actuator or another part of the system needs to be changed out. You may still have to modify points, and you WILL have to walk the curve to verify operation, but it will save you time.)

To load an existing profile from your PC:

1. Press Load Profile on the Create Profile screen.

2. Navigate to the directory where you saved the profile.

3. Highlight the file and press the OK button on the File Open window.

The curve will be displayed on the graph in the color that indicates it must be verified.

Flat Line FGR Wizard

The Flat Line FGR Wizard is supported only with version 1.3 or greater of 833-02801 Fuel Air Ratio Controllers. The Create/Modify Profile screen includes a Flat Line Wizard to help you set points for the the FGR that are precisely flat line with respect to an existing point to the right or left of the current position.

As you position the cursor on the profile, the discrete segments of the Wizard are highlighted to indicate what condition exists and inform you of the steps required to create an FGR actuator flat line segment. Refer to the following descriptions and examples.

Fig. 33. Explanation of Flat Line Wizard symbols.
Table 3. Examples of Flat Line Wizard Symbols.

<table>
<thead>
<tr>
<th></th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="M17929" alt="Symbol" /></td>
<td>The FGR actuator is above FLAT LINE with respect to the nearest point to the left. You would need to close the FGR actuator to reach the flat line condition shown next. No programmed point exists to the right.</td>
</tr>
<tr>
<td><img src="M17930" alt="Symbol" /></td>
<td>The FGR actuator is at a FLAT LINE position with respect to the nearest programmed point to the left. No programmed point exists to the right.</td>
</tr>
<tr>
<td><img src="M17931" alt="Symbol" /></td>
<td>The FGR actuator is below FLAT LINE with respect to the nearest programmed point to the left and above flat line with respect to the nearest programmed point to the right. You would need to close the FGR actuator to achieve flat line with respect to the left point and open the FGR actuator to achieve flat line with respect to the nearest programmed point to the right.</td>
</tr>
<tr>
<td><img src="M17932" alt="Symbol" /></td>
<td>The FGR actuator is at a FLAT LINE position with respect to the nearest programmed point to the left and to the nearest programmed point to the right. No further adjustment, open or closed, is necessary to enter a FLAT LINE point with respect to the closest programmed points to left and right of the current position.</td>
</tr>
<tr>
<td><img src="M17933" alt="Symbol" /></td>
<td>The FGR actuator is above FLAT LINE with respect to the nearest programmed point to the left and above FLAT LINE with respect to the nearest programmed point to the right. You would need to close the FGR actuator to achieve flat line with respect to the right point and/or close the FGR actuator to achieve flat line with respect to the nearest programmed point to the left.</td>
</tr>
<tr>
<td><img src="M17934" alt="Symbol" /></td>
<td>The FGR actuator is above FLAT LINE with respect to the nearest point to the right. You would need to close the FGR actuator to reach the flat line condition. No programmed point exists to the left.</td>
</tr>
<tr>
<td><img src="M17935" alt="Symbol" /></td>
<td>The FGR actuator is below FLAT LINE with respect to the nearest point to the right. You would need to open the FGR actuator to reach the flat line condition. No programmed point exists to the left.</td>
</tr>
</tbody>
</table>

**TROUBLESHOOTING**

   - The 833-02801 Fuel Air Ratio Controller has a preset of 25% air position/ 0% fuel for the initial light off point. Depending on the air damper technology, this may not provide enough airflow to maintain the air flow switch and cause the burner control to lock out. The 833-02801 is still functional at this time even
though the burner control is locked out. Therefore, before resetting the burner control and restarting the light off process, you should first set a new temporary light off point to a higher airflow value to prevent the air flow switch from dropping out. The next time through the sequence, the new higher light off point may allow the air flow switch to be maintained or you will have to repeat the process, i.e., move the light off point air value to a more open value such that the new point can maintain the air flow switch.

2. Purge Setting Beyond Maximum Modulation Point.
   • A finished profile requires the purge position to be lower than the maximum modulation. If you encounter a condition where you are required to place the maximum modulation point below the current purge setting, you must first move the purge point to a lower position. The purge position can be moved at any time by reselecting the Air Purge button in the Save Position command window.

3. Cannot Establish Communications.
   • Beyond the obvious difficulties associated with the communications polarity wiring errors, RS232 to RS485 converter problems, and lack of power to the devices (RS232 converter or 833-02801), there are several subtle system errors that preclude communications. All of the errors are indicated by the green LED and the red Lockout LED being continuously on. Fuel select problems after power-up are indicated with all LED being on continuously.
   a. If no fuel select inputs are on, or both fuel selects are made, you cannot establish communications with the controller. The corrective action is to select one of the fuels or remove one of the fuel select inputs.
   b. 833-02801 is in a locked out state. The corrective action is to first reset the control. If that does not work, you must correct the fault.
   c. If the Fuel Air Commissioning Tool was aborted due to a PC operating system fault or 985-00125 operating system fault, the 985-00125 software may have been improperly shut down and the program may still be running even though there is no indication on the screen. Press CTRL-ALT-DEL. This brings up the Task Manager. Select End Task for any occurrence of the Fuel Air Commissioning Tool before you start another session of Fuel Air Commissioning Tool.
   d. If the communications port settings are at the low setting, you can experience connect/disconnection problems. To check the communications port settings, the following steps get you to the proper screen(s). Double click on My Computer. Double click on Control Panel. Double click on System. Click on Device Manager. Double click on Ports (COM1 and LPT1). Double click on Comm. Port (could be COM 1-4). Double click on Port Settings. Click on Advanced Settings. This screen displays the Receive Buffer and Transmit Buffer settings. Move the slide bars up to the high setting. Click OK to verify the new settings.

4. Unable to Land on a Predefined Port.
   • Under unique actuator loading conditions, it may be difficult to land on an existing programmed point. This can occur while using the Move Along the Curve command. It can also occur when you are completing the curve verification process on extremely flat or steep line segments as you reach the end of the curve. If you are experiencing problems, back up from the problem point at least five degrees then move back to the point using a three degree, one degree or 0.1 degree movement. This should allow you to complete your curve verification or land on a problem point for deletion.

5. Password No Longer Valid.
   • Bringing a system to an unconfigured state using the 985-00125 tool wipes out your custom password and returns the system password to “password”. Enter a new password.

6. Fault Code Retrieval
The 833-02801 incorporates two methods to retrieve fault information.

- Press and hold the Reset button. The fault code is indicated by the blinks and flashes of the LED. All codes are two digits. The 10’s digit is indicated by a series of slow blinks while the 1’s digit is indicated by a series of short flashes after the slow 10’s digit. For example, 64 is made up of six slow blinks followed by four fast flashes. The cadence is repeated as long as the user holds the Reset button. The device will not reset by the action of the Reset switch once it enters the flash mode. To reset the 833-02801 Fuel Air Ratio Controller, push and release the Reset button within one second.
- Read the code directly from the Monitor screen of the 985-00125.

Click here for a list of Fault Codes and Actions.

### 833-02801 OUTPUTS AND INPUTS

The current state of the 833-02801 outputs and inputs are displayed on both the Create/Modify Profile Curve screen and the Monitor screen for convenience and diagnostics purposes. The inputs and outputs are defined as follows:

#### Table 4. Outputs.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
<th>Meaning when ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCO</td>
<td>Limit Control Output</td>
<td>Limits are satisfied and demand exits. The 833-02801 is operational and able to move all actuators.</td>
</tr>
<tr>
<td>HFP</td>
<td>High Fire Proved</td>
<td>The 833-02801 has moved the actuators to the Purge position.</td>
</tr>
<tr>
<td>LFP</td>
<td>Low Fire Proved</td>
<td>The 833-02801 has moved the actuators to the Light Off position.</td>
</tr>
<tr>
<td>FS1</td>
<td>Fuel Select Channel 1</td>
<td>Fuel 1 is selected.</td>
</tr>
<tr>
<td>FS2</td>
<td>Fuel Select Channel 2</td>
<td>Fuel 2 is selected.</td>
</tr>
<tr>
<td>ALM</td>
<td>Alarm</td>
<td>The system is in an alarm state.</td>
</tr>
</tbody>
</table>

#### Table 5. Inputs.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
<th>Meaning when ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCI</td>
<td>Limit Control Input</td>
<td>Limits are satisfied and demand is present.</td>
</tr>
<tr>
<td>HF</td>
<td>High Fire Input</td>
<td>833-02801 is being commanded to drive actuators to the Purge position.</td>
</tr>
<tr>
<td>LF</td>
<td>Low Fire Input</td>
<td>833-02801 is being commanded to drive actuators to the Light Off position</td>
</tr>
<tr>
<td>MV</td>
<td>Main Valve Input</td>
<td>The main valve input is active. Normally only active during “Run,” and transitional with LF during light off.</td>
</tr>
</tbody>
</table>

### 833-02801 FAULT CODES AND CORRECTIVE ACTIONS

The 833-02801 incorporates two methods to retrieve fault information.

- Press and hold the reset button. The fault code is indicated by the blinks and flashes of the LED. All codes are two digits. The 10’s digit is indicated by a series of slow blinks while the 1’s digit is indicated by a series of short blinks following the slow ten’s digit. For example, 64 is made up of six slow blinks followed by four fast blinks. The cadence is repeated as long as you hold the reset button. The device will not reset by the action of the reset switch once it enters the flash mode. To reset the 833-02801, push and release the reset button within one second.
- Read the code directly from the Monitor screen of the 985-00125.

Click here for LED Status Panel Blink Patterns.

Refer to “Fault Codes and Actions,” Table 6, below.
## Table 6. Fault Codes and Corrective Actions.

<table>
<thead>
<tr>
<th>Fault/ Blink Code</th>
<th>Description</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Device is operating properly.</td>
<td>—</td>
</tr>
<tr>
<td>13</td>
<td>MV input energized at an improper time.</td>
<td>Reset control. Check Burner Control Interface wiring and correct error. This error causes the device to remain in initiate state at power up.</td>
</tr>
<tr>
<td>14</td>
<td>HF and LF are energized at the same time.</td>
<td>Reset control. Check Burner Control Interface wiring and correct error. This error causes the device to remain in initiate state at power up.</td>
</tr>
<tr>
<td>15</td>
<td>Transition to the requested Burner Control input state is not allowed from the current state. E.g. Standby to Modulate is not allowed.</td>
<td>Check wiring to burner control and/or burner control operation. NOTE: Moving a RM78XX Run/Test switch to Test will Induce this fault during commissioning mode.</td>
</tr>
<tr>
<td>21</td>
<td>Internal Error - Time base.</td>
<td>Reset Controla.</td>
</tr>
<tr>
<td>22</td>
<td>Internal Error - KEY decode .</td>
<td>Reset Controlb.</td>
</tr>
<tr>
<td>23</td>
<td>Internal Error - Rdlow.</td>
<td>Reset Controla.</td>
</tr>
<tr>
<td>24</td>
<td>Internal Error - Time storage.</td>
<td>Reset Controla.</td>
</tr>
<tr>
<td>25</td>
<td>Internal Error – Limited move.</td>
<td>Reset Controla,b,c.</td>
</tr>
<tr>
<td>26</td>
<td>Internal Error – Targeted move.</td>
<td>Reset Controla,b,c.</td>
</tr>
<tr>
<td>27</td>
<td>Internal Error- LVD.</td>
<td>Reset Controla.</td>
</tr>
<tr>
<td>28</td>
<td>Internal Error- ISR check.</td>
<td>Reset Controla.</td>
</tr>
<tr>
<td>31</td>
<td>Internal Fault- A2D Range.</td>
<td>Reset Controla.</td>
</tr>
<tr>
<td>32</td>
<td>Internal Fault – A2D Matching.</td>
<td>Reset Controla.</td>
</tr>
<tr>
<td>33</td>
<td>Internal Fault - LCO Drive.</td>
<td>Reset Controlb.</td>
</tr>
<tr>
<td>34</td>
<td>Internal Fault – LCO/I Feedback.</td>
<td>1.) Reset Controlb. Check actuator wiring. See Channel LED for actuator. 2.) Terminal 14 has voltage present from an external source, correct wiring problem. 3.) d.</td>
</tr>
<tr>
<td>36</td>
<td>Fuel Selection Problem.</td>
<td>Check wiring through fuel select switch, at least one fuel must be selected at any given time (not zero, not two).</td>
</tr>
<tr>
<td>37</td>
<td>Fault HFP or LFP output.</td>
<td>Verify correct wiring to burner control. Specifically check wiring at LFP and HFP.</td>
</tr>
<tr>
<td>38</td>
<td>Internal Fault – memory curve.</td>
<td>Reset controla.</td>
</tr>
<tr>
<td>41</td>
<td>Feedback potentiometer Interface circuit fault—Air.</td>
<td>Verify correct wiring of Potentiometera.</td>
</tr>
<tr>
<td>44</td>
<td>Feedback potentiometer Interface circuit fault—FGR.</td>
<td>Verify correct wiring of Potentiometera.</td>
</tr>
<tr>
<td>45</td>
<td>Feedback potentiometer wiper resistance problem, Air.</td>
<td>Check for loose potentiometer wiringa,b,c.</td>
</tr>
<tr>
<td>46</td>
<td>Feedback potentiometer wiper resistance problem, Fuel 1.</td>
<td>Check for loose potentiometer wiringa,b,c.</td>
</tr>
</tbody>
</table>
### Table 6. Fault Codes and Corrective Actions. (Continued)

<table>
<thead>
<tr>
<th>Fault Code</th>
<th>Description</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>47</td>
<td>Feedback potentiometer wiper resistance problem, Fuel 2.</td>
<td>Check for loose potentiometer wiring&lt;sup&gt;a,c&lt;/sup&gt;.</td>
</tr>
<tr>
<td>48</td>
<td>Feedback potentiometer wiper resistance problem, FGR.</td>
<td>Check for loose potentiometer wiring&lt;sup&gt;a,c&lt;/sup&gt;.</td>
</tr>
<tr>
<td>49</td>
<td>Feedback potentiometer total resistance problem, Air.</td>
<td>Check for loose potentiometer wiring&lt;sup&gt;a,c&lt;/sup&gt;.</td>
</tr>
<tr>
<td>50</td>
<td>Feedback potentiometer total resistance problem, Fuel 1.</td>
<td>Check for loose potentiometer wiring&lt;sup&gt;a,c&lt;/sup&gt;.</td>
</tr>
<tr>
<td>51</td>
<td>Feedback potentiometer total resistance problem, Fuel 2.</td>
<td>Check for loose potentiometer wiring&lt;sup&gt;a,c&lt;/sup&gt;.</td>
</tr>
<tr>
<td>52</td>
<td>Feedback potentiometer total resistance problem, FGR.</td>
<td>Check for loose potentiometer wiring&lt;sup&gt;a,c&lt;/sup&gt;.</td>
</tr>
<tr>
<td>53</td>
<td>Internal memory function problem, Air.</td>
<td>Repeat actuator ID On-line process.</td>
</tr>
<tr>
<td>54</td>
<td>Internal memory function problem, Fuel 1.</td>
<td>Repeat actuator ID on-line process.</td>
</tr>
<tr>
<td>55</td>
<td>Internal memory function problem, Fuel 2.</td>
<td>Repeat actuator ID on-line process.</td>
</tr>
<tr>
<td>56</td>
<td>Internal memory function problem, FGR.</td>
<td>Repeat actuator ID on-line process.</td>
</tr>
<tr>
<td>57</td>
<td>Stuck Reset button.</td>
<td>Turn off remote reset switch. Check operation of controller button.</td>
</tr>
<tr>
<td>58</td>
<td>Actuators not reaching light off point.</td>
<td>Check for actuator wiring problems or stuck valves/dampers. Place controller in standby and use actuator manual keys to verify actuator travel.</td>
</tr>
<tr>
<td>59</td>
<td>Internal Memory fault.</td>
<td>Reset control&lt;sup&gt;a&lt;/sup&gt;.</td>
</tr>
<tr>
<td>60</td>
<td>Internal Initialization Error.</td>
<td>Reset control&lt;sup&gt;a&lt;/sup&gt;. Check the wiring and range capability for both the CmA+- input and XmA+- input (if configured).</td>
</tr>
<tr>
<td>61</td>
<td>Fuel Actuator off curve (selected fuel type).</td>
<td>Check for stuck fuel actuator and/or proper shielding on actuator interface.</td>
</tr>
<tr>
<td>62</td>
<td>FGR Actuator off curve.</td>
<td>Check for stuck FGR actuator and/or proper shielding on actuator interface.</td>
</tr>
<tr>
<td>63</td>
<td>Air Actuator off curve.</td>
<td>Check for stuck Air actuator and/or proper shielding on actuator interface.</td>
</tr>
<tr>
<td>64</td>
<td>Verifies that the Air actuator accepted the off-line, on-line, move counter-clock-wise and move clock-wise commands. Furthermore, all potentiometer tests must successfully passed to bring an actuator online.</td>
<td>Check wiring of actuator, verify correct ID is being used. Use Actuator LED to verify that the actuator that is being brought “online”. A fast flash in the actuator equates to “off line” state while a 1 second flash equates to an “online” state.</td>
</tr>
<tr>
<td>65</td>
<td>Verifies that the Fuel 1 actuator accepted the off-line, on-line, move counter-clock-wise and move clock-wise commands. Furthermore, all potentiometer tests must successfully passed to bring an actuator online.</td>
<td>Check wiring of actuator, verify correct ID is being used. Use Actuator LED to verify that the actuator that is being brought “online”. A fast flash in the actuator equates to “off line” state while a 1 second flash equates to an “online” state.</td>
</tr>
<tr>
<td>66</td>
<td>Verifies that the Fuel 2 actuator accepted the off-line, on-line, move counter-clock-wise and move clock-wise commands.</td>
<td>Check wiring of actuator, verify correct ID is being used. Use Actuator LED to verify that the actuator that is being brought “online”. A fast flash in the actuator equates to “off line” state while a 1 second flash equates to an “online” state.</td>
</tr>
<tr>
<td>67</td>
<td>Internal memory fault.</td>
<td>Reset Control&lt;sup&gt;a&lt;/sup&gt;.</td>
</tr>
<tr>
<td>68</td>
<td>Internal check sum error.</td>
<td>Reset Control&lt;sup&gt;a&lt;/sup&gt;.</td>
</tr>
<tr>
<td>69</td>
<td>Actuator secondary fault.</td>
<td>Check Actuator wiring. See Channel LED for Actuator.</td>
</tr>
<tr>
<td>70</td>
<td>Air actuator non-responsive.</td>
<td>Check actuator wiring and stuck damper/valve&lt;sup&gt;c&lt;/sup&gt;.</td>
</tr>
</tbody>
</table>
Table 6. Fault Codes and Corrective Actions. (Continued)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>84</td>
<td>Fuel 1 actuator non-responsive.</td>
<td>Check actuator wiring and stuck damper/valve&lt;sup&gt;c&lt;/sup&gt;.</td>
</tr>
<tr>
<td>85</td>
<td>Fuel 2 actuator non-responsive.</td>
<td>Check actuator wiring and stuck damper/valve&lt;sup&gt;c&lt;/sup&gt;.</td>
</tr>
<tr>
<td>86</td>
<td>FGR actuator non-responsive.</td>
<td>Check actuator wiring and stuck damper/valve&lt;sup&gt;c&lt;/sup&gt;.</td>
</tr>
<tr>
<td>87</td>
<td>Internal math error.</td>
<td>Reset Control&lt;sup&gt;a&lt;/sup&gt;.</td>
</tr>
<tr>
<td>91</td>
<td>The 4 to 20 mA firing rate input is below 3 mA, Out of Range—Low. (Actuators return to or remain at the minimum modulation point with the alarm on; the control remains operational only to the extent that Minimum Modulation firing operation is allowed.) Not supported on Version 1.2 controllers.</td>
<td>Check CmA+- input (Terminals 39 and 40) for proper operation polarity and range. The input must be within 3.0 mA to 21.0 mA. The voltage at this terminal must be within 0.7 to 5.0 Vdc, respectively. Conditional Alarm—Alarm output is energized, controller continues to run.</td>
</tr>
<tr>
<td>92</td>
<td>The manual potentiometer rate input is higher than an allowable range, i.e., Out of Range—High. (The actuators move to the maximum modulation point with alarm on, control will remain operable, yet when MANUAL MODE is selected, maximum modulation and alarm output shall occur.) Auto mode operation is not affected. Not supported on Version 1.2 controllers.</td>
<td>The manual potentiometer is out of range high. Make sure a 5000 ohm (±10%) potentiometer is being used and wiring to it is correct. Shielded cable is recommended. Conditional Alarm—Alarm output is energized, controller continues to run.</td>
</tr>
<tr>
<td>93</td>
<td>The auxiliary 4 to 20 mA input must be below 3. mA when configured for use. (The actuators return or remain at the minimum modulation point with alarm on, the control will remain operable only to the extent that Minimum Modulation firing operation is allowed.) Not supported on Version 1.2 controllers.</td>
<td>Check XmA+- input (Terminals 37 and 38) for proper operation polarity and range. The input must be within 3.0 mA to 21.0 mA. The voltage at this terminal must be within 0.7 to 5.0 Vdc, respectively. Conditional Alarm—Alarm output is energized, controller continues to run.</td>
</tr>
<tr>
<td>94</td>
<td>After LCO is set by the 833-02801, the Burner Control must provide a Lightoff or Purge request within 20 seconds. (Controller remains in a processing demand condition indefinitely, waiting for valid inputs on the LF, MV and HF inputs; the alarm sounds after the 20-second period expires.) Not supported on Version 1.2 controllers.</td>
<td>Check burner control interface wiring and burner control operation (Terminals 10, 11, 12). The 833-02801 is waiting for a command via these terminals. Conditional Alarm—Alarm output is energized, controller continues to run.</td>
</tr>
</tbody>
</table>

<sup>a</sup> It is possible that a random external electrical noise event has caused a fault checking algorithm to be detected. Resetting the control will allow recalculation of the fault and, provided it is not a hard failure, the device will continue to operate. If the condition will not clear, the control must be replaced.

<sup>b</sup> Check AC waveform, severe noise on AC lines can corrupt the sampling of AC signals.

<sup>c</sup> Verify actuator total resistance and wiper measurements, check the ability of the actuator to travel full stroke using the Manual override buttons within the actuator. Verify input power to the actuator. If actuator is not functioning, replace the actuator.

<sup>d</sup> Verify a short does not exist at terminal 14. The control will need replacement if a sustained fault code 34 exists after the noted items 1 and 2 have been performed. Fuse line voltage power to control system with type SC15 fuse or fuse Limit input (terminal 13) with type SC5 fuse.

<sup>e</sup> Conditional Alarm. Causes the alarm output to be energized; the system may still be operating but requires attention in order to modulate or to proceed with the light off sequence. The actuators would be positioned at lightoff point, minimum modulation point or maximum modulation point, dependent on what the particular fault is and when the fault is introduced, relative to the 833-02801 Fuel Air Ratio Controller operating state.