BURNERMATE UNIVERSAL INDUSTRIAL BOILER CONTROLLER
System Overview


Standard LCD Display


BurnerMate Universal
Fully Metered Chassis


Oxygen Probe


Color Touch Screen
Operator Interface Terminal


UV, IR Self Check
Scanners


Communication
Station


Servo Motor Actuator

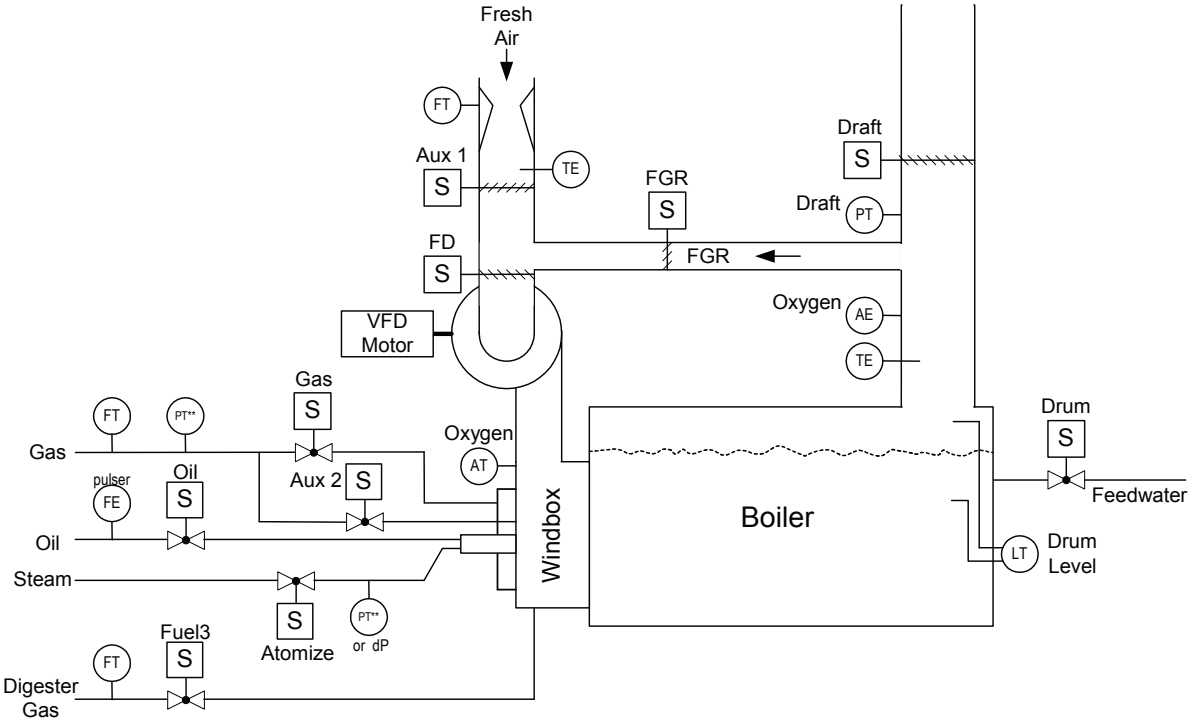
System Overview

Fully Metered combustion control is now available "off the shelf" in an economical, pre-engineered, parameter-driven control package. The **BurnerMate Universal Industrial** includes the following features:

- Patented "Predictive Full Metering" fuel-air ratio control
- Cross-limited Actuator "Position Pacing"
- Single PID fuel-air ratio tuning
- Air flow temperature compensation
- Gas flow pressure compensation
- Windbox O_2 FGR Trim + Flue O_2 Air Flow Trim

The BurnerMate Universal Industrial also includes all of the features in the Basic and Expanded versions of BMU:

- Precise high torque Servo Actuators
  (3 ft-lb -> 720 ft-lb, 8 sizes)
- FD, ID & FGR Fan and BFW Pump VFD drive control
- NFPA 85 compliant Burner Management System (BMS)
- Individual Interlock Annunciation with advanced Lockout Data storage
- Low Fire Fuel Changeover
- Firing Rate, Feedwater and Draft control
- Oil Atomizing Pressure control with Setpoint Curve
- Large 10" color Touch Screen OIT with pre-programmed graphics (Note: 15" also available on custom applications)
- Modbus communications



Typical Fully Metered BurnerMate Universal Industrial P & ID.

BURNERMATE UNIVERSAL INDUSTRIAL BOILER CONTROLLER
System Overview

The BurnerMate Universal Industrial is available off-the-shelf for immediate delivery, requires only wiring and Parameter setup to be operational and is NFPA 85 compliant and U.L. recognized

Predictive Metering Combustion Control
The BurnerMate Universal Industrial offers a patented metering fuel-air ratio combustion control technique using a unique control strategy referred to as "Predictive Metering". The ideal combustion control strategy is one that maintains a preset fuel-air ratio over the entire load range of a boiler despite changes in fuel supply, combustion air and draft conditions, and also provides rapid load change response.

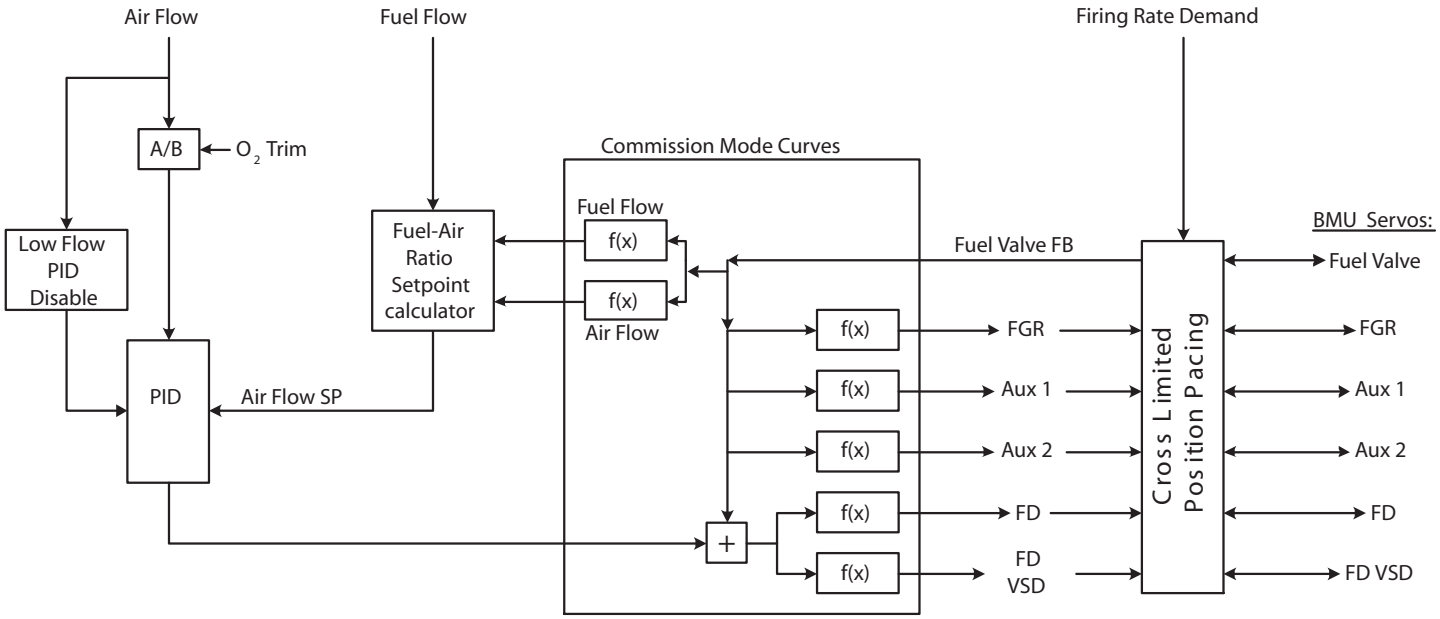
Traditional Fully Metered combustion control systems have the following weaknesses:

- Two PID loops are required, making tuning difficult
- Cross Limiting Lead-Lag causes Air Rich operation during Load changes
- Sluggish response to load changes due to PID and Cross Limiting Lead-Lag interactions
- Air Flow meter inaccuracies at low flow rates limit Burner turndown capabilities
- Flow meter malfunctions disable the burner, or require manual operation until repaired
- Until now, Fully Metered control systems were "custom" so their benefits were not available "off the shelf"

Preferred's patented "Predictive Metering" combustion control strategy combines multiple fuel, air, and FGR 'as-commissioned' feedforward curves (which predict Servo/ VSD changes during a load change), with measured flow rate based PID fuel-air ratio control that incorporates a robust Cross-Limited Position Pacing algorithm. Predictive metering uses 'as-commissioned' measured fuel flow rate and air flow rate curves to ensure that the PID fuel-air ratio remains at the 'as-commissioned' fuel-air ratio setpoint for every firing rate.

Predictive Metering, combined with "Position Pacing" logic, assures much more precise Actuator positioning and assures that each servo remains "on curve" during load changes. This allows the controller to increase or decrease firing rate more quickly, without concern for "fuel rich" or "fuel lean" burner operation. These strategies are of particular importance when applied to sensitive low NOx burners with narrow limits of flammability.

Because "Predictive Metering" combustion control uses both the Servo Actuator position feedback and fuel and air flow meter inputs, metering combustion control can be selectively "turned" off at low firing rates where air flow meters may not be as accurate. Most importantly, if a flow meter malfunctions, by simple Parameter selection the BMU Industrial controller can be directed to operate as a Parallel Positioning combustion control system with Oxygen trim until the flow meter is repaired or replaced. Traditional Fully Metered systems can only be run in manual when there is a flow meter malfunction.



BurnerMate Universal Industrial Predictive Metering Control Schematic

Because "Predictive Metering" is pre-programmed and only application-specific Parameter setup is required to make the controller functional, BurnerMate Universal Industrial is much easier to commission and operate than traditional Fully Metered combustion control systems. The single PID block (rather than the two required for traditional systems) requires that only one set of PID values need to be tuned during commissioning.

Inputs for "Predictive Metering" combustion control include:

- Combustion air flow
- Combustion air temperature
- Fuel 1 Oil flow (pulser or 4-20 mA)
- Fuel 2 (natural) gas flow
- Fuel 2 (natural) gas pressure**
- Fuel 3 (digester or other) gas flow**

**Note: The Fuel 3 Flow, Gas Pressure compensation, and Atomizing Pressure control transmitters all share a single BMU Industrial input. Only one of the three can be enabled (field selectable).

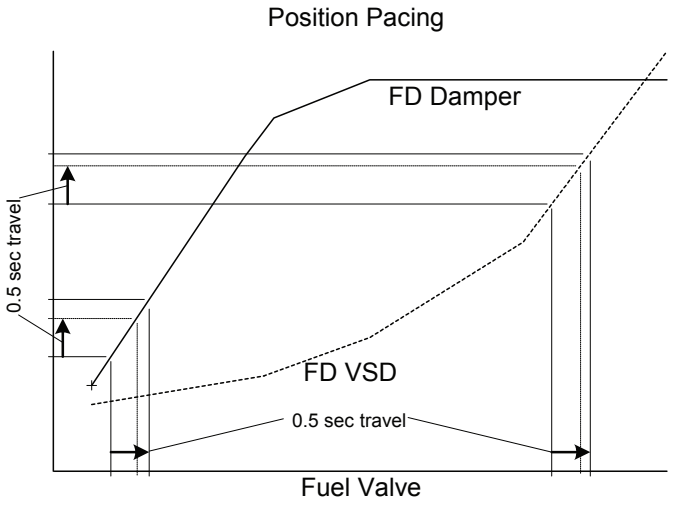
Fuel and Steam flows are also Totalized. Each of these flow rates and flow totals has a Modbus address for display on the local OIT Touch Screen or remotely via Modbus on Plant DCS system OITs.

BMU Industrial Fuel-Air-FGR Cross Limited Position Pacing

"Position Pacing" is a unique feature of the BurnerMate Universal Industrial that assures the positions of all Fuel, Air, and FGR Servos and related VSD speeds remain "on curve" during load swings. Position pacing helps avoid:

- Periods of lean combustion that can cause rumbling, vibration, or flame-outs during firing rate increases
- Fuel rich conditions that can cause smoking, burn-back, and excessive CO or unburned hydrocarbons during firing rate decreases

With traditional Fully Metered control systems, the solution to these problems is to slow down the response to firing rate changes, and to tighten "cross limiting Lead-Lag" to assure that the fuel and air flows remain "on curve." For such systems, it is not unusual for low to high fire response times to be 4-8 minutes.



Two Servo Example of Position Pacing

BMU Industrial "Position Pacing" assures that all Servo Actuators remain "on curve" in the following manner:

- All fuel, air, FGR Servos and VSDs move together and "on curve" --there is no fuel or air "Lead" or "Lag".
- Each Servo and VSD has precise position or speed feedback to insure that all devices are Cross Limited.
- The BMU Industrial "knows" how far each Servo Actuator and VSD can move in 0.5 seconds and uses "self-adaptive" Position Pacing to ensure that load changes never cause any Servo or VSD to lag behind the others.
- Every 0.5 seconds, the BMU Industrial examines all curves to "find" the Servo or VSD worst case 0.5 second 'move' caused by a requested firing rate change.
- Based on the curves, all other Servos or VSDs target positions are "scaled back" to assure ALL devices arrive "On Curve" at the end of the next 0.5 second move.

BMU Industrial "Position Pacing" is fully automatic, provides for safer combustion control and drastically improved firing rate response times and requires no user adjustments.

Description	Catalog Number
BurnerMate Universal Industrial chassis. Includes oxygen compensation inputs, and expanded processor with draft and feedwater control. LCD Keypad shipped loose for enclosure-mounting.	BMU-2ZN1

Note: BMU Industrial servos, scanners, oxygen analyzers and flow transmitters are required for a complete system.

BURNERMATE UNIVERSAL INDUSTRIAL BOILER CONTROLLER

Suggested Specifications

1. Quality Assurance

The boiler control system shall be manufactured and supported in the United States by Preferred Instruments. The burner fuel-air-FGR ratio control system and the burner flame safeguard system shall be manufactured and labelled in accordance with U.L. 372, U.L. 1998, and CSA C22.2 #199. Simply supplying UL recognized individual components is not sufficient. The assembled control cabinet as a whole must be inspected for proper wiring methods, fusing, etc., and must be labeled as conforming to UL508A and CSA C22.1 #14. Inspection and labeling shall be supervised an OSHA approved Nationally Recognized Test Lab (NRTL). The system shall comply with NFPA 85 "Requirement for Independence," the flame safeguard system shall be provided with independent hardware shall be physically separated from the combustion control logic.

2. Predictive Metering Combustion Control

A fully metered combustion control system with oxygen compensation and (optional) VSD control shall be provided for each boiler. Each system shall be designed to provide continuous boiler operation within boiler design limits with a high level of safety and energy efficiency. Fuel flow, air flow, and servo position for up to eight servos will be continually monitored and held "on curve" during boiler load changes. For ease of setup and faster response to load changes, the fully metered combustion control logic shall contain only one PID loop. As required the system shall provide continuous monitoring and control of steam pressure (or water temperature), and water level. In the event a flow meter is out of range or inoperative, the control strategy can be switched to Parallel Positioning, by parameter selection. The system shall be fully integrated to the burner management system to provide fully automatic, safe and reliable startup and shutdown.

3. Oxygen Compensation System

Provide a boiler breeching mounted in-situ, zirconium oxide oxygen analyzer for each boiler. Extractive type oxygen analyzers are not acceptable for combustion control. The probe shall be of a suitable length to sense the oxygen level in the middle third of the breeching. All wetted parts shall be stainless steel. The oxygen analyzer shall:

- Include continuous self-diagnostics with diagnostic codes for at least 10 common faults.
- Automatically send the trim control to the 'null' position and trigger the alarm dry contacts in the event of an oxygen analyzer fault.
- The detector shall be field replaceable without removing the probe from the stack and shall not require special tools.
- The analyzer shall automatically perform periodic detector cell impedance tests to be used by the operator as an indication of calibration shift.
- Analyzer calibration shall be pushbutton semi-automatic (no trim pots) with English language prompts and diagnostic messages. Analyzer output shall be field selectable as 0-10% or 0-21% without field re-calibration.

4. Windbox Oxygen FGR Control

The controller shall accept an analog input for burner windbox oxygen to be used as a measure of flue gas recirculation rate. During commissioning, a windbox oxygen vs. firing rate curve shall be established. The controller shall modulate the flue gas recirculation valve (or flue gas blower motor VSD) to maintain windbox oxygen on the pre-established curve despite changes in ambient conditions.

5. Atomizing Media Pressure Control

The controller shall accept an input for atomizing steam pressure or atomizing steam/oil differential pressure. During commissioning, an atomizing steam pressure (or atomizing steam/oil differential pressure) curve shall be established. The controller will modulate an atomizing steam flow control valve to keep the atomizing steam pressure on curve at all firing rates.

6. Flame Safeguard System (FSG)

Integral to the control system furnished shall be a Burner Management System (BMS) /Flame Safeguard System (FSG) controller. The system shall be designed to ensure the safe start-up, on-line operation, and shutdown of fuel firing equipment. Burner management system components shall be located in the combustion control cabinet and shall be fully integrated for automatic sequencing of light off and shutdown.

Microprocessor-based FSG shall provide: safety interlocks, flame monitoring protection, and timed sequences. Sequences shall include forced draft fan start and stop, furnace purge, burner light off and shutdown and post-purge. The FSG shall be capable of firing up to three fuels (two gas fuels, one oil fuel), one fuel at a time. Fuel changeover shall from oil to gas, or gas to oil firing shall be accomplished "on the fly" at low fire without boiler shutdown per NFPA.

A panel front-mounted English language, four line, twenty character LCD message display shall be provided to display flame signal strength, startup and shutdown sequence status, alarm, system diagnostic, first-out messages and burner historical information. Historical information shall include the status of all limits and servos for the last ten lockouts.

To ensure boiler low water cutouts are working correctly, the controller shall be capable of performing a daily automatic water column blow-down test. The user shall select the time of day and duration of the water column blow-down test. The controller shall ensure the low water cutoff switches are functioning correctly, and alarm the operator or lockout the boiler if it detects a switch malfunction.

To prevent nuisance trips, the flame safeguard system shall accommodate two flame scanners with one required to prove flame. The controller shall provide 120 VAC or 24 VDC scanner power, and accept two analog inputs for flame strength indication. Flame safeguard system shall include oil gun post purge for oil firing. Assured low fire cutoff shall be provided.

For additional nuisance trip protection, field adjustable time delays shall be provided for F.D. fan start, fresh air damper, minimum air flow, low draft cut out, and fuel pressure limits. Five field selectable auxiliary relays shall be included for common alarm, auxiliary fan start, blow-down, flame on, fuel valve open, hot water pump or valve.

To protect against dry firing, an option shall be available for high flue gas temperature lockout.

To ensure air switches are functioning, minimum air flow pressure switch and purge air flow pressure switch safe start check shall be included.

7. Feedwater Control

Provide a boiler water level controller capable of single-, two-, or three-element feedwater control with the ability to automatically switch between control strategies dependent on system demands.

8. Draft Control

The controller shall provide two-element draft control utilizing a Preferred Instruments JC-22XMTR draft transmitter. Burner firing rate shall be used as a feed forward for improved response to load changes. The control shall provide both automatic and manual damper control. All adjustments shall be made from the front panel display in engineering units.

9. Flue Gas Recirculation Valve Control

The controller shall have a characterizable setpoint curve for damper or variable speed fan output signal. All the logic required to insure that pre-purge, post purge, light-off, and burner modulate cycles are automated shall be provided within the controller. Alternatively, the control will regulate FGR according to a preset windbox oxygen setpoint curve.

10. Additional Control Requirements:

- Minimum number of f(x) Curves to be provided per servo: 6
- Minimum number of points per f(x) Curve to be provided: 11
- Cold FGR low fire cutback shall be provided when FGR is utilized for NOx reduction.
- Separate curves shall be provided for FD fan full speed bypass of VSD in case of VSD failure.
- Controller shall include the capability of receiving a remote firing rate input and remote set point input.
- Controller shall include dual outdoor reset setpoint curves (normal & setback)
- Controller shall include warm standby start / stop cycle.
- Controller shall include low fire hold, and cold start warm up ramping.
- All external or auxiliary power supplies necessary for electronic transmitters (or final control element) shall be included.
- Boiler control software shall be U.L. 372/ U.L. 1998 recognized and inaccessible to prevent tampering. Unit commissioning shall be by parameter selection, not requiring ladder logic or blockware programming.
- The controller shall accept standard 4-20 mA, 1-5 VDC, or RTD inputs for analog inputs. No special sensors shall be required.

11. OIT Color Touch Screen

Provide as an option a ten (10) inch Operator Interface Terminal (OIT) designed to provide local operation, graphic display of information, alarm message display, historical and real time trending, remote controller tuning, x/y plots of fuel-air curve data for intuitive commissioning, Ethernet connectivity and standard internet browser remote communication. The OIT shall contain a minimum of 75 graphic pages and be networked to the boiler control and burner management systems. The OIT shall provide graphic pages allowing step-by-step commissioning of the controller parameters using English language prompts and selections.

The system shall be an industrial hardened operator interface terminal. The terminal shall be web enabled and allow remote monitoring via a standard internet browser and support Modbus TCP/IP Master, TCP/IP Slave, RS-485 Modbus Master, and Ethernet communications.

12. High Torque Servo Features:

- Easy pushbutton set-up, not requiring the adjustment of internal or external potentiometers.
- Servo zero, span, and direction of travel shall be accomplished by push button configuration.
- Totally enclosed, dust tight, and splash-proof covers.
- Provide a separate direct acting digital servo actuator for the fuel gas and fuel oil.
- Electrically isolated shaft position feedback potentiometer, integral brake, 90° rotation in 25 seconds.
- The actuator shall be capable of being stopped, started, or instantly reversed without loss of power or overloading.
- Servo actuator positioning accuracy: 0.1 degrees. Servo full stroke safe start check shall be provided.
- For high torque applications such as watertube boiler air dampers, servo torque shall be rated minimum 70 ft-lbs with 0.4 degree accuracy.
- No servo feedback adjustments shall be required with pushbutton zero setup. Adjustable travel limit switches shall be integral, with re-adjustment not requiring new fuel air ratio curve re-entry.
- Servos shall be cycled during each light-off cycle, and the feedback from each servo monitored to ensure safe actuator operation.
- Servos shall be Preferred Instruments, model BMU-SM or BMU-UM (high torque).