ACS-100

Burner Control System

INSTALLATION AND OPERATIONS MANUAL

WEBSTER COMBUSTION
A Selas Heat Technology Company

The *Better* Burner.

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Webster ACS-100 Installation and Operations Manual

(UPDATED: October 24, 2022)

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1. GENERAL CONSIDERATIONS AND REQUIREMENTS

!!! Before beginning installation and commissioning, read through this manual and all application literature. Also, familiarize yourself with the control circuit components and diagrams.

The information and guidelines contained within this Installation and Operations Manual pertain only to the Webster Combustion Technology, LLC's ACS-100 Burner Control System with regards to the installation of the ACS-100 controller panel and connections made to the panel, as well as the commissioning and the operation of the ACS-100 control system.

Only QUALIFIED and COMPETENT technicians should attempt to install and commission the ACS-100 and connected components. Combustion tuning can be dangerous without the proper equipment and knowledge. Do not continue with the installation or commissioning of the ACS-100 and connected components without comfortable knowledge of the application, equipment, and process requirements.

1.1 INSTALLATION

The ACS-100 can come as a preassembled panel that is enclosed in a benchtop console or as a preassembled 'drop-in' unit that is custom built to fit . Regardless of which configuration is being installed some planning needs to be completed to ensure a proper installation.

The console has a **minimum space requirement of 26" wide X 18" deep** and although it is only a little over 13" high when the door is closed, it requires an additional 20" above this to accommodate for door clearance **(~35" total height allowance)**.

Place the ACS-100 console or drop-in panel in a predetermined, prepared location and route conduit/wires to the panel allowing for a clean installation.

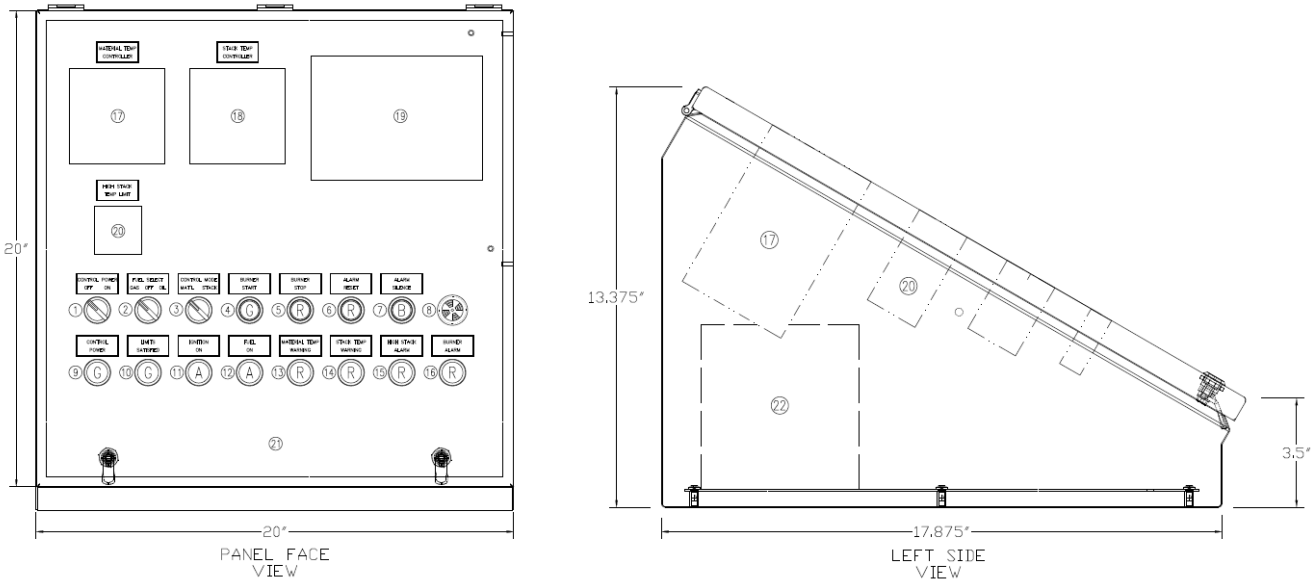
If installing a controls tray (drop-in), be sure to leave plenty of room in front for opening the door/tray and for access to the controls. Ensure enough slack is left in the wiring to allow for extension and retraction of the tray. Protect the wiring from any sharp edges or pinch points to prevent damage to the wiring and controls.

Pay attention to the low voltage sensor wiring and communications wiring with regard to routing, trying to keep the low voltage sensor and communications wiring separated from the higher voltage wires (>50 V), as best as possible.

In the case of the preassembled console, careful planning of any conduit connections and all of the wire entries needs to be done. There is some room is available along the lower end of the sides and higher up the back of right side however, the left side does not have much room for wire entries higher up the back end due to the room needed for the Material Temperature Controller. Also, the lower portion of the back end on the right side is restricted by the room required for the Burner Flame Safety Controller.

There is no room for wire entries at the bottom of the consolette enclosure.

Drop-in panels are custom fit to each installation and must be installed accordingly.



BENCH TOP CONSOLE

1.2 POWER SUPPLY AND CONTROL CIRCUIT WIRING

ALL WIRING AND ELECTRICAL CONNECTIONS SHALL BE COMPLIANT WITH THE NEC AND LOCAL ELECTRICAL CODES.

***The ACS-100 control system DOES NOT include the blower/fan motor starting and motor control components for the combustion blower and the exhaust blower. Blower/fan motor starting components, motor contactors and VFDs are expected to be supplied separately.*

The ACS-100 requires a clean **120 V / 60 HZ / 1 PH** power supply.

The ACS-100 control circuit is protected by a **10A class-CC fuse** however, a protected power supply is required.

The conductors that supply power to the ACS-100 shall be a minimum size of **#14 AWG** and be a stranded copper type suited for the application.

All 120 VAC field connected control circuit conductors that connect the ACS-100 control panel to the burner junction box or components shall be a minimum size #14 AWG, stranded copper of type THHN or equivalent.

All 120 VAC field connected control circuit conductors between the ACS-100 and the burner junction box or components should be no longer than 300 feet.

Multi-conductor cables may be used in lieu of individual wires if the cables are approved for the application and by the local Authority Having Jurisdiction. If quick connect fittings are used to make field connections, they must be approved for the application and environmental conditions.

The low voltage control and feedback signal conductors, between the ACS-100 and the burner junction box, shall be shielded cables with stranded wire conductors having a minimum size of **#18 AWG per conductor**. A braided metallic shield is preferred however, the foil screen type will be sufficient if it is a type that contains a bare drain wire within the cable.

Only one end of the shield shall be connected to the indicated grounding location, the grounded end is denoted within the wiring diagram. If the grounded end of the cable is not clearly denoted then, it shall be the end of the cable that terminates in the ACS-100 control panel that will be grounded.

A good earth ground is required, and **ground continuity MUST BE MAINTAINED** between the ACS-100 control panel and the connected components at the burner, this is referred to as the 'chassis ground', GND or, PE.

> **This control system utilizes LOW VOLTAGE signal circuits therefore, shielding and grounding is VERY important for maintaining good signal quality; in particular with the utilization of VFD(s).*

1.3 TEMPERATURE SENSORS

At a minimum, three (3) **Type-J thermocouple** temperature sensors are required to operate the ACS-100 properly. These include the Material Temperature, Stack/Baghouse Inlet Temperature, and another dedicated sensor in the drier outlet for the High Stack Temperature controller. A dual element thermocouple may be used for the Stack Temperature control and the High Limit control with this thermocouple having both elements being the J-type.

The thermocouples need to be wired accordingly, with proper extension wire. The thermocouple wires SHALL NOT be running in the same conduit with higher voltage wiring.

1.4 FLAME DETECTORS

The standard flame detector is the **Honeywell C7027 series U.V. detector**. Other flame detection methods can be used (I.R., Self-Checking U.V.) if specified when ordering the ACS-100. If required, the flame detection method can be changed at a later point in time by replacing the flame sensor and the flame amplifier module located on the bottom of the Burner Flame Safety Controller.

The flame detector needs to be wired accordingly. *See Page 1 of the wiring diagram for details.*

The flame detector wiring SHALL NOT be running in the same conduit with higher voltage wiring.

1.5 CONTROL ELEMENTS

The ACS-100 control system is designed to be integrated with burners utilizing single-point modulation control systems (linkage). The number of control elements is not important to the ACS-100 controller since only one Fire Rate Control Motor is utilized with the ACS-100 control system, this is typically connected to a jackshaft operating a common linkage system.

1.6 VARIABLE FREQUENCY DRIVES

The ACS-100 does not supply a control signal for a combustion blower VFD. The ACS-100 does not provide for any drum pressure (draft) control, this must be accomplished outside of the ACS-100 either manually controlled or with a dedicated draft controller.

1.7 CONTROL MOTORS (SERVOS)

The Fire Rate Control Motor circuit is designed based on the control logic of the **Eurotherm (Barber-Coleman) EA57 or EA73 series servo motor**. The control logic, wiring configuration and the diagrams all reflect the usage of these series of control motors.

These control motors utilize a 120VAC 'Floating' or, '3-position step' control method (*also referred to as Series 60 in Honeywell literature*). Power is applied to a winding set within the control motor to drive it CW. Power is applied to a different winding set within the control motor to drive the motor CCW. **Power should never be applied to both windings at the same time**. When no windings are energized the motor holds in position, it is not a spring return motor nor does any loss-of-signal failure force the motor to any specific position.

Smaller burners are generally setup for use with the EA57 motor control scheme. That is, closure between the case ground (X) of the control motor to any drive terminal (2 or 3, *never both*) will cause the motor to move.

Larger burners are generally setup for use with the EA73 motor control scheme. That is, closure between the ungrounded, hot leg (L1) to any of the drive terminals (2 or 3, *never both*) will cause the motor to move.

This is a significant difference between the operation of the two different motor series, care must be taken to ensure the servos are of the correct type relative to the ACS-100 configuration.

These motors also utilize a 100 ohm slide-wire feedback potentiometer. This is used for positional feedback to the ACS-100 and is powered by a 10 VDC power supply from within the Eurotherm 3504 Temperature Controllers.

If another brand or series of motor is utilized, then they must meet the same operating and feedback criteria as the EA57 and EA73 series control motors.

The Control Motors, couplers, linkage components and the control elements should be verified for proper configuration, with regards to the direction of rotation and travel limits, before continuing with commissioning.

1.7.1 **Check the rotational direction requirements for each control element:** check this relative to the controlled component, to ensure proper operation of each element. The wiring diagram for the standard ACS-100 Panel (*retrofit*) shows the Control Motors wired to open/increase in the CLOCKWISE direction, looking at the shaft end of the EA57/73 control motor.

ACS-100 packaged systems provided with Webster Combustion Technology, LLC burners will show the control motor wired 'as built' in the relative wiring diagrams.

**The control motor drive wires, and the position feedback wires, can be reconfigured at the motor or the burner junction box to change the rotational direction of the control motor if needed*.

1.7.2 **Check to ensure freedom-of-movement for each control element:** ensure there is no excessive force required to move all connected control elements throughout the entire movable range of the jackshaft/linkage system. Each controlled component in the linkage system should be able to move throughout the required range without impedance of any mechanical limit and without binding.

Proper adjustment of the linkage system will need to be done to set the control profile and to limit the stroke of each controlled element.

The EA57/73 and other common control motors are set up to move 90 degrees however, there is an internal limit switch within the EA57/73 motors that can be adjusted to reduce the travel of the control motor, if required (*other control motors may provide for this, check the motor manufacturer's literature for information*).

1.7.3 **Ensure the Control Motor is wired correctly:** leave the motor uncoupled from the jackshaft for the first commissioning.

When the ACS-100 is ready to be powered and the control motor setup is ready to be done this will allow for verification of the rotational direction and travel limits without concern for over travel or moving the control elements in the wrong direction.

After the wiring and movement has been verified to be correct the control motor may be attached to the jackshaft. Do not perform motor feedback calibration until all of the elements are firmly coupled and travel limits are verified to be correct.

1.8 PURGE/IGNITION POSITION INTERLOCKS

Determination of which mechanical Position Proving Switches are to be utilized needs to be done to ensure that the positional proving requirements, relative to the control scheme, are implemented.

At a minimum, all Combustion Air related control elements will open during the Pre-Purge phase to meet the purging requirements. The Purge Position is proven via an external mechanical limit switch on each element that 'proves' the control element is at this commanded position.

The Fuel Flow Control Valves do not require purge position proving however, the Fuel FCVs and the combustion air louvers are to be proven to be at their commanded Ignition Position. This is done with a separate external mechanical limit switch on each element.

The Atomizing Air Valve, generally, does not require these position proving switches due to the use of the Atomizing Air Pressure Switch to prove that atomizing air is available.

In the standard ACS-100 panel, all of the generally required position proving switches are accounted for; if any are not used then a jumper must be installed at the terminals to bypass the unused limits. *See Page 3 of the wiring diagram for details.*

These mechanical limit switches will need to be setup to close the contacts of the switch when the controlled element is at the commanded position, the mechanical operation of these switches needs to ensure this fail-safe function.

1.9 FUEL VALVE INTERLOCKS

The Main Fuel Shutoff Valves (Gas, Oil and LP) often have Proof-of-Closure limit switches that are integral to the valve actuators. These switches prove that the fuel valves are closed during any phase in which the fuel valves are not to be energized.

If the burner only fires a single fuel or, if any of the fuel trains do not incorporate POC limits then, jumpers will need to be installed at the terminals to bypass the unused POCs. At a minimum, any gaseous fuel train should have proof-of-closure limits implemented; it is recommended that all fuel trains incorporate POCs.

**Fuel valve POC requirements vary depending on location and the Authority Having Jurisdiction, check with local authorities to ensure compliance is maintained*.

The POCs need to be wired accordingly, *see Page 3 of the wiring diagram for details*.

1.10 SAFETY LIMITS

Determination of which safety limits are to be implemented needs to be done to ensure that all safety devices are accounted for. Each fuel train will have supervisory limits that monitor the pressures and temperatures of the fuel. The atomizing air supply piping will have a pressure proving limit, as well.

The Combustion Air Proving Switch, Combustion Motor Starter ITLK, Exhaust Air Proving Switch, Exhaust Motor Starter ITLK and an additional User Auxiliary Limit are also included in this safety limit 'chain'.

**Fuel train and other safety requirements vary depending on location and the Authority Having Jurisdiction, check with local authorities to ensure compliance is maintained*.

The standard ACS-100 panel incorporates all of the generally required safety limits, if any of these limits are not used then a jumper will need to be installed at the terminals of any unused safety limit. *See Page 1 of the wiring diagram for details.*

1.11 OTHER WIRING NOTES

The Main Fuel Valves, Pilot Fuel Valves and the Ignition Transformer all need to be wired accordingly.

2. PANEL COMPONENTS

The panel door of the standard ACS-100 benchtop console holds all of the operator interface components along with the Material and Stack Temperature Controllers, the High Stack Limit Control, and the display for the Burner Flame Safety Controller.

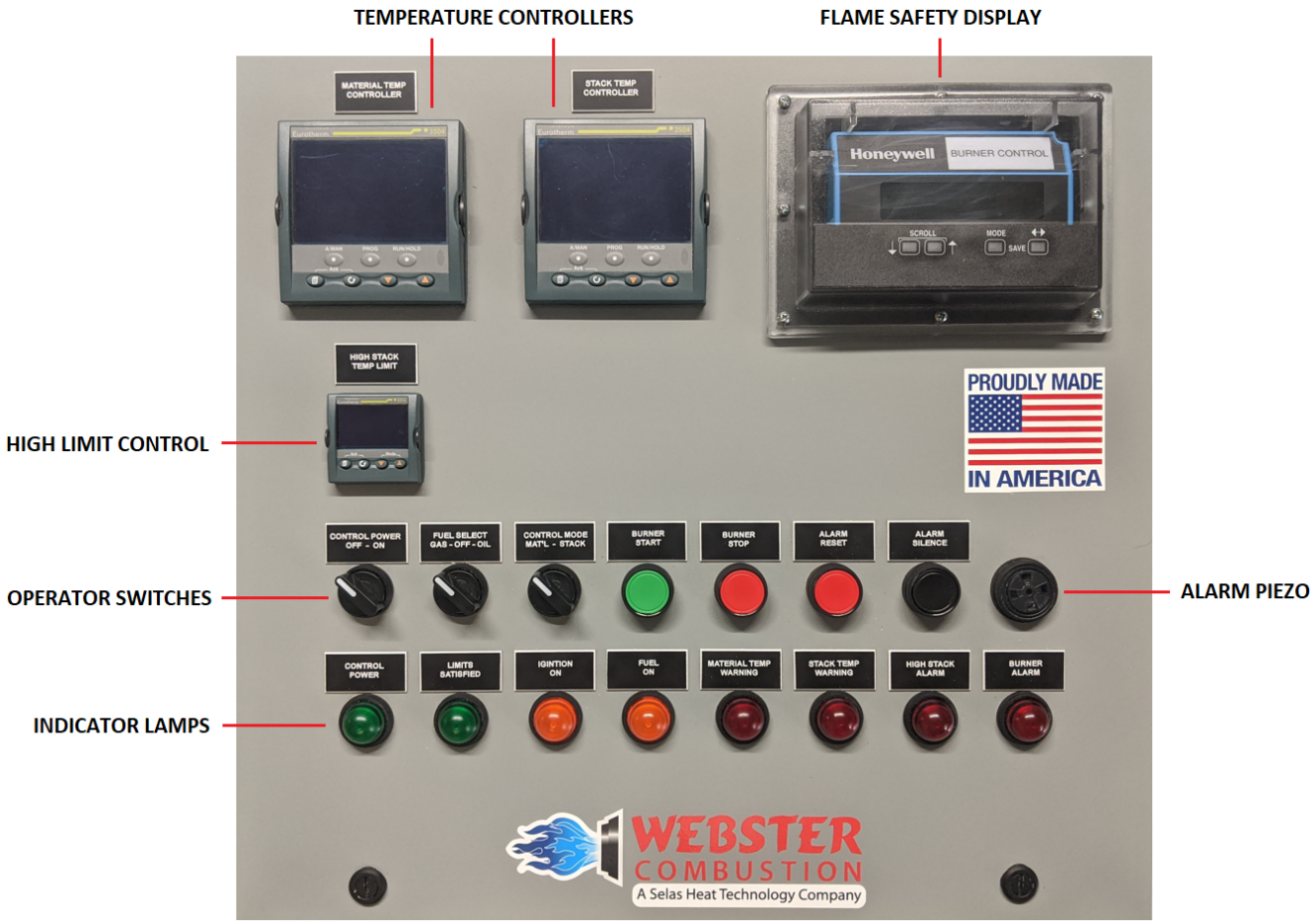
Fuel selection, temperature control mode selection, burner starting and stopping, alarm silencing and reset are all controlled with selector switches and pushbuttons on the panel door.

Indication of status, state and alarms are all done with lamps and displays on the panel door.

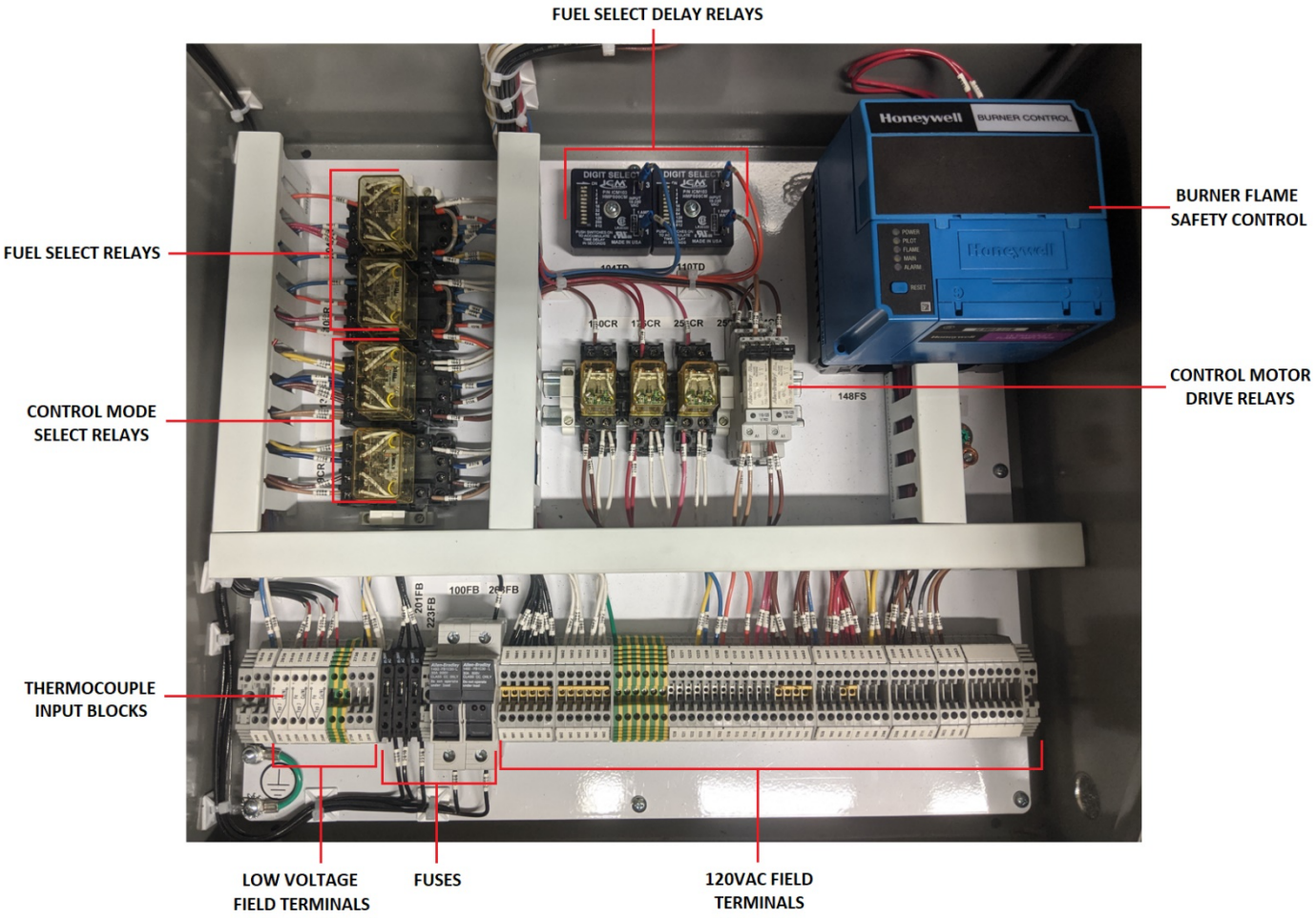
The material and stack temperature controllers are completely independent, if one controller fails or the controller fuse blows it will not shut the burner down, the operator may switch to the other temperature control mode to continue burner operation.

The burner modulation can be controlled manually or automatically from the temperature controller that is currently selected.

Temperature operating, warning, and shutdown setpoints are all made at the temperature controllers.



PANEL DOOR COMPONENTS



2.1 BURNER FLAME SAFETY CONTROLLER (FLAME SAFEGUARD)

The standard burner flame safety controller (FSG) is the Honeywell RM7840L2075. This controller has 6 individual components that make up the control package that is within the ACS-100 control panel.

Subbase, Chassis, Flame Detection Amplifier Module, Purge Timing Card, Display Extension Module, and the Keyboard Display Module.

The FSG is the main sequencing and supervisory component in the control circuit. Its job is to monitor the safety limit inputs and the controller outputs to ensure the operation of the burner is safe and permitted. It also monitors the flame sensor to determine if a good flame is present when expected and alert the operator when a flame is present during periods when there should be no flame.

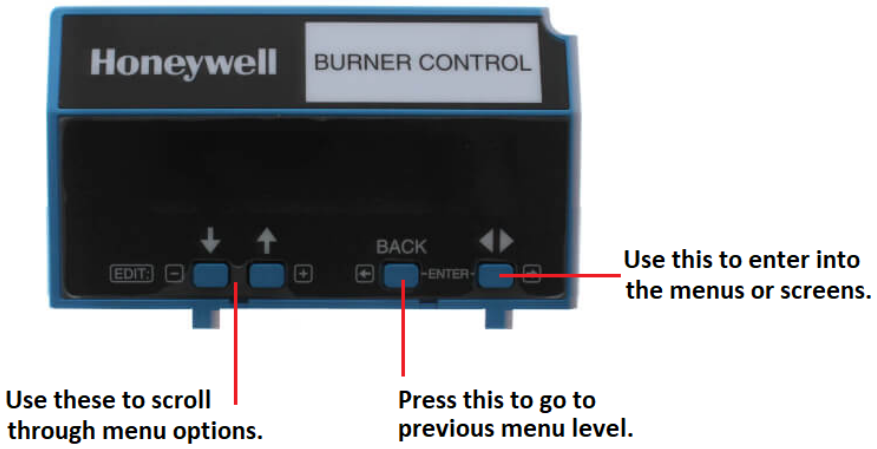
The FSG will lockout and require operator intervention to continue operation if a critical safety limit is not satisfied, if an output is energized when it should not be, if there is a false flame detection, or a loss of flame while running. The controller will also lockout if there are any internal faults detected within the FSG or a connected module.

The standard flame amplifier is the R7849A1023, this is the standard UV flame detection amplifier module used with the C7027 flame sensors. The amplifier modules can be replaced by removing them from the bottom of the FSG chassis.

The PRE-PURGE timing is a fixed set point determined by the Purge Card that is installed behind the Remote Display Expansion Module. The standard purge timing is 60 seconds however, the pre-purge sequence and timing must cycle the air through the dryer, bag house and all ducting through to the exit of the exhaust at least 4 times to comply with the majority of applicable code requirements.

****Check with local authorities for purge timing requirements****

The Display Expansion Module plugs into the front of the FSG and is used as an interface for the remotely mounted Keyboard Display Module (KDM). The expansion module can be removed by pulling out from the bottom of the module and then bring the top of the module slightly down to clear the top tangs. Reinsert the module in reverse, with top in first then the bottom.



The KDM is mounted in the door of the ACS-100 console, there are a few usable screens that can be navigated through with the arrow keys on the face of the cover. The KDM can be removed from the back of the cover.

The home screen is set to show the “FLAME SIGNAL”, and the KDM will revert to this home screen after a few minutes of inactivity from the buttons. Good flame signal strength is 2.0 – 5.0 VDC, poor signal strength is anything below 1.2 VDC.

The KDM will annunciate the sequence state, the purge timing, the flame signal, and any faults automatically as it the burner controller is running through the startup and running process.

There is a “DIAGNOSTIC INFORMATION” menu that allows viewing of the input and output status.

There is a “FAULT HISTORY” menu where the 6 most recent faults are stored along with fault codes, sequence state and time stamps.

****See the RM7840L literature for detailed information and fault code listing****

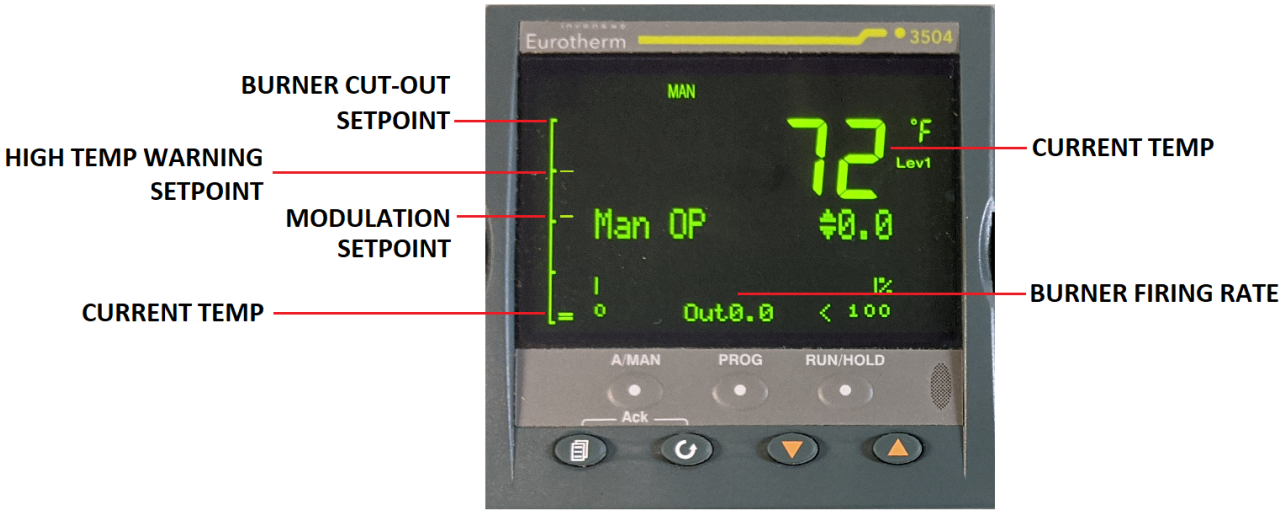
2.2 TEMPERATURE CONTROLLERS

The ACS-100 utilizes the Eurotherm 3504 Process Loop Control for Material and Stack Temperature Control modes. There are two independent controllers to accomplish this, both controllers are identical other than for PID and alarm parameter settings.

From these controllers the temperatures are indicated, the modulation setpoints are adjusted, the fire rate can be controlled in either automatic or manual modes, high temperature setpoint adjustments are made, and PID tuning adjustments are made.

Each controller can operate the Burner Fire Rate Control Motor (FRM) and receive position feedback, only the currently selected controller will be connected to the FRM, and the positional feedback will only be visible on the selected controller's display.

There are 2 bar graphs on the display, one is vertical the other is horizontal. The vertical bar graph represents the temperature and there are two lines that appear on this graph. The lower line represents the modulation setpoint, the upper line represents the High Temperature Warning setpoint. The upper range of the bar graph represents the High Temperature Cut-Out setpoint. These setpoints are all adjustable and the bar graph automatically sets the line indicators and the upper range of the scale.



The horizontal bar graph represents the output, this is the FRM's actual position feedback. The bar graph is scaled for 0 – 100%, 0% representing Low Fire and 100% representing High Fire.

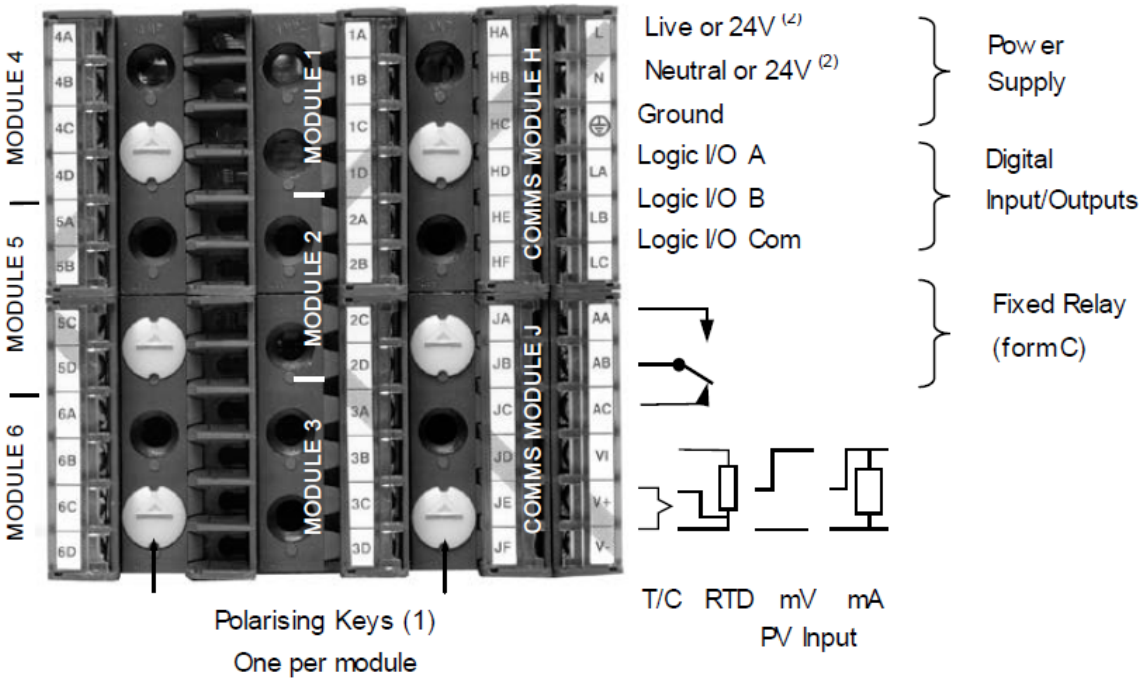
Each controller also has an output (ALM 1) to indicate a high temperature warning via lamps on the panel door and another output (ALM 2) to shut the burner down if the secondary limit temperature is exceeded.

The 3504 controllers have a universal input setup for Type-J thermocouple to read the material or stack temperature.

The 3504 controllers use a Position-Proportional PID algorithm to control the FRM. This is done with a Dual Triac output module (*in SLOT 1*) and a Potentiometer input module (*in SLOT 3*).

There is a Dual Form-A Relay output module (*in SLOT* 2) with one relay used for the high temperature warning lamp that is energized when the ALM 1 setpoint is exceeded.

There is a Form-C Changeover Relay output (AB-AC) used for the Temperature Interlock circuit, this shuts the burner down if the ALM 2 setpoint is exceeded.



The PROG and the RUN/HOLD buttons on the controllers are unused with the ACS-100, the other buttons function as shown below.

PAGE **SCROLL** **LOWER** **RAISE**

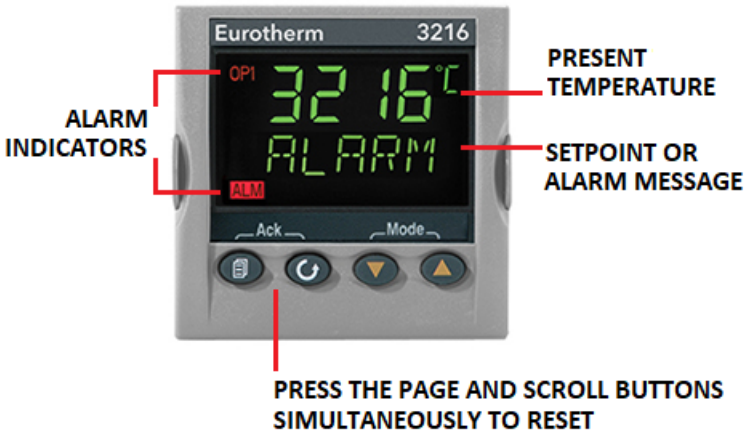
The **PAGE** button is used to move between the pages (screens/menus), the **SCROLL** button is used to scroll through the parameters within each page. These buttons only scroll in one direction however, if you press and hold the page or scroll button then press the **RAISE** button the page or scroll will go in the other direction. This is convenient when you do not want to scroll through the entire page/parameter list to get back to a page/parameter that was passed.

The **A/MAN** button is used to switch between the manual and automatic modulation modes.

2.3 HIGH STACK TEMPERATURE LIMIT

The High Stack Temperature Limit (HSTL) is a Eurotherm 3216i controller. The HSTL is a FM type limit control, it is responsible for monitoring the dryer exhaust outlet temperature (stack) and shutting the burner off if the stack temperature breaches the setpoint.

If this occurs the HSTL will lockout and the red "**HIGH STACK ALARM**" indicator lamp (251PL) will illuminate which will require operator intervention to acknowledge the alarm and reset the HSTL to permit burner operation.



The button layout is the same as the temperature controllers. The setpoint can be adjusted with the RAISE and LOWER buttons. The setpoint can be locked so it cannot be adjusted without a passcode if preferred.

3. INITIAL PANEL CHECKOUT AND SETUP

!!! Before applying power to the panel, perform a general static circuit analysis of the control system !!!

Check for ground continuity between the control panel and the burner chassis, short-circuit potentials, limit chain function and any other static (unpowered) checkout that can be done.

Check to ensure the available power supply meets the requirements of the panel (120VAC/60HZ, protected, with a good ground).

Check to ensure all field wiring is correct, cleanly installed and terminated in the proper location.

3.1 LIVE CHECKOUT

When power is applied the "CONTROL POWER" switch will need to be turned to the "ON" position to energize the control circuit. After this is done the panel lamps and displays should begin to illuminate and show data.

The temperature controllers will go through a booting process and the burner flame safety controller will go through an INITIATE period whenever power is reapplied, this usually takes about 10 seconds to complete.

Check for voltage potential at the panel ground, there should be <1V of potential between the panel ground lug/terminals and the neutral (L2/N) terminal **1002**.

Ensure that proper control voltages are present at each power supply fuse; there are four (4) fuses…

100FB is a 10A CC class fuse for protecting the control circuit; there should be 120 VAC between terminals 1001 and 1002. Also, 120 VAC between 1001 and the panel ground should be observed.

201FB and **223FB** are 1A glass fuses for protecting the process temperature controllers. If one controller experiences a failure that causes the fuse to blow, the other controller should remain online and ready for use. There should be 120 VAC between terminal 1002 and the bottom terminal of these fuse blocks (*wires 2010 and 2230 respectively*).

268FB is a 3A glass fuse for protecting the fire rate control motor. There should be 120 VAC between terminal 1002 and terminal 2680.

If a controller enters a fault state or a lockout state some investigation will need to be done to correct the issue. Try to reset the control that is issuing the fault/alarm, if the fault remains then the issue should be resolved before continuing with the commissioning.

Check to ensure that power is only measured at expected terminals; investigate any anomalies.

3.2 CONTROL MOTOR FEEDBACK CALIBRATION

To ensure proper operation of the burner Fire Rate Control Motor the feedback potentiometer's zero and span should be calibrated within the Material and Stack Temperature Controllers. This is done to ensure that 0-100% of the control motor's stroke will equally match with both controller's analog output from 0-100% and will be correctly represented on the horizontal bar graph and numeric readout for manual control.

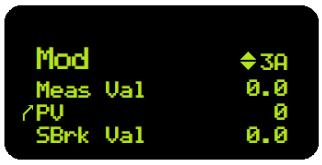
The following procedure should be used for calibrating the feedback, this will need to be done for BOTH of the temperature controllers.

1. Access Level 3 by pressing and holding the **PAGE** button down until the "ACCESS" page is visible.
2. Use the **RAISE/LOWER** buttons to change to access (Level 3), wait for the display to change to "PASSCODE"

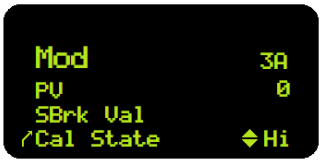
3. Use the **RAISE/LOWER** buttons to set the passcode to (30), wait for a few seconds; you are now in Level 3.

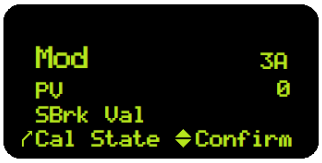
4. Press the **PAGE** button a few times until the "MOD" page is visible.
5. Use the arrow buttons to change to (3A).

6. Press the **SCROLL** button a few times until the "PV" parameter is visible.

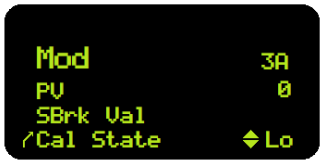


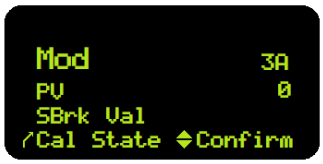
7. Start the burner to enter the purge phase and wait until the control motor is at the fully open position (the PV and Meas Value should raise and stabilize).
8. When the control motor is fully open press and release the **SCROLL** button until the "CAL STATE" parameter is visible
9. Use the **RAISE/LOWER** buttons to change the "CAL STATE" parameter to (HI) then, (CONFIRM) then, (GO).





10. The controller will state “BUSY”, wait until the display states “PASSED”, then change the parameter to (ACCEPT).
11. Shut burner off.
12. Use the **SCROLL** button to view the “PV” parameter again.
13. A soon as the control motor is at the fully closed position (PV and MEAS VALUE will be stable again) use the **SCROLL** button to go back to the “CAL STATE” parameter.
14. Use the **RAISE/LOWER** buttons to change the parameter to (LO) then, (CONFIRM) then, (GO).





15. The controller will state “BUSY”, wait until the display states “PASSED”, then change the parameter to (ACCEPT).
16. Press and hold the **PAGE** button until the “ACCESS” page is visible, change the parameter to (Level 1), wait…no passcode is required, the control is now back in Level 1.

3.3 TEMPERATURE WARNING AND CUT-OUT SETPOINT ADJUSTMENT

Adjustment of the setpoints for the High Temperature Warning and High Temperature Cut-Out functions of the Material and Stack Temperature Controllers is made from the “ALARM SETTINGS” page.

This page can be accessed in the main operator level (Level 1) by pressing the **PAGE** button until the “ALARM SETTINGS” page is visible.

Use the **SCROLL** button to change between the ALM1 and ALM2 setpoints and use the **RAISE/LOWER** buttons to adjust the setting.

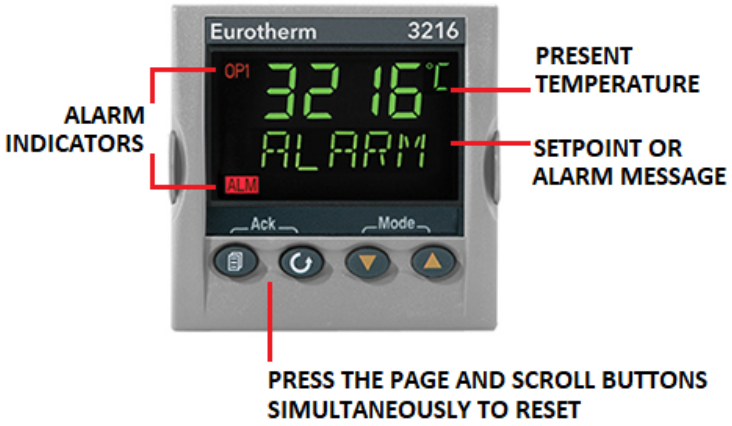
The ALM1 setpoint (Warning SP) represents the temperature at which the Temperature Warning lamp will illuminate if exceeded.

The ALM2 setpoint (Cut-Out SP) represents the temperature at which the burner will shut down if exceeded.

These alarms generated by the temperature controllers are non-latching and will reset automatically after the temperatures drop 10 degrees below the relative alarm’s setpoint. The burner will NOT refire automatically if the High Temperature Cut-Out setpoint is exceeded, the burner will need to be restarted to fire again.

3.4 HIGH TEMPERATURE LIMIT SETPOINT ADJUSTMENT

The High Stack Temperature Limit setpoint is adjusted at the High Stack Temperature Limit controller (247HL).



The **Page** button is used to move through the available Menu Pages. The available Menu Pages vary depending on the access level that is currently enabled.

The **Scroll** button is used to 'scroll' within the Menu Pages, in order to view and select configuration parameters.

Use the 'Up' and 'Down' buttons to adjust the parameter values.

To acknowledge and, reset an alarm state, press the **Page** and **Scroll** buttons together, simultaneously.

To change the HSTL setpoint you only need to use the **RAISE/LOWER** buttons from the main operation page to change the setpoint.

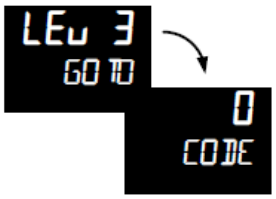
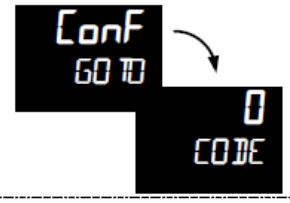
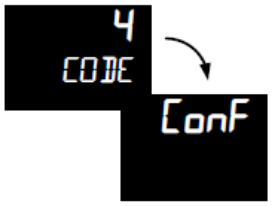
Often, the operator needs to adjust this between some material/batch types…such as cold material batches that have AC or other additives that have low flash points in which the operator may want the burner to shutdown at 240-250 deg F, for example. However, hot material batches may need this limit adjusted and set much higher.

The primary function for the HSTL is to protect the components of the drier and the exhaust system, such as baghouse filters/bags, draft fans/motor, and the ducting itself. Remember that there are independent High Temperature Cut-Out functions in the Material and Stack Temperature Controllers, these functions in the temperature controllers should be used for adjustable, preventative warnings and limits.

The ACS-100 comes setup by the factory to allow the HSTL setpoint to be viewed and adjustable from the HOME page.

For installations where this setpoint will not need to be changed the setpoint adjustment can be restricted to parameter levels that require a passcode to prevent accidental or unauthorized changes to the setpoint.

To block the setpoint from being made in operator Level 1 the Configuration Level (**Conf**) will need to be accessed. Access is similar to the Material and Stack Temperature Controllers…follow these procedures.

Do This	The Display You Should See	Additional Notes
1. From any display press and hold ⓟ for more than 5 seconds	To Select Level 3 	The display will pass from the current operating level, for example, LEu 1 to LEu 3 as the button is held down. (If no button is then pressed for about 50 seconds the display returns to the HOME display)
2. Press ⓤ or ⓓ to enter the passcode for Level 3		The default code is 3: If an incorrect code is entered the display reverts to 'GO TO'. If a correct code is entered the indicator is now in the level 3 will then revert to the HOME display
3. When the LEU3 GO TO view is shown, as in paragraph 1 above, press ⓤ to select 'ConF'	To Select Configuration level 	Note: ⓤ must be pressed quickly before the indicator requests the code for level 3
4. Press ⓤ or ⓓ to enter the passcode for Configuration level		The default code is 4: If an incorrect code is entered the display reverts to 'GO TO'. If a correct code is entered the indicator is now in Configuration level will now show ConF

Once in the Configuration Level use the **PAGE** button to move to the "**ACCESS**" page, from here use the **SCROLL** button to scroll down to the "**HOME**" parameter setting.

HOME	HOME DISPLAY	To configure the parameters to be displayed in the HOME display	PU	Process Value - top display Blank lower display	Std	Conf
			ALm	First configured alarm - top Blank lower display		
		Default Setting: Allows viewing and adjustment of the setpoint in Level 1.	PUAL	PV - top display First configured alarm in lower section		
		Alternate Setting: Allows viewing only of the setpoint in Level 1.	PAro	PV - top display First configured alarm read only in lower section		

Set the "**HOME**" parameter to "**P.A.r.o**" if the setpoint is to be <u>viewable and not adjustable</u> on the main operator Level 1 "HOME" page.

Return to Level 1 by pressing and holding the **PAGE** button until the "**GOTO**" page appears then use the **RAISE/LOWER** buttons to change the parameter to Level 1…no access code is required to return to Level 1.

When the setpoint is blocked from adjustment in Level 1, the setpoint can be adjusted in parameter Level 2, 3 or the Configuration Level. Unique passcodes can be assigned for access levels 2, 3 and Configuration in the **Conf > ACCESS** parameter page. Record these passcodes if they are changed, there is no *back door* access to bypass these changes if they are forgotten!

When in Level 2 use the **PAGE** button to move to the "**A1.HI**" parameter, from here the HSTL setpoint (A1.HI) can be adjusted.

Remember to change back to Level 1 after making any adjustments.

If the HSTL setpoint is exceeded the burner will shutdown and the HSTL will lockout, requiring reset before the burner can be restarted. If the HSTL is tripped and locked out the red ALM indicator on the display will be flashing and there will be an alarm message that scrolls across the lower display.

If the alarm is acknowledged by pressing the **PAGE and SCROLL** buttons simultaneously and the temperature is still higher than the hysteresis setting (A1.HYS) then the red ALM indicator will remain illuminated constantly until the temperature drops below the A1.HYS setting; this is default set for 10 deg F below the A1.HI setpoint.

4. BASIC OPERATIONS

The control panel power is applied by placing the "**CONTROL POWER**" switch in the "ON" position (this is component 100SS in the wiring diagram). The "CONTROL POWER" lamp (102PL) will illuminate indicating that the control circuit is energized, and all of the controller displays should come online.

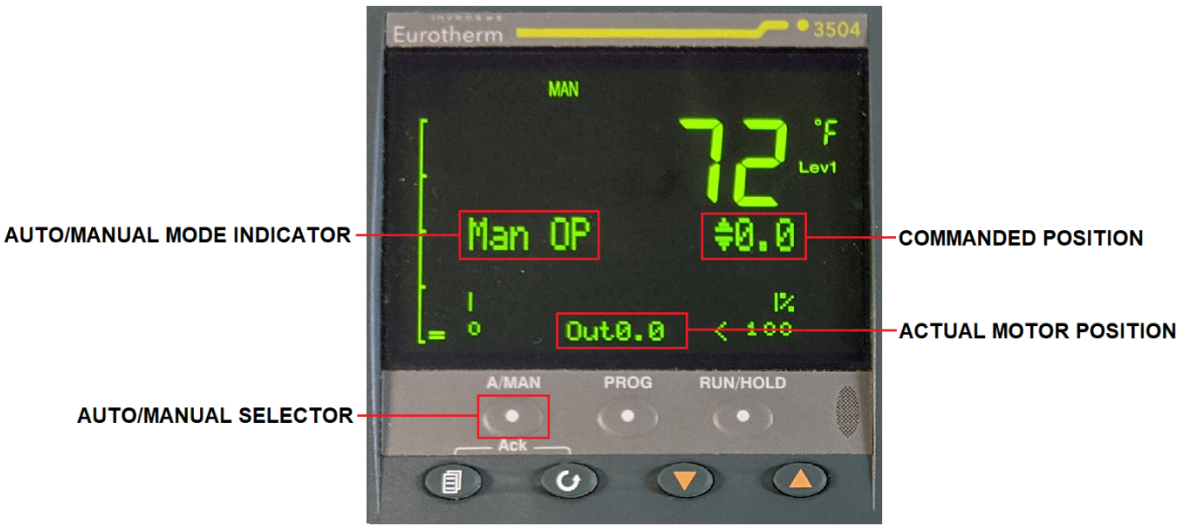
The fuel needs to be selected by placing the "**FUEL SELECT**" switch (104SS) in the position of the fuel you are choosing to run on. There is a 5 second delay between the fuel selection and the control system changeover. If the FUEL SELECT switch is in the "OFF" position the burner will not fire since neither of the fuel selection circuits will be energized.

4.1 BURNER STARTING, STOPPING AND BASIC FAULTS

If all of the safety limits and the selected fuel train limits are closed, then the "**LIMITS SATISFIED**" indicator lamp (145PL) will illuminate, this will not occur until after the 5 second fuel select delay expires.

If the LIMITS SATISFIED lamp is not illuminated check all of the safety limits and the selected fuel train limits to find which component is not satisfied. This includes all of the air flow proving limits therefore, the draft fan and the burner combustion fan will need to be running for the limit circuit to be satisfied.

Select which temperature controller you want to run on with the "**CONTROL MODE**" switch (113SS). On a cold start the STACK TEMP CONTROLLER (223TC) is often used. The temperature controllers are generally started in the 'Manual' mode with the 'Output' set at 0% or at a percentage that is known to be a good startup/warming setting.



If, at any time, the FSG locks out the red "**BURNER ALARM**" indicator lamp (178PL) will illuminate, and the Alarm Buzzer (173HORN) will sound. The audible alarm (buzzer) can be silenced by pressing the black "**ALARM SILENCE**" button (176PB). The FSG can be reset by pressing the red "**ALARM RESET**" button (156PB).

The idle state of the FSG is the "**STANDBY**" phase, if any installed Fuel Valve PROOF OF CLOSURE switch (302PC-*n*) is open during STANDBY or, any phase in which the Main Fuel Valves are NOT energized the FSG will lockout and enter the FAULT state issuing a "**FAULT 10: PREIGNITION INTERLOCK**" message.

With the safety limits satisfied the burner may be started by pressing the green "**BURNER START**" button (140PB-2). The burner controller (FSG, 148FS) will enter the "**PURGE HOLD: T19 (HIGH FIRE SW)**" phase. During this phase the Firing Rate Control Motor (FRM, 268CM) will drive the linkage to the full open (High Fire) position.

If the FSG display states "**PURGE DELAY: T19 (HIGH FIRE SW JUMPERED)**" this indicated that the Purge Position Switch was already closed, or jumped, therefore the FSG will add 30 seconds to the purge timing. If there is no jumper around the Purge Position Switch, then the switch needs to be checked for proper adjustment.

Once the LOUVER BOX PURGE POSITION switch is closed (305LS) the FSG will enter the "**PURGE**" phase. The purge timing is dependent on the size of the drier and the exhaust ducting. If the purge position switch does not close the FSG display will continue to state, "PURGE HOLD: T19 (HIGH FIRE SW)" and after a couple of minutes the FSG will lockout and enter the FAULT state issuing a "**FAULT 14: HIGH FIRE SW**" message. If this occurs the purge position switch needs to be checked for proper adjustment or the FRM needs to be verified to have moved the linkage to the purge position.

After the PURGE timer has expired the FSG will enter the "**PURGE HOLD: T18 (LOW FIRE SW)**" phase. During this phase the FRM will drive the linkage back down to the ignition position (Low Fire). If all installed Low Fire Position switches (308LS-*n*) are already closed, or jumped, the display will state "**PURGE DELAY: T18 (LOW FIRE SW)**" and the FSG will add another 30 seconds to the purge time.

Once all of the installed LOW FIRE POSITION switches are closed the burner will begin the "**PILOT IGN**" period (Pilot Trial For Ignition, PTFI) and the "**IGNITION ON**" lamp (148PL) will illuminate. During this phase the Ignition Transformer (180XFMR) and the Pilot Safety Shutoff Valve(s) (152SOV) are energized.

5 seconds after the PTFI period begins the Ignition Transformer is deenergized, this is known as the Pilot Flame Establishing Period (PFEP), this is done to ensure that the pilot is stable without the aid of the spark from the Ignitor.

5 seconds after the Ignition Transformer is deenergized, if a good Flame Signal (1.2 – 5.0 VDC) is not established by the Flame Scanner (184UVS) by the end of the PTFI/PFEP then the FSG will lockout and enter the FAULT state issuing a "**FAULT 28: PILOT FLAME FAIL**" message.

If there is a good Flame Signal established then the FSG will begin the "**MAIN IGN**" period (Main Trial For Ignition, MTFI). During this phase the Pilot SSOV(s) remain energized, the Main Fuel Safety Shutoff Valves are energized (*which ones depend on the selected fuel*) and the "**FUEL ON**" indicator lamp (158PL) is illuminated.

10 seconds after the MTFI period begins the Pilot SSOV(s) and the "IGNITION ON" lamp are deenergized, this is known as the Main Flame Establishing Period (MFEP), this is done to ensure the main flame is stable without the aid of the Pilot. The MFEP continues for 5 seconds after the Pilot SSOV(s) are deenergized.

If the Flame Signal is lost or becomes too low during the MTFI/MFEP the FSG will lockout and enter the FAULT state issuing a "**FAULT 19: MAIN FLAME IGN**" message.

If the Flame Signal remains to be at good levels the FSG will enter the "**RUN**" phase. During this phase the FRM is released to modulate the burner firing rate. If the Flame Signal is lost or becomes too low during the RUN phase the FSG will lockout and enter the FAULT state issuing a "**FAULT 17: MAIN FLAME FAIL**" message.

If any of the safety limits or selected fuel train limits open or, if the red "**BURNER STOP**" button (140PB-1) is pressed during the burner operation the "LIMITS SATISFIED" lamp will deenergize and the FSG will shut down and enter the "**POST PURGE**" phase which lasts 15 seconds. During this phase the FRM will drive the linkage back down to the Low Fire/Ignition position. The "BURNER START" button will have to be pressed to start the burner again.

4.2 TEMPERATURE CONTROLLER BASIC OPERATIONS

If operating the burner firing rate in the Manual Control Mode from one of the Temperature Controllers and you want to switch over to Manual Control Mode on the other Temperature Controller make sure that you pre-adjust the commanded output to match the current selected controllers commanded output BEFORE making the transfer, this will ensure that the burner firing rate remains in the same position.

After the transfer has been made with the "CONTROL MODE" selector switch you can now adjust the commanded output position from the newly selected Temperature Controller.

FOR EXAMPLE: if you are preheating with the Stack Temperature Controller and the manually commanded output is set for 30%, it is possible that the Material Temperature Controller is not set at this same value…it may not even be placed in the Manual Control Mode. Therefore, ensure that the Material Temperature Controller is placed in the Manual Control Mode and use the RAISE/LOWER buttons to set the manually commanded output to 30%. Now you can place the "CONTROL MODE" selector switch in the "MATERIAL" position, the burner will not change firing rate.

IMPORTANT: the actual motor position that is indicated on the Temperature Controller displays will only be actively updated on the currently selected Temperature Controller; the controller that is not selected will show 0% until the transfer is made. After the transfer is made the actual position of the motor will be indicated on the newly selected Temperature Controller.

If the Temperature Controllers are in the Automatic Control mode and a transfer is made from one Temperature Controller to the other there may be some movement of the firing rate. This is due to the controllers having separate setpoints, temperature sensing locations and separate PID parameters that justify the positioning of the Firing Rate Control Motor.

It is always best practice to make transfers in the Manual Control Modes or, during stable operation of the dryer such that the temperatures of the Stack and the Material are fairly stable if making the transfer in Automatic Control Mode.

4.3 OPERATOR LEVEL 1 PAGES

In the operator Level 1 there are 4 pages (screens) that are available for viewing and adjusting the controllers.

These pages include the Main Loop Summary Page, the Alarm Settings Page, the Actuator and Setpoint Data Page and the Contact Information Page.

Pressing the **PAGE** button will change between these 4 pages, if you are on the last page (Contact Information) a press of the PAGE button will return you to the first page (Mail Loop Summary).

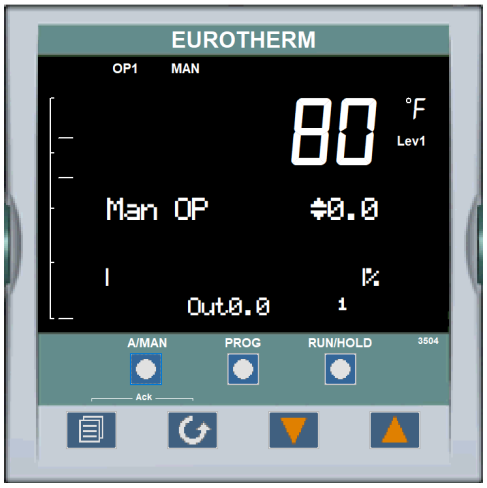
In all pages the vertical bar graph is visible, this is the graph that represents the current temperature relative to the Temperature Setpoint, the Temperature Warning Setpoint and the Temperature Cut-Out Setpoint.

The Main Loop Summary Page allows the operator to view the current temperature and the current position of the Firing Rate Control Motor.

If the controller is in the Manual Control Mode, the operator can adjust the manually commanded output with the **RAISE** and **LOWER** buttons.

LOOP SUMMARY PAGE

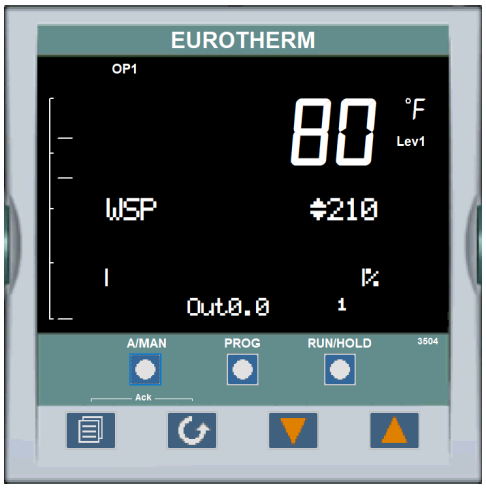
MANUAL MODE



Pressing the **A/MAN** button will change between the Manual Control mode and the Automatic Control mode. In the Automatic Control mode, the temperature Setpoint (Working Setpoint, WSP) is adjustable with the **RAISE** and **LOWER** buttons.

LOOP SUMMARY PAGE

AUTOMATIC MODE

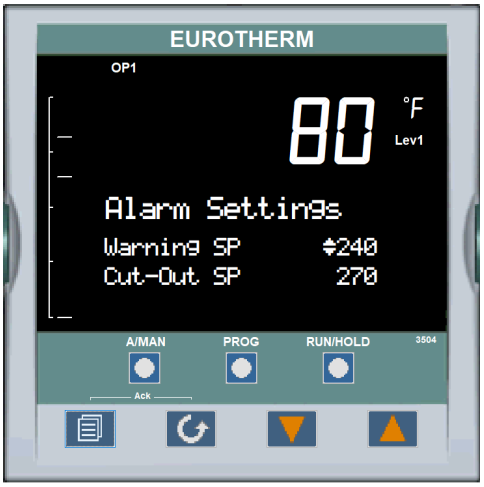


The next page in the Operator Level 1 is the Alarm Settings page, from here the setpoint for the Temperature Warning setpoint that initiates the temperature warning lamps can be adjusted.

The Cut-Off setpoint can also be adjusted from this same screen.

Pressing the **SCROLL** button will change between the Warning Setpoint and the Cut-Off Setpoint adjustment.

ALARM SETTINGS PAGE

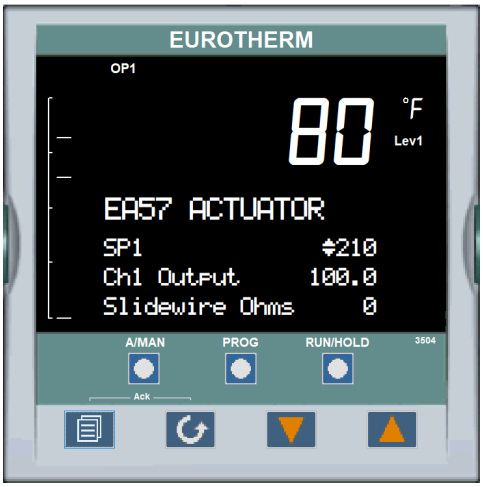


The next page in the Operator Level 1 is the Actuator and Setpoint Date page. This page will display the current temperature setpoint and allows adjustment of the setpoint when in the Manual Control Mode or the Automatic Control Mode.

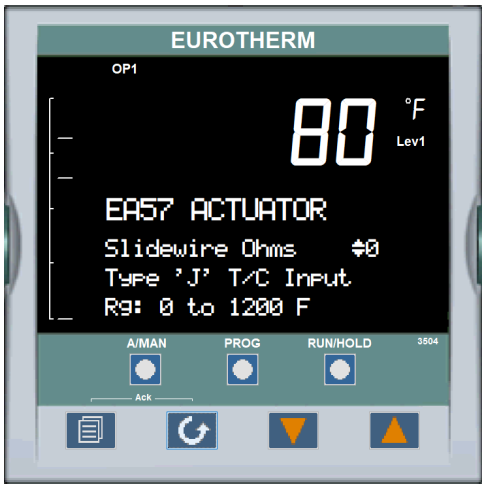
This is useful when wanting to preadjust the temperature setpoint before transferring from manual to automatic control modes.

This page also displays the current firing rate control motor output and the control motor slidewire feedback in OHMS. This is helpful with motor position calibration and troubleshooting.

ACTUATOR DATA/SP PAGE

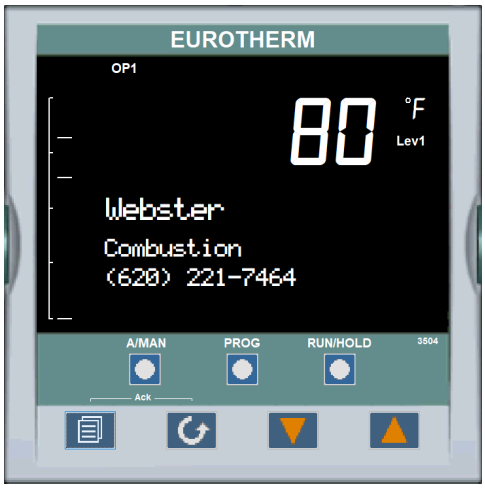


Pressing the **SCROLL** button will reveal the Input Type selection and the Input Range, this information is viewable only.



The next page in the Operator Level 1 is the Contact Information page, this page displays the Webster Combustion Technology, LLC phone number to use for technical help.

CONTACT INFO PAGE



5. CONTROLLER OUTPUT TUNING

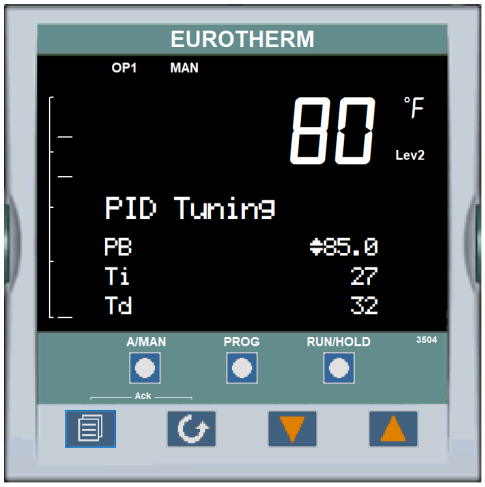
The Eurotherm 3504 temperature controllers utilize PID algorithms (Proportional, Integral, Derivative) to determine the automatic control output relative to the difference between the setpoint (**SP**) and the current temperature (**PV**), known as the error signal (**ERR**).

These parameters are available in the Operator Level 2. Level 2 is accessed by pressing and holding the **PAGE** button until the ACCESS page appears. Use the **RAISE/LOWER** buttons to select Level (2) and set the Passcode to (2) when prompted.

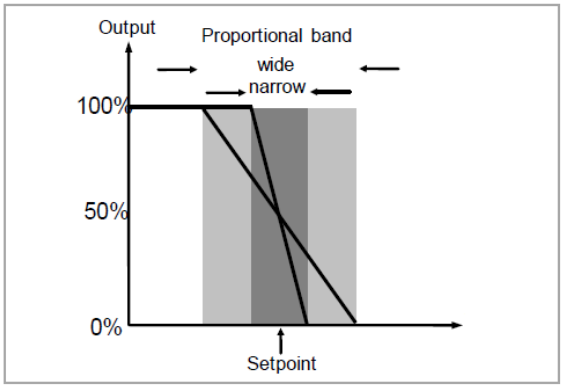
5.1 PID TUNING BASICS

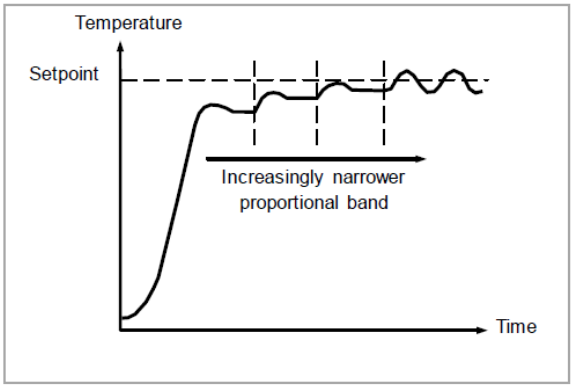
In Operator Level 2 there is an extra page available that allows for adjustment of the PID parameters, the parameters that are available for adjustment are the Proportional Band, Integral Term, Derivative Term, Manual Reset, Cutback High, Cutback Low and the High Output Limit.

Pressing the **SCROLL** button will allow you to view and adjust all of the relevant parameters. The image below shows the first 3 available parameters in this page, these are **PB** (Proportional Band), **Ti** (Integral Term) and **Td** (Derivative Term).



The **PROPORTIONAL BAND** (PB) delivers an output which is proportional to the size of the error signal. It is the range over which the output power is continuously adjustable in a linear fashion from 0% to 100%. Below the Proportional Band the output is full on (100%), above the proportional band the output is full off (0%).

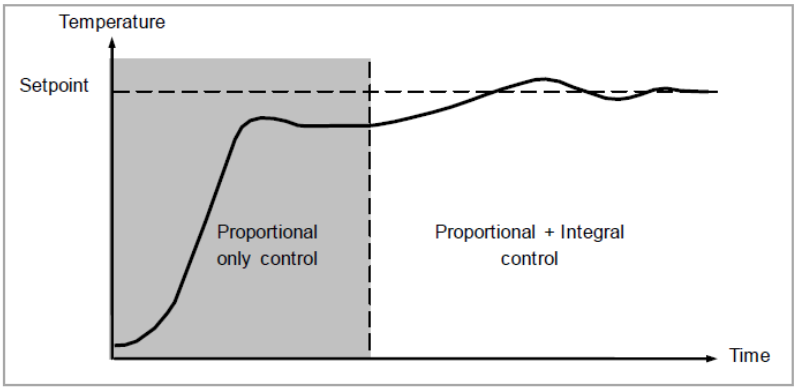




The width of the proportional band determines the magnitude of the response to the error. If it too narrow (high gain) the system oscillates by being over responsive. If it is too wide (low gain) the control is sluggish. The ideal situation is when the proportional band is as narrow as possible without causing oscillation.

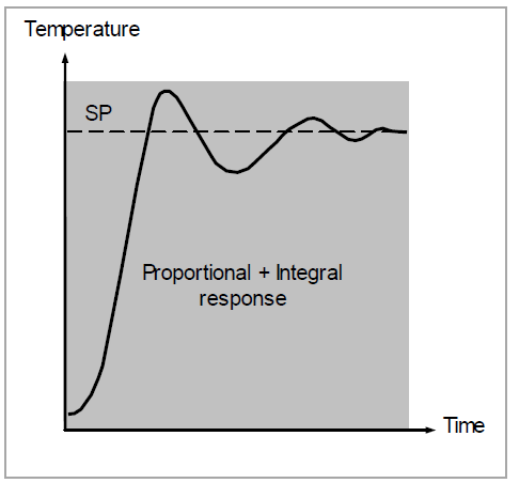
The **INTEGRAL TERM** (Ti) slowly shifts the output level as a result of an error between setpoint and measured value. If the measured value is below setpoint the integral action gradually increases the output in an attempt to correct the error. If it is above setpoint integral action gradually decreases the output or increases the cooling power to correct the error.

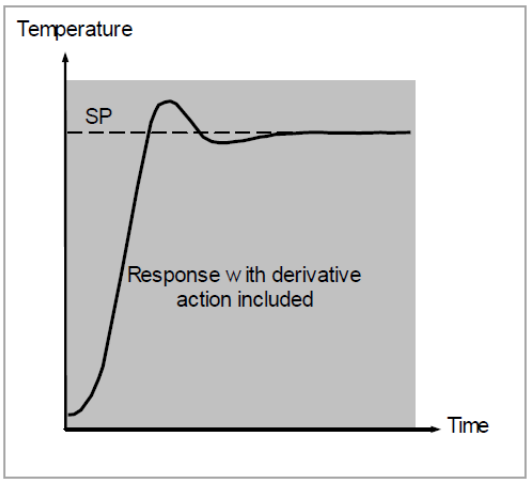
In a proportional only controller, an error between setpoint and Process Variable (PV = Temperature) must exist for the controller to deliver power. Integral is used to achieve zero steady state control error.



The **DERIVATIVE** TERM (Td) provides a sudden shift in output as a result of a rapid change in error, if the measured value falls quickly derivative provides a large change in output in an attempt to correct the perturbation before it goes too far. It is most beneficial in recovering from small perturbations.

The Derivative Term modifies the output to reduce the rate of change of error. It reacts to changes in the PV by changing the output to remove the transient. Increasing the derivative time will reduce the settling time of the loop after a transient change.

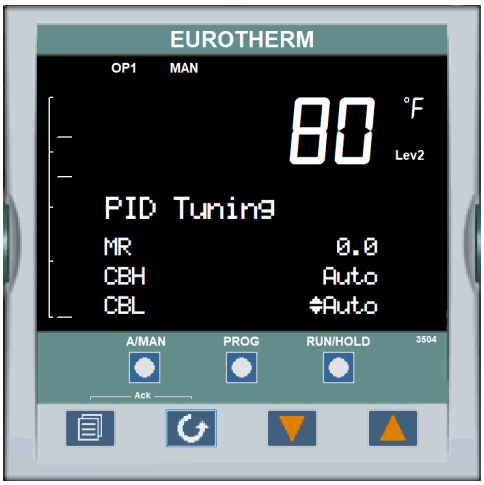




Derivative is often mistakenly associated with overshoot inhibition rather than transient response. In fact, derivative should not be used to curb overshoot on start up since this will inevitably degrade the steady state performance of the system. Overshoot inhibition is best left to the approach control parameters, High and Low Cutback.

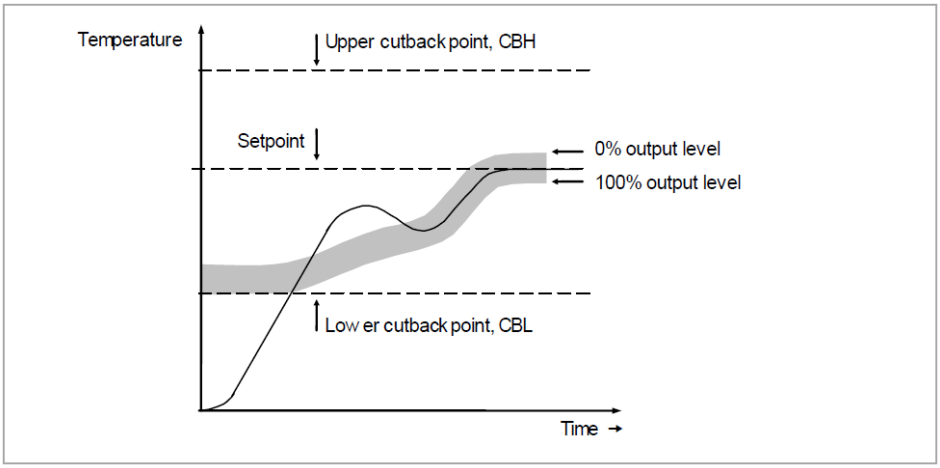
Derivative is generally used to increase the stability of the loop, however, there are situations where derivative may be the cause of instability. For example, if the PV is noisy, then derivative can amplify that noise and cause excessive output changes, in these situations it is often better to disable the derivative and re-tune the loop.

The image below shows the next 3 parameters that are available in this page, these are **MR** (Manual Reset), **CBH** (Cutback High) and **CBL** (Cutback Low).



MANUAL RESET (MR): In a full three-term controller (that is, a PID controller), the integral term automatically removes the steady state error from the setpoint. If the controller is set as a PD controller, the integral term will be set to 'OFF'. Under these conditions the measured value may not settle precisely at setpoint. The Manual Reset parameter represents the value of the power output that will be delivered when the error is zero. You must set this value manually in order to remove the steady state error.

CUTBACK HIGH (CBH) and **CUTBACK LOW** (CBL) are values that modify the amount of overshoot, or undershoot, that occurs during large step changes in PV (*for example, under start-up conditions*). They are independent of the PID terms which means that the PID terms can be set for optimal steady state response and the cutback parameters used to modify any overshoot which may be present.



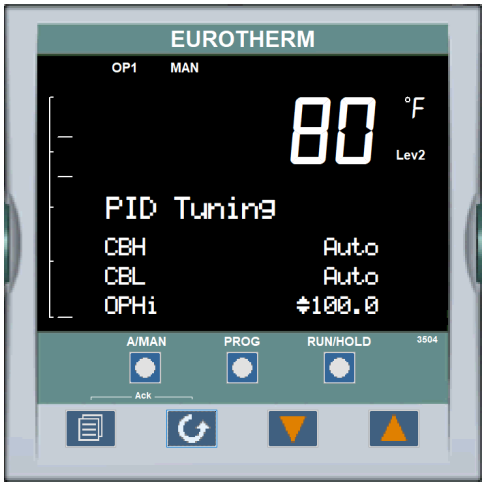
Cutback involves moving the proportional band towards the cutback point nearest the measured value whenever the latter is outside the proportional band and the power is saturated (at 0% or 100%). The proportional band moves downscale to the lower cutback point and waits for the measured value to enter it. It then escorts the measured value with full PID control to the setpoint. In some cases, it can cause a 'dip' in the measured value as it approaches setpoint as shown in the following figure, but generally decreases the time to needed to bring the process into operation.

The action described above is reversed for falling temperature.

If cutback is set to (Auto) the cutback values are automatically configured to 3*PB.

The image below shows the last parameter that is available in this page, **OPHi** (Output High Limit).

OUTPUT HIGH LIMIT (OPHi) is the maximum allowable control output when in the Automatic Control Mode. This parameter can be used to prevent the burner from positioning the Fire Rate Control Motor any higher than the position set at this parameter.



5.2 PID AUTOTUNE FUNCTION

The Material and Stack Temperature Controllers have the capability to perform an Auto Tuning process that can be utilized to help set the initial PID parameters. The autotune function requires some presetting of the PID parameters to allow for a proper tuning process.

The autotune process will also require the dryer system to be operating at close to nominal conditions to simulate actual loading conditions. The feed rate of the product does not need to be at the maximum rate of the dryer however, the closer to nominal conditions that you can simulate will generate better initial parameter settings.

Often, this is difficult to accomplish, and some fine tuning may need to be done to better optimize the operation of the Automatic Control Mode after the autotune has been performed. Also, if there is a wide operating temperature range due to different types of material or finished products it is possible that one set of PID parameters does not work as well at both ends of the operating range.

This is common with dryer systems that produce different products such as Cold Material batches and Hot Material batches or, dryers that use differing virgin materials for different end products.

In these cases, it may be necessary to have two (or more) different PID sets and therefore, the need to perform controller tuning in different operating conditions.

The ACS-100 is capable of having multiple PID sets programmed into the memory and be selectable manually or automatically based on the temperature setpoint.

BEFORE beginning any autotune process the Integral and the Derivative terms need to be set to any value other than (0). If a parameter, such as the Derivative Term, is set to (0) the autotune will ignore this parameter. If the Cutback parameters are set to (AUTO) then the autotune will not configure these parameters and they will be set to the standard (3*PB)…generally this is acceptable for the CBH and CBL parameters.

To access the Autotune parameters and to start the Autotune process you must be in Operator Level 3. Press and hold the PAGE button until the ACCESS page appears, change the level to (3) and enter the passcode (30) when prompted.

The controller must be in the Automatic Control Mode for the Autotune process to function.

Once in Level 3 use the PAGE button to scroll to the LP1 page then, use the **RAISE** and **LOWER** buttons to change the LP1 sub-menu to **TUNE**.

Next, the output limits for the autotune process will need to be set. These are referred to as **HIGH OUTPUT** and **LOW OUTPUT** in the TUNE parameter list.

The image below shows the relative parameter within he TUNE sub-menu list.

Enable	To start auto-tune	Off	Auto-tune not running. If Off is selected during a tune, tuning will stop.	Off	L3
		On	Auto-tune running		
High Output Low Output	Set high and low limits to be imposed when auto-tune is running	Between Output Hi and Output Lo overall limits set in the OP block. Max and Min limits -100% to 100%.			L3
State	Reads the progress of auto-tune.	Off	Not running	Off	L3 R/O
		Ready			
		Running	In progress		
		Complete	Auto-tune completed successfully		
		Timeout	Error conditions, see section 21.6.13.		
		TI_Limit			
		R2G_Limit			
Stage	Progress of auto-tune	Settling	Displayed during the first minute	Off	L3 R/O
		To SP	Heat (or cool) output on		
		Wait min	Power output off		
		Wait max	Power output on		
		Timeout	See section 21.6.13		
		TI Limit			
		R2G Limit			
Stage Time	Time in current tune stage	0 to 99999 seconds			L3 R/O
Diagnostic	Tuning diagnostics	This parameter is for internal use only			L3

***This is a chart used from the Eurotherm 3504 manual, sections referred to here are in the 3504 manual.

Before starting the Autotune process the burner should be running and the material input should be at the rate you want to perform the Autotune.

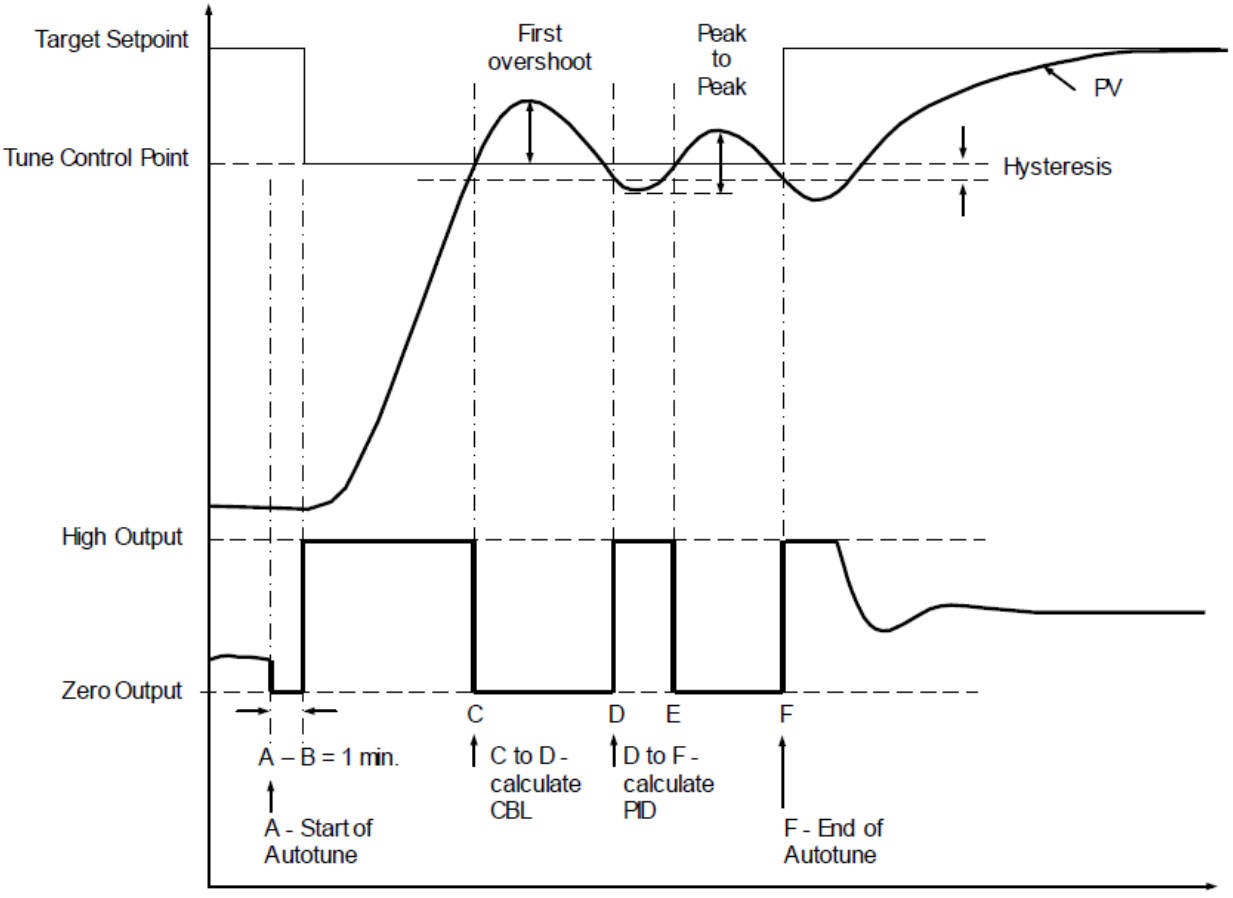
The **Tune Control Setpoint** (temperature) of the Autotune is automatically generated with the following calculation…

TUNE SP = INITIAL PV + 0.75(TARGET SP – INITIAL PV)

The **INITAIL PV** is the temperature that is recorded 1 minute after the Autotune is started, this one minute period is with the control output at 0%. Therefore, if the dryer has a long lag time in the temperature reaction, which is dependent on the temperature controller you are tuning (*generally much longer with the Material Temp than the Stack Temp*), then it is best to set the Target SP (Target SP = Working Setpoint, WSP) to your general operating SP you are tuning for and run the burner in manual mode at around 10 deg F lower in temperature, wait for the temperature to remain fairly stable here and then change to Automatic Control Mode at the moment you want to start the Autotune.

FOR EXAMPLE: you have a plant that generally runs material at 300 F at a rate of 200-250 TPH. Feed the material in at 200 TPH with the burner running in the Manual Control Mode until the temperature is fairly stable at 290 F. At this point change the control mode to Automatic and then start the Autotune process.

To start the Autotune process, set the ENABLE parameter within the LP1 > TUNE sub-menu to (ON), the Autotune will now begin to operate as shown below.



Once the Autotune process is completed the controller will operate in the Automatic control mode at the currently selected Target SP.

If there is an error that occurs that renders the Autotune unsuccessful this will be shown in the STATE parameter of the TUNE sub-menu.

TIMEOUT: The current tune stage took longer than 1 hour to complete.

Ti_LIMT: The Integral Term that has been calculated is higher than the maximum allowable setting of 99999 seconds. This occurs if the tune is taking too long due to excess reaction time or no control response from the Fire Rate Control Motor.

After the Autotune is completed, return to Operator Level 2, and do any fine tuning from there.

This process may need to be done at different operating conditions in BOTH temperature controllers to finalize an optimum commissioning of the ACS-100.

Once all tuning and parameter settings are completed, return the both temperature controllers and the High Stack limit controller to Operator Level 1.

WEBSTER COMBUSTION TECHNOLOGY LLC.
STANDARD TERMS AND CONDITIONS

EXCLUSION OF OTHER TERMS

This constitutes an offer on behalf of Webster Combustion Technology LLC. (the Company) to sell the goods described in the quotation/acknowledgment (the Equipment) exclusively on the terms and conditions stated in the body of the quotation/acknowledgment and in these Standard Terms and Conditions. Acceptance of this proposal by the buyer (the Buyer) is hereby limited to these Terms and Conditions, whether stated in the Buyer's purchase order form or elsewhere shall be applicable to the transaction unless specifically agreed to in a separately written and signed letter by an officer of the Company at its headquarters in Winfield, Kansas, USA.

LIMITATIONS ON QUOTATION

Unless otherwise stated in the quotation, the quotation will remain open for acceptance for a period of thirty days after the date hereof, at which time it will automatically expire unless extended by a signed, written letter issued by the Company from its headquarters in Winfield, Kansas, USA.

EQUIPMENT SELECTION

The selection of sizes, types, capacities, and specifications of Equipment purchased by the Buyer's specific application shall be the sole responsibility of the Buyer and/or the Buyer's representative or consultant.

PRICES

Unless otherwise stated in the quotation/acknowledgment, prices are F.O.B. Winfield, Kansas, USA, exclusive of freight, storage, installation, and local delivery charges, if any.

TAXES

In addition to the purchase price, Buyer shall be liable for all government taxes and/or charges in respect to the purchase and/or sale contemplated herein or hereunder (except taxes on or measured by net income on the Company) including those which the Company may be required to pay.

Buyer agrees to pay, indemnify, and hold harmless the Company for and against all liabilities, expenses, and damages in respect of any claim, action, or suit, proceeding, assessment, demand, and/or judgment arising in any manner from Buyer's failure or refusal to pay any government taxes and/or charges that are the responsibility of Buyer (whether pursuant to these Standard Terms and Conditions or otherwise).

Buyer further agrees that the Company may, in good faith, compromise and settle any claim, action, suit, proceeding, assessment, and/or demand upon the Company on account or by reason or refusal of Buyer to pay any government taxes and/or charges that are the responsibility of Buyer (whether pursuant to these Standard Terms and Conditions or otherwise).

PAYMENT

Unless otherwise stated in the quotation/acknowledgment, Buyer shall pay the full purchase price within thirty-days after the date of shipment as evidenced by the Company's invoice. Beginning thirty-days after the date of shipment, Buyer shall pay a late payment charge equal to the lesser of (a) One and One-half (1.5%) percent per month, which is an annual rate of eighteen (18%) percent and (b) the maximum amount allowable under applicable law, on any unpaid portion of the purchase price.

DELINQUENT ACCOUNT COLLECTION EXPENSES

In the event that Buyer fails to timely make any or all payments due to the Company, and in the event the Company incurs any expenses arising from the collection of Buyer's delinquent account, Buyer hereby agrees to pay, in addition to all other fees and charges, any collection expenses incurred by the Company. Collection expenses shall include the Company's fees for independent collections agencies, reasonable attorney's fees, costs of court, and other charges directly related to the collection of Buyer's account.

RETENTION OF TITLE; SECURITY INTEREST

The Company shall retain title to the Equipment, any replacements thereof, and any additions thereto, for purpose of security and title shall not pass to Buyer until the purchase price of all sums due under any order resulting from this quotation are fully paid. Buyer shall execute a financing statement (if requested by the Company) and other documents necessary to enable the Company to perfect its security interest in the Equipment. When Buyer has made all the payments called for herein including taxes and has fully complied with the other provisions of this quotation/acknowledgment, the Company shall immediately deliver to the buyer appropriate document evidencing the transfer of title and terminating the security interest.

SERVICE

Where the Company has agreed to provide a factory trained technician, the technician will assist the Buyer in the initial start-up of Equipment and the initial instruction of the Buyer's employees in the operation of the Equipment, and such services shall be supplied Monday through Friday, legal holidays excepted, 8 a.m. through 5 p.m. inclusive. Starting and/or field service shall not be supplied by the Company on days or at times other than those provided herein unless the Company agrees to do so in writing on Buyer's request, in which case the Buyer shall pay the Company the applicable overtime rate for the services. The Company shall not be responsible for any delays in start-up due to Buyer's failure to have Equipment completely installed and ready for operation, and provided with fuel, power, exhaust, vent, and other necessary connections, or failure to provide Seller with sufficient advance notice to meet Buyer's schedule. Buyer agrees to pay the Company for any added expenses it incurs as a result of Buyer's failure to have Equipment ready for start-up. Prices which include starting service of multi-unit installations are based upon this service being completed in a single service call. Return trips to start Equipment which was not ready during the initial trip shall be invoiced to the Buyer at the current rate.

SHIPMENT

Any shipping date shown in the body of the quotation/acknowledgment represents the Company's reasonable estimate as the date hereof, and is not binding. The Company shall not incur any liability of any kind for failure to ship on any particular date unless a firm shipping date has been expressly agreed to by an officer of the Company in a separately signed written letter. Risk of all loss passes to Buyer when the Equipment is placed in possession of a common carrier. Claims against the carrier shall be the responsibility of the Buyer. Claims against the Company for patent defects, errors, or shortages must be made in writing to the Company within thirty days of receipt of the Equipment or such claims shall be deemed to have been waived.

CANCELLATION AND DELAYS

Subsequent to the date an order from Buyer has been acknowledged by the Company, Buyer may not change or cancel the order in whole or part, without the Company's written approval. When equipment has not yet become work in progress, the Company may condition its approval or a change upon a price change to reflect the Company's prevailing prices at the time of such change. If Buyer requests a delay in shipment after the Equipment has become work in progress, the Company may place the Equipment in storage at Buyer's risk and expense, and transfer to storage shall be deemed delivery for all purposes, including invoicing and payments. Cancellations approved by the Company may be conditioned on Buyer's payment of cost incurred by the Company prior to such approval, including engineering,testing, material, labor, burden, profit, and commission and similar expense in connection with the order cancelled.

WARRANTY MATTERS AND EXCLUSION OF IMPLIED WARRANTIES

The following warranty applies: All Products manufactured by the Company are warranted to be free from defects in material and workmanship under normal use and service for a period of eighteen months from the date of shipment or twelve months from the date of start-up; whichever should occur first. Products which are purchased by the Company and resold without further processing by the Company are not covered by the Company's warranty. The Company shall pass to the Buyer whatever warranty the Company receives on such products. The Company will repair or replace, at its option, its products which prove to be defective within the warranty period, F.O.B. the factory. The Company's warranty shall be voided by any abuse, misuse, or neglect of the products by use not in accordance with the Company's published instructions. The remedies for any failureof the Company's product to meet warranty specified herein shall be those remedies herein and no others; these remedies being exclusive remedies as a condition of sale irrespective of the theory upon which any claim might be based, including negligence, breach of contract or strict liability. **IN ALL EVENTS, THE COMPANY WILL NOT BE LIABLE FOR AND WILL NOT REIMBURSE ANY LABOR, MATERIAL, OR OTHER REPAIR CHARGES INCURRED BY ANYONE OTHER THAN THE COMPANY ON ANY WARRANTY EQUIPMENT, UNLESS SUCH CHARGES HAVE BEEN SPECIFICALLY AUTHORIZED IN ADVANCE IN WRITING, BY THE COMPANY. THIS PARAGRAPH CONTAINS THE COMPANY'S SOLE WARRANTY.THE COMPANY MAKES NO IMPLIED WARRANTY, AND THERE IS NO IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.**

DAMAGE LIMITATION

Under no circumstances shall the Company be liable for any loss of profits, down time, or any incidental, consequential, special, punitive, exemplary, enhanced, or indirect damages of any kind with respect to its products or the transaction by which its products are sold. **IN NO EVENT SHALL THE COMPANY'S AGGREGATE LIABILITY ARISING OUT OF OR RELATED TO THE EQUIPMENT OR THE TRANSACTION BY WHICH THE EQUIPMENT IS SOLD, WHETHER ARISING OUT OF OR RELATED TO BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE), OR OTHERWISE, EXCEED THE TOTAL OF THE AMOUNTS PAID TO THE COMPANY WITH RESPECT TO SUCH EQUIPMENT.**

EXCUSE

In no event shall the Company be liable for any loss or damage resulting from any delay or failure in shipment or other failure, loss or damage that is the proximate result of any act of government authority, revolution, riot, civil disorder or disturbance, act of enemies, delay or default in transportation, inability to obtain materials or facilities from normal sources of fire, flood, act of God, or any cause not within the reasonable control of the Company, whether of the class of causes enumerated or otherwise. Without limiting the generality of the foregoing, the Company may, without causing a breach or incurring liability, allocate goods which are in short supply irrespective of the reasons therefore among customers in any manner which the Company in its sole discretion deems advisable. If an event occurs that is beyond the control of the Company's performance and causes its cost of production to increase because of the delay, the Company may pass such increase on to the Buyer.

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