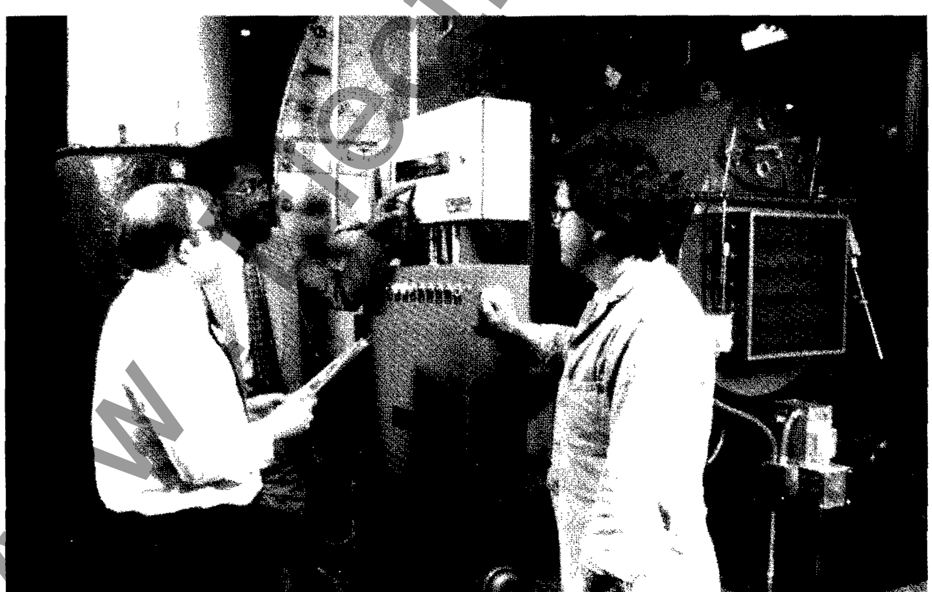
VeriTrim™ Microprocessor-based Oxygen Trim Package



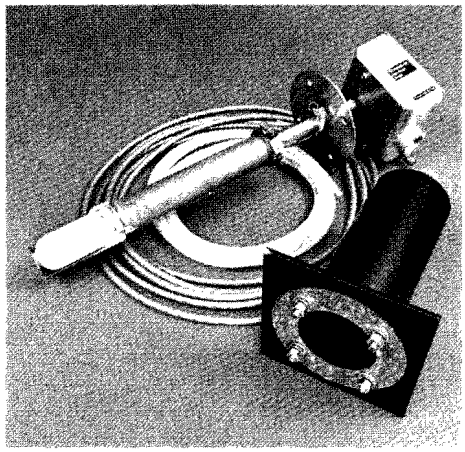
Description
Westinghouse, maintaining the tradition established by Hagan, has long been successful in the development and manufacture of combustion trim control systems, which make fuel burning more efficient.

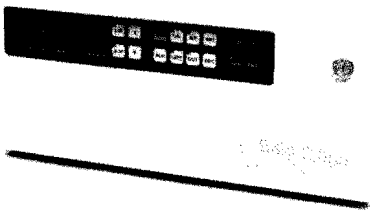
The Westinghouse VeriTrim controller is one of the first on the market designed specifically for use in small boilers. Westinghouse has maintained its proven combustion control strategies and streamlined the hardware to make a microprocessor-based combustion trim control package cost effective for small boilers.

The VeriTrim package① includes an industry-standard Hagan, in situ excess oxygen analyzer designed specifically for small boilers; a microprocessor-based electronic control unit and a simple electro-mechanical VeriLink™ interface for easy retrofit onto the existing combustion control system.

This package will cost effectively control the air to fuel ratio in boilers, drastically reducing fuel consumption. Typical installation for the Westinghouse VeriTrim package would include boilers in hospitals, schools, universities and colleges, hotels, apartment buildings and industrial buildings.

① VeriTrim and VeriLink – patents pending.





Excess Oxygen Sensor Features

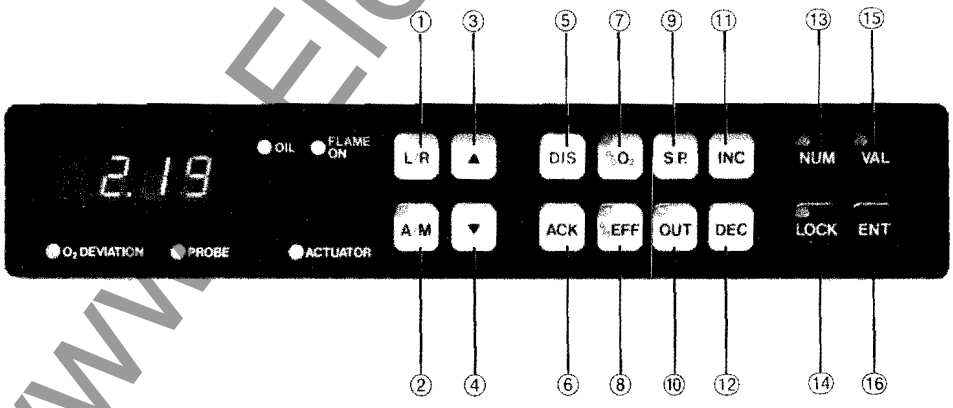
- A non-sampling, in situ excess oxygen flue gas analyzer that measures directly within the flue stack
- Utilizes same sensing cell as Westinghouse's proven industrial oxygen analyzer
- Optional Factory Mutual (FM) approved oxygen analyzer probe
- No requirement for plant compressed air
- Oxygen measurement represents actual air to fuel ratio supplied to the burner

Controller Features

- State of the art microprocessor-based system
- Self learning mode sets the proper feed forward and set point indexes
- Load programmed oxygen setpoint
- Digital display of percent oxygen, oxygen setpoint and, optionally, combustion efficiency selected by dedicated push buttons. (Available on TC190 via hand held keyboard option)
- Keylocked enclosure to prevent unauthorized access to system
- Code combination provides protection of microprocessor parameters
- Unique feedforward control action
- Dual fuel programming capability for natural gas or oil
- Semi automatic calibration of oxygen probe is standard
- Automatic oxygen cell quality check

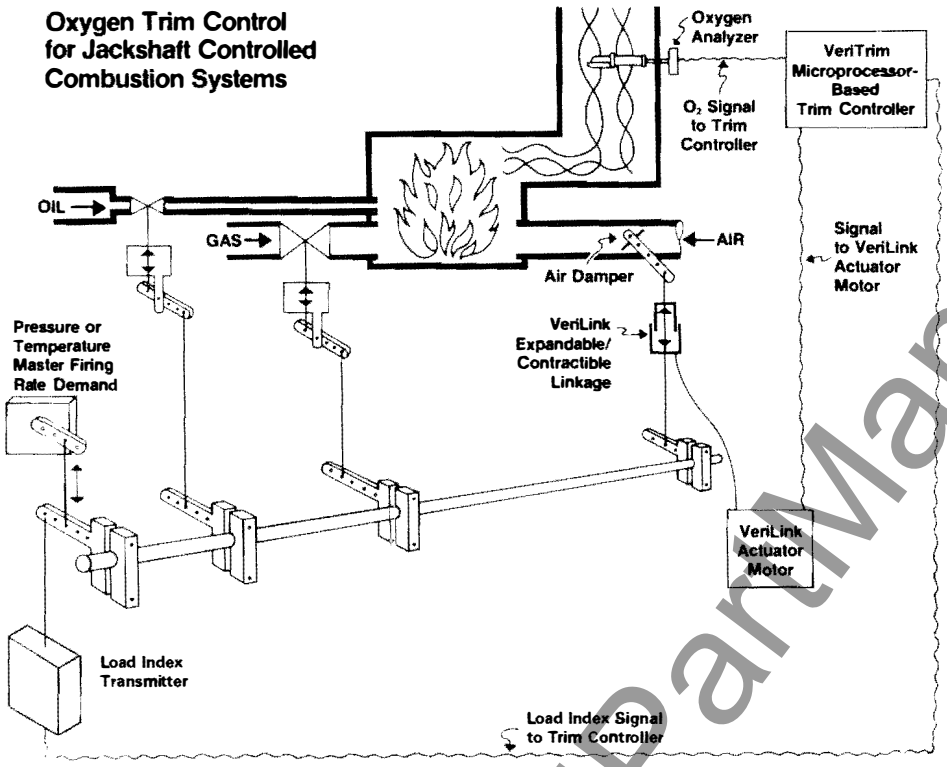
Mechanical Interface Features

- Simple, mechanical interface to existing combustion controls
- Fast, easy installation without jackshaft modification
- Electrical VeriTrim actuator which automatically moves to safe condition on control failure



Membrane Keyboard

1 Local/remote setpoint
2 Auto/manual
3 Controller manual output increase
4 Controller manual output decrease
5 Control disable
6 Alarm acknowledge
7 % Oxygen actual value
8 % Combustion efficiency
9 Oxygen Setpoint
10 Controller output
11 Increase Setpoint & Parameters
12 Decrease Setpoint & Parameters
13 Parameter number
14 Lock
15 Parameter value
16 Enter



User Benefits

- Continuous, cost-effective combustion trim control for all load conditions
- Drastically reduced fuel consumption resulting in quick returns on investments
- Low installation costs
- Operator has ability to quickly select and obtain all operational information; although unauthorized entry is safeguarded
- No special electrical power requirements
- No need for special programming when switching from one fuel to another
- Fail safe system reliability
- Fast, continuous excess oxygen flue gas analysis without the maintenance requirements inherent to sampling systems
- Reliability of proven Hagan combustion control expertise

System Overview

Maximum combustion efficiency occurs when air and fuel are uniformly mixed and burned so that no fuel and oxygen (in the air) remain. This is called stoichiometric combustion.

In practice this stoichiometric combustion is not usually achieved. Burners do not mix the air and fuel perfectly; and, usually, boiler operators supply excess air to the combustion process to ensure that all fuel is burned.

An oxygen trim control system attempts to keep the air to fuel ratio in a combustion process at a point as near to maximum efficiency as possible. By measuring the exact amount of oxygen remaining in the flue gases following combustion, a trim control signal can be developed which will adjust the amount of air supplied to the combustion process to improve combustion efficiency.

The air to fuel ratio is, however, not a constant value. It varies according to the type of burner, the Btu content of fuel, atmospheric temperatures and as a function of boiler loads. The air to fuel ratio must, therefore, be continually adjusted to allow for these variations.

Many small-packaged boilers proportion air and fuel with simple parallel mechanical linkage. The VeriTrim system measures the burner excess air by sensing the excess oxygen in the flue gas and compares it to an oxygen setpoint programmed according to varying loads. It then alters the mechanical position of the air damper from its normal position until the desired oxygen value is obtained. The combustion process is thus optimized and made fuel efficient by adjusting the air to fuel ratio supplied to the burner.

Specifications①

Sensor

Enclosure	Dripproof - S.S. probe body, aluminum electrical junction box.
Accuracy	2.0% O_2.
Repeatability	Better than ± 0.1% of O_2.
Resolution	To 0.01% of actual O_2/reading.
Response Time	Cell response time 1 millisecond. System response time less than 5 seconds.
Process Interface	Non sampling - in situ.
Process Gas Temperatures	50-1000°F standard probe limits.
Calibration	In place using certified test gases. Calibration port provided.
Range of Measurement	0% to 25% oxygen.

Electronics Package

Enclosure	Surface - meets requirements of Nema 12-drip proof. All electronics within a single enclosure.
Power Requirements	115VAC or 220VAC, ±10% 50-60 Hz, 500 watts.
Sensor Temperature Controller	3 term-proportional, integral, and derivative, maintains control at setpoint to better than ± 2°F. Software controlled for maximum heater life.
Cell Protection	Design protects electrode against reducing atmospheres.
Probe Reference Air	Supplied from the system package.
Trim Controller	PID (proportional, integral, and derivative). Control System is configured for constant loop gain.
Dead Band	None.
Control Output	24VAC - pulse increase/decrease. Optional 4-20 ma. Trim action is limited by preset high/low limits.
Display	3½ digit LED display. Displays O_2, O_2 setpoint, output, % EFF. and up to 262 other VeriTrim parameters.
Probe Calibration	The O_2 sensor calibration is set by means of a semi automatic mode within the microprocessor, utilizing suitable test gases. Calibration can also be accomplished manually.
Feed Forward	The controller provides an instant output response to boiler load changes via a unique feed forward control action to the trim linkage. This unique action is entered into the controller through its self learning mode.
Manual Setpoint	Continuously adjustable over entire operating range.
Optimized Setpoint (Load Programmed)	Two separate (dual fuels) programmed setpoint curves developed through the self learn mode are maintained permanently in memory. Operating O_2 setpoint curve is switch selected within the enclosure, or optionally by remote contacts.
Oxygen Display	Digital readout 0.05% to 25.0% O_2.
Alarms	1. Adjustable high and low O_2 setpoint deviation. 2. O_2 probe failure. 3. Actuator failure. Any alarm condition will cause the control unit to drive the actuator to its neutral position.
Auxiliary Outputs	Two 0-10 volt into a minimum impedance of 2K ohms/4-20 MA outputs into a maximum impedance of 390 ohms can be provided for use with indicator or recorders for any of the 265 functions within the control unit.
Diagnostics	Cell quality check Memory check Program check Low voltage check Calibration monitors
Temperature Limits	40° to 120°F
Fail Safe	For unlikely failures of the O_2 probe, microprocessor or trim actuator.

Trim Actuator (Veri Link)

Case	Designed to meet Nema 12 (drip proof).
Output	± ½ inch linear stroke.
VeriLink Thrust	20 pounds thrust, break away spring set at 24 pounds thrust to protect linkage.
Trim Correction	Adjustable, typically set to ± 20% air trim.
Speed of Response	(1 inch travel) in 30 seconds.
Brake	Self locking on loss of power by design.
Temperature Limits	0° to 140°F
Installation Requirements	VeriLink replaces normal air damper connecting link. Actuator motor may be mounted within three feet.
Actuator Size	1.5 inches by 2 inches by 7 inches long. Replaces 11 inch or longer connecting link between jackshaft air arm and air damper with standard ball joint ends. Shorter lengths can be accommodated with custom ends.

① Equipment ordered utilizing this DB as reference will be supplied to the USA standard design. Customers needing the EEC standard design should request the EEC standard DB and utilize its ordering data.

Three Trim Control packages were available and may be ordered as follows:

Description	Part Number
TC190 Non-Indicating Trim Package	**4510C80G01**

The basic package includes:
- Microprocessor controller
- VeriLink actuator with 3 ft. mechanical drive cable and 30 ft. electrical cable
- In-situ O_2 probe with 30 ft. armored signal cable
- Load index transmitter with 30 ft. signal cable
- 30 ft. of air tubing
- Installation hardware

This package requires the use of the hand-held keyboard loader for servicing and display of variables.

TC200 Indicating Trim Package	**4510C81G01**

The basic package includes:
- Microprocessor controller with integral keyboard
- VeriLink actuator with 3 ft. mechanical drive cable and 30 ft. electrical cable
- In-situ O_2 probe with 30 ft. armored signal cable
- Load index transmitter with 30 ft. signal cable
- 30 ft. of air tubing
- Installation hardware

TC200 Indicating Trim Package	**4510C81G02**

The basic package includes:
- Microprocessor controller with pulsed output and integral keyboard
- In-situ O_2 probe with 50 ft. armored signal cable
- Remote flame on status relay
- Remote alarm relay
- Analog output module 0-10 VDC/4-20 mA for one recorder
- 50 ft. of air tubing
- Varistor assembly
- Installation hardware

This package does not include the VeriLink and actuator or load index transmitter. Its primary use is on "ON-OFF" fired boilers. These boilers are usually fitted with air trim damper actuators which can be driven directly by the VeriTrim controller whose 24 VAC pulsed output signal is converted to 4-20 mA.

Optional kits to extend the VeriTrim features are available and must be called out separately by part number when they are required. They are:

Optional Kits

4510C82G01	Stack Thermocouple with 30 feet T/C lead wire. This is a type J ungrounded thermocouple and is required when the "percent combustion efficiency" feature is required.
4510C82G02	Stack Thermocouple with 50 feet T/C lead wire.
4510C83G01	Remote Alarm Relay. 12 VDC coil with 3 amp rated contacts. Required to interface the VeriTrim to an existing annunciator.
4510C84G01	Remote Oil/Gas Relay. 24 VAC coil with 3 amp rated contacts. Required when boiler uses two fuels and user requires the VeriTrim be made cognizant to which fuel is being used from the combustion control panel.
4510C85G01	Remote Flame On Status Relay. 24 VAC coil with 3 amp rated contacts. Required when user desires interface to the flame safety system.
4510C86G01	Remote Manual Status Relay. 24 VAC coil with 3 amp rated contacts. Required when user desires to disable Trim Control when the combustion control system is placed on "Manual".
4510C87G01	Analog Output Module. Outputs 0-10 VDC or 4-20 mA signal. Required when user requires up to two related VeriTrim signals be recorded. This module may also be used to replace the standard pulsed output module when a 4-20 mA control signal is required.
4510C88G01	Hand Loader. This unit is required to program model TC190 VeriTrim.
4510C94G01	Test Gas Kit. Contains two test gas bottles and regulator.
1500D76G02	Analog Input Module 4-20 mA input signal. This module is used to replace the standard potentiometer interface module when steam flow is used for load indexing.

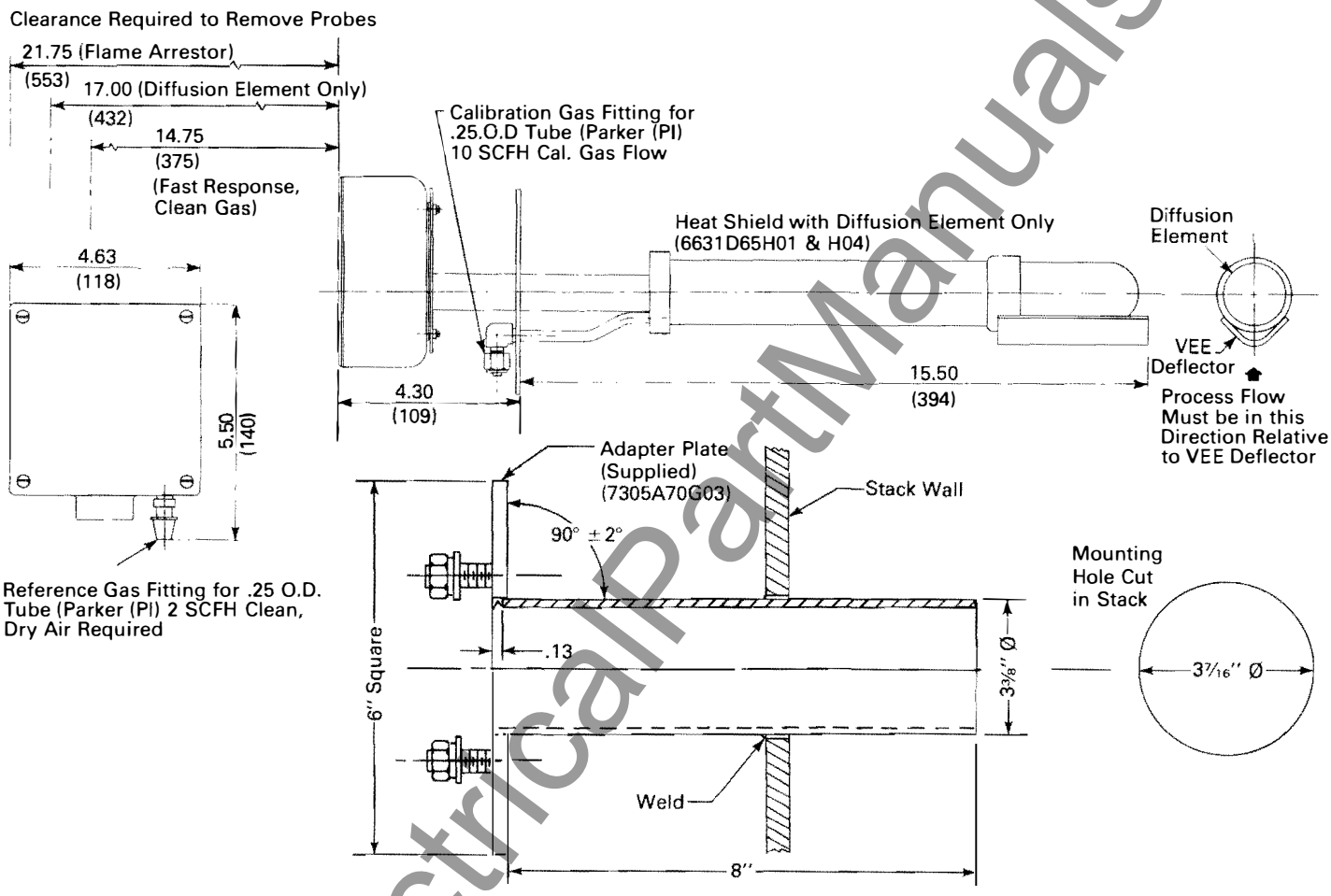
Optional kits to overcome installation problems are also available. They are:

Optional kits

4510C89G01	VeriLink with 6 ft. drive cable. (Does not include the actuator.)
4510C90G01	Actuator Electrical Cable, 50 ft.
4510C91G01	Load Index Transmitter cable, 50 ft.
4510C92G01	Oxygen Probe Cable, 50 t.
4510C93G01	Load Index Transmitter, Jackshaft driven. This kit is complete with levers, threaded rod and rod ends.

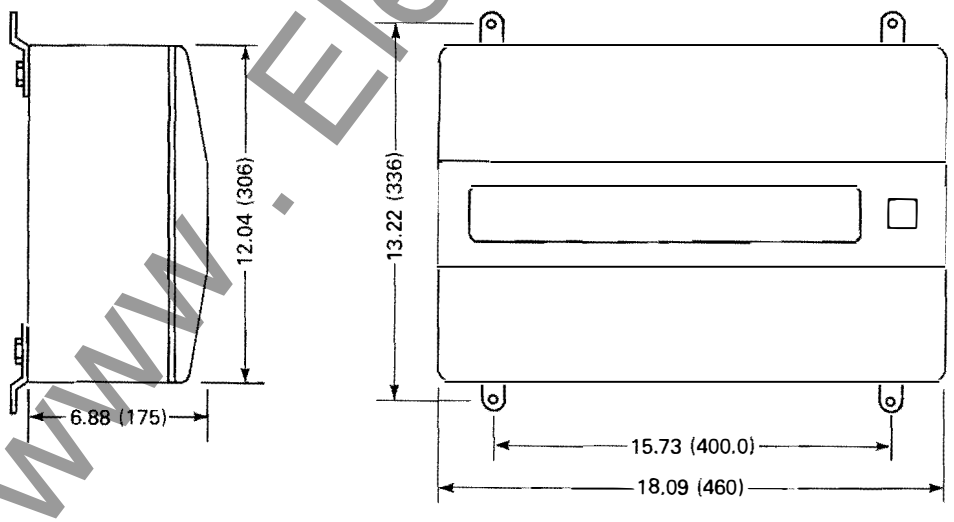
Installation Dimensions①
VeriTrim TC200

Model 132 Analyzer and Mounting Plate



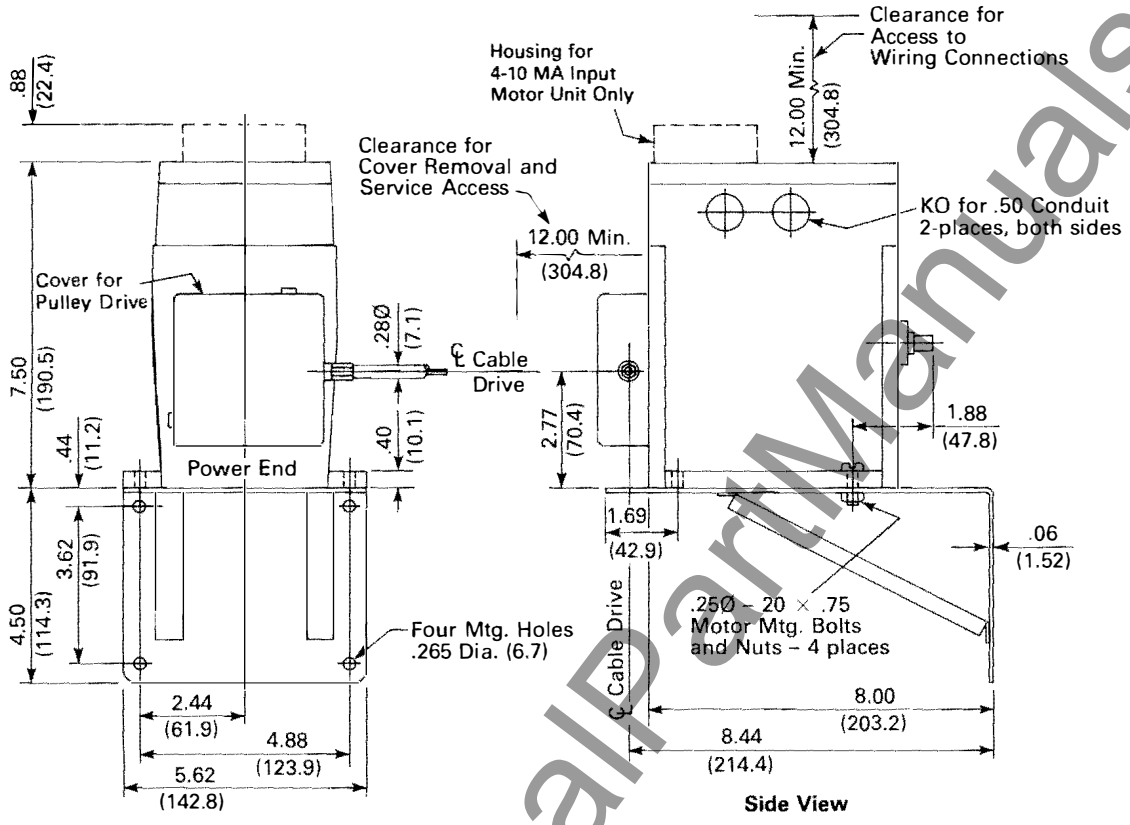
Mounting Plate Assembly

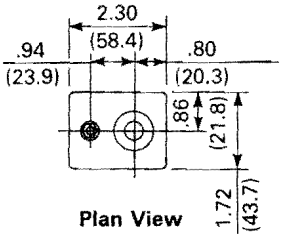
Microprocessor Controller

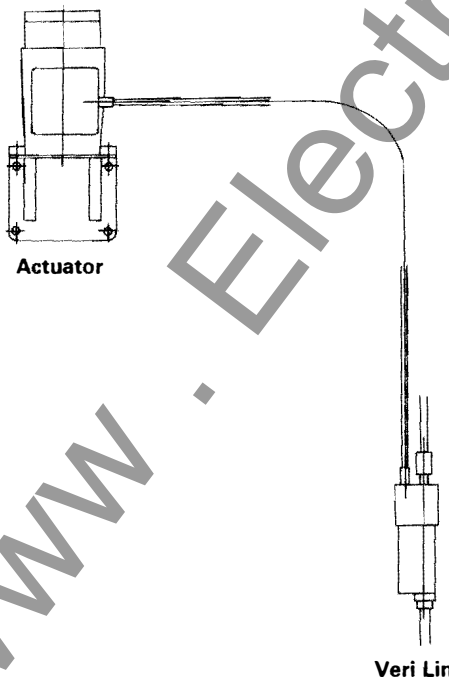


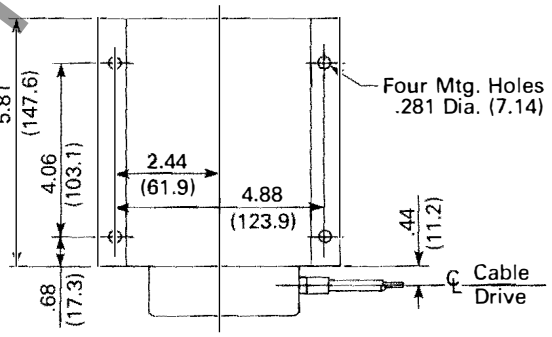
① All dimensions in inches, mm in parentheses.
CAUTION: Dimensions subject to change without notice.

Electro-Mechanical VeriLink Interface and Actuator

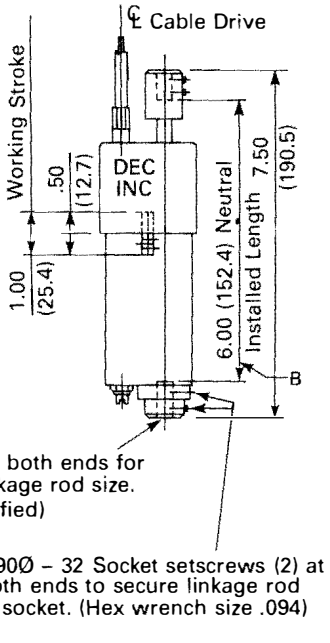








Motor drive base outline and plan drilling



How The System Works

The first step in optimizing the air to fuel ratio in a combustion process is obtaining a reliable, fast excess oxygen flue gas measurement. The probe must continuously measure and provide fast response to oxygen changes in the flue gas.

Westinghouse has designed an in situ excess oxygen analyzer especially suited for the fuels typically fired in small boilers. It utilizes a zirconium oxide sensor invented by Westinghouse in the 1960's for space flight applications and proven successful for industrial boilers.

In 1971, Westinghouse converted this invention into the first reliable in situ oxygen analyzer. The analyzer quickly revolutionized the combustion control industry and is considered the industry standard today. The direct-insertion, probe-type analyzer completely eliminated the need for a flue gas sampling system. It needs no extraction air pump, no sample probe, no sample cooling, no scrubbing and virtually no maintenance.

The Westinghouse oxygen analyzer designed for boiler applications provides a linear excess oxygen measuring range of 0 to 25 percent.

While it is unlikely that a probe will need frequent recalibration following installation, each unit is supplied with a simple "in-place calibration gas" port. This port allows calibration gas to be introduced directly into the sensing element, providing a simple and instant check of calibration accuracy.

More important, if the oxygen sensor should need recalibration, the VeriTrim microprocessor carries out that function automatically. The operator needs only to introduce the two test gases from a Westinghouse portable gas kit. The VeriTrim microprocessor-based control unit easily performs all the computational and calibration functions required by the system.

The unit accepts an input signal from the in situ oxygen analyzer representing excess oxygen. It also accepts an input signal representing boiler load and establishes an excess oxygen setpoint as a function of load. The controller provides a unique feedforward control action on the air to fuel ratio, producing an instant response to sudden boiler load changes. It then finally trims the air to fuel ratio to the load programmed excess oxygen value.

A setpoint program is implemented for each fuel based on the desired relationship between the excess oxygen level and operating load.

Dual fuel, feedforward and oxygen setpoint programming is standard. This feature allows the user to switch fuels without the need to establish a new program. Typically, this feature is appropriate for boilers firing on one fuel with the second fuel as standby.

The VeriTrim controller output is fed to a mechanical trim control actuator which in turn modifies the air damper control arm position. The modified movement of the damper control linkage trims the combustion air, establishing the appropriate optimum air to fuel ratio continuously.

The VeriTrim microprocessor has a unique robotic-like programming capability. It can carry out an expert combustion control calibration of both the feedforward characteristic and the load programmed oxygen setpoints without the need for a specially trained programmer or a combustion engineer.

To program the setpoints, the microprocessor-based unit is placed in the learn mode. The boiler is then manually operated at two to five load points. At each load point, the boiler air to fuel ratio is manually adjusted to obtain the desired oxygen value. An appropriate keyboard button is pushed at each load point, telling the microprocessor to learn both the feedforward mechanical linkage position and the oxygen setpoint as a function of load.

These programmed setpoints then allow the oxygen controller to continuously and automatically adjust the air to fuel ratio to maintain the most efficient combustion conditions. The end result is optimization of energy usage and drastically reduced fuel consumption.

The VeriTrim microprocessor has built in intelligence to assure safe boiler operation even under failure conditions. It is capable of driving the trim actuator to its original or neutral position whenever the main burner is off; oxygen is too low or too high; oxygen probe calibration is in error; the load index signal has failed or there is a flame out. In addition, the system is capable of driving the trim actuator to its safe position even when the microprocessor fails or the actuator positioning system fails.

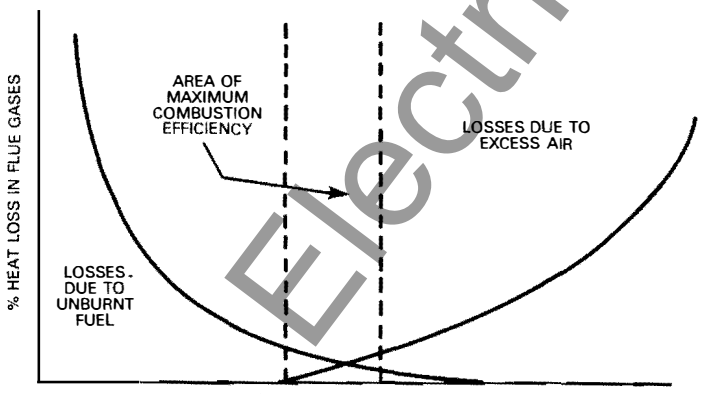


Fig. 1

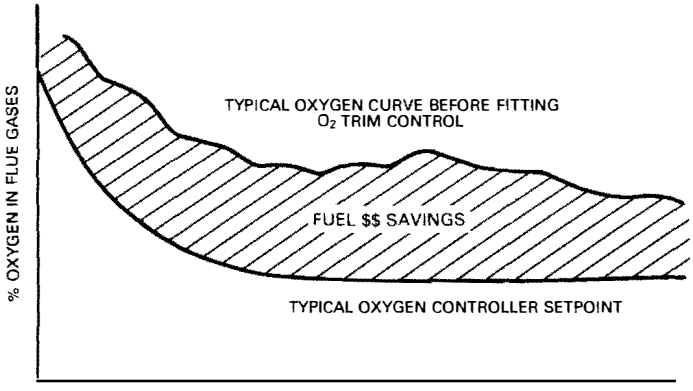


FIG. 2

Westinghouse Electric Corporation
Combustion Control Division
Orrville, Ohio, U.S.A. 44667
Toll Free: 1-800-628-1200, Ext. 658

Division Locations
- Shannon – Ireland
- Villalba – Puerto Rico
- Hamburg – Germany
- Hitchin – England
- Sydney — Australia
- Frankfurt – Germany
- Zoetermeer – Holland
- Milan – Italy
- Madrid – Spain
- Paris – France
- Vienna – Austria

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