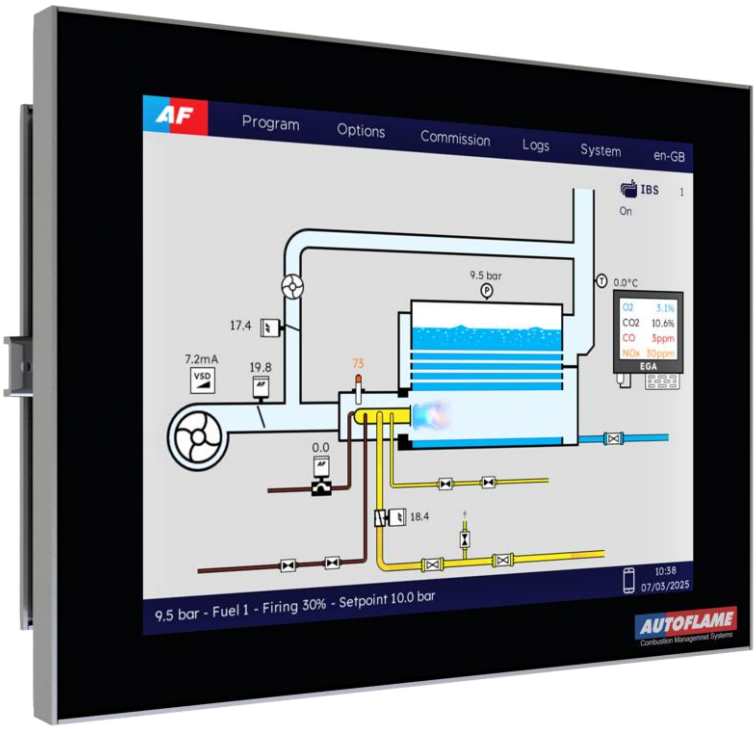
AUTOFLAME®



MINI MK9 MM
MANUAL
MMM9002

28.01.2026

Combustion Management Systems

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MINI MK9 MM MANUAL
MMM9002

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Autoflame Engineering Ltd.'s policy is one of continuous improvement in both design and manufacture. We therefore reserve the right to amend specifications and/or data without prior notice. All details contained in this manual are correct at the time of going to print.

Important Notes

A knowledge of combustion related procedures and commissioning is essential before embarking work on any of the MM / EGA. systems. This is for safety reasons and effective use of the MM / EGA system. Hands on training is required. For details on schedules and fees relating to group training courses and individual instruction, please contact the Autoflame Engineering Ltd. offices at the address listed herein.

Short Form - General Terms And Conditions

A full statement of our business terms and conditions are printed on the reverse of all invoices. A copy of these can be issued upon application, if requested in writing.

The System equipment and control concepts referred to in this Manual MUST be installed, commissioned and applied by personnel skilled in the various technical disciplines that are inherent to the Autoflame product range, i.e. combustion, electrical and control.

The sale of Autoflame's systems and equipment referred to in this Manual assume that the dealer, purchaser and installer has the necessary skills at his disposal. i.e. A high degree of combustion engineering experience, and a thorough understanding of the local electrical codes of practice concerning boilers, burners and their ancillary systems and equipment.

Autoflame's Warranty From Point Of Sale

- Two years on all electronic and electro-mechanical equipment, assemblies and components.
- One year on all EGA systems and UV & IR scanners, including parts, components, cells and sensors.

The warranty assumes that all equipment supplied will be used for the purpose that it was intended and in strict compliance with our technical recommendations.

Autoflame's warranty and guarantee is limited strictly to product build quality, and design. Excluded absolutely are any claims arising from misapplication, incorrect installation and/or incorrect commissioning.

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2 IMPORTANT SAFETY NOTES



Please fully read and understand the following notes before commencing with any work related to the Mini Mk9 MM. Failing to do so can result in serious or even fatal injury, and can cause permanent equipment failure and substantial property damage.

Installation, commissioning, burner start-up and changing option settings must only be carried out by an Autoflame trained and certified technician with thorough understanding of the Autoflame combustion control systems and boiler/combustion control in general. Any person carrying out this work without undergoing the necessary training and gaining an understanding of the boiler plant may place themselves and others in a potentially dangerous situation or cause permanent equipment failure.

Any person working on a boiler plant must be adequately trained and have a thorough understanding and appreciation of the boiler plant.

It is the responsibility of the commissioning technician to ensure that the system operation meets all local codes and regulations.

Electrical connections are live, make sure to fully and safely isolate the mains power before carrying out any work related to the wiring connections, failure to do so can result in serious or even fatal injury.

Modification to the Autoflame system settings should only ever be carried out by a qualified combustion engineer. Changes to the Autoflame control system setup has the potential to make the controller operate in an unstable and potentially unsafe manner.

If you are unclear about anything related to the Autoflame system, please contact Autoflame for advice.

3 MINI MK9 MM OVERVIEW, SPECIFICATIONS AND WIRING

3.1 Mini Mk9 MM Overview

The Mini Mk9 is a Micro-Modulating system that provides an easily programmable and flexible means of optimising combustion throughout the load requirement range of the boiler/burner.

This control module encompasses all the functions required for reliable burner management as follows:.

- A fully automated flame safeguard and valve proving system.
- An accurate and repeatable fuel-air ratio control system.
- An interface to gas, air and temperature sensors for boiler monitoring.
- An interface to an exhaust gas analyser for emissions monitoring and combustion trimming.
- An interface to multiple flame scanners for combustion monitoring.
- A burner commissioning procedure.
- Run times and setpoint programs to control firing rates and times.
- An intelligent boiler sequencing (IBS) function to provide efficient load control over multiple linked boilers.
- Comprehensive system, lockout, errors, alarms and warnings logs to track performance.
- A capacitive multi-touchscreen interface.
- BT/WiFi & Ethernet connectivity.
- MODBUS/BACnet interface for connection to a Building Management System (BMS).
- A modern graphical and menu driven interface for ease of setup and control.
- Settings and log data upload/download and software upgrade via a connected App.

This system ensures the burner temperature is accurate to within 1°C/F and pressure to within 1 PSI. The positioning accuracy of the direct drive motors controlling the air dampers and fuel valve is 0.1° throughout the load range. This accuracy ensures repeatable fuel-to-air ratio that leads to improved fuel economy and a reduced carbon footprint.

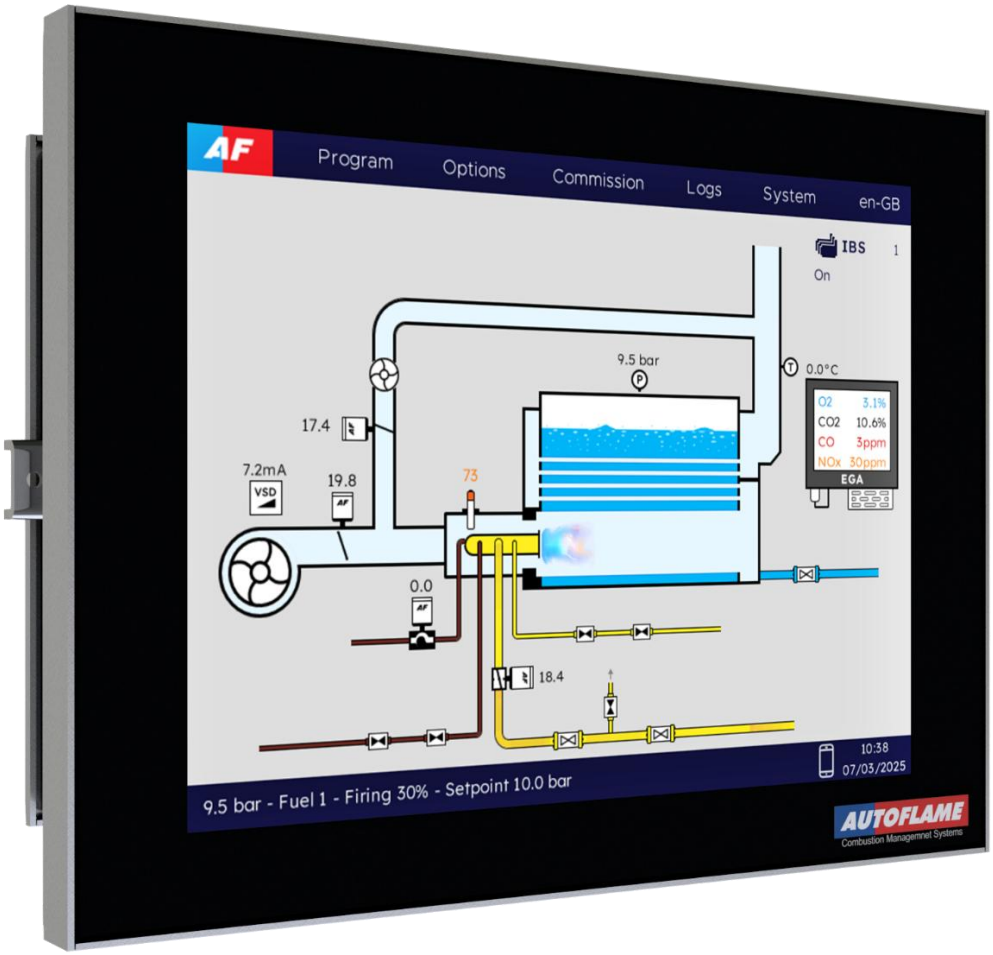


Figure 1 - Mini Mk9 MM

3.1.1 Mini Mk9 MM Main Features

The Mini Mk9 MM features include the following:

- Fuel-Air ratio control.
- Full colour multi-touch screen.
- 120V or 230V standard operation 50/60Hz.
- Controls up to 3 servomotors, 1 variable speed drive (VSD/VFD) and 1 PWM drive (fan).
- Operation with no servos (VSD only).
- 2 independent fuel programmes with per fuel settings.
- Fully adjustable PID load control for temperature or pressure.
- Internal flame safeguard – full flame supervision with UV, self-check UV, solid-state UV, IR, ionisation & flame switch.
- Gas valve train leak supervision and high/low gas pressure monitoring.
- Air pressure proving and monitoring.
- System log, lockouts, errors, alarms and warnings stored with date, time, phase and reset.
- Single point change function for adding, removing and adjusting fuel-air positions on the commission curve.
- User definable optimum ignition position – golden start.
- User definable flue gas recirculation start position.
- Variable servomotor travel speed.
- Adjustable burner control safety times.
- External voltage load control.
- Outside temperature compensation of boiler setpoint.
- 2 user definable run times programs with On/Reduced/Off setpoint control.
- Multiple User definable setpoint programs for fine control of the setpoint for process applications.
- Hand/Auto/Low Flame Hold from soft switch or via programmable FAR input.
- 3 programmable Burner Control inputs. 1 programmable FAR input.
- Change-On-The-Fly (COF) functionality (in software update).
- PWM Fan control.
- Various boiler load detectors available.
- Fuel flow metering capability – instantaneous and totalised.
- Direct Modbus/BACnet communications to a BMS system including remote setpoint and firing rate adjustment, enable/disable.
- Password protection of all safety related functions.
- BT/WiFi connection for upload/download of commissioning data to a PC/Tablet/Phone using Mk9 Download manager App.
- Software update over wireless connection from PC/Tablet/Phone using Mk9 Download manager App.
- System will sequence hot water boilers or steam boilers via lead/lag distribution.
- Fully adjustable user options within the system to tailor sequencing operation to the application.
- System control for isolation of valves or pumps (2 port valve operation).
- Standby setpoint and warming for lag boilers via a standby pressure and timing sequence aqua-stat.
- Direct connection of an O2 sensor allowing single parameter trim.
- QR code for registration of unit.

The following features also available when used with a Mk8 DTI:

- Modbus communications from MM include remote setpoint, firing rate adjustment and enable/disable.
- DTI will collect operational data for up to 10 MM modules, 10 EGAs, and 10 Universal I/O modules on one site.
- Information transmitted via RS422 or Ethernet link to a local PC/network for running Autoflame DTI Manager Software.

The following features also available when used with a Mk8 EGA EVO:

- 3 Parameter Trim of O_2, CO_2, and CO.
- Trim using servo channel or VSD/PWM channel.
- Analysis of O_2, CO_2, CO, NO, exhaust gas temperature, efficiency and delta temperature.
- Optional analysis of NO_2 and SO_2.
- Local display for re-calibration, changing cells, user configuration and stand-alone operation.
- Upper/lower/absolute limits for O_2, CO_2, CO, NO and exhaust temperature.
- Six 4-20mA output signals for interface with other controls/chart recorders.

The following features is available when used with a UV Trim Scanner:

- Near-instantaneous trim directly off the flame signal.

Note UV Trim requires connection of an EGA or O2 module to provide feedback checking of the trim level.

3.1.2 Overview Of Micro-Modulation (MM)

To ensure maximum efficiency and reliability of the boiler plant operation, two requirements are of paramount importance:

- **The Fuel to Air Ratio** must be carefully controlled to ensure complete combustion within the limitations of the combustion head design, whilst maintaining some excess air for safe combustion. A large amount of excess air decreases the overall efficiency of the boiler. The fuel valve and air damper positions set this optimum fuel to air ratio along the whole commission curve and must be infinitely repeatable with an incredibly high degree of accuracy to maintain optimum efficiency.

- **The Target Temperature or Pressure** of the boiler should be monitored by the combustion system at all times, with exactly the right amount of fuel and air fired to achieve this target value. The burner/boiler system should be able to meet the target temperature or pressure irrespective of load changes.

The burner's fuel to air ratio was traditionally governed by mechanical systems involving multiple cams, shafts and linkages controlled by one motor. An inherent hysteresis in this system design caused components to become loose, making it impossible to achieve the required level of accuracy. With poor accuracy, the burner would run inefficiently and the system would regularly overshoot or fall short of the target temperature/pressure.

The Micro-Modulation module is the basic building block of the Autoflame System. The Autoflame MM module provides an easily programmable and flexible means of optimising combustion quality throughout the load range of the burner/boiler unit whilst ensuring the temperature is accurate to within 1°C (1°F) and pressure to within 1 PSI (0.1Bar). Using direct drive motors to individually control the air damper(s) and fuel valve, gives the optimum combustion of the burner at every point along the firing range. The allowed error in angular degrees of rotation between the two servomotors at any position in the load range is 0.1°.

This automated system of burner control can achieve 'locked on' near stoichiometric air to fuel mixing throughout the fuel input range of the boiler while maintaining exact temperature or pressure target values. The load control incorporates user-variable Proportional Integral Derivative control. The PID control is infinitely adjustable to match any boiler room requirements.

3.2 Enclosure Fixing Holes And Dimensions

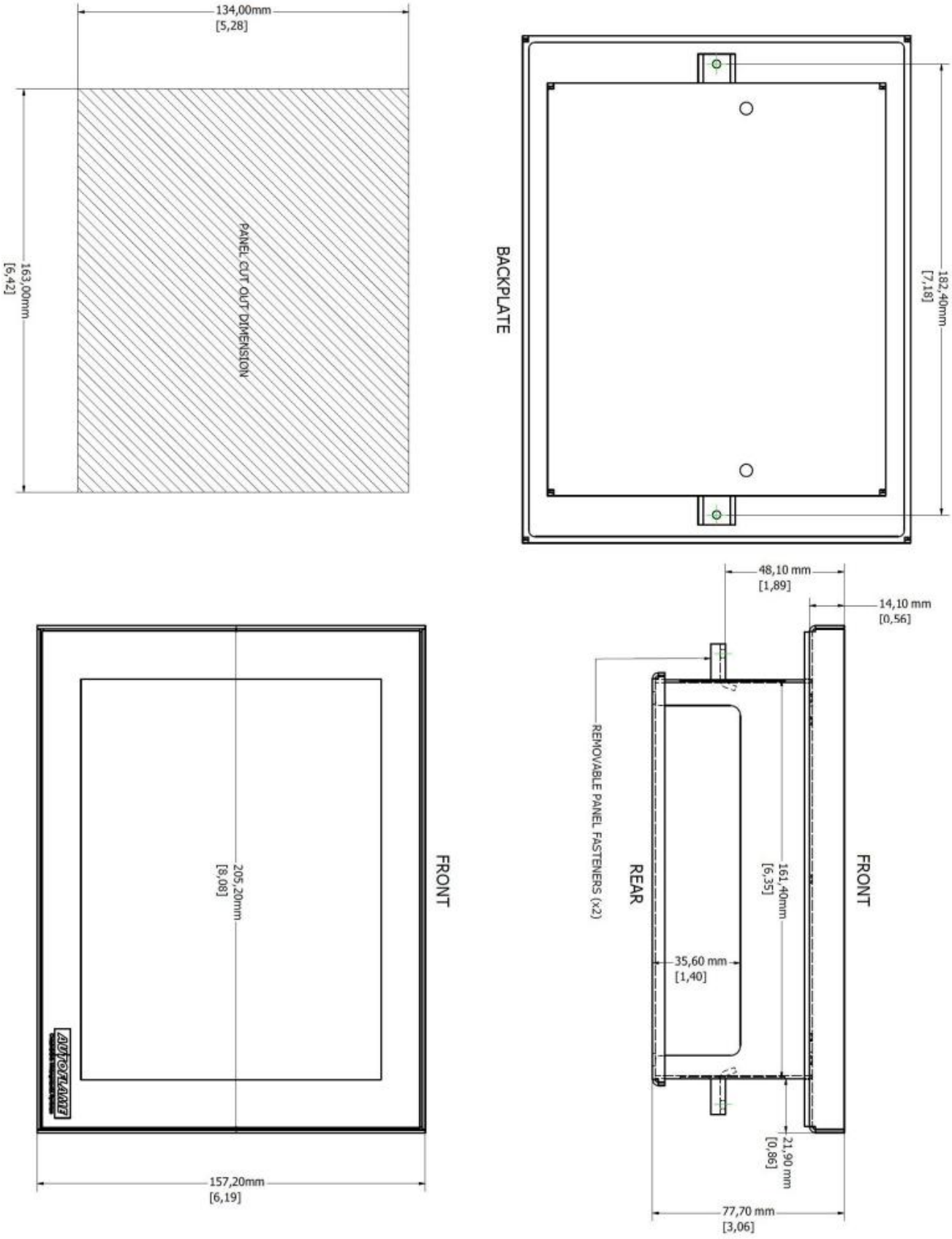


Figure 2 - Mini Mk9 Enclosure Dimensions

To mount the Mini Mk9 in a panel or enclosure, the aperture shall be as defined in the diagram above. The supplied panel mounting bolts shall be used to secure the Mini Mk9 in place.

3.3 Wiring Schematic

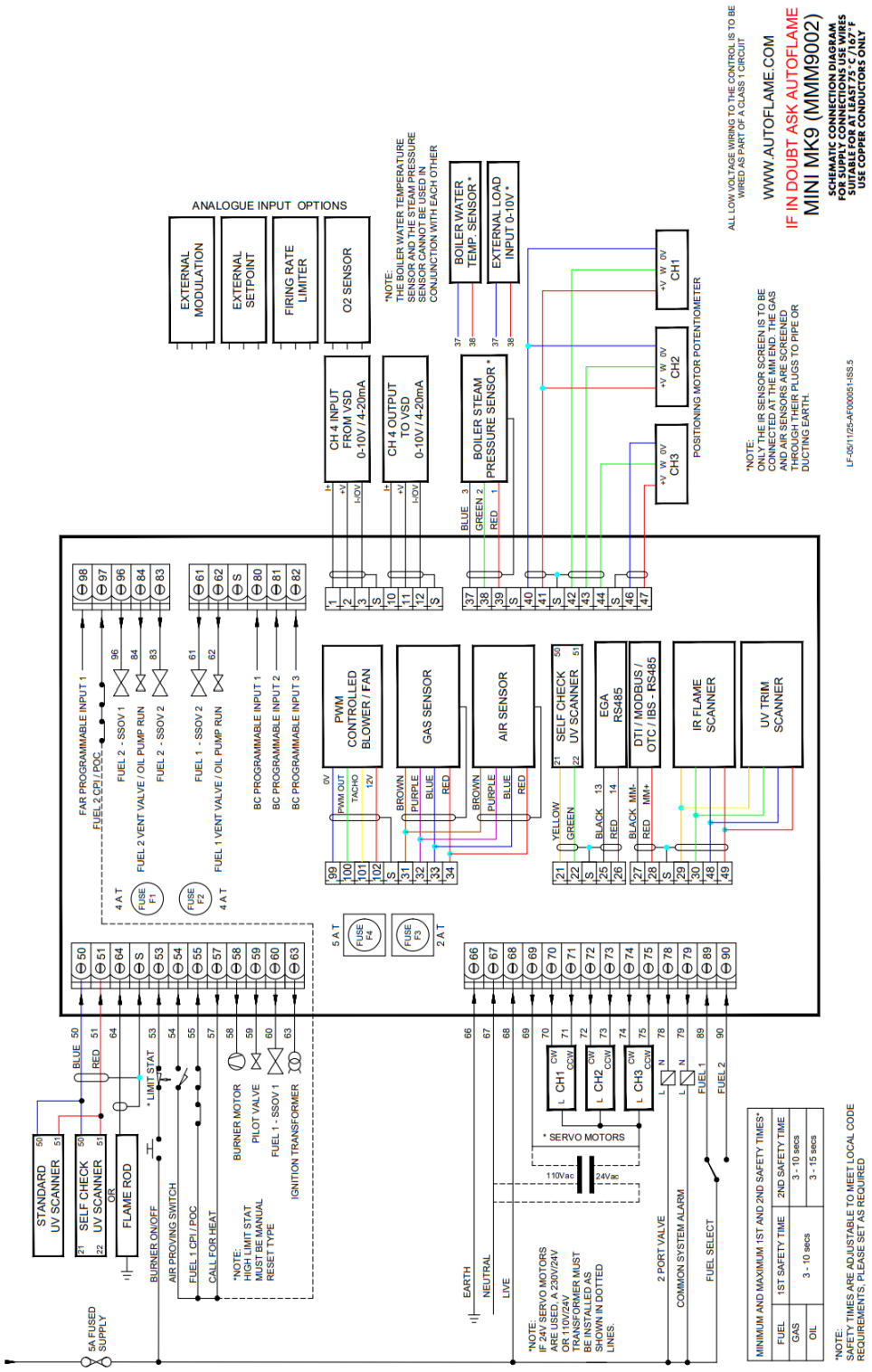


Figure 3 - Mini Mk9 Wiring Schematic

Fuse	Terminals Protected
F1: 4A	Mains voltage outputs group 1: T58; T59; T60; T63; T96
F2: 4A	Mains voltage outputs group 2: T61; T62; T83; T84
F3: 2A	Low voltage terminals and switched neutral outputs
F4: 5A	Mains voltage outputs T57 – T63 plus T83, T84 & T96 Split into 2 banks F1 (4A) & F2 (4A).

4 SAFETY MANUAL

This section defines the operational criteria, usage restrictions, environmental limits, approvals and functional safety data for the Mini Mk9 MM.



Installation, commissioning, burner start-up and changing option settings must only be carried out by an Autoflame trained and certified technician with thorough understanding of the Autoflame combustion control systems and boiler/combustion control in general. Any person carrying out this work without undergoing the necessary training and gaining an understanding of the boiler plant may place themselves and others in a potentially dangerous situation or cause permanent equipment failure.

The process for setting up and commissioning the Mini Mk9 is detailed within this document and must be followed for correct installation.

The commissioning safety instructions defined in sections 7.1 and 7.2 must be fully understood and adhered to.

4.1 Operational Criteria

4.1.1 Environmental Specifications

The Mini Mk9 operation shall be limited to the following environmental conditions:

Climate:	Min. Temperature	0°C (32°F)
	Recommended Temperature	Less than 40°C (104°F)
	Max. Temperature	60°C (140°F)
	Humidity	0 to 90% non-condensing
Storage:	Temperature	-20 to 85°C (-4 to 185°F)
Protection Rating:	The Mini Mk9 itself is rated as NEMA1/IP20. However when mounted in a suitable panel, the front facia has been tested and shown to provide NEMA4/IP55 protection. To meet IP65 the Mini Mk9 enclosure should be sealed to a panel using a silicone sealant applied around the display frame where it meets the panel.	

4.1.2 Electrical Specifications

Classification according to EN298, UL60730:

Mains Supply:	230V, +10%/-15%} 120V, +10%/-15%}	47-63 Hz, unit max. consumption 140W

The Mains Supply should be connected within the panel with a cable length of no more than 3m. The Earth Terminal in particular should be connected to a suitable earth stud in the panel and should present an impedance of no more than 1Ω.

Note: The Mini Mk9 shall be supplied within the panel through a branch fuse rated to 12A maximum.

The Mains Supply input terminals are:

T68: Live T67: Neutral T66: Earth

When first powered on, the Mini Mk9 will show a splash screen with information showing the software version number along the top and the current stage of the startup process along the bottom.

4.1.2.1 Mains Voltage Inputs And Outputs

Table 1 - Terminal Ratings

Outputs Terminal	Rating (230V)	Rating (120V)	Notes
57	250mA	250mA	Must be connected through contactor
58	250mA	250mA	Must be connected through contactor
59	1A	2A	0.6 power factor
60	1A	2A	0.6 power factor
61	1A	2A	0.6 power factor
62	1A	2A	0.6 power factor
63	1A	2A	0.6 power factor
78	100mA	100mA	To drive relay only – switched neutral
79	100mA	100mA	To drive relay/lamp only – switched neutral
83	1A	2A	0.6 power factor
84	1A	2A	0.6 power factor
96	1A	2A	0.6 power factor
Max. load T58 T59 T60 T63 T96	4A	4A	Load limited by fuse F1
Max. Load T61 T62 T83 T84	4A	4A	Load limited by fuse F2
Max. Load	5A	5A	Load Limited across the 2 banks of terminals by fuse F4



Note: CAUTION – ELECTRIC SHOCK HAZARD.

- The high and low voltage connections are not safe to touch. Protection against electric shock is provided by correct installation.
- Control voltage cabling should be maximum 10m, screened (if not screened then less than 1m, however servomotors can be unscreened up to 10m).
- Any cabling over 10m must have additional surge protection.
- Low voltage cables should be screened (shielded) cable as specified in section 4.1.2.2.
- The burner 'High Limit Stat' must be a manual reset type.

The cover (back plate) of the MM must always be re-fitted after the wiring is completed to prevent unauthorised wiring modifications or fuse replacement.

4.1.2.2 Cable Specifications

Low Voltage

The screened cable used for low voltage wiring from the MM to the servomotors, detectors and variable speed drive must conform to the following specification:

U.V. cable length should not exceed 25m; all other screened cable should not exceed 50m.

- 16/0.2mm PVC insulated overall braid, screened, PVC sheathed.
- Sixteen wires per core.
- Diameter of wires in each core 0.2mm.
- Rated at 440V AC rms at 1600Hz.
- DEF 61-12 current rating per core 2.5A.
- Maximum operating temperature 70°C (158°F).
- Nominal conductor area 0.5sq mm per core.
- Nominal insulation radial thickness on core 0.45mm.
- Nominal conductor diameter per core 0.93mm.
- Nominal core resistance at 20°C. 40.1Ω/1000m.
- Nominal overall diameter per core 1.83mm.
- Fill factor of braid screen 0.7.
- Equivalent imperial conductor sizes 14/0.0076.

Use the number of cores suitable for the application. A universal part numbering system has been adopted for this type of cable as follows (5 Core not readily available):

- 16-2-2C 2 Core.
- 16-2-3C 3 Core.
- 16-2-4C 4 Core.
- 16-2-6C 6 Core.
- 16-2-8C 8 Core.

Note: If using 4 Core cable and interference is detected, use 2 sets of 2 Core.

Data Cable

Data cable must be used for communication connections between MMs for sequencing applications as well as between MMs to EGAs, MMs to a DTI and DTI to BMS systems. Alternatively, Mk9 units may be connected together using Ethernet cable. Any units on the same LAN will be able to communicate for sequencing.

Communication cable should not exceed 1km.

Types of data cable that can be used:

- Belden 9501 for 2-core shielded cable (1 twisted pair)
- Belden 9502 for 4-core shielded cable (2 twisted pairs)
- STC OS1P24

Samples are available upon request. Low voltage and data cable can be ordered directly from Autoflame Engineering, please contact Autoflame.

When using a VSD, please review the manufacturer's guidelines on installations to prevent EMC, including the recommendations for reactors and filters.

Note: For the 4-20mA outputs on the Mini Mk8 MM, the maximum voltage drop supported is 12V.

4.1.2.3 Terminals Descriptions

The terminals on the Mini Mk9 are colour coded to help with the wiring and are shown in Figure 4 below.

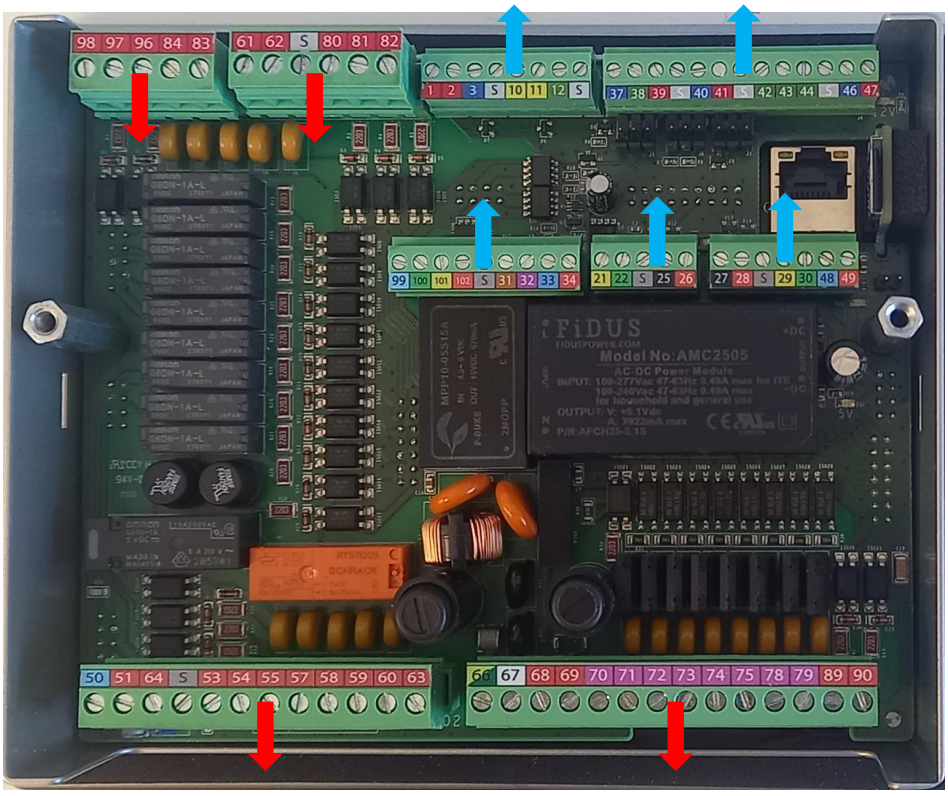


Figure 4 - Colour Coded Connectors and Wiring Directions

Separation between the high voltage (power) and low voltage (data) cabling is recommended and shall be achieved by exiting all High Voltage (red) connections from the base of the Mini Mk9 and the low voltage (blue) connections from the top of the unit as shown in Figure 4.

Table 2 - Terminal Definition

S	All terminals marked S are internally connected to the system earth and provide connections to the various screened cables.
1	Current Input, 0-20mA/ 4-20mA. Can be connected to: the current output of a VSD or tachometer system. a 4-20mA servomotor feedback. a 4-20mA analogue input for external modulation, external setpoint, external firing rate limit, or O2 sensor.
2	Voltage Input, 0-10V. Can be connected to: the voltage output of a VSD or tachometer system. a 0-10V analogue input for external modulation, external setpoint, external firing rate limit, or O2 sensor.
3	0V common for Terminals 1 or 2.
10	Current Output, 0-20mA/ 4-20mA. Can be connected to: the current input of a VSD or tachometer system. a 4-20mA servomotor drive.
11	Voltage Output, 0-10V. Can be connected to: the voltage input of a VSD or tachometer system.
12	0V common for Terminals 10 or 11.
21, 22	Connections to an Autoflame self-check UV sensor self-check motor drive.
25, 26	Communications port connections to an Exhaust Gas Analyser (EGA).
27, 28	Communications port connections for DTI and/or IBS, Modbus or BACnet.
29, 30	Digital communications connections to an Autoflame IR scanner and/or Autoflame UV Trim scanner.
31, 32	Digital Communications to an Autoflame gas and/or air sensor.
33, 34	+15V Supply to an Autoflame gas and/or air sensor.
37	0V supply to an Autoflame or external temperature/pressure detector.
38	Signal input from an Autoflame or external temperature/pressure detector.
39	12V supply to an Autoflame pressure detector.
40	0V supply to channel 1 and channel 2 servomotors.
41	+12V supply to channel 1 and channel 2 servomotors.
42	Signal from channel 1 servomotor, indicating position.
43	Signal from channel 2 servomotor, indicating position.
44	Signal from channel 3 servomotor, indicating position.
46	0V Supply to channel 3 servomotor.
47	+12V Supply to channel 3 servomotor.
48, 49	+15V Supply to an Autoflame IR scanner and/or Autoflame UV trim scanner.
50, 51	Connections to an Autoflame UV sensor.
64	Connections to a flame rod.
53	Mains voltage input – burner on/off signal, running interlock circuit. Note: All external safety devices that require manual reset must be reset external to the Autoflame system and prior to completing the recycling interlock.
54	Mains voltage input – air proving switch.
55	Mains voltage input – fuel 1 proving circuits, e.g. gas valve proof of closure.
57	Mains voltage output – call for heat.
58	Mains voltage output – burner motor.
59	Mains voltage output – start/pilot valve.
60	Mains voltage output – fuel 1 valve 1.
61	Mains voltage output – fuel 1 valve 2.
62	Mains voltage output – fuel 1 vent valve.
63	Mains voltage output – ignition transformer.
66	Mains supply – earth.
67	Main supply – neutral.
68	Mains supply – live/hot.
69	Mains voltage output, power to servomotors and/or stepdown transformer.

70	Switched neutral – drives channel 1 servomotor clockwise.
71	Switched neutral – drives channel 1 servomotor counterclockwise.
72	Switched neutral – drives channel 2 servomotor clockwise.
73	Switched neutral – drives channel 2 servomotor counterclockwise
74	Switched neutral – drives channel 3 servomotor clockwise.
75	Switched neutral – drives channel 3 servomotor counterclockwise.
78	Switched neutral – 2-port valve for IBS operation.
79	Switched neutral – alarm output for MM lockout/MM error/EGA error.
80, **81**, **82**	Burner controller programmable inputs for: Start Position Interlock. Purge Position Interlock. Valve Proving. Delay To Purge. Purge Pressure Proving. Flame Switch. Flame Switch Inverse Input. Night Setback. Reduced Setpoint Select. Lockout Reset. Valve Proving (Secondary Fuel Output).
83	Mains voltage output – fuel 2 valve 2.
84	Mains voltage output – fuel 2 vent valve.
89	Mains voltage input – selects fuel 1 curve.
90	Mains voltage input – selects fuel 2 curve.
96	Mains voltage output – fuel 2 valve 1.
97	Mains voltage input – fuel 2 proving circuits, e.g. gas valve proof of closure.
98	FAR programmable input for: COF Enable. Lead Boiler Select. External Modulation Select. External Firing Rate Limiter Select. External Setpoint Select. Low Flame Hold. Hand Mode. Night Setback. Warming STAT. Manual Purge. Fixed Firing Rate Limit Enable. Reduced Setpoint Select.
99	0V common for PWM Fan control.
100	PWM fan output signal.
101	PWM fan tacho input.
102	12V supply for PWM fan.
Ethernet	Communications port connection for a Mk9 DTI and/or IBS, Modbus or BACnet.

4.2 Approvals

The Mini Mk9 MM has been tested and approved to the following standards:

- BS EN 298:2022.
- BS EN 13611:2019 + A2:2021.
- UL 60730-1, Edition 5.
- CAN/CSA E 60730-1, Edition 5.2.
- IEC 61508-1, Edition 2.
- IEC 61508-2, Edition 2.
- IEC 61508-3, Edition 2.
- AS 4625 – 2008.
- AS 4630 – 2005 (Incorporating Amdt 1).

4.3 FUNCTIONAL SAFETY OPERATION

The Mini Mk9 Controller has been certified by a notified body for **Functional Safety** for the following operations:

- A **Flame Safeguard** device.
- A **Fuel-Air Ratio** controller.



The **Functional Safety** operations assume that the unit is operated in normal operating conditions as defined in section 4.1.

The Mini Mk9 controller has integrated **Flame Safeguard** and **Fuel-Air Ratio** controls. It is intended for use only as described in this manual.

Note: The functional safety assessment does not include the fuel valves. In order to achieve the SIL ratings defined in Table 4 & Table 5 below, then the SIL rating of the Fuel Valves must meet the hardware architectural constraints for SIL 2 at HFT = 0, SFF > 60% and a common cause factor of less than 10%. The valves should be selected such that considering the valves and the Mini Mk9, the combined $\mathrm{PFH}_{\mathrm{system}} \leq 5\times10^{-7}$.

The Mini Mk9 is a Type B device with programmable electronics.

4.3.1 Flame Safeguard Device.

The Mini Mk9 controller contains a built-in **Flame Safeguard** device which monitors the presence/absence of a flame using one or more flame scanners and controls a pair of fuel valves and an ignition transformer. The **Flame Safeguard** runs according to an embedded state machine which defines the status of all the inputs/outputs and ensures that the valves are shut off in the event of a failure such as a loss of flame.

The **Flame Safeguard** carries out the following tasks:

- Checks the relay outputs prior to combustion.
- Carries out valve proving before and/or after combustion to check the integrity of the gas supply line.
- Follows a flame light off sequence to check the flame is established successfully.
- Monitors the presence/absence of the flame at all times, locking out the system if there is either a simulated flame error when no flame should be present, or a loss of flame error when combustion should be taking place.
- Ensures a safe shutdown of the system in the event of any issues, including loss of power or component failure.
- Continually assesses the integrity of the relays driving the valves to ensure they never remain in a stuck position.

4.3.1.1 Safety Function

The **Flame Safeguard** safety function is:



When the flame signal does not match the expected state (i.e. simulated flame when combustion is not expected or no-flame signal when combustion should be in progress), the burner is brought to a safe state and the fuel flow is stopped by de-energizing the fuel valves.

4.3.1.2 Constraints

The Mini Mk9 can operate with single flame scanners or a number of different flame scanners connected in parallel and these can be connected in an AND/OR configuration, where:

- AND: All attached scanners must agree on the status of the flame. Any single scanner not seeing the flame will result in a safety lockout.
- OR: Any single scanner must see the flame for combustion to continue. This is primarily intended for when different scanners are needed to see the pilot and main flames due to constraints in the burner head design.

Operating with a single flame scanner or with two scanners in AND mode, will result in different functional safety levels being achieved. OR mode is not considered for Functional Safety applications.

The Standard or High sensitivity UV scanners may not be used for continuous operation. The controller forces a burner shut down after 24 hours of continuous operation if one of these scanners is selected in order to

validate the operation of the scanner. The MM will recycle, shutting off the burner and restarting automatically and recording a **Stat Off – Continuous Run Time Limit** in the system log. If the burner shuts down for any other reason during the 24 hour period then the continuous operation timer is reset.

The connection of each of the flame scanner types to the Mini Mk9 is defined in section 9.8.

The allowed combinations of flame scanners are as shown in the table below:

Table 3 - Flame Scanner Combinations

Type	UV Scanner	Ionization Rod	IR Scanner	UV Trim Scanner	Flame Switch*
UV Scanner		-	●	●	●
Ionization Rod	-		●	●	●
IR Scanner	●	●		●	●
UV Trim Scanner	●	●	●		●
Flame Switch*	●	●	●	●	

* The Flame Switch input is for flame scanners from other manufacturers.

4.3.1.3 PFH

For the Flame Safeguard function, a dangerous undetected failure would be where the system fails to respond to the loss of a flame by shutting down the fuel valves. The following table defines the average probability of such a failure, and provides the achievable SIL rating with the defined combinations of scanners:

Table 4 - Flame Safeguard SIL Ratings

Flame Scanner(s)	$PFH_{MiniMk9}$	HFT	SIL
UV Pencil Scanner AND IR Pencil Scanner	2.32×10^{-8}	1	SIL3
UV Pencil Scanner AND UV Trim Scanner	2.32×10^{-8}	1	SIL3
UV Self-Check Scanner AND IR Pencil Scanner	1.27×10^{-8}	1	SIL3
UV Self-Check Scanner AND UV Trim Scanner	1.27×10^{-8}	1	SIL3
Flame Rod Ionization AND IR Pencil Scanner	1.15×10^{-8}	1	SIL3
Flame Rod Ionization AND UV Trim Scanner	1.15×10^{-8}	1	SIL3
UV Trim Scanner AND IR Pencil Scanner	1.15×10^{-8}	1	SIL3
UV Pencil Scanner*	1.29×10^{-7}	0	SIL2*
UV Self-Check Scanner	1.29×10^{-7}	0	SIL2
Flame Rod Ionization	1.17×10^{-8}	0	SIL3
IR Pencil Scanner	1.20×10^{-8}	0	SIL3
UV Trim Scanner	1.21×10^{-8}	0	SIL3

* See constraints for UV scanner use.

When multiple scanners are combined using the OR mode, the achievable SIL is that of the lowest rated scanner used for the combination.

The scanner models are:

- UV Scanners: MM60004/*; MM80004/*; MM90004/*.
- UV Self Check Scanners: MM60003/*.
- IR Scanners: MM80017/*; MM90017/*.
- UV Trim Scanner: MM90004/TRIM.

4.3.2 Fuel-Air Ratio Controller

The **Fuel-Air Ratio** is defined by the movement of up to 3 servomotors controlled directly from the FAR microprocessor. The positions of the servomotors are defined during the commissioning process for the complete combustion curve. The controller then drives the servos up and down the commissioned curve during firing to ensure correct combustion.

The servomotors are driven clockwise or counterclockwise by turning on/off a pair of switched neutral connections to the servo's drive motor. The position of the servomotor, and therefore the damper that it is connected to is determined by feedback from a potentiometer connected directly on the drive shaft.

The feedback follows two paths within the controller, one amplified, which must agree on the servo position or else a movement error is generated. The servo's must also get to within a defined error band of their expected angle within a defined time limit or else an error will again be generated.

If an error is generated, the FAR processor instructs the burner control to shut down the system, closing the fuel valves and achieving a safe state. The FAR and BC microprocessors maintain a direct link which must be constantly toggling to confirm that they are both operational. Any failure of the link will also cause a safety lockout of the system.

4.3.2.1 Safety Function

The **Fuel-Air Ratio** safety function is:



When either the fuel or air servo motors feedback angle does not match the expected angle to which it is being driven, the burner is brought to a safe state and the fuel flow is stopped by de-energizing the fuel valves.

4.3.2.2 Constraints

The Mini Mk9 can control Autoflame small, large or industrial servos on the 3 servo channels. In addition it can drive a VSD, a PWM fan and/or 4-20mA servomotors. For the purposes of functional safety, only the 3 servomotor channels are considered.

4.3.2.3 PFH

For the Fuel-Air Ratio safety function, a dangerous undetected failure would be where the system fails to respond to the loss of control on a servo motor by shutting down the fuel valves. The following table defines the average probability of such a failure, and provides the achievable SIL rating:

Table 5 - FAR Controller SIL Ratings

Far Control	$PFH_{MiniMk9}$	HFT	SIL Rating
Servomotors	1.32×10^{-8}	0	SIL3

4.3.3 Failure Modes

The Mini Mk9 is designed to fail safe in the event of any component or site issues, closing off the fuel valves and bringing the burner to a safe state. Issues with loss of flame/simulated flame and servo movement errors will all result in non-volatile lockouts. These must be cleared from the Lockout screen for the Mini Mk9 to re-try combustion. Lockouts will re-occur if the cause of the fault has not been addressed. Contact your Autoflame trained Service Engineer for resolution of the issue or contact technicalsupport@autoflame.com for further support.

4.3.4 Proof Test



For Functional Safety installations, a Proof Test Interval of 1 year is defined for the Mini Mk9. It is required that the proof test is carried out once a year to ensure that the safety functions and diagnostics are operational. This could be done during an annual maintenance service and shall include the following tests (Note only carry out the tests that are relevant to your set-up):

#	Test	Result	Diagnostics tested
1	Remove Flame Scanner 1 from the burner	No Flame Signal Lockout on startup	Count on scanner 1 (1)
2	Remove Flame Scanner 2 from the burner (2)	No Flame Signal Lockout on startup	Count on scanner 2 (1)
3	Disconnect Scanner 1 connection	No Flame Signal Lockout or No Comms lockout for the IR or UV Trim scanners	Count or Comms on scanner 1 (1)
4	Disconnect Scanner 2 connection (2)	No Flame Signal Lockout or No Comms lockout for the IR or UV Trim scanners	Count or Comms on scanner 2 (1)
5	Disconnect UV Self Check Drive (T21/T22) (3)	UV Shutter Fault Lockout	UV Count (self-check)
6	Disconnect Wiper T42 from Servo 1 connection (4)	Servo Movement Error	Servo Movement
7	Disconnect Wiper T43 from Servo 2 connection (4)	Servo Movement Error	Servo Movement
8	Disconnect Wiper T44 from Servo 3 connection (4)	Servo Movement Error	Servo Movement
9	Disconnect 0V T40 from Servo 1 & 2 connection (4)	Servo Positioning Error	Servo Positioning
10	Disconnect +V T41 from Servo 1 & 2 connection (4)	Servo Positioning Error	Servo Positioning
11	Disconnect 0V T46 from Servo 3 connection (4)	Servo Positioning Error	Servo Positioning
12	Disconnect +V T47 from Servo 3 connection (4)	Servo Positioning Error	Servo Positioning
13	With all connections re-made, start the burner normally	Burner starts up and fires	Coil Feedback on all relays. Relay Feedback on all relays
14	Leave Running for at least 1 hour. (5) (set low flame hold if required to stop boiler reaching setpoint too soon)	Burner continues to fire normally	All diagnostics checks are completed within this timescale.

(1) Whichever type of scanner is fitted.

(2) Omit if only a single scanner is used.

(3) Omit if a UV self-check scanner is not used.

(4) Check all connected servomotors only.

(5) 1 Hour is the longest diagnostic interval, which is the self-check function on the UV Self-Check. If using IR or UV Trim flame scanners this check may be reduced to ½ hour (the self-check interval of the comms scanners).

Note: The following diagnostics tests are carried out in the normal operation of the system:

- The relay coils driving fuel valves and the safety valves are checked for correct operation continually throughout the operation of the Mini Mk9.
- The correct opening and closing of the fuel valves is confirmed every time the system shuts down the burner and restarts.
- The correct operation of the safety relays is verified at the beginning of each start-up process for the burner.
- The correct detection of a flame by a UV bulb scanner is checked at every shut down of the burner, or at every self-check interval if it is a self-check UV scanner (this has a maximum diagnostic test time of 1 hour to generate an error if in fault).
- The data comms of the IR and UV Trim scanners are continually assessed.
- The self-check functions of the IR or UV Trim scanners are checked every 30 minutes.
- Servo movement is continually monitored to confirm that the valves or dampers are moving as expected in response to a change in firing rate or request to start-up or shut down the burner.
- The correct operation of the unit is checked against a state machine as it moves through the startup, firing and shutdown procedures.
- The Comms between the BC and FAR microprocessors is continually monitored to ensure both parts of the control system are operating normally.

4.3.5 Maintenance



It is recommended that the Mini Mk9 is serviced at least once per year. Servicing shall be carried out by an Autoflame trained service engineer who is familiar with the Autoflame controller and systems and has a thorough understanding of burner combustion control.

The servicing should check the Proof Tests as described above (Mandatory if it is a Functional safety installation) and should carry out the following checks:

- Update the software to the latest release if a newer version is available.
- Check the Lockouts, Errors, Alarms and Warnings logs for any issues that have occurred since the last service. If there are persistent themes or regular issues then these should be resolved using the information in the Lockouts and Errors Section 19.
  Alternatively contact technicalsupport@autoflame.com for help in resolving issues.

4.3.6 Operational Lifetime

The Operational Lifetime of the Mini Mk9 is defined as 10 years. This is based on experience of the operational lifetime of other Autoflame burner controllers. If a unit is used in a Functional Safety installation, it shall be replaced once the Operational Lifetime has been reached.

4.4 Typical Usage

The Mini Mk9 is designed to be used as a dedicated burner controller for use with gaseous or liquid fuels when connected using a range of Autoflame components, including flame scanners, pressure sensors and servo motors.

The unit is very flexible with a range of configurations defined within this document. A typical use case would see the Mini Mk9 configured as follows:

- An Autoflame small servo motor MM10005 connected to drive terminals T69/T70/T71, with feedback on T40/T41/T42 controlling a fuel valve.
- An Autoflame small servo motor MM10005 connected to drive terminals T69/T72/T73, with feedback on T40/T41/T43 controlling an air damper.
- A VSD connected to terminals T1/T3 (input) and T10/T12 (output) giving 4-20mA control of the speed of the burner fan.
- An Autoflame UV scanner MM90004 connected to terminals T50/T51 giving flame detection.
- An Autoflame IR scanner MM90017 connected to terminals T29/T30/T48/T49 and defined as AND mode for enhanced flame detection.
- A set of fuel and vent valves connected to terminals T60/T61/T62 giving control of a single fuel supply.
- Proof of closure switches from the valves connected in series into terminal T55 to confirm the correct status of the valves.

- An Autoflame gas sensor MM80006 connected to terminals T31/T32/T33/T34 measuring the gas pressure between the fuel valves to allow valve proving before start-up.
- An Autoflame air sensor MM80005 connected to terminals T31/T32/T33/T34 measuring the air pressure on the air inlet and/or an air proving switch connected to terminal T54, confirming purge and firing air flows.
- The air inlet fan driven from terminal T58 to drive it during purge and firing.
- Pilot valve and ignition transformer connected to terminals T59 and T63 respectively to drive them at the correct point in the start-up sequence.
- Panel mounted Burner On/Off switch and high limit switch wired in series into terminal T53 to activate the controller and allow firing to occur in response to a setpoint demand.
- A temperature or pressure sensor wired into terminals T37/T38/T39 to determine the actual load of the boiler allowing firing to commence and modulation of the firing rate in response to the required setpoint.

The detailed configuration of the unit is described within this manual. The unit could be set up to control a second fuel, use a third servo or different flame scanners.

A series of system connections are defined below showing how the unit can be connected to an exhaust gas analyser, or to other Autoflame controllers or a DTI for sequencing.

4.4.1 Updating from a Mini Mk8

The Mini Mk9 has the same rear enclosure size as the Mini Mk8 so it will fit in the same panel opening. However the screen is slightly larger, so will overhang the panel opening by a larger amount.

The layout of the connectors has minimal changes from the Mini Mk8 to simplify the upgrade between the two units. The only changes are as follows:

- Connector J1 (Inputs/outputs 83,84,96,97,98) is a new connector for the 2nd fuel and has no equivalent connections currently on a Mini Mk8.
- On a Mini Mk8, the Gas/Air sensors are wired into the IR scanner terminals 29, 30, 48, 49. On a Mini Mk9 these are separated out into terminals 31, 32, 33, 34 and will require re-wiring if gas/air sensors were present on the Mini Mk8. This is to facilitate the addition of the UV Trim scanner sharing the IR scanner connection.
- Terminals 99, 100, 101, 102 are new to the Mini Mk9 and are for wiring a PWM fan directly to the Mini Mk9. Previously this feature was only available via an add-on board on the Mini Mk8.

The settings and any commission curve may be transferred from the Mini Mk8 to the Mini Mk9 using the process defined in section 11.2.6.3.1 below.

4.4.2 Connection Between Mini Mk9 MM And Mk8 EGA EVO

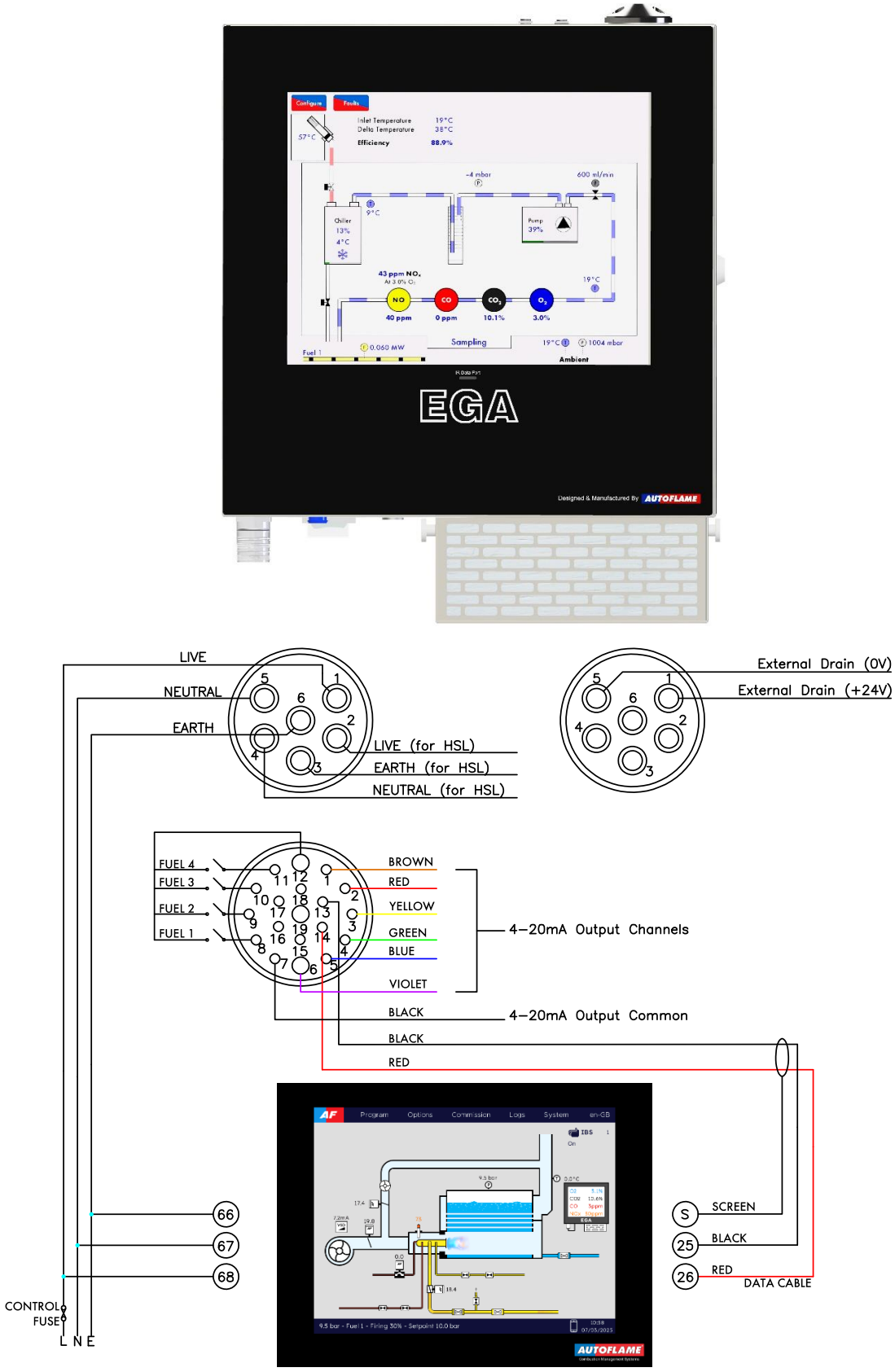
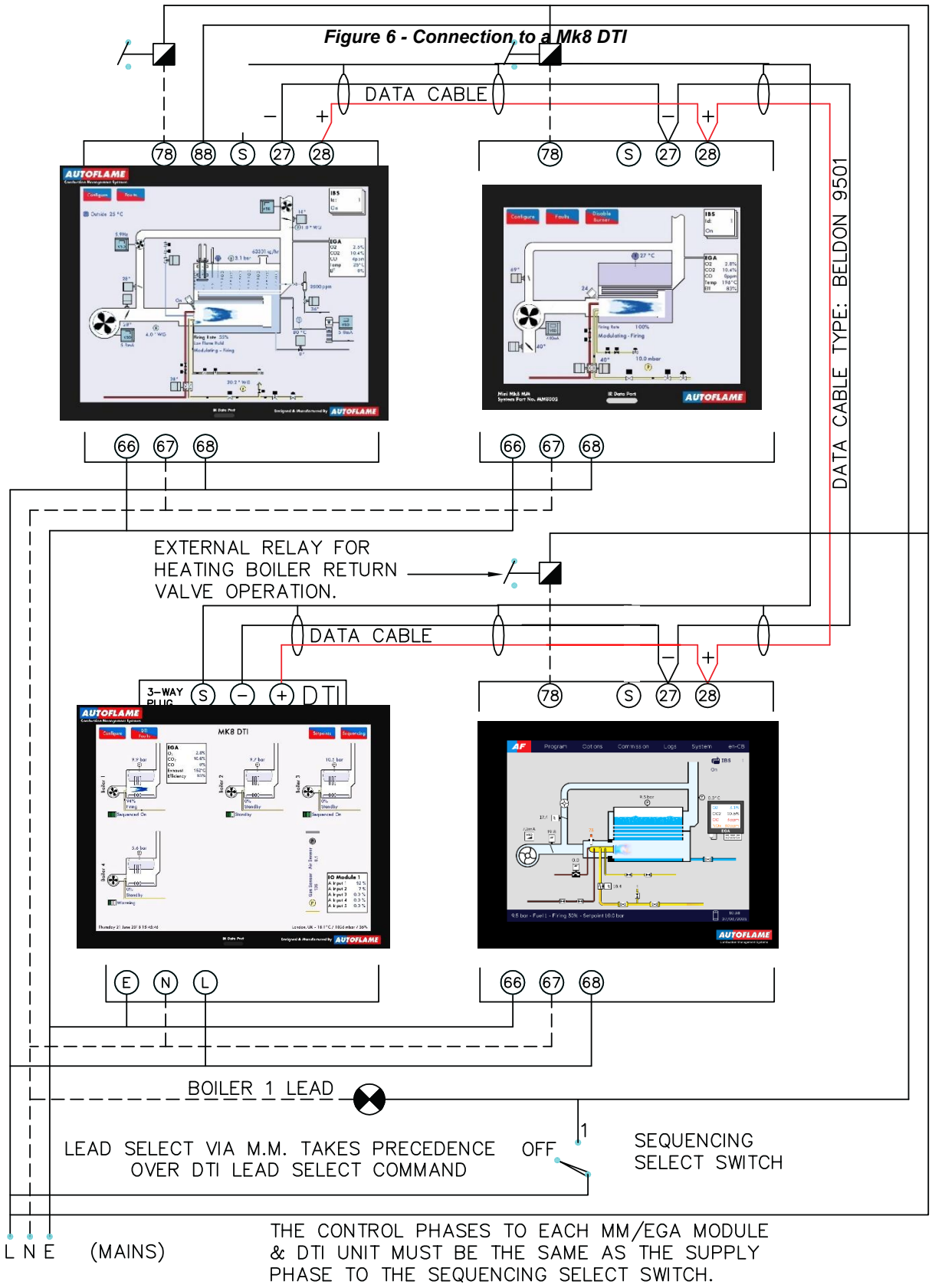


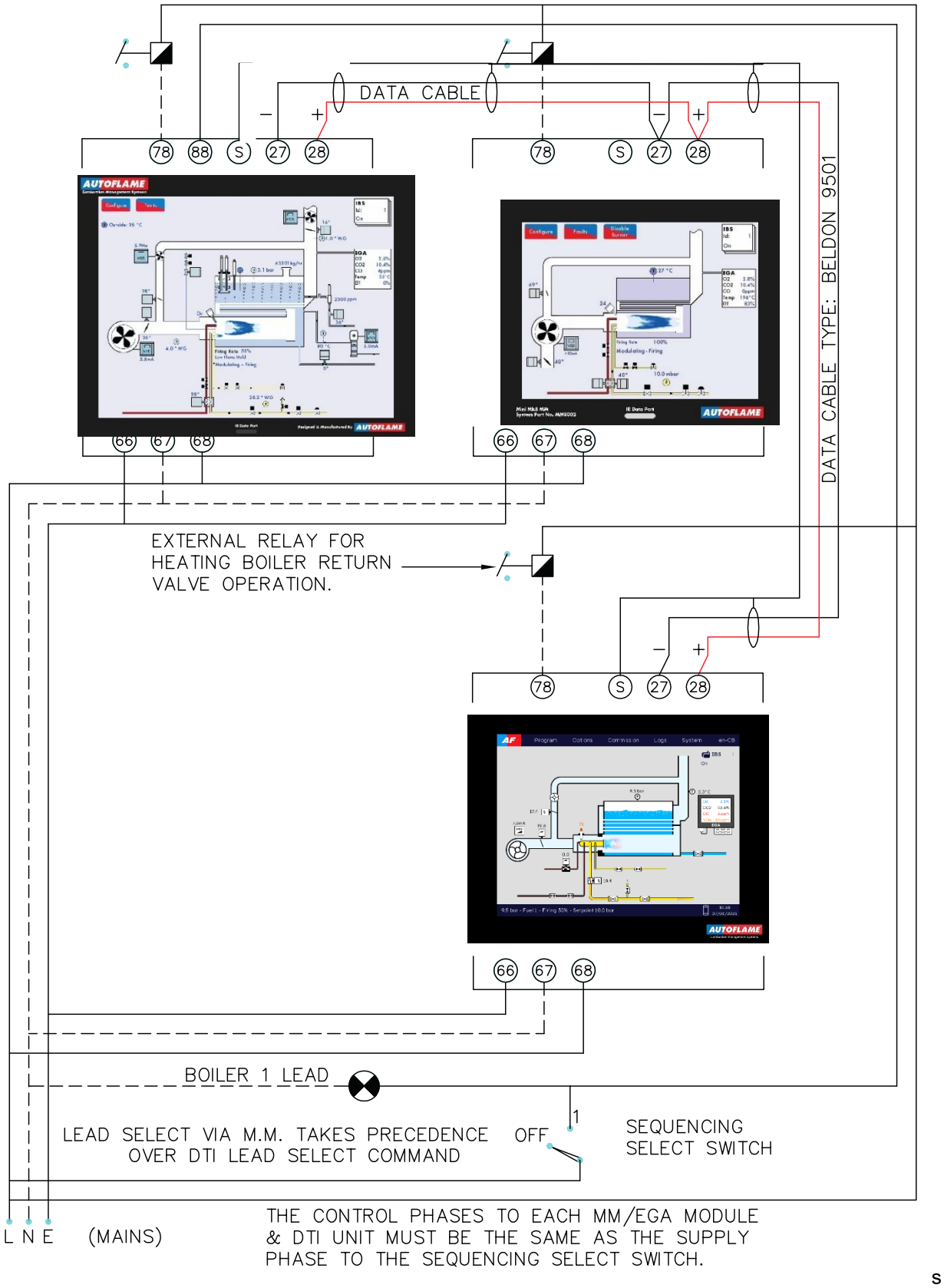
Figure 5 - Connection to a Mk8 EGA EVO

4.4.3 Connection Between Mini Mk9 MMs, Mk8 Minis/MMs And Mk8 DTI

Figure 6 - Connection to a Mk8 DTI



4.4.4 Sequencing Connection Diagram



s

Figure 7 - Connection For Sequencing

5 DISPLAY NAVIGATION

The Mini Mk9 MM controller uses an 8” capacitive, multi-touch, high-resolution display. The software has been updated to provide a more modern, menu-driven navigation around the various screens and functions.

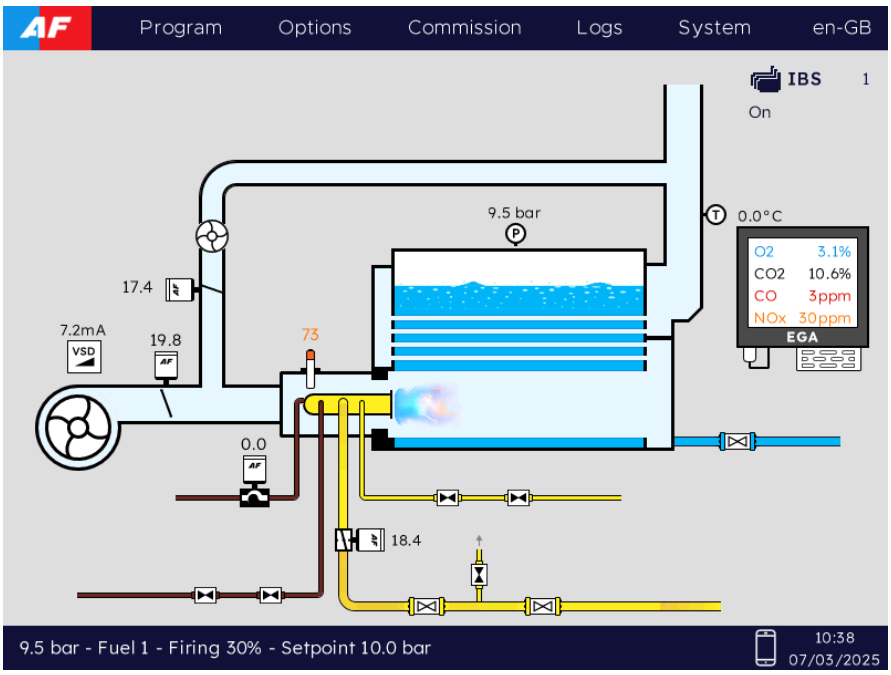


Figure 8 - Home Screen

The (Autoflame) logo in the top left corner is the **Home Button** and will return a user to the **Home Screen** from any other screen**,** displaying the boiler picture. When the boiler graphic is visible, screens relating to the operation of the boiler can be accessed by pressing on the part of the graphic associated with that function (e.g. pressing on the flame brings up the Fuel-Air screen). These screens can also be accessed by selecting the AF logo when already in the **Home Screen** to bring up a menu bar of the boiler screens.

The top section of the screen contains 3 menu bars as follows:

Main Menu Bar: This is the very top of the screen and is always visible. It gives access to the main functions of the controller and the **Home Button**.

Red Menu Bar: The **Red Menu Bar** pops up when a tab on the **Main Menu Bar** is selected to give a set of choices associated with that tab.

Blue Menu Bar: The **Blue Menu Bar** pops up when a selection is made on the **Red Menu Bar** which has a further set of choices associated with it.

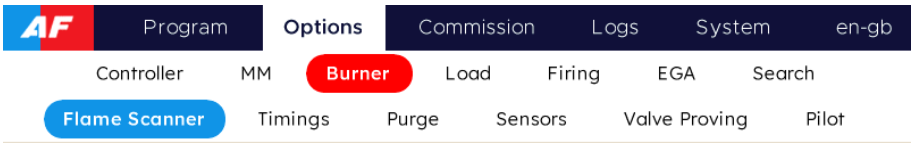


Figure 9 - Main, Red And Blue Menu Bars

Throughout this manual, navigation instructions will be given such as **Options/Burner/Flame Scanner**. This refers to pressing **Options** on the **Main Menu Bar**, then **Burner** on the **Red Menu Bar** and finally **Flame Scanner** on the **Blue Menu Bar** as shown in Figure 9 above.

Along the bottom of the display, an **Information Bar** is always visible which describes the current state of the burner together with the time and date and the WiFi status.

6 OPTIONS

6.1 Options Definition

The Mini Mk9 MM has consolidated the **Options** and **Parameters** from the Mk8 range of controllers into a single menu-driven list of **Options**. To ease the set-up process, **Options** have been grouped together, so that all the **Options** relating to a particular function are in one place. To aid continuity, the **Option** or **Parameter** numbers as defined in the Mk8 range are also displayed. These numbers can be switched off by setting **Options**/**Controller**/**Display**/**Hide Setting Numbers** to **Enabled**. Familiarizing yourself with the location of various **Options** groups on the **Red Menu Bar** and **Blue Menu Bar** will greatly improve the speed at which you can find **Options** and set up the Mini Mk9.

The **Options** are accessed by selecting the **Options** tab on the **Main Menu Bar**.

This accesses the **Option Groups** on the **Red Menu Bar** which collect the options into broad groups as follows:

- **Controller**: Options relating to the setup of the controller.
- **MM**: Options relating to the operation of the MM.
- **Burner**: Options relating to burner control.
- **Load**: Options relating the system load.
- **Firing**: Options relating to the burner firing.
- **EGA**: Options relating to Exhaust Gas Analyser control.
- **Search**: Access to the search function.

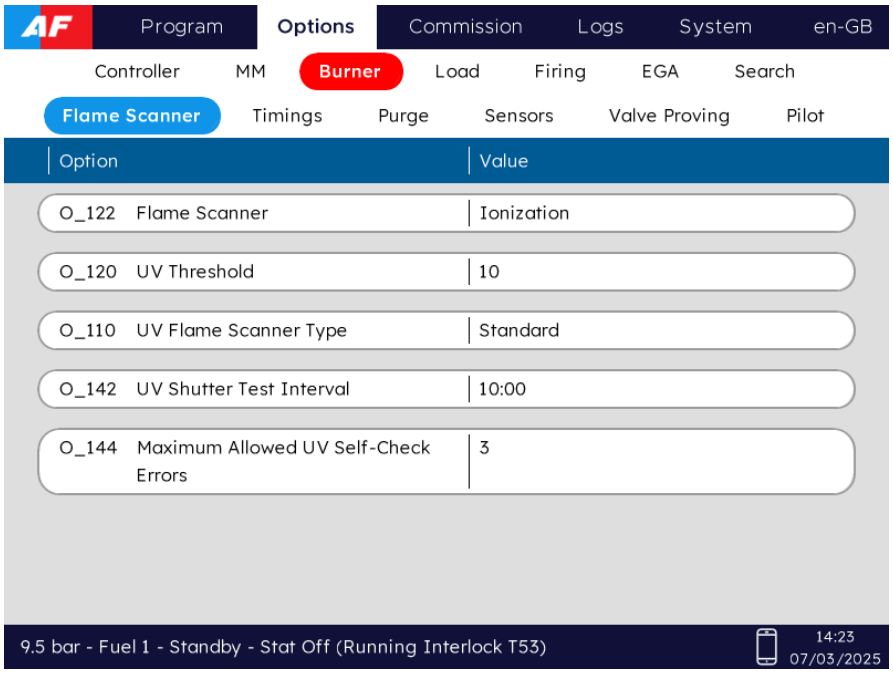


Figure 10 - Options Selection

Selecting an **Option Group** on the **Red Menu Bar** brings up a second layer of **Option Categories** on the **Blue Menu Bar**. The layered menu structure arranges all the options for a particular task into small groups so that all the options required to change a particular type of behaviour are co-located.

The **Option Groups** on the **Red Menu Bar** are split into the **Option Categories** on the **Blue Menu Bar** as follows:

- **Controller**:
  - **Boiler**: Define the boiler graphic configuration.
  - **Display**: Define the control of the display.
  - **Units**: Define the units used.
  - **Modbus**: Define the Modbus setup.
  - **Network**: Define the network communications.
  - **Passwords**: Set the passwords.

- **MM**:
  - **Fuel**: Define the fuels.
  - **Servo**: Set up the servo channels.
  - **VSD**: Set up the VSD.
  - **PWM**: Set up the PWM fan.
  - **Terminals**: Define the response of terminals.

- **Burner**:
  - **Flame Scanner**: Define the flame scanners.
  - **Timings**: Set the safety timings.
  - **Purge**: Set the pre and post purges.
  - **Sensors**: Set up the fuel and air sensors.
  - **Valve Proving**: Set up the valve proving method.
  - **Pilot**: Select the pilot type.

- **Load**:
  - **Load Sensor**: Set up the load sensor.
  - **Setpoint**: Define the setpoint.
  - **Sequencing**: Define sequencing operation.
  - **PID**: Set up the PID control.

- **Firing**:
  - **Start-Up**: Define the burner start-up procedure.
  - **Modulation**: Set up the modulation.
  - **Shut-Down**: Define the burner shut-down procedure.
  - **FGR**: Define flue gas recirculation.

- **EGA**:
  - **Operation**: Set up the EGA.
  - **O2 Sensor**: Set up an O2 sensor.
  - **Limits**: Set up limits on gas emissions.
  - **Trim**: Set up EGA or UV trim.

Alternatively an option may be found by searching for it. Selecting the Search button on the **Red Menu Bar** brings up a keypad to type in what you wish to search for.

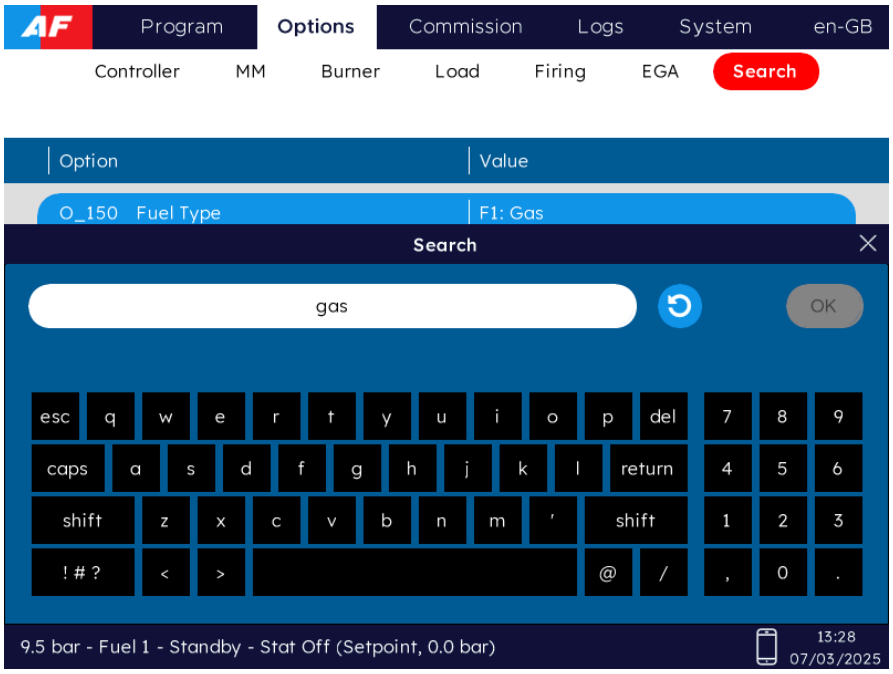


Figure 11 - Options Search

In Figure 11 for example, entering the word ‘gas’, brings up a list of all **Options** that contain this word in the **Option Title** or the **Value Settings** as shown in Figure 12. The search engine works on complete words only so typing in ‘CO’ would bring up all the options that control EGA Carbon Monoxide settings, but not every word that contains the letters ‘CO’. The Options Menu location of the particular setting is given in brackets to aid familiarization with the Options groupings.

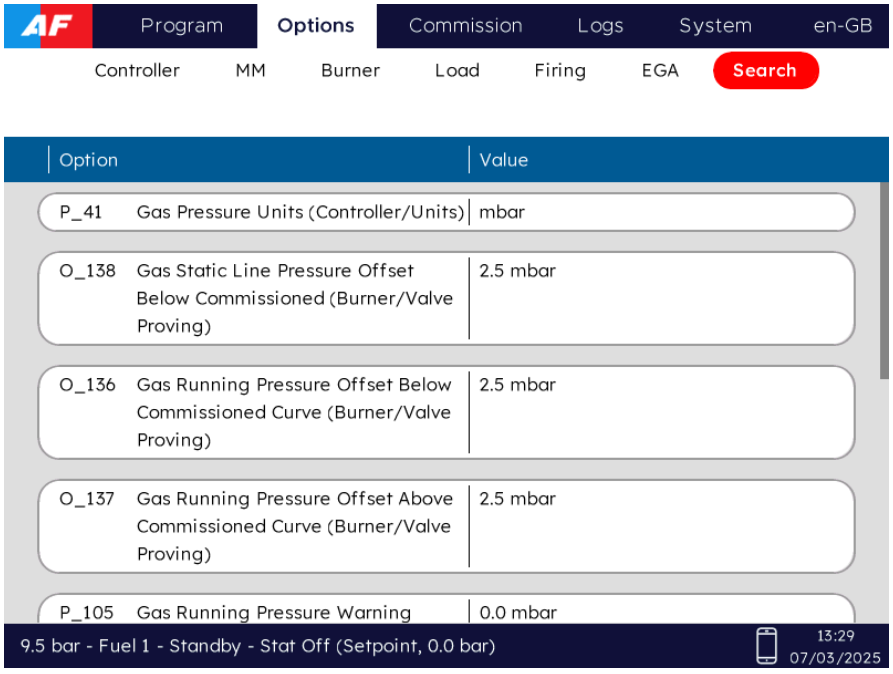


Figure 12 - Options Search Results List

If you are familiar with the **Option** and **Parameter** numbers from the Mini Mk8, typing the number into the search bar will bring up 2 results, one being the **Option** for that number and the other being the **Parameter**.

Becoming familiar with the **Option Categories** and **Option Groups** will provide the quickest way of setting up the Mini Mk9 since all options for a particular task are grouped together.

6.2 Changing Options

All **Options** are viewable at any time, including while the MM is in run mode and the burner is firing. An option is selected by navigating to a list and tapping on that option in the list. This brings up a pop-up box detailing the option and its possible settings. They are all locked by default as indicated by a padlock in the top left corner of the pop-up box for any individual option and the settings are greyed out and are not selectable.



Figure 13 - Option Pop-Up - Locked

Any **Options** displaying the padlock may be adjusted through **Online Changes** at any time, even while the burner is firing. Navigate to the desired option using the menu bars, select it and then touch the padlock to enter the **On-Line Changes Password** screen. Passwords are case-sensitive alphanumeric characters and the entry must match the defined password. Enter the password using the keypad and press **enter.**

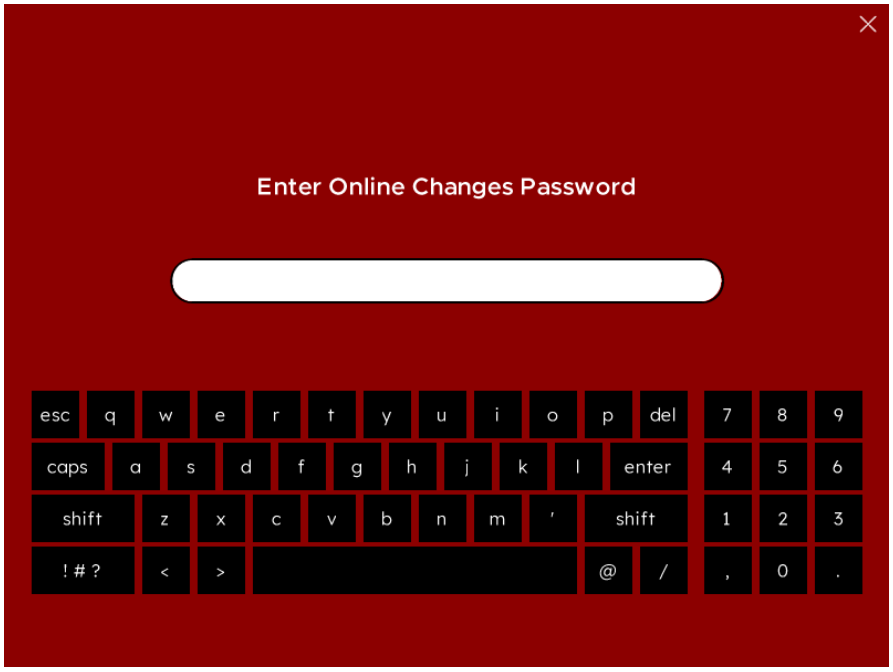


Figure 14 - On-Line Changes Password Entry

Successfully entering the password opens the padlock and the option becomes selectable. The option choices are no longer greyed out and a new selection can be made. Once the **On-line Changes Password** has been entered, all **Options** are unlocked if they are allowed to be changed under **On-line Changes**.

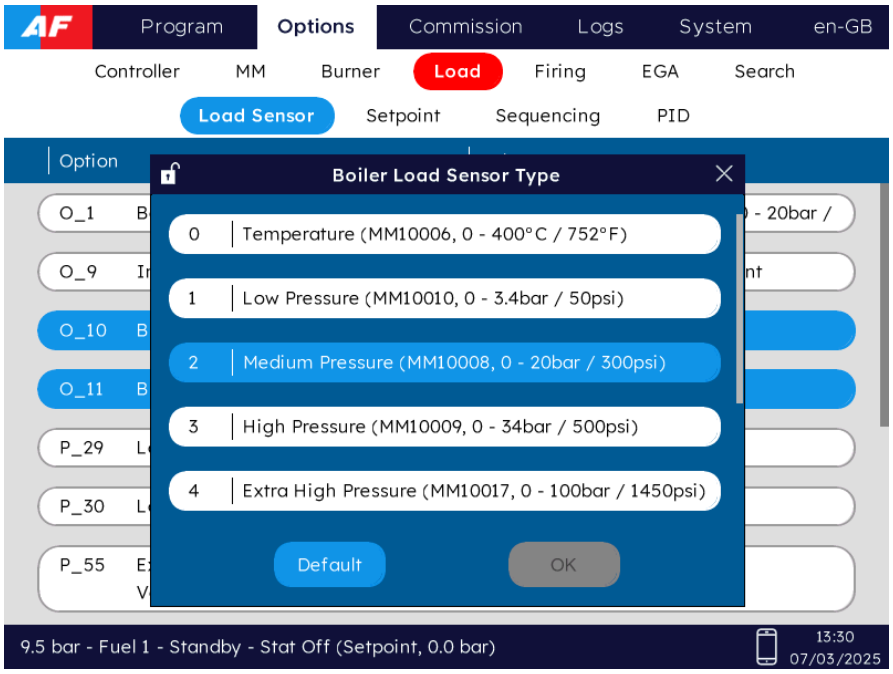


Figure 15 - Unlocked Option

In addition, all **Burner Control** (**Burner Menu**) **Options** plus a number of other **Options** associated with safety functions can only be changed when the burner is shut down and require the added protection of the **Commission Mode Password**. These options are identified by the padlock being replaced with a no-entry symbol to indicate that they cannot be unlocked using **On-Line Changes**.

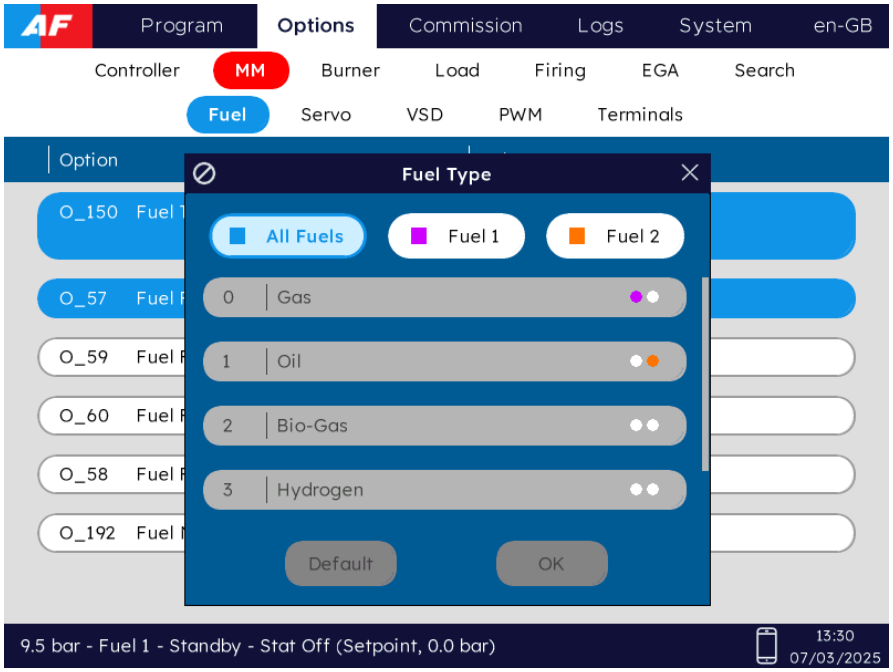


Figure 16 - Commission Locked Option

To enter **Commission Mode**, ensure the burner is shut down and in **Standby**, select **Commission** on the **Main Menu Bar** and then **Commission** on the **Red Menu Bar**. If the burner is firing, or has not yet reached **Standby** mode, then a pop-up box stating **Not Ready For Commission Mode** will appear.

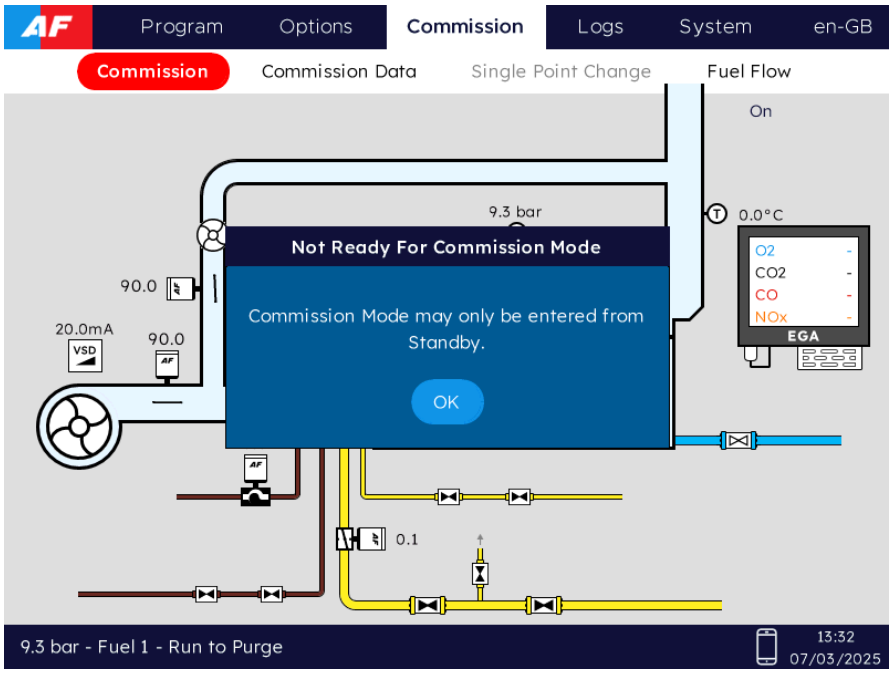


Figure 17 - Not Ready For Commission Mode

As long as the controller is in **Standby** mode the **Commission Password** screen will pop-up to allow entry of the **Commission Password**. The main commission screen will be accessed by correctly entering the **Commission Password** followed by the **enter** key.

Note: The **Commission Password** should not be distributed to anyone who is not a factory trained and certified engineer. Safety related options should only be changed by someone with the correct training and knowledge.

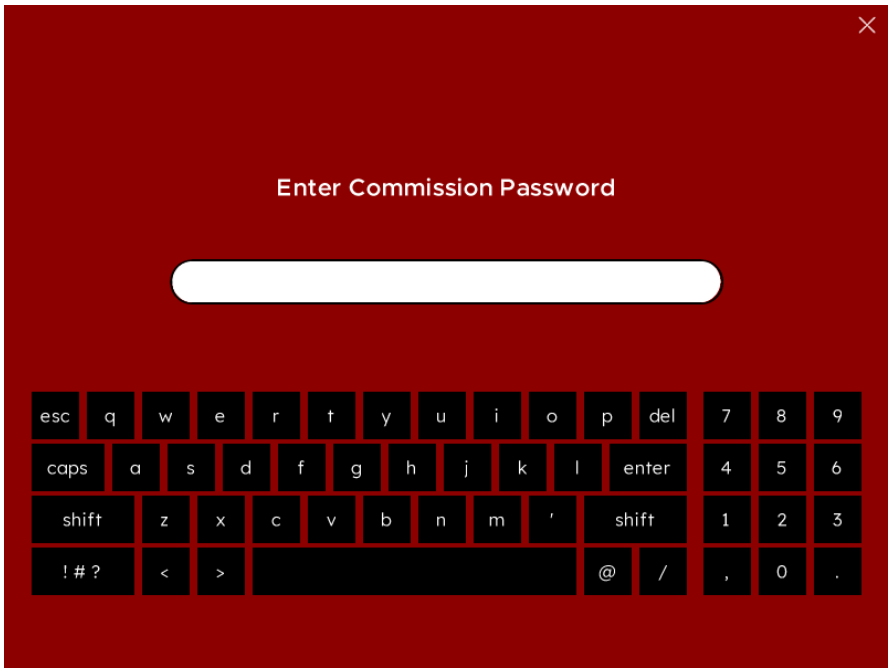


Figure 18 - Commission Password Entry

The Info bar at the bottom of the screen turns **light blue** when Commissioning has been successfully entered and will remain so to indicate that you are still in commissioning mode.

Having successfully entered the **Commission Screen**, selecting **Options** through the **Main Menu Bar** will access a full set of unlocked options. Any individual **Option** may be selected from the list of options. A pop-up box then details the option together with the possible settings, any of which may be selected.

There are three types of entry for defining **Options**. The first type has a list of possible states for that **Option**, one of which may be selected. Some of these **Options** allow different selections to be made per fuel. The default state is to apply the changes to all fuels (the **All Fuels** button is highlighted), in which case making a selection from the list moves both of the fuel indication circles to that selection. To change the option for a single fuel only, select **Fuel 1** or **Fuel 2** first, followed by the required selection. The two fuel indicator circles will then be at different places as shown below.

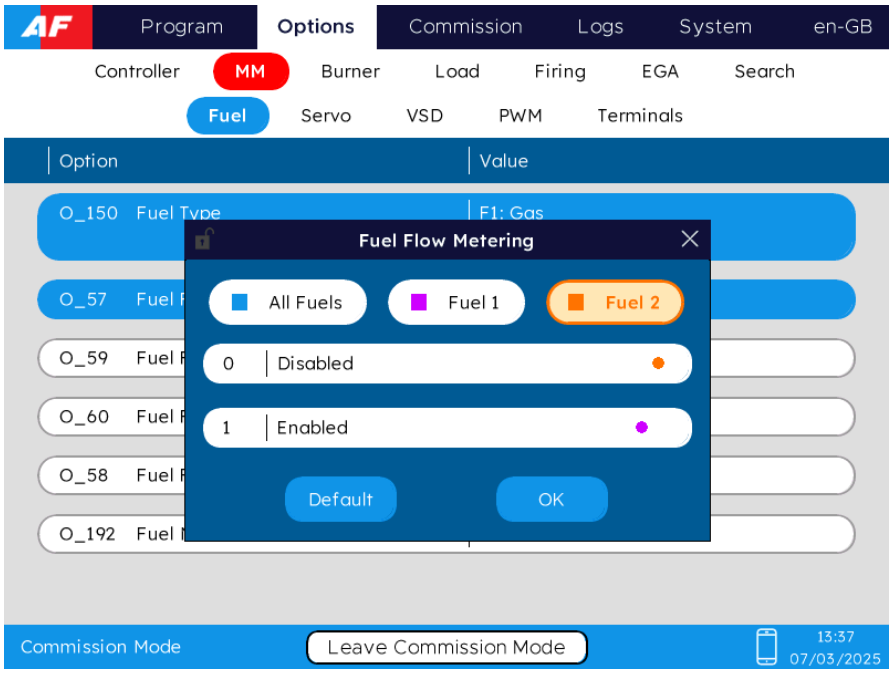


Figure 19 - Selecting Per-Fuel Options

When a change has been made, the **OK** button becomes active and may be selected to confirm the **Option**. The new selection is then identified in the options list.

Any **Option** which has a selection which is not a default setting will be highlighted in blue.

If the settings are different per-fuel, then both settings will be shown in the **Options** list.

The **Default** button changes the entry to the system default value.

The second type of entry is a numerical input, which brings up a numeric keypad in the pop-up box for number entry. Select the number in the white box to activate entry (the number pad turns from grey to black). The new value can then be entered followed by the **Enter** key. When a new value has been entered the **OK** button becomes active to confirm the entry.

The allowed range of numbers for the **Option** are shown on the black bar at bottom of the pop-up box.

If per fuel entry is allowed for this option, then there is no '**All Fuels**' **Option** and both entries must be made separately. If the entry affect both fuels then it will be marked as '**All Fuels**'.

The **+/-** key allows toggling between positive and negative numbers.

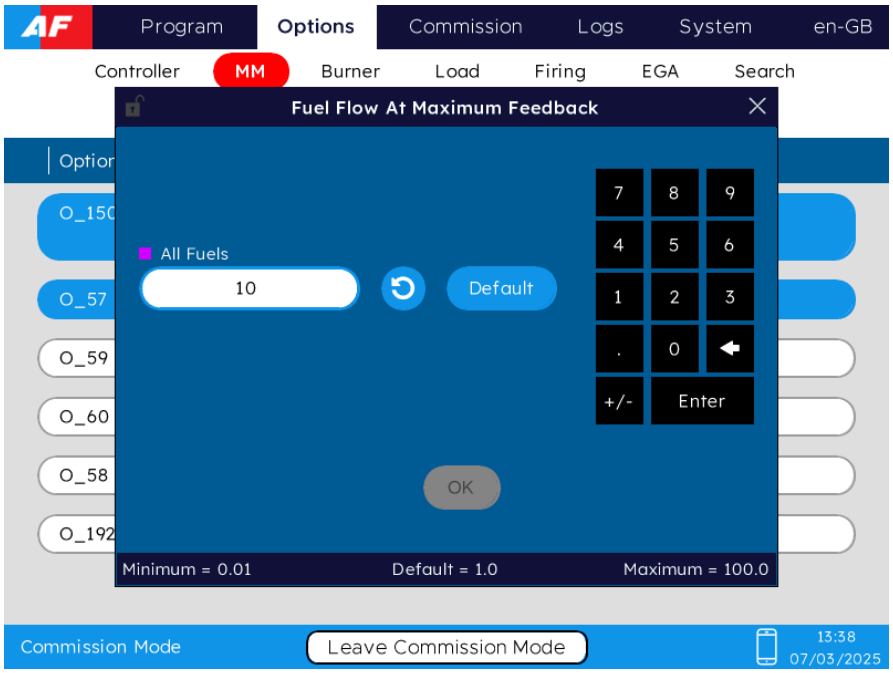


Figure 20 - Option Numeric Entry

The third type is for times where the hours, minutes and seconds may be entered, dependent upon the allowed range, to provide the required duration. Note that some time entries don't have the option to enter seconds as they only make sense in whole numbers of minutes.



Figure 21 - Option Time Entry

Any of the **Options** that required the **Commission Mode Password** before they can be changed, require confirmation when making changes. These **Options** affect the burner control and other safety features and as such must only be changed by someone trained in the use of the Mini Mk9 controller. The confirmation provides a two-step process allowing the commissioning engineer to check that the correct change is being made.

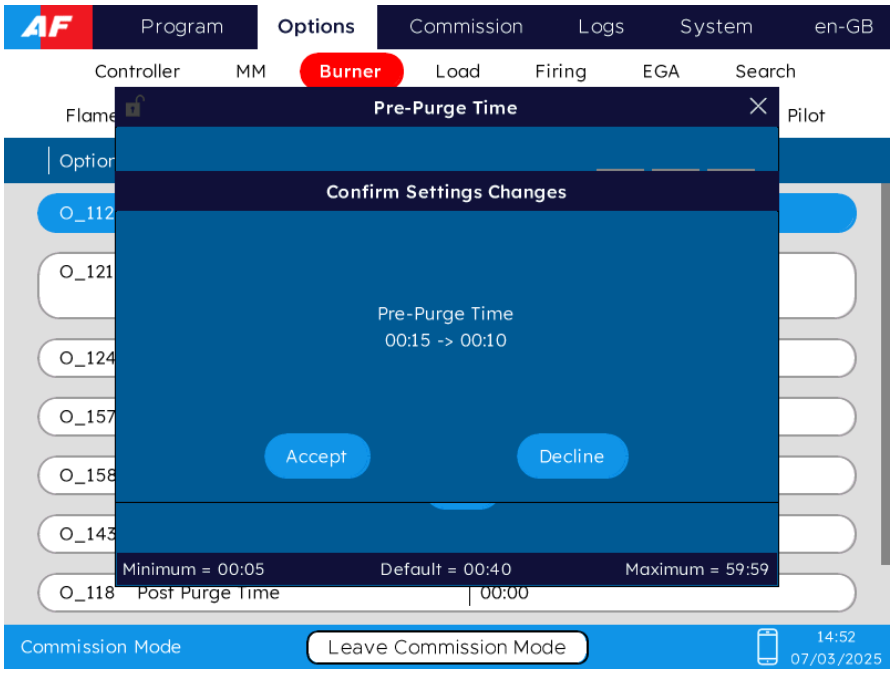


Figure 22 - Burner Control Change Confirmation

On pressing **OK** a **Confirm Settings Changes** pop-up appears, detailing the change being made to provide a second entry confirmation. Selecting **Accept** on this confirmation pop-up checks that you understand the change being made and are happy with it.

No Changes are actually implemented while the alterations are being made. To save the changes select the **Home Button** from the **Main Menu Bar** to return to the **Home Screen**. A **Confirm New Setting Values** pop-up box then lists the changes made and gives three options as follows:

Button	Action
Save & Exit	Implements all the changes and returns to the Boiler screen.
Discard Changes	Exits the **Options List** without implementing any of the changes.
Continue Editing	Returns to the **Options List** for further changes to be made.

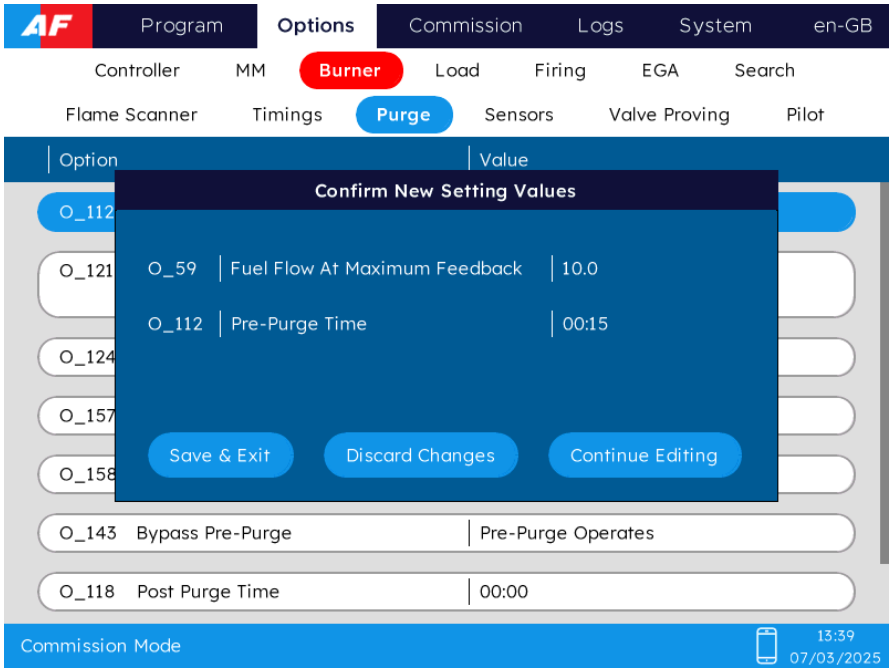


Figure 23 - Confirm Options Changes

6.3 Option Description

The **Options** are detailed below in each of the categories. To view each list on the Mini Mk9 MM select the three menu bar **Options** from each section title – i.e. to access the **Boiler Options** in section 6.3.1 below select ***Options*** on the **Main Menu Bar**, ***Controller*** on the **Red Menu Bar** and ***Boiler*** on the **Blue Menu Bar**.

The headings in each of the sections below therefore follows the pattern of **Main Menu Bar: Red Menu Bar: Blue Menu Bar** so the above selection would be written in this manual as **Options/Controller/Boiler.**

The columns in each section are as follows:

Description	Title and details of the option.
Setting	Possible selections for the option.
CP	Commission Password required to Change it (Y/N).
PF	Per Fuel Setting (Y/N).
FSG	Available in Flame Safeguard Only Mode (Y/N).
#	Mini Mk8 Option or Parameter number.

The **Description Name** and the **Default Setting** are highlighted in pale blue for each **Option**.

6.3.1 Options: Controller: Boiler

The **Boiler Options** define how the graphic on the home screen looks. The selection should match the actual boiler set up as close as possible to provide a realistic graphic.

Description	Setting	CP	PF	FSG	#
Boiler Type Select the boiler type for displaying on the home screen.	0) Water Tube 1) Two-Pass Fire Tube 2) Three-Pass Fire Tube 3) Four-Pass Fire Tube 4) Cast-Sectional Tube 5) Horizontal Coil Tube 6) Vertical Coil Tube 7) Horizontal Condenser 8) Vertical Condenser	N	N	N	O_161
Servo 1 Shown As Select how Servo 1 is displayed on the graphic.	0) None 1) Fuel Damper 2) Inlet Air Damper 3) Outlet Air Damper 4) FGR Air Damper 5) Draught Air Damper 6) Steam Air Atomization Damper 7) Rotary Cup Damper	N	N	N	O_162
Servo 2 Shown As Select how Servo 2 is displayed on the graphic.	0) None 1) Fuel Damper 2) Inlet Air Damper 3) Outlet Air Damper 4) FGR Air Damper 5) Draught Air Damper 6) Steam Air Atomization Damper 7) Rotary Cup Damper	N	N	N	O_163

Description	Setting	CP	PF	FSG	#
Servo 3 Shown As Select how Servo 3 is displayed on the graphic.	0) None 1) Fuel Damper 2) Inlet Air Damper 3) Outlet Air Damper 4) FGR Air Damper 5) Draught Air Damper 6) Steam Air Atomization Damper 7) Rotary Cup Damper	N	N	N	O_164
VSD 1 Shown As Select how VSD 1 is displayed on the graphic.	0) None 1) Burner Fan 2) FGR Fan 3) Draught Fan 4) Rotary Cup Fan 5) Fuel Damper 6) Inlet Air Damper 7) Outlet Air Damper 8) FGR Air Damper 9) Draught Air Damper 10) Steam Air Atomization Damper 11) Rotary Cup Damper	N	N	N	O_165
PWM Shown As Select how the PWM is displayed on the graphic.	0) None 1) Burner Fan 2) FGR Fan 3) Draught Fan 4) Rotary Cup Fan	N	N	N	O_166
Servo 1 Label Free text input for Servo 1 label If you change Servo 1 from its default setting (Fuel Servo) then you must change this label to match its new function.	Fuel	N	N	N	O_173
Servo 2 Label Free text input for Servo 2 label If you change Servo 2 from its default setting (Air Servo) then you must change this label to match its new function.	Air	N	N	N	O_174
Servo 3 Label Free text input for Servo 3 label If you change Servo 3 from its default setting (Servo Channel 3) then you must change this label to match its new function.	Servo Channel 3	N	N	N	O_175
VSD 1 Label Free text input for VSD 1 label If you change VSD 1 from its default setting (e.g. make it into a Servo) then you must change this label to match its new function.	VSD 1	N	N	N	O_178
Feed Configuration Select the configuration of the feed	0) Forced Draught 1) Rotary Cup	N	N	N	O_180
FGR Type Select the FGR configuration	0) None 1) Induced FGR 2) Forced FGR	N	N	N	O_181
Induced Draught Select the induced draught configuration	0) Disabled 1) Enabled	N	N	N	O_182
Steam Air Atomization Select the air atomization configuration	0) None 1) Show Steam/Air Train	N	N	N	O_183
Two-Port Valve Select the two-port valve configuration.	0) None 1) Show Two-Port Valve	N	N	N	O_184

Description	Setting	CP	PF	FSG	#
Two-Port Valve Output Polarity Select the operation of the two-port valve	0) Valve Normally Open (Closes When Energised) 1) Valve Normally Closed (Opens When Energised)	N	N	N	P_63
Combustion Head Type Select the combustion head type	0) Diffuser 1) Mesh	N	N	N	O_185

6.3.2 Options: Controller: Display

The **Display** **Options** control the operation of the display when the unit is not being actively touched.

Description	Setting	CP	PF	FSG	#
Logo Display Timer Screensaver will appear once the timer has elapsed. A custom screensaver may be uploaded onto the Mini Mk9 via the Download Manager app.	Default: 00:01:00 Disabled: 0 Range 1 to 23 hours, 59 minutes and 59 seconds	N	N	Y	P_60
Logo Display Preferences If Disabled, the main boiler screen will remain on while the burner is firing.	0) Logo Disabled While Firing 1) Logo Displayed While Firing	N	N	N	P_64
Backlight Timer The backlight will dim if the screen is not pressed for this duration.	Default: 00:15:00 Disabled: 0 Range 1 to 59 minutes and 59 seconds	N	N	Y	P_61
Hide Setting Numbers Allows the Mk8 Option and Parameter numbers to be hidden if enabled.	0) Disabled 1) Enabled	N	N	Y	O_0

6.3.3 Options: Controller: Units

The **Units** **Options** control how various units are defined and displayed.

Description	Setting	CP	PF	FSG	#
Displayed Units Define the main units used throughout the controller	0) Metric 1) US Customary	N	N	N	P_40
BACNet Units Define the units used in BACNet communications	0) Metric 1) US Customary	N	N	N	O_196
Modbus Units Define the units used in Modbus communications	0) Metric 1) US Customary	N	N	N	O_197
Boiler Pressure Metric Display Units Select the metric pressure units for the boiler pressure	2) Bar 3) kPa	N	N	N	O_187
Gas Pressure Units Select the units displayed for the optioned Autoflame gas pressure sensor. Note, PSI units are not available for sensor MM80006.	0) mbar 1) inWG 2) PSI	N	N	N	P_41
Air Pressure Units Select the units displayed for the optioned Autoflame air pressure sensor	0) Mbar 1) inWG	N	N	N	P_43

6.3.4 Options: Controller: Modbus

The **Modbus** **Options** define how the controller communicates over the Modbus protocol for connection to external devices such as a BMS.

Description	Setting	CP	PF	FSG	#
Modbus Serial Enable Define the operation of Modbus	0) Disabled 1) Enabled Read-Only 2) Enabled Read/Write	N	N	Y	E_100
Modbus Serial Baud Rate Selection of the Modbus connection baud rate.	0) 9600 1) 19200	N	N	Y	E_101
Modbus Serial Parity Selection of the Modbus signal parity.	0) No Parity 1) Odd Parity 2) Even Parity	N	N	Y	E_102
Modbus Serial Stop Bits Selection of the Modbus signal stop bits.	0) 1 Stop Bit 1) 2 Stop Bits	N	N	Y	E_103
Modbus Data Format Set the Modbus data type..	0) Binary 1) ASCII	N	N	Y	E_105
Modbus Device ID Set the Modbus ID of the device.	Default: 1 Range 1 to 247	N	N	Y	E_104
Modbus Over Ethernet Enable Modbus comms over the ethernet connection.	0) Disabled 1) Enabled Read-Only 2) Enabled Read/Write	N	N	Y	O_188
Modbus Over Ethernet Port Number input for the ethernet port	Default: 502 Range 0 to 65535	N	N	Y	O_193

6.3.5 Options: Controller: Network

The **Network** **Options** define how the controller communicates with external devices, either as inputs or to provide data.

Description	Setting	CP	PF	FSG	#
WIFI Operation Set how the WIFI connection operates.	3) Always On 4) Off Until Needed 5) Always Off	N	N	Y	O_300
WIFI SSID Name Free text input of the SSID for the device WIFI connection.	Default: Mini Mk9 **** **** is the serial number of the device	N	N	Y	O_301
Ethernet Network Name Free text input of the Ethernet Network name.	Default: Mini Mk9 **** **** is the serial number of the device	N	N	Y	O_302
Software DTI Over Ethernet Enable Mk9 Software DTI comms over the ethernet connection.	0) Disabled 1) Enabled	N	N	N	O_190
Remote Control BACnet Ethernet Enable BACnet comms over the ethernet connection.	0) Disabled 1) Enabled	N	N	Y	O_189
BACnet Ethernet Port Set the BACnet Port of the device.	Default: 49338 Range 0 to 65535	N	N	Y	O_195
BACnet Device Instance Set the BACnet ID of the device.	Default: 1 Range 1 to 4194302	N	N	Y	O_191
Ethernet DHCP Enable Enable Dynamic Host Configuration Protocol.	0) Disabled 1) Enabled	N	N	Y	O_303
Ethernet Static IPV4 Address Set the static IP address for ethernet comms.	Default: 0.0.0.0	N	N	Y	O_304
Ethernet Subnet Mask Set the subnet mask for ethernet comms.	Default: 0.0.0.0	N	N	Y	O_305

Description	Setting	CP	PF	FSG	#
Ethernet Default Gateway Set the default gateway address for ethernet comms.	Default: 0.0.0.0	N	N	Y	O_306
Ethernet DNS Mode Define how DNS servers are obtained.	0) Obtain DNS Servers Automatically 1) Specify DNS Servers manually	N	N	Y	O_307
Ethernet primary DNS Server Set the primary DNS server address for ethernet comms.	Default: 0.0.0.0	N	N	Y	O_308
Ethernet Secondary DNS Server Set the secondary DNS server address for ethernet comms.	Default: 0.0.0.0	N	N	Y	O_309

6.3.6 Options: Controller: Passwords

The **Passwords** **Options** control access to the device settings at two levels, namely Commission and Online Changes. The current password must be entered before changes can be made. Care should be taken when changing passwords. Access to changing option settings should be restricted to trained and competent personnel. Note that the set clock password is permanently set to '1010' in line with the Mk8 devices so that it can be adjusted without providing access to other functions.

Description	Setting	CP	PF	FSG	#
Commission Password Free text input of the Commission password	Default: ****	Y	N	Y	P_38
Online Changes Password Free text input of the Online Changes password	Default: ****	Y	N	Y	P_107
Remote Client Password Free text input of the Remote Client password. This is initially blank	Default: ****	Y	N	Y	P_225

6.3.7 Options: MM: Fuel

The **Fuel** **Options** define the fuel types and control fuel flow metering.

Description	Setting	CP	PF	FSG	#
Fuel Type Selection of fuel types	0) Gas 1) Oil 2) Bio-Gas 3) Hydrogen 4) Solid	Y	Y	Y	O_150
Fuel Flow Metering Determines the firing rate when enabled. If enabled, fuel flow metering is initiated once the burner has been commissioned and is firing. If no fuel flow meter is available, a 'dummy curve' should be entered using the burner turndown ratio from the burner rating to determine the low fire point, and the burner rating for the high fire point.	0) Disabled 1) Enabled	N	Y	N	O_57
Fuel Flow at Maximum Feedback This will set the fuel flow value at 20mA feedback.	Default: 1.0 Range 0.01 to 100.0	N	Y	N	O_59
Fuel Flow Feedback Fault Tolerance The fuel flow feedback fault tolerance allows an upper limit to be set on the fuel flow when Fuel Flow Metering is set to 2. If the fuel flow exceeds this limit for 5 seconds, then a warning will appear.	Default: 0 Disabled: 0 Range 0.1 to 50.0 % of high fire fuel flow	N	Y	N	O_60

Description	Setting	CP	PF	FSG	#
Fuel Flow Metering Ignition Delay Fuel flow metering begins after the time delay set in this option has elapsed.	Default: 00:00 Disabled: 00:00 Range 1 to 4 minutes and 0 seconds	N	Y	N	O_58
Fuel Name Free text input for fuel names	Default: Gas for fuel 1 Oil for fuel 2	N	Y	N	O_192

6.3.8 Options: MM: Servo

The **Servo** **Options** define the operation of the 3 servo channels on the Mini Mk9. Note that the channel settings are flexible with each of the 3 channels able to be set as fuel, air, independent or disabled.

Description	Setting	CP	PF	FSG	#
Servo Channel 1 Enable Servo 1 is set to fuel as default. If this option is changed after commission then a new commission will be needed	0) Disabled 1) Fuel Channel 2) Air Channel 3) Independent Channel	Y	Y	N	O_8
Servo Channel 2 Enable Servo 2 is set to fuel as default. If this option is changed after commission then a new commission will be needed	0) Disabled 1) Fuel Channel 2) Air Channel 3) Independent Channel	Y	Y	N	O_8
Servo Channel 3 Enable Servo 3 is set to fuel as default. If this option is changed after commission then a new commission will be needed	0) Disabled 1) Fuel Channel 2) Air Channel 3) Independent Channel	Y	Y	N	O_8
Servo Channel 1 Control Method Control tolerance on the movement of servo 1	0) Autoflame Servo Control 0.1 1) Autoflame Servo Control 0.5 2) Industrial Servo Control 0.1 3) Industrial Servo Control 0.5	N	Y	N	O_86
Servo Channel 2 Control Method Control tolerance on the movement of servo 2	0) Autoflame Servo Control 0.1 1) Autoflame Servo Control 0.5 2) Industrial Servo Control 0.1 3) Industrial Servo Control 0.5	N	Y	N	O_87
Servo Channel 3 Control Method Control tolerance on the movement of servo 3	0) Autoflame Servo Control 0.1 1) Autoflame Servo Control 0.5 2) Industrial Servo Control 0.1 3) Industrial Servo Control 0.5	N	Y	N	O_88
Servo Channel 1 Purge Position Defines position of the servo 1 during a purge.	0) Purge At Open Position 1) Remain Closed For Purge	Y	Y	N	O_67
Servo Channel 2 Purge Position Defines position of the servo 2 during a purge.	0) Purge At Open Position 1) Remain Closed For Purge	Y	Y	N	O_68

Description	Setting	CP	PF	FSG	#
Servo Channel 3 Purge Position Defines position of the servo 3 during a purge.	0) Purge At Open Position 1) Remain Closed For Purge	Y	Y	N	O_69
Purge Motor Travel Speed Speed of motor movement during purge cycle.	Default: 10.0 Range 1.0 to 10.0	N	N	N	O_75
Modulating Motor Travel Speed Speed of motor movement during modulation. Slow the movement down if servo movement errors occur. The motors move at full speed at other times or at the Purge Motor Travel Speed. Movement is limited by the slowest channel (i.e. the slowest moving motor).	Default: 1.5 Range 0.6 to 10.0	N	N	N	O_2

6.3.9 Options: MM: VSD

The **VSD Options** define the operation of the VSD (VFD) drive on the Mini Mk9.

Description	Setting	CP	PF	FSG	#
VSD 1 Enable Set up the VSD (VFD) operation.	0) Disabled 1) Enabled as VSD 2) Enabled as Servo (Fuel) 3) Enabled as Servo (Air) 4) Enabled as Servo (Independent)	Y	Y	N	O_90
VSD 1 Output Mode Defines the VSD (VFD) drive signal.	0) 4-20mA 1) 0-20mA 2) 0-10V	Y	Y	N	O_91
VSD 1 Input Mode Defines the VSD (VFD) feedback signal.	0) 4-20mA 1) 0-20mA 2) 0-10V	Y	Y	N	O_95
VSD 1 Feedback Fault Tolerance The allowed feedback tolerance from the VSD while firing. For example, if this option is set to 4%, the allowed tolerance during firing is ±4% of the whole VSD range. For commissioning, the difference between the lowest feedback point and the highest feedback point must be bigger than twice the tolerance. So for the default of 4% tolerance, the difference between the lowest feedback point and the highest feedback point must be greater than 8% of the whole VSD range.	Default: 4.0 Range 0.5 to 4.0 %	Y	Y	N	O_99
VSD 1 Purge Position Defines the drive of the VSD during a purge	0) Purge At Maximum Output 1) Purge At Minimum Output	Y	Y	N	O_73
VSD Servo 1 Accuracy Defines the control accuracy of the VSD when acting as a servo	0) 0.5 Degrees 1) 1.0 Degrees	N	Y	N	O_212
VSD 1 Displayed Output Units Select the units to display for the VSD 1 output	0) Hz 1) V/mA	N	N	N	O_92
VSD 1 Output Low Speed VSD speed when the output is low	Default: 25.0 Hz Range 0.0 to 200.0 Hz	N	N	N	O_93
VSD 1 Output High Speed VSD speed when the output is high.	Default: 50.0 Hz Range 0.0 to 200.0 Hz	N	N	N	O_94
VSD 1 Displayed Input Units Select the units to display for the VSD 1 input.	0) Hz 1) V/mA	N	N	N	O_96
VSD 1 Input Low Speed VSD speed when the input is low.	Default: 25.0 Hz Range 0.0 to 200.0 Hz	N	N	N	O_97

Description	Setting	CP	PF	FSG	#
VSD 1 Input High Speed VSD speed when the input is high.	Default: 50.0 Hz Range 0.0 to 200.0 Hz	N	N	N	O_98

6.3.10 Options: MM: PWM

The **PWM Options** define the operation of the PWM fan drive on the Mini Mk9.

Description	Setting	CP	PF	FSG	#
PWM Fan Channel Enable Set up the PWM fan operation.	0) Disabled 1) Enabled With Feedback 2) Enabled Without Feedback	Y	Y	N	O_209
PWM Fan Input Pulses Per Revolution Defines the number of pulses per revolution received from a PWM controlled fan	Default: 1 Range 1 to 10	Y	N	N	O_210
PWM Fan Channel Label Free text input for PWM fan channel label	PWM Fan Channel	N	N	N	O_211
PWM Output Polarity Controls whether the PWM output signal is Active High (default) (Low output signal = 0%, High output signal = 100%) or Active Low (Low output signal = 100%, High output signal = 0%)	0) Active High 1) Active Low	Y	N	N	O_223
PWM Feedback Fault Tolerance This defines the error window for PWM feedback vs commissioned.	Default: 4.0 Range 0.5 to 4.0	Y	Y		O_224
PWM Output Frequency The rate at which the PWM outputs a signal	Default: 1kHz Range 1 to 5kHz	N	N	N	O_225

6.3.11 Options: MM: Terminals

The **Terminals Options** define the operation of the input and output terminals on the Mini Mk9.

Description	Setting	CP	PF	FSG	#
T80 Function Define the use of the T80 burner control input. Terminals T80, T81 and T82 can all be configured to provide any three of the available options. See Section 9.9.1 for details.	0) Not Used 1) Start Position Interlock 2) Purge Position Interlock 3) Valve Proving 4) Delay To Purge 5) Purge Pressure Proving 6) Flame Switch 7) Flame Switch Inverse Input 8) Night Setback 9) Reduced Setpoint Select 10) Lockout Reset 11) Valve Proving (Secondary Fuel Output)	Y	N	Y	O_154

Description	Setting	CP	PF	FSG	#
T81 Function Define the use of the T81 burner control input. Terminals T80, T81 and T82 can all be configured to provide any three of the available options. See Section 9.9.1 for details	0) Not Used 1) Start Position Interlock 2) Purge Position Interlock 3) Valve Proving 4) Delay To Purge 5) Purge Pressure Proving 6) Flame Switch 7) Flame Switch Inverse Input 8) Night Setback 9) Reduced Setpoint Select 10) Lockout Reset 11) Valve Proving (Secondary Fuel Output)	Y	N	Y	O_155
T82 Function Define the use of the T82 burner control input. Terminals T80, T81 and T82 can all be configured to provide any three of the available options. See Section 9.9.1 for details	0) Not Used 1) Start Position Interlock 2) Purge Position Interlock 3) Valve Proving 4) Delay To Purge 5) Purge Pressure Proving 6) Flame Switch 7) Flame Switch Inverse Input 8) Night Setback 9) Reduced Setpoint Select 10) Lockout Reset 11) Valve Proving (Secondary Fuel Output)	Y	N	Y	O_156
Alarm Output Operation This is a switched neutral output to select how the alarm function operates.	0) Relay Normally Off, On During Alarm 1) Relay Normally On, Off During Alarm	N	N	N	O_56
Alarm Response Defines how the alarm responds to warnings	0) Warnings Drive Common System Alarm Output 1) Warnings Do Not Drive Common System Alarm Output	N	N	N	O_14
VSD Channel 1 Current Input Function The VSD current channel (T1, T3) can be used for a range of inputs selected from the list with standard VSD feedback being the default. Both the Current and Voltage inputs can be used independently at the same time, so any two functions may be selected across these inputs	0) VSD 1 Feedback 1) External Modulation 2) External Setpoint 3) External Firing Rate Limit 4) O2 Trim Signal	Y	N	N	O_205
VSD Channel 1 Voltage Input Function The VSD voltage channel (T2, T3) can be used for a range of inputs selected from the list with standard VSD feedback being the default. Both the Current and Voltage inputs can be used independently at the same time, so any two functions may be selected across these inputs	0) VSD 1 Feedback 1) External Modulation 2) External Setpoint 3) External Firing Rate Limit 4) O2 Trim Signal	Y	N	N	O_206
Load Sensor Input Function The load sensor input terminals (T37, T38, T39) may be reconfigured to any of the options in the list. Note that when used as a load sensor, the boiler water temperature sensor and the steam pressure sensor cannot be used in conjunction with each other	0) Load Sensor Input 1) External Modulation 2) External Setpoint 3) External Firing Rate Limit 4) O2 Trim Signal	Y	N	N	O_215

Description	Setting	CP	PF	FSG	#
Fuel Valve Output Configuration Defines the way multi-fuels are configured on the MM: 0) allows the configuration of 2 fuels and switching between them is possible using changeover relays. 1) allows 2 fuels to be configured with each fuel having its own set of outputs and switching between fuels is possible without changeover relays. 2) As 1 but with the possibility of fuel Change on the Fly (COF). See section 15 of this guide for the full details. Fuel curves must be commissioned for each fuel valve output mode. This option must be set before commissioning the MM.	0) One Set Of Outputs (Changeover Relays) 1) Two Sets Of Outputs (No Changeover Relays) 2) Two Sets of Outputs, Change On The Fly (COF)	Y	N	Y	O_131
T98 Function Defines the use of the T98 FAR processor input. The input can be configured to be any option for the list. See Section 9.9.2 for details	0) Not used 1) COF Enable 2) Lead Boiler Select 3) External Modulation Select 4) External Firing Rate Limiter Select 5) External Setpoint Select 6) Low Flame Hold 7) Hand Mode 8) Night Setback 9) Warming STAT 10) Manual Purge 11) Fixed Firing Rate Limit Enable 12) Reduced Setpoint Select	N	N	N	O_260
Flame Safeguard Mode Sets the Mini Mk9 to operate only as a Flame Safeguard device. See Section 12 for details	0) Disabled 1) Enabled	Y	N	Y	O_299

6.3.12 Options: Burner: Flame Scanner

The **Flame Scanner** **Options** set up and define the flame scanners connected to the Mini Mk9.

Description	Setting	CP	PF	FSG	#
Flame Scanner Selects the flame scanners attached to the Mini Mk9. Any scanners may be selected from the list to be connected in parallel (except for UV and Ionization which share the same circuit and must use switchover mode if both installed). A further selection determines how the scanners work if more than 1 are selected. **AND** means that both scanners must see the same result and either scanner seeing a false flame or not seeing a real flame will result in a shutdown. **OR** means that only one scanner needs to see the flame to carry on firing. Any scanner seeing a false flame will still cause a lockout.	1) UV 2) Ionization 3) UV/Ionization Switchover 4) IR 5) Flame Trim 6) Flame Switch	Y	Y	Y	O_122
UV Threshold This is the minimum flame signal strength. A lockout will occur if the UV count drops below this level. The system will try to stabilize the UV count at 5 times this level.	Default: 10 Range 5 to 50	Y	N	Y	O_120

Description	Setting	CP	PF	FSG	#
UV Flame Scanner Type Allows selection between two types of UV scanner, these being standard and self-check, with the latter opening and closing a shutter to verify that the scanner is not giving a false flame reading.	0) Standard 1) Self-Check	Y	N	Y	O_110
UV Shutter Test Interval This is the time interval between shutter tests on the self-check UV scanner.	Default: 10:00 Range 1 minute to 10 minutes	Y	N	Y	O_142
Maximum Allowed UV Self-Check Errors The MM will test the flame detection of self-check UV scanner at a time interval defined as above, and will generate a lockout if it has more errors than set in this option. Note that the total time represented by the UV Shutter Test Interval x Maximum Allowed UV Self-Check Errors cannot exceed 1 hour (Check local regulations for maximum allowed self-check interval).	Default: 3 Range 1 to 5	Y	N	Y	O_144

6.3.13 Options: Burner: Timings

The **Timings** **Options** set up and define the safety times associated with burner start-up.

Description	Setting	CP	PF	FSG	#
Pre-Ignition Time The time period when the ignition transformer is on before the pilot valves opens.	Default: 00:03 Range 3 to 5 seconds	Y	Y	Y	O_113
First Safety Time The time period when the pilot valve is open, before the flame is checked. The time range of this option depends on whether its firing gas or oil	Default: 00:03 Range 3 to 10 seconds	Y	Y	Y	O_114
Pilot Proving Time The time period for when the flame is checked after the first safety time, to prove the pilot flame (Pilot Trial For Ignition – PTFI)	Default: 00:03 Range 3 to 5 seconds	Y	Y	Y	O_115
Second Safety Time The time period when the main valves are open and the pilot valve is maintained open before the flame is checked (Main Trial For Ignition – MTFI). This safety time does not apply for intermittent pilot.	Default: 00:03 Gas Fuels Range 3 to 10 seconds Oil Fuel Range 3 to 15 seconds	Y	Y	Y	O_116
Main Flame Proving Time The time period after the second safety phase for interrupted pilot or after the pilot proving phase for intermittent pilot, where the flame is checked, before going to normal firing/modulation.	Default: 00:05 Range 5 to 20 seconds	Y	Y	Y	O_117
Recycle Time The time delay between the burner shutting down (including going through post-purge if optioned) and the burner being ready to start up again..	Default: 00:10 Range 3 seconds to 2 minutes	Y	Y	Y	O_119

6.3.14 Options: Burner: Purge

The **Purge** **Options** set up and define the pre-purge and post-purge functions associated with burner start-up and shutdown.

Description	Setting	CP	PF	FSG	#
Pre-Purge Time Purging the burner with air before start-up will force any combustion remnants out of the stack. The purge time should be set according to the boiler manufacturer's requirements and local codes and regulations.	Default: 00:40 Range 5 to 59 minutes and 59 seconds	Y	N	Y	O_112
Delay From Start Of Pre-Purge Until Air Switch Checked The time delay where the air switch is not checked, before starting the pre-purge time set above.	Default: 5 seconds Range 5 to 10 seconds	Y	N	Y	O_121
Timeout For Reaching Purge If the MM is stuck in Run to Purge or Run to Post Purge because the servomotors and VSDs are still moving to the purge position, then a lockout will occur after the timeout set in this option has elapsed. This does not apply to any requirements on purge timing such as any additional proving inputs.	Default: 00:00 Disabled: 00:00 Range 1 second to 59 minutes and 59 seconds	Y	N	Y	O_124
Delay To Purge Timeout If terminal T80, T81 or T82 is set to 'Delay To Purge Input', then an input is required on that terminal to indicate the system is ready to move toward the purge phase. If that signal is not seen for 1 second after this set time, then a lockout will occur. Setting this to 0 (disable) means the MM would sit indefinitely in delay to purge until the input is made.	Default: 00:00 Disabled: 00:00 Range 1 second to 59 minutes and 59 seconds	Y	N	Y	O_157
Purge Pressure Proving Timeout If terminal T80, T81 or T82 is set to 'Purge Pressure Proving', then the system will lockout if this purge interlock timer has elapsed. Setting this to 0 (disable) means the MM will be in the purge phase indefinitely until the input is made.	Default: 00:00 Disabled: 00:00 Range 1 second to 59 minutes and 59 seconds	Y	N	Y	O_158
Bypass Pre-Purge If selected, there will only be no pre-purge if the burner has recycled after crossing the internal stat, and has gone through VPS checks successfully. If the burner has a lockout, or is restarting after a lockout has been cleared, the MM will force a pre-purge. Fuel must be set to gas.	0) Pre-Purge Operates 1) No Pre-Purge	Y	N	Y	O_143
Post-Purge Time If set, a post-purge will occur after a normal burner shutdown. The timer begins once all channels have reached their post-purge positions. The flame is not checked during post-purge. This timing relates to Normal or NFPA post purge.	Default: 00:00 Disabled: 00:00 Range 1 second to 59 minutes and 59 seconds	Y	N	Y	O_118
Post-Purge Type Normal post-purge drives all channels to their defined purge positions and then purges for the time set above. For NFPA post-purge, all the servomotors will remain in the position they were in before normal shutdown or lockout. The NFPA post-purge will occur under any normal shutdown or lockout at any point in firing. The NFPA post-purge time must be set to 15 seconds or higher.	0) Normal Post-Purge 1) NFPA Post-Purge	Y	N	Y	O_135

6.3.15 Options: Burner: Sensors

The **Sensors** **Options** set up and define the Autoflame gas and air sensor operation.

Description	Setting	CP	PF	FSG	#
Fuel Pressure Sensor Mode Defines how valve proving operates: 0) Valve proving is not checked. 1) Valve proving is checked by an Autoflame gas sensor and pressure limits checked against the defined limits during combustion. 2) Valve proving is checked by an Autoflame gas sensor. 3) Valve proving is checked by a switch. 4) Valve proving is not checked, but pressure limits are checked against the defined limits during combustion using an Autoflame gas sensor. 5) External VPS will wait for a mains voltage input on the CPI/POC input (T55 for Fuel1 and T97 for Fuel 2) to confirm that the VPS test is completed. If a voltage is not detected on terminal 55 within 10 minutes, a lockout will occur.	0) Not Monitored 1) Valve Proving And Pressure Limits 2) Valve Proving With Pressure Sensor 3) Valve Proving With Digital Input 4) Pressure Limits Only 5) External VPS	Y	Y	Y	O_125
Fuel Pressure Sensor Serial Number Serial number of the gas sensor connected to allow the MM to identify each sensor so that separate gas sensors can be used for each fuel. If only one gas sensor is fitted then this is not needed and should be left disabled.	Default: 0 Disabled: 0 Range 1 to 10000	Y	Y	Y	O_126
Fuel Pressure Sensor Type Specifies which pressure sensor is used for each fuel type. If only one gas sensor is fitted then this is not needed and should be left Not Defined.	0) Not Defined 1) MM80006 – 68mBar, 25”wg, 1PSI 2) MM00008 – 344mBar, 138”wg, 5PSI 3) MM00011 – 1034mBar, 415”wg, 15PSI 4) MM00012 – 2068mBar, 831”wg, 30PSI 5) MM00014 – 6894mBar, 2770”wg, 100PSI	Y	Y	Y	O_127
Air Pressure Sensor Type Defines the type of air pressure sensor being used: 0) An external air pressure switch must be wired to T54. If a voltage reset is not detected within 2 minutes on T54 during the ‘Wait for Air Switch’ phase before running to purge, a lockout will occur. 1) An Autoflame air pressure sensor will look for zero air pressure in the ‘Zero Air Sensor’ phase before running to purge. 2) Both of the above checks are made.	0) Air Switch 1) Air Pressure Sensor 2) Air Switch And Air Pressure Sensor	Y	N	N	O_148
Air Pressure Error Window The air pressure error window is only active during modulation; the burner will lockout if the air pressure is outside of this window and limits are being checked. The air pressure units are set in **Options/Controller/Units**. **Note:** If set to zero Air Pressure checking will only happen during purge, not during firing.	Default: 0 Range 0 to 30.0 mbar Range 0 to 12.06 “WG	Y	N	N	O_147

Description	Setting	CP	PF	FSG	#
Air Proving Pressure Threshold The minimum air pressure that must be detected by the MM during normal firing when using an Autoflame air pressure sensor. The air pressure units are set in **Options/Controller/Units**.	Default: 1.0 mbar or 0.4"WG Range 0.7 to 120.0 mbar Range 0.281 to 48.22 "WG	Y	N	N	O_149
Purge Proving Pressure Threshold The minimum air pressure that must be detected by the MM during purge when using an Autoflame air pressure sensor. The air pressure units are set in **Options/Controller/Units**.	Default: 1.0 mbar or 0.4"WG Range 0.7 to 120.0 mbar Range 0.281 to 48.22 "WG	Y	N	N	O_141
Air Pressure Warning Offset Below Commissioned A warning is generated if the air pressure falls below this offset lower limit from the commissioned air pressure. The air pressure units are set in **Options/Controller/Units**.	Default: 0 Range 0 to 100.0 mbar Range 0 to 40.19 "WG	Y	N	N	P_103
Air Pressure Warning Offset Above Commissioned A warning is generated if the air pressure rises above this offset upper limit from the commissioned air pressure. The air pressure units are set in **Options/Controller/Units**.	Default: 0 Range 0 to 100.0 mbar Range 0 to 40.19 "WG	Y	N	N	P_104

6.3.16 Options: Burner: Valve Proving

The **Valve Proving** **Options** set up and define the valve proving operation and checks.

Description	Setting	CP	PF	FSG	#
Vent Valve Configuration Defines the vent valve configuration	0) No Vent Valve 1) Vent Normally Closed 2) Vent Normally Open	Y	Y	Y	O_130
Valve Proving Operation Defines when the VPS process operates	0) VPS Operates Before Startup 1) VPS Operates After Shutdown 2) VPS Operates Before And After Firing	Y	N	Y	O_129
Valve Proving Valve Opening Time The time period for each phase when a gas valve is opened: • 'VPS Venting' for the void to vent to atmosphere • 'VPS Void to Gas' for the void to fill with gas	Default: 3 seconds Range 3 to 20 seconds	Y	Y	Y	O_134
Valve Proving Time The time period when both gas valves are closed to detect a change in air pressure for the 'VPS air proving' phase, or a change in gas pressure for 'VPS gas proving' phase.	Default: 00:20 Range 10 seconds to 5 minutes	Y	Y	Y	O_132
Maximum Pressure Change Allowed During VPS A lockout will occur if the pressure changes by more than this value during VPS. Gas pressure units are set in **Options/Controller/Units**.	Default: 2.5mbar, 1.004"WG, 0.04PSI Range 0 to 1340.0 mbar Range 0 to 537.8 "WG Range 0 to 19.5 PSI	Y	Y	N	O_133
Gas Static Line Pressure Offset Below Commissioned A lockout will occur if the static line gas pressure falls below this offset limit. If set to 0, the Gas Running Pressure Offset Below Commission is used for this check. If both the Static and Running Pressure Offsets are set to 0, then a lockout will occur if the measured static line pressure during VPS void to gas phase falls below the Maximum Pressure Change Allowed During VPS. Gas pressure units are set in **Options/Controller/Units**.	Default: 2.5mbar, 1.004"WG, 0.04PSI Range 0 to 5000.0 mbar Range 0 to 2006.63 "WG Range 0 to 72.52 PSI	Y	Y	N	O_138

Description	Setting	CP	PF	FSG	#
Gas Running Pressure Offset Below Commissioned Curve This is an offset lower limit from the commissioned gas pressure. See **Options/Burner/Sensors** for setting the operation in the Fuel Pressure Sensor Mode option. Gas pressure units are set in **Options/Controller/Units**.	Default: 2.5mbar, 1.004"WG, 0.04PSI Range 0 to 1340.0 mbar Range 0 to 537.8 "WG Range 0 to 19.5 PSI	Y	Y	N	O_136
Gas Running Pressure Offset Above Commissioned Curve This is an offset upper limit from the commissioned gas pressure. Gas pressure units are set in **Options/Controller/Units**.	Default: 2.5mbar, 1.004"WG, 0.04PSI Range 0 to 1340.0 mbar Range 0 to 537.8 "WG Range 0 to 19.5 PSI	Y	Y	N	O_137
Gas Running Pressure Warning Offset Below Commissioned Curve A warning will be generated if the running gas pressure falls below this offset lower limit from the commissioned gas pressure. See **Options/Burner/Sensors** for setting the operation in the Fuel Pressure Sensor Mode option. Gas pressure units are set in **Options/Controller/Units**.	Default: 0 (disabled) Range 0 to 1340.0 mbar Range 0 to 537.8 "WG Range 0 to 19.5 PSI	Y	Y	N	P_105
Gas Running Pressure Warning Offset above Commissioned Curve A warning will be generated if the running gas pressure rises above this offset upper limit from the commissioned gas pressure. See **Options/Burner/Sensors** for setting the operation in the Fuel Pressure Sensor Mode option. Gas pressure units are set in **Options/Controller/Units**.	Default: 0 (disabled) Range 0 to 1340.0 mbar Range 0 to 537.8 "WG Range 0 to 19.5 PSI	Y	Y	N	P_106

6.3.17 Options: Burner: Pilot

The **Pilot** **Options** define the operation of the pilot.

Description	Setting	CP	PF	FSG	#
Single Valve Pilot Sets whether single valve pilot is enabled or disabled. Cannot be used with Oil fuels or in Dual Fuel Mode	0) Single Valve Pilot Disabled 1) Single Valve Pilot Enabled	Y	Y	Y	O_130
Pilot Mode For Interrupted Pilot, when lighting off, the pilot valve will close at the point the main flame proving phase begins. For Intermittent Pilot, the pilot valve will remain open during firing.	0) Interrupted Pilot 1) Intermittent Pilot 2) No Pilot	Y	Y	Y	O_111
Continuous Pilot If Continuous Pilot is enabled, when the burner goes above the STAT off point, the burner will continue to fire with just the pilot valves energized until the timer or threshold level defined below is met. Requires **Options/Firing/Shut-Down/Assured Low Fire Shutdown** to be **Enabled**.	0) Disabled 1) Enabled	Y	Y	Y	O_230
Continuous Pilot Shutoff Timer If Continuous Pilot is enabled then the burner will switch off after this timer has elapsed	Default: 00:00:00 Disabled: 00:00:00 Range 1 second to 23hours, 59 minutes and 59 seconds	Y	Y	Y	O_71

Description	Setting	CP	PF	FSG	#
Continuous Pilot Shutoff Offset If Continuous Pilot is enabled then if the actual value is higher than the combined burner switch-off offset (see **Options/Firing/STAT**) and this offset above the required setpoint, the burner will go off.	Default: 0 (disabled) Range 0 to 100 Units are °C, °F, PSI or bar depending on displayed units and boiler load sensor type settings	Y	Y	Y	O_72

6.3.18 Options: Load: Load Sensor

The **Load Sensor** **Options** define the type of load sensor fitted and its operation.

Description	Setting	CP	PF	FSG	#
Boiler Load Sensor Type Selection of temperature or pressure sensor for measuring the load. A range of Autoflame sensors can be selected. External Temperature or Pressure sensors require defining using the External Load Detector settings outlined below. The 'None' Setting is for when the Load Sensor is being used for other functions, such as External Modulation or External Setpoint as defined in **Options/MM/Terminals/Load Sensor Input Function**.	0) Temperature (MM10006, 0 to 400°C / 752°F) 1) Low Pressure (MM10010, 0 – 3.4bar / 50psi) 2) Medium Pressure (MM10008, 0 – 20-bar / 300psi) 3) High Pressure (MM10009, 0 – 34bar / 500psi) 4) Extra High Pressure (MM10017, 0 – 100bar / 1450psi) 5) External Temperature 6) External Pressure 7) None	N	N	N	O_1
Internal STAT Operation The internal stat turns the burner on and off according to the actual value relative to the required setpoint as follows: 0) Internal stat is closed all the time, and a working stat must be fitted to the boiler. 1) Internal stat is opened at an offset above the required setpoint, and closed at an offset below the required setpoint. 2) Internal stat is opened at an offset above the required setpoint, and closed at an offset above the required setpoint. The offset values are set in **Burner Switch Off Offset** and **Burner Switch On Offset**.	0) Internal STAT Always Closed 1) Burner Operates Below Setpoint 2) Burner Operates Above Setpoint	N	N	N	O_9
Burner Switch Off Offset The offset from the required setpoint at which the burner switches off. **Note**: if change units away from °C, then the default offset may not be optimal and should be adjusted.	Default: 3.0 Range 0.2 to 100 Units are °C, °F, PSI or bar depending on displayed units and boiler load sensor type settings	N	N	N	O_10
Burner Switch On Offset The offset from the required setpoint at which the burner switches on. **Note**: if change units away from °C, then the default offset may not be optimal and should be adjusted.	Default: 3.0 Range 0.0 to 100 Units are °C, °F, PSI or bar depending on displayed units and boiler load sensor type settings	N	N	N	O_11
Load Sensor Adjustment Adjust the load sensor by the set percentage to align it with a calibrated sensor reading	Default: 100.0 Range 80.0 to 120.0 %	N	N	N	P_29

Description	Setting	CP	PF	FSG	#
Load Sensor Filter Time The time over which load sensor measurements are averaged	Default: 00:10 Range 1 to 40 seconds	N	N	N	P_30
External Load Detector Minimum Value The external load detector reading when the voltage is at its minimum – that is the lowest reading of the external detector.	Default: 0 Range 0.0 to 9990.0 Units are °C, °F, PSI or bar depending on displayed units and boiler load sensor type settings	N	N	N	P_55
External Load Detector Maximum Value The external load detector reading when the voltage is at its maximum – that is the highest reading of the external detector.	Default: 0 Range 0.0 to 9990.0 Units are °C, °F, PSI or bar depending on displayed units and boiler load sensor type settings	N	N	N	P_53
External Load Detector Minimum Voltage The minimum voltage from the external load detector.	Default: 0 Range 0.0 to 10 V	N	N	N	P_56
External Load Detector Maximum Voltage The minimum voltage from the external load detector.	Default: 10 Range 0.0 to 10 V	N	N	N	P_54
External Load Detector Decimal Places Number of decimal places displayed for an external load detector	Default: 0 Range 0 to 2 d.p.	N	N	N	P_52

6.3.19 Options: Load: Setpoint

The **Setpoint** **Options** define the setpoint is configured.

Description	Setting	CP	PF	FSG	#
User Setpoint Control Sets if the user can change the setpoint via the setpoint screen on the MM. If Locked, the up/down arrows are disabled on the **AF/Setpoint/Status** and the Main/Reduced Setpoints cannot be changed from their current positions on the **AF/Fuel-Air/Curve** screen.	0) Locked 1) Unlocked	N	N	N	O_15
User Burner On/Off Control Sets if the user can turn the burner on/off via the **Disable Burner** slider switch on **AF/Setpoint/Status** screen. When Locked the slider cannot be changed from its current position.	0) Locked 1) Unlocked	N	N	N	O_15
Setpoint Minimum Defines the Minimum Setpoint that can be set using either the arrowed buttons on the setpoint screen or from a remote input. This combines the previous User and Remote Setpoint Minimum into one.	Default: 0.0 (disabled) Range 0.0 to 10000.0 Units are °C, °F, PSI or bar depending on displayed units and boiler load sensor type settings	N	N	N	P_32
Setpoint Maximum Defines the Maximum Setpoint that can be set using either the arrowed buttons on the setpoint screen or from a remote input. This combines the previous User and Remote Setpoint Maximum into one.	Default: 0.0 (disabled) Range 0.0 to 10000.0 Units are °C, °F, PSI or bar depending on displayed units and boiler load sensor type settings	N	N	N	P_33

Description	Setting	CP	PF	FSG	#
Internal High Limit Setpoint Defines an absolute shutdown setpoint that also operates in commission mode as well as normal running mode.	Default: 0 Disabled 0 Range 0.0 to 99.9 Units are °C, °F, PSI or bar depending on displayed units and boiler load sensor type settings	N	N	N	P_28
Outside Temperature Compensation Method of compensating for the outside temperature.	0) Disabled 1) Enabled Using OTC Unit 2) Enabled Using MM Sensor 3) Enabled Using Internet Weather Data	N	N	N	O_80
Setpoint At Minimum Temperature The setpoint used when at Minimum Outside Temperature if Outside Temperature Compensation is enabled. Note the setpoint is limited by the selected load detector.	Default: 9.0 Range 5.0 to 99.9 Units are °C, °F, PSI or bar depending on displayed units and boiler load sensor type settings	N	N	N	O_81
Minimum Outside Temperature The temperature at which a Setpoint At Minimum Temperature will operate if Outside Temperature Compensation is enabled. The High temperature allows this setting to be used for process control.	Default: -10.0 Range -40.0 to 500.0 Units are °C, °F depending on displayed units	N	N	N	O_82
Setpoint At Maximum Temperature The setpoint used when at Maximum Outside Temperature if Outside Temperature Compensation is enabled. Note the setpoint is limited by the selected load detector.	Default: 8.0 Range 5.0 to 99.9 Units are °C, °F, PSI or bar depending on displayed units and boiler load sensor type settings	N	N	N	O_83
Maximum Outside Temperature The temperature at which a Setpoint At Maximum Temperature will operate if Outside Temperature Compensation is enabled. The High temperature allows this setting to be used for process control.	Default: 40.0 Range -40.0 to 500.0 Units are °C, °F depending on displayed units	N	N	N	O_84
Night Setback Offset This offset value is subtracted from the required setpoint. An input is required on Terminal T80, T81, T82 or T98 and ***Night Setback*** to be optioned in the appropriate Terminal Function in **Options/MM/Terminals**.	Default: 0.0 Range 0.0 to 10.0	N	N	N	O_85
High Limit Setpoint Turn-On Offset Defines the level below the High Setpoint Limit at which the burner will restart after having switched off due to breaching the limit.	Default: 0 Disabled 0 Range 0.0 to 99.9 Units are °C, °F, PSI or bar depending on displayed units and boiler load sensor type settings	N	N	N	P_161
High Limit Setpoint Fault Response Determines the alarm response if a High Limit Setpoint has been breached. Recycling Alarm with automatically clear once the setpoint drops below the **High Limit Setpoint Turn-On Offset**. Non-Recycling alarms require user reset.	0) Generates Non-Recycling Alarm 1) Generates Recycling Alarm	N	N	N	P_162

Description	Setting	CP	PF	FSG	#
External Setpoint Defines how external setpoint is enabled. Enabled By Input requires an input on T98 and ***External Setpoint Select*** to be optioned in **Options/MM/Terminals/T98 Function**.	0) Disabled 1) Enabled 2) Enabled By Input	N	N	N	O_219
External Setpoint Input Range Defines the range of the current or voltage input seen on T1, T3 for current input or T2, T3 for voltage input	0) 4-20mA, 2-10V 1) 0-20mA, 0-10V	N	N	N	O_220
External Setpoint Minimum Setpoint Defines the minimum setpoint if external setpoint is being used.	Default: 0 Range 0.0 to 1000.0 Units are °C, °F, PSI or bar depending on displayed units and boiler load sensor type settings	N	N	N	O_221
External Setpoint Maximum Setpoint Defines the maximum setpoint if external setpoint is being used.	Default: 20.0 Range 0.0 to 1000.0 Units are °C, °F, PSI or bar depending on displayed units and boiler load sensor type settings	N	N	N	O_222

6.3.20 Options: Load: Sequencing

The **Sequencing** **Options** define how the MM works when sequenced with other units.

Description	Setting	CP	PF	FSG	#
Sequencing Enable Defines the sequencing and/or DTI function. With Sequencing Enabled a group of interconnected MM's will operate together. With DTI enabled a connected DTI can control the Mini Mk9. With both enabled, the DTI can control sequencing. A lead boiler can be selected by pressing Lead Boiler in the IBS screen or via the DTI if optioned. Only 1 MM may be selected as lead boiler at a time, or the sequencing will not operate. The Lead Boiler button on the MM overrides the DTI Lead Boiler Select. Note this is only for sequencing over the RS485 connection with/without a Mk8 DTI. Mk9 DTI Sequencing over Ethernet ignores these settings.	0) Disabled 1) Sequencing Enabled 2) DTI Enabled 3) Sequencing And DTI	N	N	N	O_16
Sequencing ID Each MM within a sequencing/DTI/Modbus loop must be set with an individual ID number. For communications between the MMs, there cannot be more than 1 MM with the same ID number.	Default: 1 Range 1 to 10	N	N	N	O_33
Sequencing MM Count Defines the MM with the highest number in the sequencing loop	Default: 2 Range 2 to 10	N	N	N	P_57

Description	Setting	CP	PF	FSG	#
Sequencing Mode For low Pressure Steam For sequencing applications where non-return valves are not installed, it is not possible to use a setpoint to keep the boilers in a standby condition. A thermostat (aquastat) can be installed into the boiler shell. In **Options/MM/Terminals**, set one of T80, T81 or T82 Function to ***Warming Stat***. When the defined terminal sees a 230/120V input, warming is stopped. The boiler will remain in a warming state based on the settings of the Sequencing Warming Burner Off Time and Sequencing Warming Burner On Time.	0) With Non-Return Valves 1) Without Non-Return Valves	N	N	N	O_40
Sequencing Mode For Hot Water Defines how the lag boilers will work with hot water sequencing. For setting 0, the lag boilers will be off. For setting 1, the lag boiler will operate as defined in the Warming Mode Setting	0) Two State Hot Water Sequencing (On/Off) 1) Three State Hot Water Sequencing (On/Warming/Off)	N	N	N	P_62
Warming Mode Defines how many boilers are kept in warming mode. For setting 0, the first lag is kept in a standby state with the second lag in warming, and the remaining lag boilers off. For setting 1, the first lag boiler is in standby, and the remaining lag boilers are in warming.	0) One MM in Warming State 1) All Unused MMs in Warming State	N	N	N	O_41
Sequencing Scan Time This is the time period between sequencing requests from the lead and the lag MMs. On the sequence scan time, the lead MM will demand lag burners to be brought online or offline, depending on load requirements and the **Sequencing Change Down Threshold**/**Sequencing Change Up Threshold**. Accurate fuel flow metering must be entered for sequencing to operate correctly.	Default: 10 Range 1 to 120 minutes	N	N	N	O_35
Sequencing Scan Time When Unit Goes Offline This sets the time delay to the next scan when a sequenced MM drops out of the sequence loop.	Default: 3 Range 0 to 20 minutes	N	N	N	P_1
Sequencing Change Down Threshold If the combined firing rate of the last 2 MMs in the sequence loop is below this value, then the last lag MM will go from 'on' to the next phase ('standby', 'warming' or 'off') depending on how **Warming Mode** is set.	Default: 85 Range 0 to 99 %	N	N	N	P_86
Sequencing Change Up Threshold If the firing rate of the last MM in the sequence loop is above this value, then the next MM will go to the 'on' phase at the next sequence scan time in order to meet load.	Default: 95 Range 0 to 100 %	N	N	N	P_87
Standby Or Phantom Setpoint Offset For sequencing applications where non-return valves are installed, the first lag boiler uses a standby setpoint to keep the boiler in a standby condition. This value is the required setpoint if Use Fixed Standby Setpoint is selected below. This value is an offset below the required setpoint if Use Phantom Setpoint Offset is selected below. When the standby setpoint is in effect, the burner is held at low flame hold.	Default: 2.0 Range 0.5 to 999.0 Units are °C, °F, PSI or bar depending on displayed units and boiler load sensor type settings	N	N	N	O_42

Description	Setting	CP	PF	FSG	#
Standby Or Phantom Setpoint Mode Defines whether the Standby Or Phantom Setpoint Offset is an absolute setpoint value, or an offset value from the normal setpoint.	0) Use Fixed Standby Setpoint 1) Use Phantom Setpoint Offset	N	N	N	P_47
Number Of Boilers Initially On Defines the number of boilers in the On state in the sequence loop when powered on after a shutdown. Set to the highest MM ID number (see Sequencing MM Count) if the application requires all the MMs to be On in the sequence loop when powered back on.	Default: 2 Range 2 to 10	N	N	N	P_3
Modulation Timeout If a sequenced MM does not start modulating within this time after being asked to by the lead MM, it is ignored in the sequencing loop. Upon the next scan time, if the MM modulates as required, it will be included in the sequencing loop.	Default: 4 Range 1 to 50 minutes	N	N	N	P_5
Sequencing Warming Burner Off Time When the MM is in warming mode, it will warm to the standby setpoint according to the on and off times set in **Sequencing Warming Burner Off Time**/ **Sequencing Warming Burner On Time**.	Default: 0 Disabled 0 Range 1 to 200 minutes	N	N	N	O_53
Sequencing Warming Burner On Time When the MM is in warming mode, it will warm to the standby setpoint according to the on and off times set in **Sequencing Warming Burner Off Time**/ **Sequencing Warming Burner On Time**.	Default: 5 Range 1 to 30 minutes	N	N	N	O_54
Shuffle Sequencing Allows the DTI to control the sequence order if Enabled.	0) Disabled 1) Enabled	N	N	N	P_101

6.3.21 Options: Load: PID

The **PID** **Options** define how the PID loop control works.

Description	Setting	CP	PF	FSG	#
PID Proportional Band The proportional band is an offset below the required setpoint; when the actual temperature/ pressure reaches this band, the burner will begin to modulate down as it approaches the required setpoint.	Default: 10.0 Range 0.5 to 200.0 Units are °C, °F, PSI or bar depending on displayed units and boiler load sensor type settings	N	N	N	O_6
PID Integral Time Every 'n' seconds, 10% of the present offset from the required setpoint is added or subtracted when below or above the setpoint, respectively, to the present proportional value. The value of 'n' is the number of seconds set in this option; if set to 0, there will be no integral control.	Default: 01:00 Disabled: 00:00 Range 1 second to 4 minutes	N	N	N	O_7
PID Integral Band This is the percentage of the proportional band over which the integral control is active.	Default: 80 Range 0 to 100.0 %	N	N	N	P_48
PID Derivative Time Sets the time taken to add/remove an additional 10% to the firing rate based on the actual value and the required value.	Default: 00:00 Disabled: 00:00 Range 1 second to 3 minutes and 20 seconds	N	N	N	O_37

Description	Setting	CP	PF	FSG	#
PID Derivative Deadband Sets a deadband above and below the required setpoint in which no derivative control occurs.	Default: 0.2 Disabled 0 Range 1 to 1.5 Units are °C, °F, PSI or bar depending on displayed units and boiler load sensor type settings	N	N	N	O_38

6.3.22 Options: Firing: Start-Up

The **Start-Up** **Options** define the starting procedure of the burner.

Description	Setting	CP	PF	FSG	#
Golden Start Golden start allows an optimum ignition position to be set, separate from the main fuel-air curve. The Golden Start Time sets how long golden start position is maintained from ignition.	0) Disabled 1) Enabled	Y	Y	N	O_29
Golden Start Time This is the time period for which the golden start position is held.	Default: 00:05 Range 2 seconds to 2 minutes	N	Y	N	P_15
Cold Start Routine On start-up, the burner will be held at **Low Fire** for the number of minutes set in this option if the actual load is at or below the **Cold Start First Fraction**. It will then move to mid-fire. If the actual value is below the **Cold Start Second Fraction**, then the burner will be held at **Mid-Fire** for the set minutes. Once this cold start time has elapsed, or the value goes above the **Cold Start Second Fraction**, the burner will modulate as per the internal PID. It is not recommended to use a **Cold Start Routine** with **External Modulation** or **Sequencing**.	Default: 0 Disabled 0 Range 1 to 2000 minutes	N	N	N	O_47
Cold Start Inhibit Time If the MM progresses through **the Cold Start Routine** to modulating and the burner shuts down, then a **Cold Start** will not occur if the burner starts up again within the **Cold Start Inhibit Time**. This allows the burner to move straight to normal modulation in situations where the demand has increased drastically and the load value drops fast, but the boiler is still warm from the earlier firing.	Default: 0 Disabled 0 Range 1 to 120 minutes	N	N	N	O_46
Cold Start First Setpoint Fraction % of setpoint below which the burner will be held in low fire during a cold start	Default: 30 Range 1 to 98 %	N	N	N	P_49
Cold Start Second Setpoint Fraction % of setpoint below which the burner will be held in mid-fire during a cold start	Default: 60 Range 2 to 99 %	N	N	N	P_49

6.3.23 Options: Firing: Modulation

The **Modulation** **Options** define how the burner modulation is controlled.

Description	Setting	CP	PF	FSG	#
External Modulation When enabled, the internal PID control is disabled and the firing rate is set by an external controller applied to terminals T37 and T38. This input control signal can be 0-10V or 2-10V selected in **External Modulation Input Range**. The range represents zero or low to high fire by setting **External Modulation Input Control Range**. A manual reset high limit stat must be fitted.	0) Disabled 1) Enabled 2) Enabled By Input	N	N	N	O_45
External Modulation Input Control Range Defines whether the external modulation input covers the range from zero, or low fire to high fire.	0) Low To High 1) Zero To High	N	N	N	P_68
External Modulation Input Range Sets the range for the external modulation input on terminals T37 and T38. To use a current input (mA), a 500ohm resistor needs to be placed across the terminals.	0) 4-20mA, 2-10V 1) 0-20mA, 0-10V	N	N	N	P_69
Fixed Firing Rate Limit This is the maximum firing rate that can be obtained by the system and is imposed in auto and hand modes. Firing Rate Limit should not be used with DTI Load Index control or Sequencing. The Firing Rate Limit also applies to external modulation.	Default: 0 Range 0 to 100 %	N	N	N	O_66
Fixed Firing Rate Limit Enable Defines how Firing Rate Limit is enabled. Enabled By Input, requires an input on T98 and **Fixed Firing Rate Limit Enable** to be optioned in **Options/MM/Terminals/T98 Function**.	0) Disabled 1) Enabled 2) Enabled By Input	N	N	N	O_66
External Firing Rate Limiter Defines how External Firing Rate Limit is enabled. When Enabled, a 4-20mA or 0-10V signal is required on the VSD 1 Inputs T1/T2 and T3 to set the limit. **Options/MM/Terminals/VSD Channel 1 Current (Voltage) Input Function** must be set to **External Firing Rate Limit** as appropriate. Enabled By Input, requires an input on T98 and **External Firing Rate Limiter Select** to be optioned in **Options/MM/Terminals/T98 Function**.	0) Disabled 1) Enabled 2) Enabled By Input	N	N	N	O_216
External Firing Rate Limiter Input Control Range Defines whether the External Firing Rate Limiter input covers the range from zero, or low fire to high fire.	0) Low To High 1) Zero To High	N	N	N	O_217
External Firing Rate Limiter Input Range Sets the range for the External Firing Rate Limiter input on terminals T37 and T38. To use a current input (mA), a 500ohm resistor needs to be placed across the terminals.	0) 4-20mA, 2-10V 1) 0-20mA, 0-10V	N	N	N	O_218
Modulation Exerciser Period When enabled, the MM will repeatedly run between high fire and low fire. This value sets how long the MM will spend moving towards and sitting at the high fire and low fire positions. This should only be used in test/inspection conditions.	Default: 00:00 Disabled: 00:00 Range 1 second to 59 minutes and 59 seconds	N	N	N	P_85

Description	Setting	CP	PF	FSG	#
STAT Exerciser Period When enabled, then T53 will be repeatedly turned on for this timer duration, and then turned off for this timer duration. This must only be used in test/inspection conditions.	Default: 00:00 Disabled: 00:00 Range 1 second to 59 minutes and 59 seconds	N	N	N	P_89

6.3.24 Options: Firing: Shut-Down

The **Shut-Down** **Options** define the shut-down procedure of the burner.

Description	Setting	CP	PF	FSG	#
Assured Low Fire Shutdown If enabled, when the burner internal stat turns off, the MM will first modulate to low fire and then shut down and recycle the system before turning off.	0) Disabled 1) Enabled	N	N	N	P_100

6.3.25 Options: Firing: FGR

The **FGR** **Options** define how Flue Gas Recirculation works.

Description	Setting	CP	PF	FSG	#
Flue Gas Recirculation Timer An FGR position may be commissioned as a point separate to the main Fuel-Air curve. If this timer is set, start-up occurs at the FGR position and is held for the set time before moving to the main Fuel-Air curve and starting modulation. FGR allows approximately 15% of the boiler flue gases to be fed back to the burner and mixed with combustion air, to reduce NOx. One of the servos must be enabled as an **Independent Channel** in **Options/MM/Servos** to control this. If **Golden Start** is optioned the burner will start up at **Golden Start** and then move to the **FGR position**.	Default: 00:00 Disabled: 00:00 Range 1 second to 59 minutes and 59 seconds	Y	Y	N	O_48
Flue Gas Recirculation Offset This is an offset from the required setpoint. If set, the FGR position is held until the actual value reaches this offset value below the required setpoint.	Default: 0.0 Range 0.0 to 100.0 Units are °C, °F, PSI or bar depending on displayed units and boiler load sensor type settings	Y	Y	N	O_49
Flue Gas Recirculation Temperature Threshold The FGR position is held until the flue gas temperature has reached 120°C (248°F). This option can only be used if an EGA is optioned and operational.	0) Disabled 1) Enabled	Y	Y	N	O_50

6.3.26 Options: EGA: Operation

The **Operation** **Options** define set up a connection to an EGA.

Description	Setting	CP	PF	FSG	#
EGA Mode Defines the operation of a connected EGA. For Monitoring Only, the EGA values are communicated to the Mini and shown on screens. If Applies trim is set, the EGA will trim on the air channel or VSD once trim data has been added. Note Trim data is added separately from the Fuel-Air curve commission using **Commission/Single Point Change/Trim Change**.	0) Disabled 1) Monitoring Only 2) Applies Trim	N	N	N	O_12
EGA Fault Response Sets the MM operation when an EGA fault occurs. EGA alarms will drive the common system alarm output (T79). see **Options/MM/Terminals/Alarm Response** to set how warnings drive the alarm.	0) EGA Faults Generate Alarms (Burner Stops) 1) EGA Faults Generate Warnings (Burner Runs)	N	N	N	O_13
Air Calibration On Startup Will force an Air Calibration when the burner starts up. For the Mk8 EGA, the air calibration schedule is set on the EGA itself.	0) Disabled 1) Enabled	N	N	N	P_58
Delay Before Commission Can Be Stored Sets a delay before the EGA values are stored during **Commission/Single Point Change/Trim Change**. This value should be set to the length of time it takes for the gases to reach the EGA.	Default: 00:45 Range 10 seconds to 2 minutes	N	N	N	P_4
Time Between Air Calibrations The time period between air calibrations if the burner does not go off.	Default: 12 hours Range 1 to 48 hours	N	N	N	P_16

6.3.27 Options: EGA: O2 Sensor

The **O2 Sensor** **Options** define the setup of a connection to an O2 Sensor.

Description	Setting	CP	PF	FSG	#
O2 Sensor Mode Defines the operation of a connected O2 sensor. For Monitoring Only, the O2 sensor values are communicated to the Mini and shown on screens. If Applies trim is set, the O2 sensor will trim on the air channel or VSD once trim data has been added. Note Trim data is added separately from the Fuel-Air curve commission using **Commission/Single Point Change/Trim Change**.	0) Disabled 1) Monitoring Only 2) Applies Trim	N	N	N	O_240
O2 Sensor Input Range Sets the range used by the O2 sensor for its maximum and minimum outputs.	0) 4-20mA, 2-10V 1) 0-20mA, 0-10V	N	N	N	O_241
O2 Sensor Minimum O2 Concentration Defines the O2 Concentration at the minimum sensor output.	Default: 0.0% Range 0.0% to 100.0%	N	N	N	O_242
O2 Sensor Maximum O2 Concentration Defines the O2 Concentration at the maximum sensor output.	Default: 20.95% Range 0.0% to 100.0%	N	N	N	O_243

Description	Setting	CP	PF	FSG	#
O2 Sensor Maximum CO2 Concentration Defines the calculated CO2 reading at the minimum O2 concentration. This is calculated linearly with 0.0% CO2 being at the Maximum O2 concentration (i.e. not firing)	Default: 11.8% Range 0.0% to 100.0%	N	Y	N	O_244

6.3.28 Options: EGA: Limits

The **Limits Options** set up combustion limits for each of the gases and the exhaust temperature when using an EGA and applying combustion limits.

Note Combustion Limits must be selected in Option/EGA/Operation/EGA Mode. Option/EGA/Operation/EGA Fault Response defines whether an alarm or warning will occur.

Description	Setting	CP	PF	FSG	#
Test Combustion Limits If Enabled then the combustion exhaust gas levels will be checked against the settings defined in **Options/EGA/Limits**.	0) Disabled 1) Enabled	N	N	N	O_262
Combustion Limits Interval When Not Trimming Combustion limits can still be checked when trim is not activated, or at points for which trim has not been set up. When the combustion limits have been exceeded, the MM will make trim corrections on the air damper. If the limits are exceeded for the duration set in this parameter an error will be generated.	Default: 00:30 Range 0 seconds to 59 minutes and 59 seconds	N	N	N	O_261
O2 Upper Limit Offset If the current O2 value is above this offset limit from the commissioned value, an alarm/warning will occur.	Default: 0 Disabled 0 Range 0.1 to 10.0 %	N	N	N	O_19
O2 Lower Limit Offset If the current O2 value is below this offset limit from the commissioned value, an alarm/warning will occur.	Default: 0 Disabled 0 Range 0.1 to 10.0 %	N	N	N	O_22
O2 Absolute Limit If the current O2 value is below this absolute limit, an alarm/warning will occur.	Default: 0 Disabled 0 Range 0.1 to 20.0 %	N	N	N	O_25
CO2 Upper Limit Offset If the current CO2 value is above this offset limit from the commissioned value, an alarm/warning will occur.	Default: 0 Disabled 0 Range 0.1 to 10.0 %	N	N	N	O_20
CO2 Lower Limit Offset If the current CO2 value is below this offset limit from the commissioned value, an alarm/warning will occur.	Default: 0 Disabled 0 Range 0.1 to 10.0 %	N	N	N	O_23
CO2 Absolute Limit If the current CO2 value is above this absolute limit, an alarm/warning will occur.	Default: 0 Disabled 0 Range 0.1 to 20.0 %	N	N	N	O_26
CO Upper Limit Offset If the current CO value is above this offset limit from the commissioned value, an alarm/warning will occur.	Default: 0 Disabled 0 Range 1 to 200 ppm	N	N	N	O_21
CO Absolute Limit If the current CO value is above this absolute limit, an alarm/warning will occur.	Default: 0 Disabled 0 Range 1 to 200 ppm	N	N	N	O_27
NO Upper Limit Offset If the current NO value is above this offset limit from the commissioned value, an alarm/warning will occur.	Default: 0 Disabled 0 Range 1 to 200 ppm	N	N	N	P_94
Exhaust Temperature Upper Limit Offset If the current Exhaust Temperature value is above this offset limit from the commissioned value, an alarm/warning will occur.	Default: 0 Disabled 0 Range 1 to 999 °C or °F	N	N	N	P_96

Description	Setting	CP	PF	FSG	#
Exhaust Temperature Absolute Limit If the current Exhaust Temperature value is above this absolute limit, an alarm/warning will occur.	Default: 0 Disabled 0 Range 1 to 999 °C or °F	N	N	N	P_97
Trim Samples Before Combustion Limits Triggered When the combustion limits have been exceeded, the MM will make trim corrections on the air damper. If the number of these trims reaches the value set in this parameter an error will be generated.	Default: 3 Range 0 to 10	N	N	N	P_17

6.3.29 Options: EGA: Trim

The **Trim Options** set up how the MM will apply trim using an EGA or an O2 sensor a UV Trim scanner in combination with either an EGA or O2 sensor.

Description	Setting	CP	PF	FSG	#
VSD or PWM Channel Used for Trim Selects if the VSD or PWM channel may be used for trim if both are optioned. **Note:** The servo can always be selected in **Trim Change**	0) Trim Using VSD 1 1) Trim Using PWM	N	N	N	O_76
Maximum Trim This is the maximum trim % of air damper movement or VSD/PWM change during firing.	Default: 10.0 Range 2.0 to 10.0 %	N	N	N	P_18
Trim Carry Forward When modulating to a new point during trim, any existing correction may be carried forward to the new trim position. Trim will be reset if the rate of change of the fuel valve angle is greater than that set in **Options/EGA/Trim/Trim Reset Angular Rate.**	0) Disabled 1) Enabled	N	N	N	O_18
Trim Threshold Offset Below Setpoint An offset from the required setpoint, below which the EGA will not trim. This option should be set to 0 if trim is to be effective at all times during firing, and/or if external modulation is optioned. No single point changes can be made if the actual value is below this trim threshold.	Default: 0.0 Disabled 0.0 Range 0.1 to 50.0 Units are °C, °F, PSI or bar depending on displayed units and boiler load sensor type settings	N	N	N	O_28
Trim Delay On Modulation If Trim is enabled, the EGA does not sample for the time delay set in this option to allow the combustion to stabilise before sampling commences. The delay timer starts at the ignition point.	Default: 00:20 Range 0 seconds to 4 minutes	N	N	N	O_32
Trim Delay After Drain When the EGA performs a drain, trim is paused for this duration while the EGA cells are purged with air before the trim cycle restarts. During this delay, the currently applied trim correction is maintained.	Default: 00:30 Range 5 seconds to 4 minutes	N	N	N	P_8
Commissioned Fuel-Rich Trim The % of air damper movement when commissioning fuel-rich trim.	Default: 5.0 Range 2.0 to 7.5 %	N	N	N	P_13
Commissioned Air-Rich Trim The % of air damper movement when commissioning air-rich trim.	Default: 5.0 Range 2.0 to 7.5 %	N	N	N	P_19

Description	Setting	CP	PF	FSG	#
Trim Reset Angular Rate The trim correction will reset if the fuel valve angle changes at a greater rate than this setting when moving to a new modulation point.	Default: 5.0 Range 0.0 to 90.0 °/minute	N	N	N	P_14
Add Air When CO Present If enabled and the CO appears fuel rich, then the air damper will open further to remove CO, even if O2 and CO2 appear air rich.	0) Disabled 1) Enabled	N	N	N	P_23
Trim Using CO For Oil Fuels If Enabled and the fuel has been set as oil (**Options/MM/Fuel/Fuel Type**), then the trim function includes CO to calculate the required trim correction.	0) Disabled 1) Enabled	N	N	N	P_12
Trim Samples Per Cycle This sets the number of trim corrections carried out between EGA drains. A cycle is the period between successive EGA drains to get rid of excess moisture in the exhaust gas sample.	Default: 8 Range 1 to 50 trims	N	N	N	P_26
UV Trim Enable Enables trim to use the UV Trim Scanner to trim directly from the flame.	0) Disabled 1) Enabled	N	N	N	O_250
UV Trim Cycle Time The time between successive trims using the UV scanner	Default: 00:10 Range 5 seconds to 4 minutes	N	N	N	O_251
UV Trim Deadband If the UV count is within this deadband compared to the commissioned value, then no trim change will be applied.	Default: 20.0 Range 5.0 to 50.0 %	N	N	N	O_252
UV Trim Scaling The trim adjustment as a percentage of the distance between the current trim value and the commissioned trim value	Default: 40.0 Range 10.0 to 100.0 %	N	N	N	O_253
UV Adjust Scaling The adjustment of the UV correction value as a percentage of the difference between the UV reading and the predicted reading from feedback of the O2 level from an EGA or O2 sensor.	Default: 60.0 Range 10.0 to 100.0 %	N	N	N	O_254
UV Trim Residence Time Adjustment Adds in an extra delay to allow for EGA or O2 sensor averaging when comparing the gas analyser feedback level with the UV trim level	Default: 0 Range 0 seconds to 1 minute	N	N	N	O_255
UV Trim CO Abort Above Level UV Trim will be aborted if the CO level rises above this value.	Default: 0 Disabled: 0 Range 0 to 10000 ppm	N	N	N	O_256
UV Trim O2 Abort Below Level UV Trim will be aborted if the O2 level drops below this value.	Default: 0 Disabled: 0 Range 0 to 20 %	N	N	N	O_257

7 COMMISSIONING THE MINI MK9 MM

7.1 Overview



Important Note: Prior to commissioning, the fuel and air servomotors **MUST** be calibrated to ensure that the position of the valves and damper correspond to the potentiometer feedback signal as displayed on the Mini Mk9 MM. **ALWAYS** physically check that the valve is **FULLY CLOSED** when the MM displays **ZERO DEGREES**. If it is not fully closed, please drive the valves to the fully closed position and adjust the servomotor potentiometer to set the zero position. Failure to do so can result in serious or even fatal injury, and can cause permanent equipment failure and substantial property damage.

If the MM is commissioned without an EGA, then a combustion analyser is required to check the exhaust gases. If the system does have an EGA, then this performs all normal exhaust gas measurements. When burning oil, a smoke detection device is also necessary to check that the smoke generated is within safe limits.

Once an initial firing position has been established, the points on the Fuel-Air curve may be established in any order, but are recommended to be set from low to high fire. The fuel and air channel positions must always be different to the adjacent ones previously entered. When moving up the Fuel-Air curve, air should be added first followed by fuel to maintain safe combustion. Conversely when moving down the Fuel-Air curve, the fuel should be reduced first followed by the air. Once a Fuel-Air curve is established, it must be saved before exiting commission to take effect. If only a partial curve is made (e.g. due to limitations on heating the boiler slowly) then single point change may be used to add additional points anywhere on the Fuel-Air curve. At least 5 points must be entered to be able to save a curve.

Important Note: On a newly installed system the following procedures should be carried out systematically:



1. Check all interconnecting wiring between the MM and external components is correct (see section 3.3 for the wiring schematic).
2. Set options as required (refer to section 1 for option settings and details).
3. Set up servomotors, ensuring that they a correctly zeroed.
4. Program the Fuel-Air curve.

The commissioning procedure as described must be strictly adhered to. Anybody commissioning a Micro-Modulation system must have an adequate understanding of combustion plant. In the wrong hands, hazardous conditions could be made to exist. The Autoflame products must only be installed, set up, commissioned and adjusted by an Autoflame certified technical engineer.

The fundamental idea of the system is to set a fuel valve position and then set a corresponding air damper position. Care must be taken when adjusting the fuel and air positions so as not to create any unstable or hazardous combustion conditions, e.g. moving the fuel valve to the open position without increasing the air damper position.

Particular care should be taken when establishing a flame for the first time in a boiler to ensure that the combustion conditions are suitable for light-off.

Improper use may result in property damage, serious physical injury or death.

Please make sure that you fully read and understand the safety notes section before starting the commissioning process.

Only carry out the commissioning process if you are fully trained in its requirements and procedures.

7.2 Powering The Mini Mk9

The Mini Mk9 shall be connected to Mains Power in the Panel/Pod as defined in section 4.1.2.

The connections of Servomotors, flame scanner, fuel valves, gas/air sensors is all made according to the wiring diagram of section 3.3 and the terminal descriptions of section 4.1.2.3.

Installation should always be done by an Autoflame trained commissioning engineer. A thorough knowledge of the Mini Mk9 and combustion control is required.

When first powered on, the Mini Mk9 will show a splash screen with information showing the software version number along the top and the current stage of the startup process along the bottom. For a first installation, the Mini Mk9 will not be commissioned. When the boiler screen appears, the information bar at the bottom of the screen will be red with the message 'Not Ready to Run: Fuel not Commissioned' displayed.

The setup and commissioning process described below should be followed to define a fuel-air curve. This shall be done by a competent commissioning engineer. The commissioning and operational checks must be carried out to confirm the correct operation of the system.

7.3 Installation Checks

7.3.1 Commissioning Checks

When all installation and burner adjustments are completed, the entire burner control system should be tested in accordance with the manufacturer's instructions. This procedure should verify the correct operation of:

1. Each operating control (temperature, pressure etc.)
2. Each limit switch (temperature, pressure, low water cut-off, etc.)
3. Each interlock switch (airflow switch, high and low fuel pressure or temperature switches, purge and low fire switches, fuel valve proof of closure interlock etc.)
4. Pilot flame failure response and lockout.
5. Main flame failure response and lockout.
6. Tight shut-off for all valves.

7.3.2 Operational Checks

1. Close manual main shut-off valve.
2. Check all limit circuit wiring for proper operation and correct connection.
3. Confirm that the automatic main fuel valves are wired correctly.
4. Power the control and electronically check the proper sequence of operation.
5. After assuring yourself that all the interlocks and valves are properly wired and that the sequence of operation is correct, open the manual main shut-off fuel valve and proceed cautiously through the boiler light off process. Check all safety interlocks for proper shutdown of the boiler.

7.3.3 Installation Precautions

The reliability of the equipment may be impaired if used in environments where strong electromagnetic fields exist e.g. if the equipment is installed in a boiler house where radio systems exist then additional EMC (Electro Magnetic Compatibility) measures may have to be considered. Please contact Autoflame for more information.

7.3.4 Maintenance And Servicing

The Micro-Modulation unit uses solid state technology. It requires no routine maintenance.

The servomotors and gas/oil/FGR valves do require routine maintenance. Any fault associated with these parts is usually diagnosed by the MM. Contact Autoflame for preventative maintenance procedures; please refer to the Valves and Servomotors manual for general checks.

7.4 Servomotors

Autoflame supply three standard sizes of servomotors – small, large and industrial, which can be used for all channels. Autoflame fuel valves require small or large servomotors only. Both small and large servomotors can be configured to drive clockwise or counterclockwise to open a valve or damper. Servomotors can be installed in any orientation. For layout of the small, large and industrial servomotors please refer to the Autoflame Servomotors Guide.

Viewing the shaft end-on, from the potentiometer end, all servomotors drive in a clockwise direction if power is applied between the LIVE and CW terminals, and counterclockwise if the power is applied between the LIVE and CCW terminal.

The operation of fuel valves and air dampers is often such that they open in a clockwise direction. If the operation needs to be reversed, it is necessary to swap various wiring connections between the MM and the servomotor(s). An example of reversing the operation of a servomotor is shown in Figure 25.



Servomotors are supplied by the factory preset at 0.0° position. Remember that this position may not necessarily automatically position the damper at 0.0° or a closed position. This MUST be physically checked. Failure to do so can result in damage to equipment, serious injury or death.

7.4.1 Adjusting The Servomotor Potentiometer

Before a burner is fired, it is essential to set up each Micro-Modulation servomotor. A tamper proof screwdriver is required for this (please contact Autoflame).

Control valves/air dampers that the servomotors drive, usually move through up to 90°. The MM system has the ability to drive valves through 360°, but the MM will only display from -6° to 96°.



All Servomotor Channel readings displayed on the MM are in angular degrees. It is necessary to adjust the potentiometer in the servomotor assembly so that the MM reads 0.0° when the relevant valve/damper is at its fully closed position. The technician must physically check the mechanical position of the dampers and valves. Whilst all servomotors are set to 0.0° before leaving the factory, this may have changed during shipping.

DO NOT ASSUME THEY HAVE BEEN PREVIOUSLY SET CORRECTLY.

Procedure

To set up the servomotors, put the MM into commissioning mode by selecting **Commission/Commission** and entering the ***Commission Password***. The unit must be in **Standby Mode** before **Commission Mode** may be entered. The default is for **Full Commission**, but specific **Golden Start**, **FGR** and **Pressure** commissions may be accessed on the **Blue Menu Bar**.

Press **Start** to begin commission. The servo control buttons then become active allowing the servos to be driven up/down using the arrow keys .

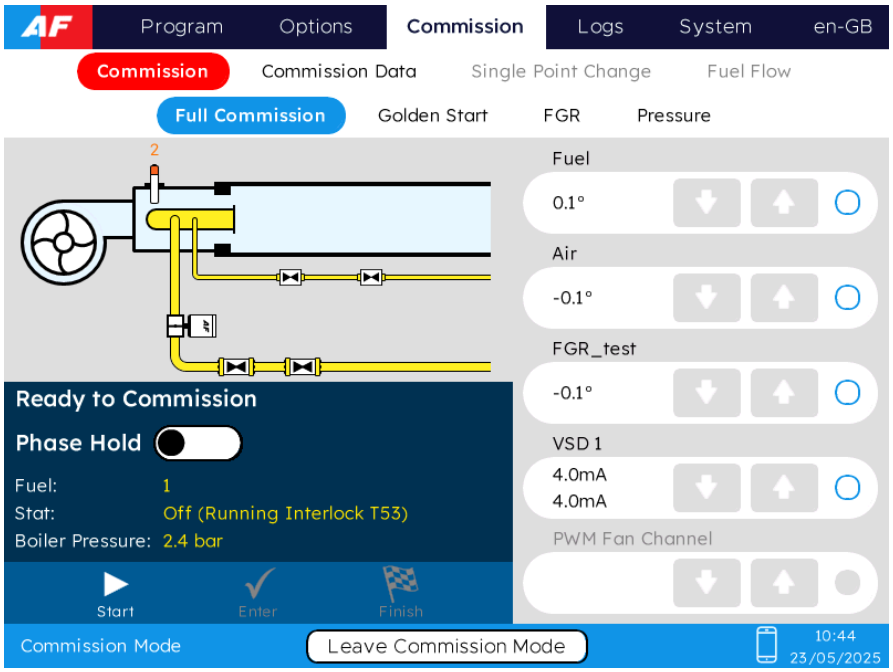


Figure 24 – Adjusting Servo Motors

Switch the burner on and the Mini Mk9 MM will go through its relay and start-up tests.

Once the '**Enter Closed Position**' is seen in the bottom left-hand corner box, drive each of the servomotors so that their valves are fully closed and in their correct zero position.

It is important to physically check all valves. Do not rely on the angle displayed on the MM.

Once all valves are confirmed as fully closed, check if the servomotor readings on the MM screen are correctly reading zero. If any of them need adjusting remove the appropriate servomotor cover.

For air servomotors carry out the following procedure:

Confirm that the air damper is in its physically closed position. Loosen the two tamper proof screws just enough to enable the potentiometer to rotate. Rotate the potentiometer clockwise or counterclockwise until the relevant channel reads 0.0°. Tighten the two tamper proof screws gently until the potentiometer is secure. Do not over tighten the screws. Check that the display still reads 0.0°. If still incorrect repeat the adjustment process.

For fuel servomotors carry out the following procedure:

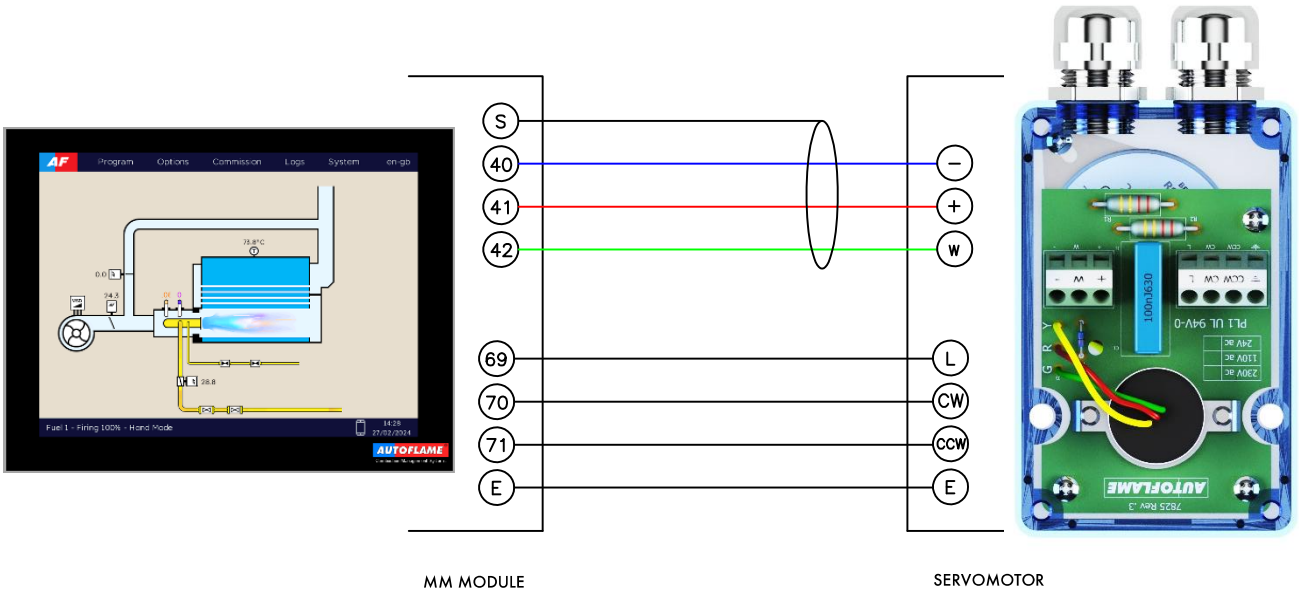
On Autoflame gas, oil and gas/oil piggy-back valves it is necessary to remove the servomotor. Manually position the oil/gas valve slot to its closed position. Observe the position of the drive pin on the servomotor.

Use the relevant channel  buttons to position the pin so that when the servomotor is reassembled to the valve it is in line with the slot. Reassemble the servomotor to the valve, loosen the two tamper proof screws and proceed to adjust the potentiometer position until 0.0° is displayed. Tighten the two tamper proof screws gently until the potentiometer is secure. Do not over tighten the screws. Check that the display still reads 0.0°. If still incorrect repeat the adjustment process. Use the external position indicator to confirm the valve is in the fully closed position.

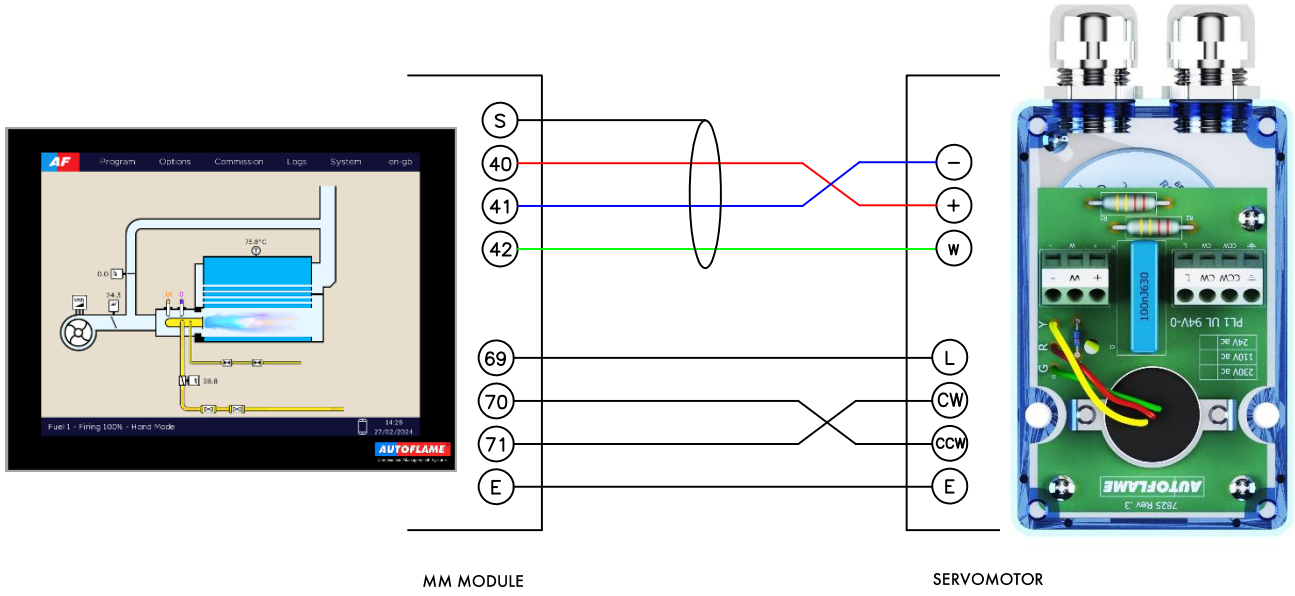
7.4.2 Servomotor Feedback Voltage

In applications where the servomotor is not positioned close to the display, then it is possible to measure the feedback voltage from the servomotor in order to ensure that 0.0° is displayed. By testing the DC voltage between the blue and green wires (wiper and 0V) on the servomotor low voltage terminals this will read 0.21V DC when the reading on the display is 0.0°. The same can be done for when the servomotor is at 96.0˚ where the voltage will be 3.6V.

7.4.3 Servomotors – Direction Change



SERVOMOTOR CLOCKWISE ROTATION



SERVOMOTOR ANTICLOCKWISE ROTATION

Figure 25 - Servomotor Wiring

7.4.4 Servomotors With Autoflame Valves

On threaded valves, the pin on the top of the valve is 90° opposite from the position of the butterfly valve.

On flanged valves, the pin on the top of the valve is in line with the position of the butterfly valve.

For both valves the external visual position indicator is in line with the position of the butterfly valve. Regardless of the type of valve being used, the servomotor is dispatched from the factory with the potentiometer in the zero position. The same servomotor will be correct for both types of valve, as the servomotor for the threaded valve is mounted at 90° different from the flanged valve.

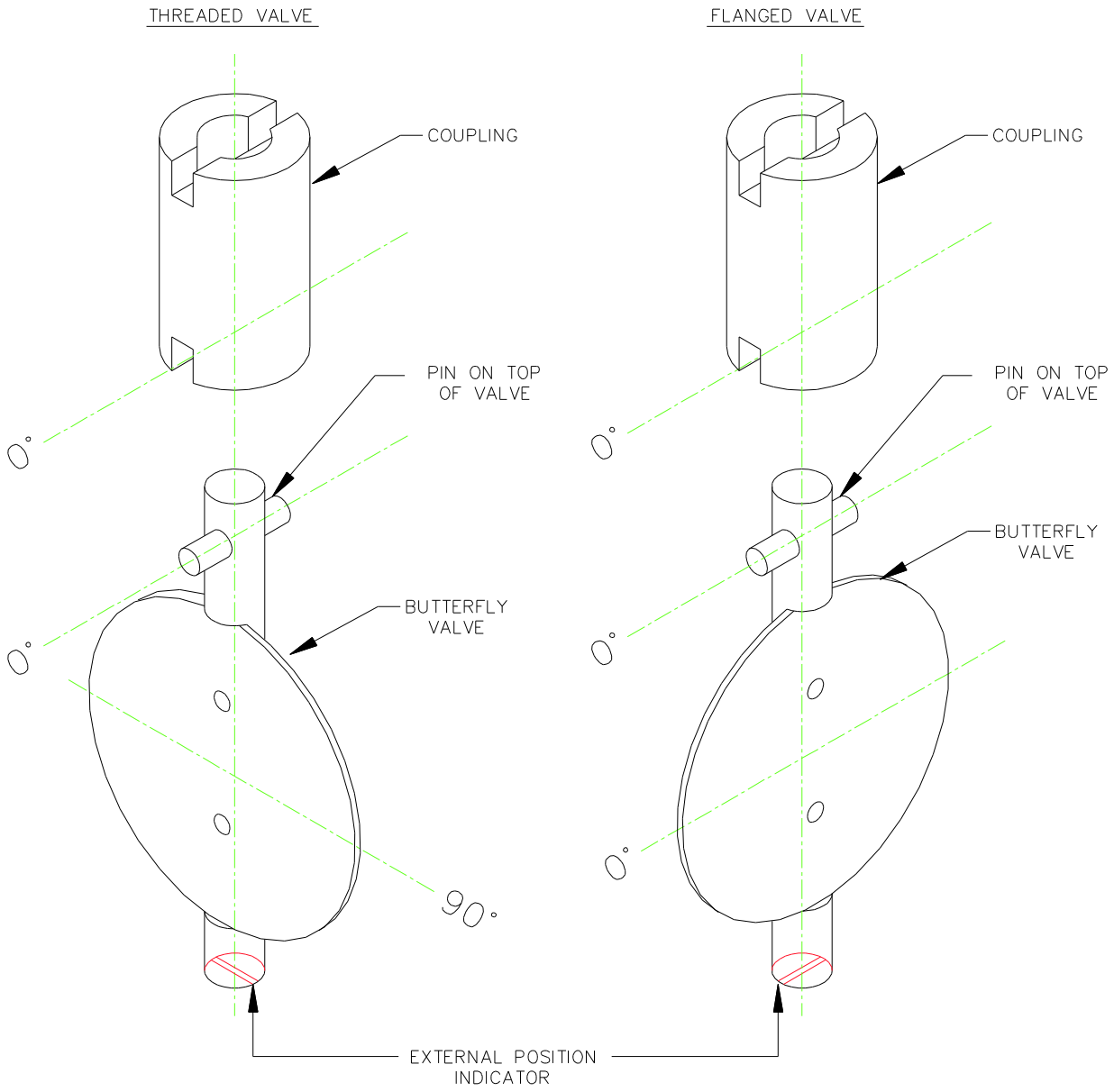


Figure 26 - Valve Pin Positions

7.5 Settings Considerations

When first setting up a Mini Mk9, it is important to carefully check through all the settings to ensure that they are correct for your burner/boiler. This should always be done by a trained and competent service engineer. The following settings in particular should be checked to ensure that they match the application, especially if changing between temperature and pressure:

Setting	Comment	Potential Issue
Servos	On the Mini Mk9 any of the 3 servos can be set to perform any function. You must have only one fuel servo, but it does not have to be servo 1. **Always** change the servo labels to match the function if the default functions are changed.	If the servos have been changed from their default, confusion could arise as to which servo is providing which function.
VSD	The VSD can be set up to be a servo (Fuel, Air or Independent). **Always** change the VSD label to match the function selected for the VSD.	If the VSD has been changed from its default setting, confusion could arise as to which function it is providing.
Load Sensor	This should match the load sensor installed on the boiler	Changing between temperature and pressure, or changing the pressure range could mean a number of settings are no longer optimum.
Displayed Units	Set whether you want Metric or US Customary units	
PID Proportional band	Defines the Proportional part of the PID control	If set too small the burner will modulate rapidly between low and high fire when it nears the setpoint.
Burner Switch On Offset/Burner Switch Off Offset	The on and off points around the setpoint	If they are too small the burner will continually switch on and off. If they are too large the burner will not remain close to setpoint.
Setpoint Minimum/ Setpoint Maximum	Range of allowable setpoints	May prevent you from firing if set (non-zero) too low. If set too high could allow the setpoint to be moved above the rating of the boiler.
Internal High Setpoint Limit	Shutdown temperature or pressure	May shut the system down below setpoint if set too low. If set too high could allow firing above the rating of the boiler.
Outside Temperature Compensation Settings	Define how OTC operates	May not work as intended if the settings are in the wrong ranges
External Setpoint Settings	Define how External Setpoint operates	May prevent you from firing if set too low. If set too high could allow the setpoint to be moved above the rating of the boiler.



Note: When **Commissioning** a burner, ensure that the **Servo** and **VSD** functions and labels defined under **Options**/**Controller**/**Boiler** match the functions defined for each **Servo** and the **VSD**. This will make the graphic match the installation and will ensure the correct function is labelled on the **Commissioning** screen to ensure you move the correct actuator.

7.6 Commissioning Fuel And Air Positions

On the Mini Mk9 MM, commissioning is done for the main **Fuel-Air** curve, plus any special points (**Golden Start**, **FGR**) and gas/air pressures if selected (see section 7.8 for details on gas/air pressure commission).

Note: Even if Trim is selected in **Options/EGA/Operation/EGA Mode**, it is always added later using **Single Point Change** (see section 7.9.2).

The fuel and air positions need to be programmed for the following points: ***Closed***, ***Open***, ***Golden Start*** (if optioned), ***FGR Start*** (if optioned), ***Inter Points*** (includes ***Low Fire/Start*** and ***High Fire***).

There must be a minimum of 5 points entered on the **Fuel-Air** curve, and a maximum of 20. Points can be added/removed/modified in **Single Point Change** (see section 7.9.1).

Note: During commissioning, the required setpoint is not active, so the internal stat always remains on regardless of the actual value.

Ensure that the **High Limit STAT** is set correctly and wired into the recycling interlock (**T53**), as this will turn the burner off in the event that the safe working maximum temperature or pressure of the boiler is exceeded.

The high limit stat should be set below the rating of the safety valve - please see the manufacturer's guidelines for the safety valve of the boiler.

If a fault occurs where the boiler goes above the high limit stat or power is lost to the MM during commissioning, no data is stored. The points entered are only stored within the MM once the commission has been completed.

7.6.1 Start Commission

Enter the commission mode by selecting **Commission/Commission** and entering the ***Commission Password***. The main commissioning screen is accessed as shown in Figure 27. The **Info Bar** turns bright blue to indicate that the controller is currently in **Commissioning Mode**.

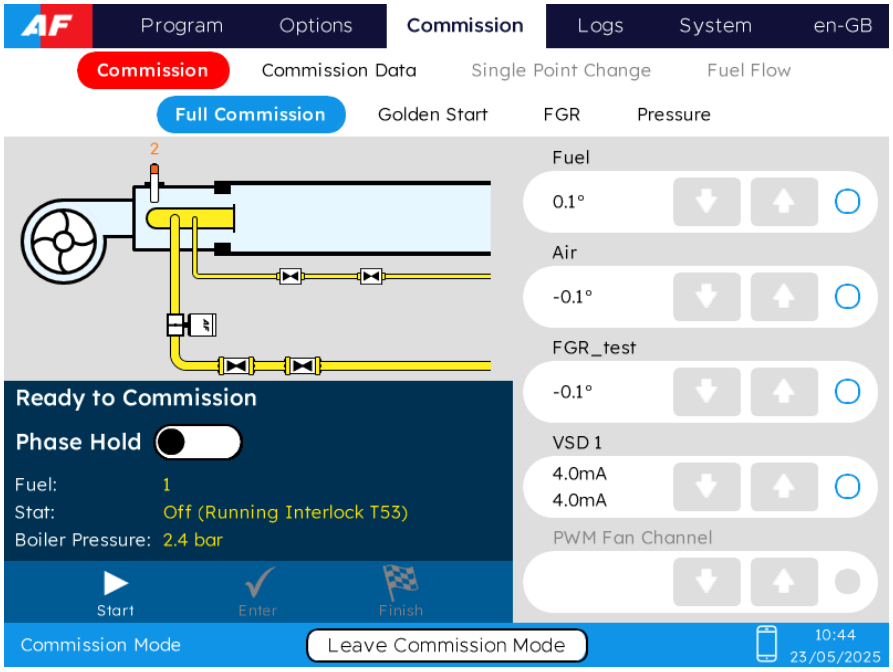


Figure 27 - Start Commission

Selecting **Options** at this stage will give access to a full set of unlocked options, including the burner control options since the commissioning password has been successfully entered. Once any required changes have been made, selecting **Commission/Commission** gets back to the main commission screen. If **Commission Mode** was entered to change an option secured behind the commission mode password, but that does not affect the actual **Commission**, any existing **Commission** may be retained at this stage by selecting **Leave Commission Mode**.

Alternatively, press the Start button to begin a new **Commission** – this will overwrite any existing **Commission**. The become active for all defined channels. Switch the burner on at the main switch on the panel and the MM will go through all the start-up relay checks and **VPS** (if optioned), before pausing at the **Wait For Closed** point.

In commissioning, the boiler graphic will show in the top left corner of the screen by default. Tapping on the boiler picture brings up a selection of alternative screens giving access to a range of graphical data as follows:

Table 6 - Commission Screens

View	Icon	Description
Status	Status	The boiler graphic showing flame scanners, fan rotation and fuel flow.
Fuel-Air	Fuel-Air	Graph of air servo angle against fuel servo angle (the commission curve).
VSD	VSD	Graph of VSD input against fuel servo angle.
PWM	PWM	Graph of PWM input against fuel servo angle.
O2/CO2	O2/CO2	Graph of the EGA O2 & CO2, plus list of all the other EGA values
CO/NOx	CO/NOx	Graph of the EGA CO & NOx, plus list of all the other EGA values
UV Trim	UV Trim	Graph of the UV Trim Scanner values
Fuel	Fuel	Graph of the gas pressure against fuel servo angle.
Air	Air	Graph of the air pressure against fuel servo angle.

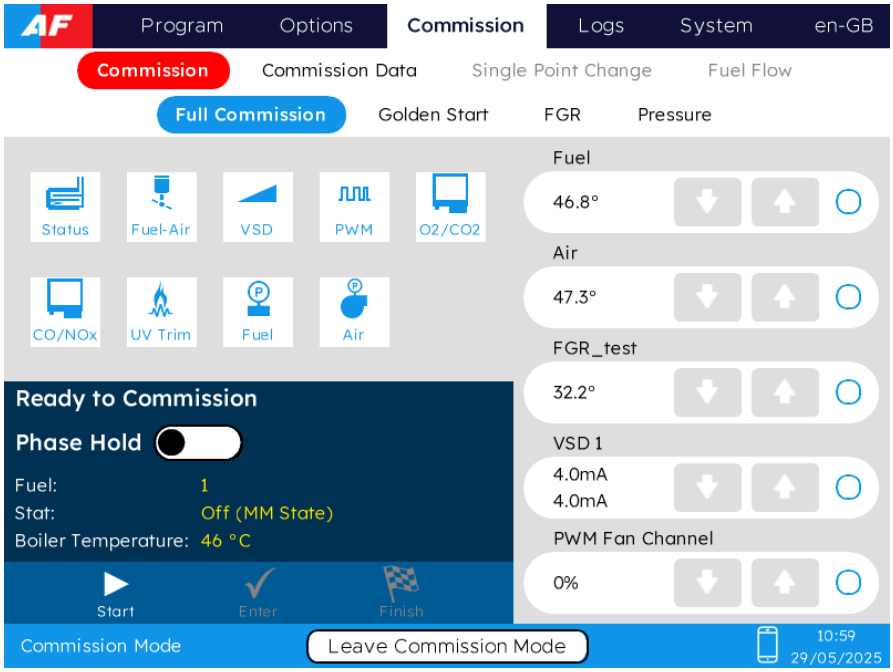


Figure 28 - Commission Screens

7.6.2 Enter Closed Position

The MM is now waiting for the **Closed** position to be entered.

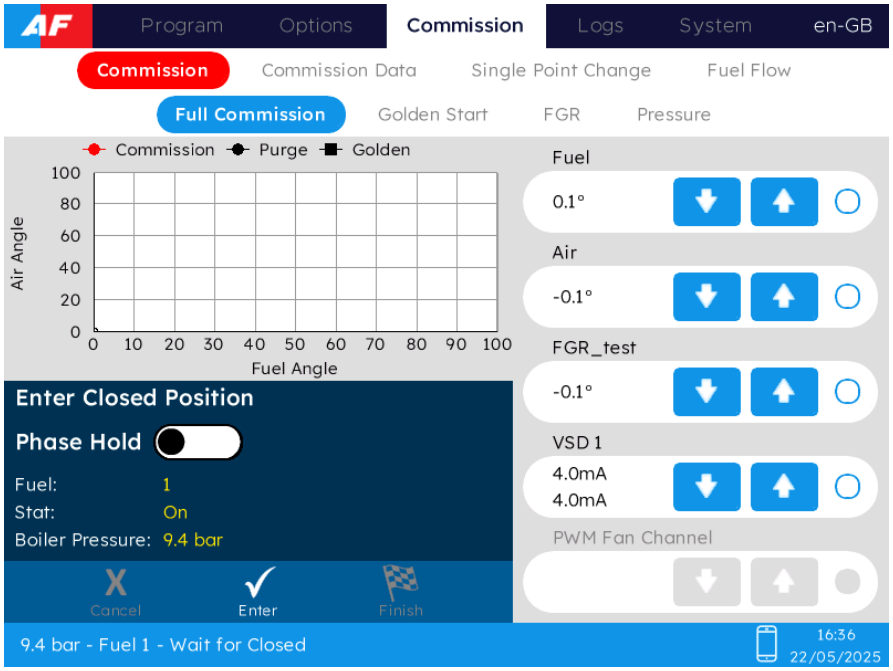


Figure 29 - Enter Closed Position

Note: No error checking of the servomotors is enabled at this stage, therefore, do not drive the servomotors/dampers beyond any mechanical limitations that may be present on the damper/valve. This may cause damage to the servomotor and/or the damper/valve.

Use the  buttons to set the positions of all servos to 0.0°. Selecting the circles to the right of the servo movement buttons allows multiple servos to be linked and driven together. The linked channels change colour and have a linked line to identify which channels will move together. Reselecting the blue circle removes the servo from the link. Alternatively, since this is a multi-touch display, placing fingers on more than one arrow will drive more than one channel.

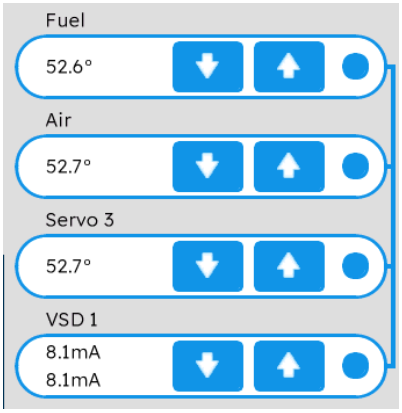


Figure 30 - Linking Channels

Note: Double check the dampers/valves are physically at the 0.0° (closed) position. This can be achieved by checking for external indications on the damper assembly or the fuel valve. It is the engineer's responsibility to ensure that the servomotors are correctly calibrated. Incorrect calibration can cause serious injury or death.

Press Enter to store the **Closed** position.

7.6.3 Enter OPEN Position

The burner motor output T58 will energise at this point. A message will then be displayed '**Enter Open Position**'.

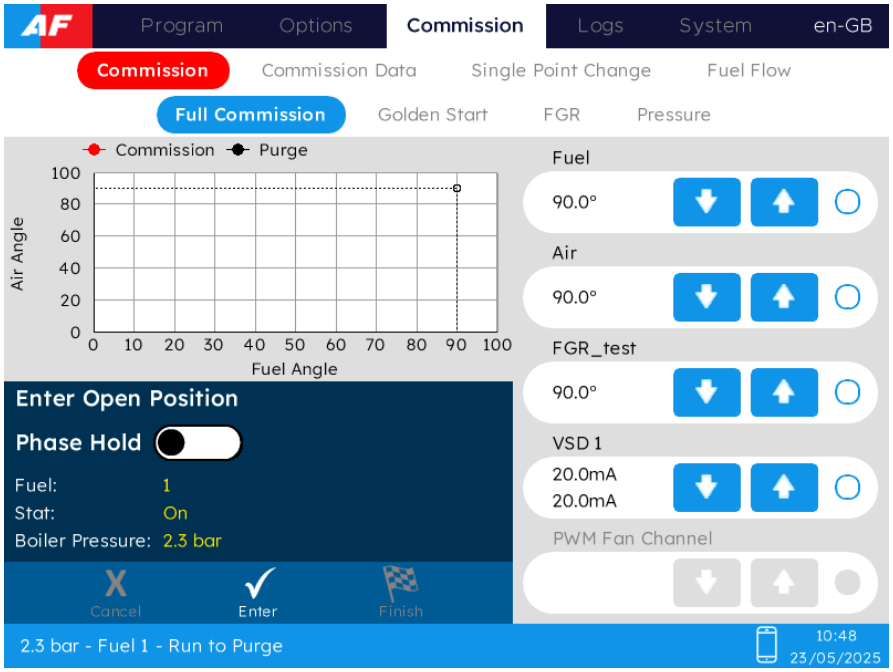


Figure 31 - Enter Open Position

Drive the active servomotors to their **OPEN** position using the  buttons. This is normally 90.0 ° for gas butterfly valves and burner air dampers, but may be set to less than 90.0 ° if there are mechanical stops/limits. Press **Enter** to save the **OPEN** positions.

7.6.4 Enter START Position

Having entered the open position, the system will purge for the set pre-purge time. Once purge has completed the MM will pause waiting for the **Start** position to be entered.

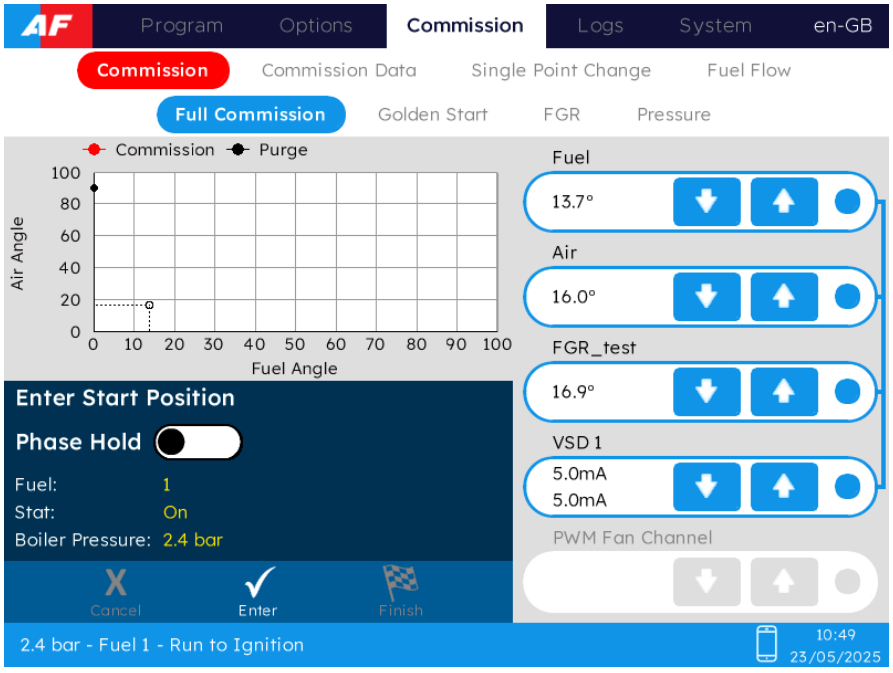


Figure 32 - Enter Start Position

Drive the enabled servomotors, VSD and/or PWM to their **Start** position.

Note: This is not a stored position, it is just for establishing a flame to carry out the commission process. It is the engineer's responsibility to ensure that the start position is suitable for light off on the burner/boiler. Incorrect setting of the light off position can result in serious damage to the equipment and may cause serious injury or death.

To enter a fuel servo **Start** position which is less than 10 degrees below the **Open** position, you must drive the servomotor below this band, and then back open. For example, if the Fuel Servo **Open** position is set at 90.0˚, to set a **Start** position of 83.0˚, you must drive the Fuel servomotor to below 80.0˚ and then back up to 83.0˚.

Note: Care must be taken when setting this first position to ensure that it is suitable for light off. It is the engineer's responsibility to ensure that the fuel-air settings are appropriate for the size of the burner and will not cause a dangerous situation to occur. Only define this position if you are fully trained and competent to do so.

To check the VSD or PWM fan during commission, select the graph to bring up the options and display the VSD or PWM graph. Alternatively the VSD input and VSD output numbers are both shown next to the VSD move arrows 

(similarly for the PWM input and tacho feedback).

If there is little movement required with the VSD signal, the feedback fault tolerance should be set accordingly. If the tolerance is not set according to the variation, an error 'VSD feedback change too small' will occur.

The setting **Options/MM/VSD/VSD 1 Feedback Fault Tolerance** ensures that a VSD can be verified to be at the correct speed at low fire and different to that of high fire. This also ensures that the VSD signal is checked for fixed values and cannot be bypassed, preventing an unsafe condition with reduced air compared to commission. The minimum feedback variation applies to both the upper and lower limits so the total commission must allow for the two combined.

Note: For the 4-20mA outputs on the Mini Mk9 MM, the maximum voltage drop supported is 12V.

WARNING: ENTERING THE START POSITION BEFORE REDUCING FUEL INPUT APPROPRIATELY COULD RESULT IN AN EXPLOSION.

This process is critical and should only be carried out by trained engineers who are confident that the initial light off position is suitable.

Press Enter to confirm the **START** position. The burner will then go through the ignition sequence including the safety checks to ensure the flame is correctly established. During the safety checks, the servo movement buttons will be disabled, locking the burner light off in the **START** position. As soon as Main Flame Proving has successfully completed, the servo movement buttons become active allowing movement of the servos to help stabilize this initial flame.

Note: The **START** position is not stored permanently as it is just a light-off position to put a flame in the boiler and begin the commissioning process.

7.6.5 Phase Hold

When the system is in commissioning mode only, the **Phase Hold** feature enables the commissioning engineer to pause the ignition sequence of the burner, in order to make adjustments to the start gas flame if needed.

To activate phase hold, move the **Phase Hold** slider to the right (the slider button will turn blue). Once the **START** position has been entered, the phase will then be held at the next phase hold point. The phase hold points are:

- **Pilot Open**
- **Pilot Proving**
- **Main Flame Proving**.

If the phase is held in the **Pilot Open** stage and the flame goes out, a lockout will occur after 20 seconds. However, if the phase is held in either the **Pilot Proving** or **Main Flame Proving** stages, the MM will lockout immediately if the flame scanner does not detect a flame.

If the flame is present and the '**Phase Hold'** condition is left indefinitely the '**Freeze Timeout'** lockout will occur after 10 minutes. When the system is in a run mode the **Phase Hold** facility is disabled.

To make manual adjustments to the gas, activate the **Phase Hold** position to pause the commission at the required point. Ensure that the main fuel valve is manually isolated until the pilot flame has been successfully established. Once a flame is there, gradually introduce the main fuel supply to the burner while observing the flame stability. Continue to introduce fuel until the manual operated main fuel isolation valve is fully open providing safe and stable combustion can be maintained. If the combustion is not safe and stable, then adjust the fuel/air ratio accordingly. Once the adjustments have been made, slide **Phase Hold** back to the left to continue with the commissioning process. Sliding the button off, and then back on will allow it to pause at the next step in the sequence.

7.6.6 Set GOLDEN START Position

If **Golden Start** has been enabled in **Options/Firing/Start-Up/Golden Start** on a new system which has not been commissioned, the message **'Enter Golden Start'** will display after the initial **Start** position has been entered.

Drive the active channels to the required **Golden Start** position using the  buttons and then press **Enter** to store the point. This will be marked on the fuel air curve by a black square.

Note: If a system has already been commissioned and **Golden Start** is subsequently enabled, selecting **Commission/Commission/Golden Start** allows just the **Golden Start** point to be added to the existing fuel-air curve. In this case, starting the commission and switching the burner on will see the full start-up procedure completed including all the relay checks, VPS if optioned, and purge. A **Start Position** is then required to light off the burner. If a Fuel-Air curve already exists, the channels will all move to the existing **Start Position** before pausing and waiting for the user to select **Enter** to begin the light off process – this position can be adjusted if required. This is then followed by the **'Enter Golden Start'** message requesting the new **Golden Start** position to be set and entered. This process can also be used to modify an existing **Golden Start** position.

The **Golden Start** position of the fuel and air servomotors is completely independent from the modulating load index and commissioned value data.

Golden Start is particularly useful on combustion systems with large turndowns and when firing heavy oil, as it enables the burner to start/ignite at a fuel rich position and then, after a stable flame is established, return to the commissioned combustion curve.

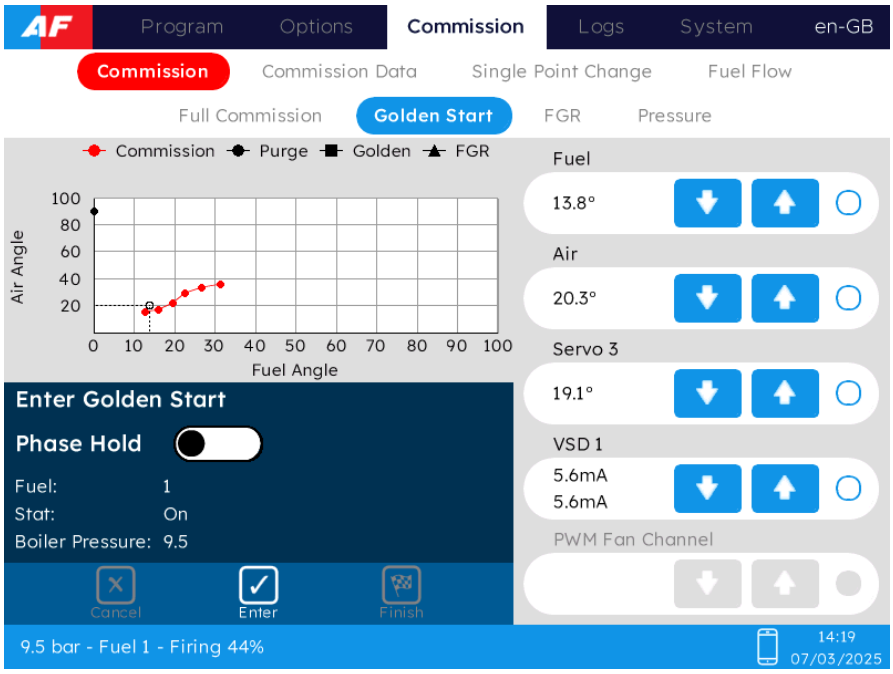


Figure 33 - Golden Start Position

The **Golden Start** position needs to be entered separately for each required fuel.

The MM holds the **Golden Start** position for a time set in **Options/Firing/Start-Up/Golden Start Time**. This time starts immediately following the end of main flame proving. After this time:

- If the **Golden Start** fuel position is between **Low Fire** and **High Fire**, the air damper will move and the fuel valve will stay in the same position, until the fuel-air ratio is on the commissioned combustion curve.
- If the **Golden Start** fuel position is outside of the main curve, then both the air and fuel dampers will move to the **Low Fire** position.

Once on the commission curve, the MM will modulate as per the load requirement.

7.6.7 Set FGR Start Position

Flue Gas Recirculation (**FGR**) is a method whereby a quantity (approximately 15%) of the boiler flue gases are fed back to the burner and mixed with the combustion air. The virtue of **FGR** is the reduction of NOx gases. With the **FGR** facility, one of the servomotor channels can be used to control the amount of flue gas fed back, by setting is as an independent channel. It is not good practice to feed back the gases when the flue gas is cold, so all the elements (i.e. servomotors and VSD) cannot be set at '**FGR**' positions until the gases are hot. During this time the **FGR** Damper Channel would normally be set closed. Once the **FGR** holding conditions are met, modulation takes place in the normal way using the curve entered during commissioning.

On a system which has not been commissioned, **FGR** may be enabled in **Options/Firing/FGR** by setting any of:

- **Flue Gas Recirculation Timer** – The FGR position will be held for this set time.
- **Flue Gas Recirculation Offset** – The FGR position is held until the setpoint reaches this offset below the required setpoint.
- **Flue Gas Recirculation Temperature Threshold** - The FGR position is held until the flue gas temperature has reached 120°C (248°F). This requires an EGA to be fitted.

The message **'Enter FGR Start'** will display after entering the light-off **Start** position (or after entering the **Golden Start** position if that is enabled).

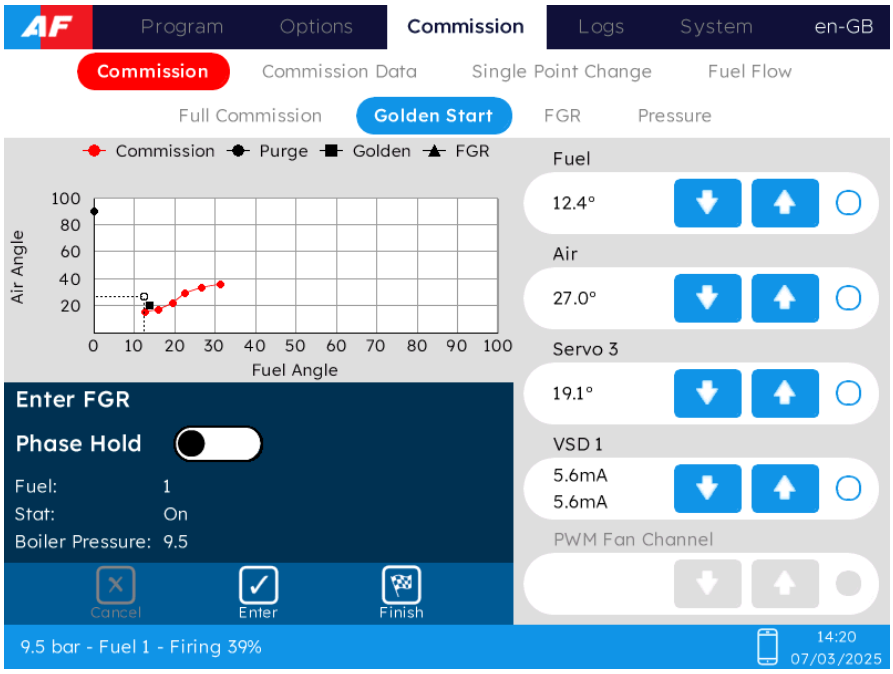


Figure 34 - FGR Start Position

Drive the active channels to the required **FGR Start** position using the  buttons and then press **Enter** to store the point. This will be marked on the fuel air curve by a black triangle.

Note: If a system has already been commissioned and FGR is subsequently enabled, selecting **Commission/Commission/FGR** allows just the **FGR Start** point to be added to the existing fuel-air curve. In this case, starting the commission and switching the burner on will see the full start-up procedure completed including all the relay checks, VPS if optioned, and purge before moving to the existing **Start Position** on the

curve. This start position may be changed if required and then **Enter** allows the burner to light off. This is followed by the **'Enter FGR Start'** message requesting the new **FGR Start** position to be set and entered.

This process can also be used to modify an existing **FGR Start** position. The **FGR Start** position of the fuel and air servomotors is completely independent from the modulating load index and commissioned value data.

Note: If both **Golden Start** and **FGR** are optioned then the **Golden Start** position is entered before the **FGR START** position.

Note: Golden Start takes priority over **FGR**. Once the **Golden Start** timer has finished, the servomotors will go straight to the **FGR Start** position.

7.6.8 Set Fuel Air Curve

Once the burner has been successfully lit and **Golden Start/FGR** positions entered if optioned, then the main fuel-air curve may be entered. This is done by defining a series of points in any order (it is recommended to work from low fire up to high fire) until a minimum of 5 and maximum of 20 points are defined.

To enter a point on the curve, drive the active channels to the required position using the  buttons and then press **Enter** to store the point. This will be marked on the fuel air curve by a red circle, with the points of the curve being joined by a line. Successive points are entered until at least 5 points have been defined, after which the **Finish** button becomes active, and may be pressed at any time to complete commission and store the curve. To enter a new point, the air and fuel servos must move a minimum of 0.5° for the **Enter** button to become active allowing the point to be stored.

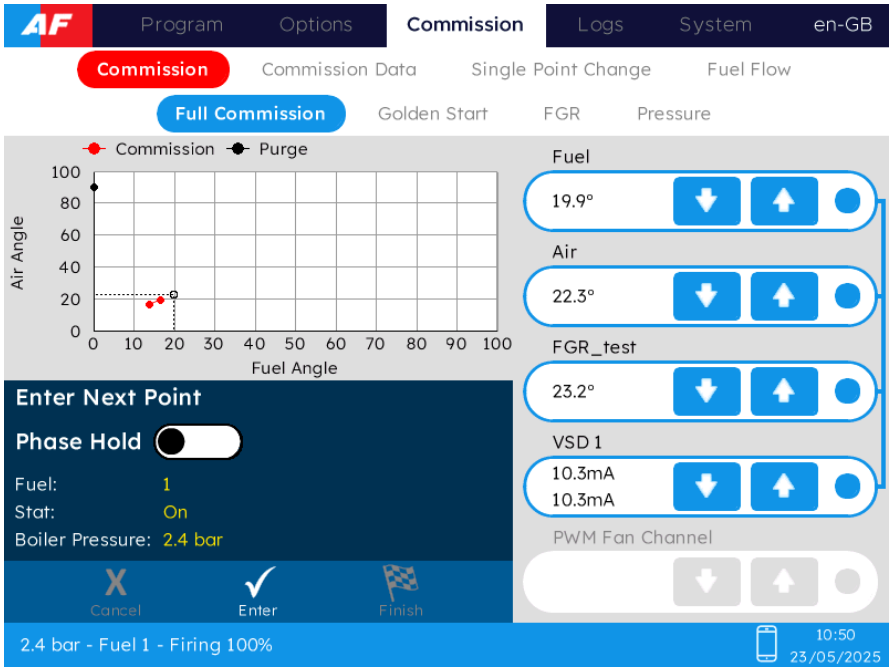


Figure 35 - Set Fuel-Air Curve

When increasing the firing rate, the air servo should be moved first, followed by the fuel servo, in order to maintain safe, air-rich combustion. Conversely when decreasing the firing rate, move the fuel servo first. Any movement to a new desired point should be achieved in small steps, changing the **Fuel-Air** ratio slightly each time in order to keep tight control of the combustion. The exhaust gases should be continually monitored during this process to ensure that safe combustion is maintained. It is the commissioning engineer's responsibility to ensure that a safe combustion curve is defined for the system.

If 20 points have been defined the **Enter** button deactivates and is greyed out so that no extra points may be entered.

Selecting the **Finish** button completes the commission. The new fuel-air curve is stored and the MM will leave commission mode and revert back to normal firing mode.

If the burner had been previously commissioned then the new saved curve will overwrite the previous data for the fuel selected.

Failure to save the curve, or a power loss to the unit before saving, will result in the commissioning data not being stored and will result in a loss of data for the fuel selected.

If during commissioning the burner turns off, due to the 'running interlock' opening or a fault, or if the power has been recycled, no points entered are stored.

It is recommended to commission the MM with a quick base curve and then adjust/add/remove points using **Single Point Change**. This also holds true if only a partial curve may be entered, e.g. due to needing to slowly warm up a cold boiler, where **Single Point Change** may be used to add higher firing points as the boiler warms up.

Note: If commissioning a fuel for the first time the default required setpoint will be 0.0bar/0PSI/0°C/0°F. The burner will shut down at commission completion due to the low default required setpoint. Go to the **AF/Setpoint/Status** screen to change the required setpoint.

7.6.9 Backup to SD Card

The Mini Mk9 stores all its **Options** and **Commission Data** in an on-board NAND flash memory device. Once the first commission is completed, or once updates to the commission have been made, then it is recommended to backup this data to the **SD card**.

To carry out a backup, select **System/Backup & Restore** and enter the Commission password to access the screen below. Select **Backup To SD Card** which turns blue to show it is selected and press the **Start** button. The **Backup To SD Card** box turns green to indicate the backup was completed successfully.

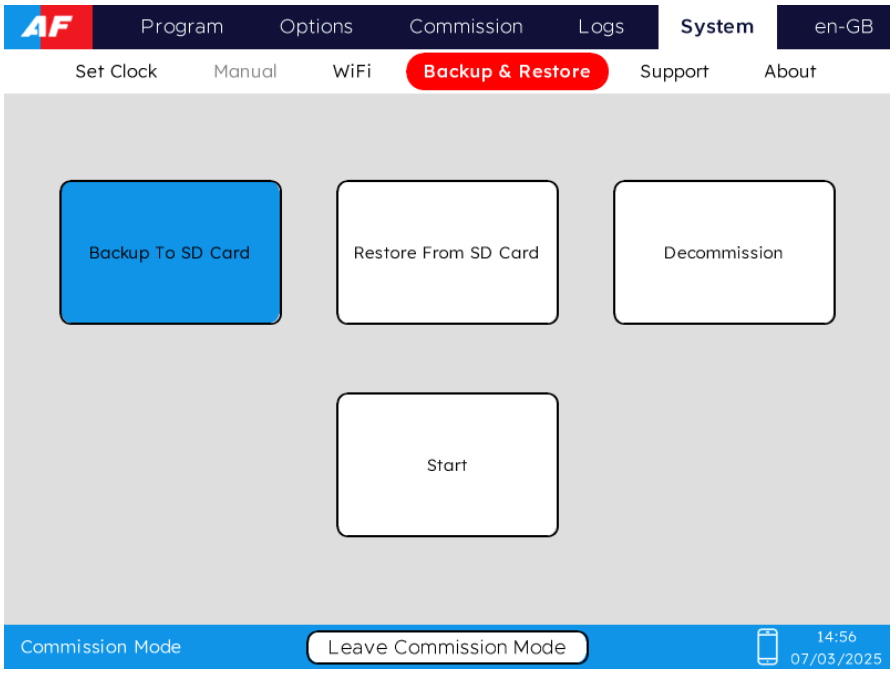


Figure 36 - Backup to SD Card

This page also allows you to restore the **Options** and **Commission Data** in the SD Card, overwriting the values in the internal memory. The SD card is therefore a backup of all your data with this function acting as a system recovery if the main memory gets corrupted.

Note: The **Decommission** selection removes all **Options** and **Commission Data**, carrying out a factory restore of the unit. **Only select this option if you intend to wipe all data from the unit.**

7.7 Fuel Flow Commissioning

Once the burner returns to normal firing, if **Options/MM/Fuel/Fuel Flow Metering** is enabled, the message **'Fuel Flow Not Commissioned'** appears on the **Info bar**.

Note: Fuel Flow commissioning should only be done once the full **Fuel-Air** curve has been completed. If single point change is later used and the low or high fire points are moved, then the **Fuel Flow** commission will be invalid and will need to be redone.

Fuel Flow metering is used to rate the size or burner and calculate the firing rate.

If **Fuel Flow** metering is not commissioned and sequencing is optioned, then MM will assume a default burner rating which is based on the fractional fuel valve angle.

The **Fuel Flow** is commissioned from the low fire point up to high fire.

A fuel flow meter provides the most accurate method of defining the fuel flow commission. If a meter is not being used and only arbitrary values are being entered then make sure a good range of values are being used (e.g. 1 to 10) with equal spaces between the values. Not doing this could lead to problems when using IBS.

When using arbitrary values it is good practice to use the following calculation to determine the heat value for each of the 10 points.

$$Value\ Between\ Points = \frac{Burner\ Rating - \left(\frac{Burner\ Rating}{Turndown}\right)}{9}$$

For example: Burner Rating: 5.4MW; Turndown Ratio: 5:1.

$$\frac{5.4 - \left(\frac{5.4}{5}\right)}{9} = 0.48$$

Giving the range (5.40, 4.92, 4.44, 3.96, 3.48, 3.00, 2.52, 2.04, 1.56, 1.08) from high fire to low fire.

Fuel flow commissioning is carried out in Run mode with the burner firing. To enter it select **Commission/Fuel Flow.** A request to enter the **On-Line Changes Password** will then be made. Once successfully entered, the **Fuel Flow Commission** screen will appear.

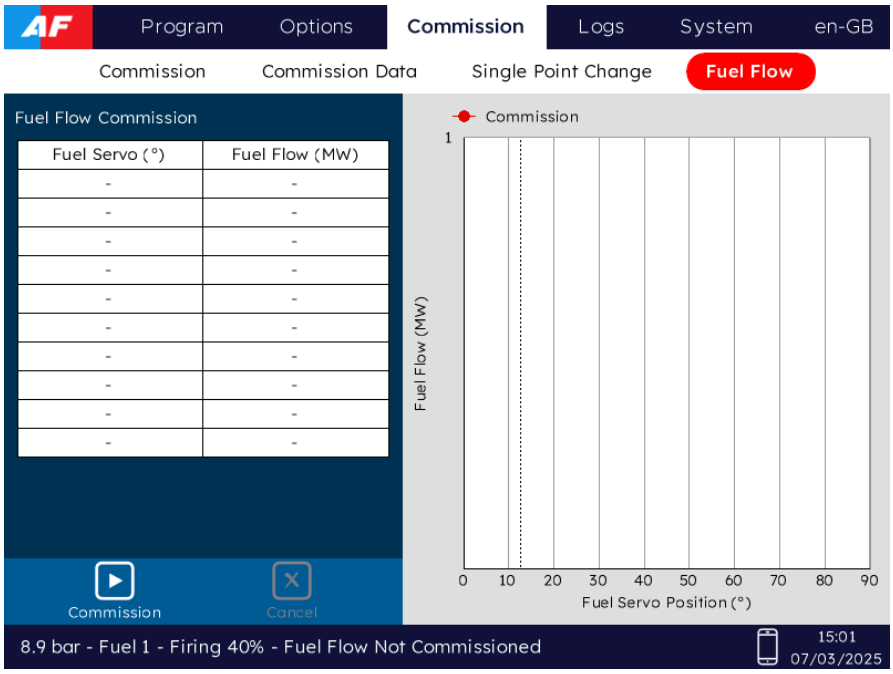


Figure 37 - Fuel Flow Commission Screen

Press the **Commission** button to commence commission. The channels will all move to the low fire point on the commission curve and a pop-up box will appear requesting **'Enter Fuel Flow For Point 1'**. Enter the value shown on the fuel flow meter, or as calculated using the method described above.

Press **Enter** to confirm the value and **OK** to enter it to the **Fuel Flow** list. There are 10 points which need to be entered across the commission curve from low fire to high fire, with low fire being point 1, and high fire point 10.

Note: The servomotors will drive to the low fire position, and then drive up as the fuel flow commissioning points are entered. Precautions must be taken to ensure that the boiler is warm enough for all 10 points to be entered.

As you enter the heat values for the 10 points, these will become marked on the graph to the right of the screen. Once the fuel flow commissioning is complete, press the **Home Button** to return to **Home Screen** in normal firing mode. If you press **Cancel** at any time during fuel flow commission, this will not store the points.



Figure 38 - Fuel Flow Data Entry

Note: Accurate **Fuel Flow** data is required to know exactly how much fuel you are burning. Having an accurate **Fuel Flow** calibration is particularly important for **Intelligent Boiler Sequencing** so that the system knows how much each boiler can contribute to the load.



Figure 39 - Automated Fuel Flow Entry Data

If an existing Fuel Flow Commission is being redone (e.g. due to a low fire or high fire point being moved) then the System will fill in the interim points based on the previous values. These can be accepted by pressing **OK** if they are suitable or pressing the number in the white box allows it to be changed.

7.7.1 Calorific Fuel Data

Stats	Kerosene SG	Gas Oil CI/SH	Light fuel Oil SG	Medium fuel Oil SG	Heavy Fuel Oil SG
Relative density 15.6°C (60°F) approx. / = litres x = kg	0.79	0.835	0.93	0.94	0.96
Flash point (closed) min °C (°F)	37.8 (100)	65.6 (150)	65.6 (150)	65.6 (150)	65.6 (150)
Viscosity kinematic (cSt) at 15.6°C (60°F) approx. 37.8°C (100°F) approx. 82.2°C (180°F) approx.	 2.0 - -	 - 3.0 -	 - - 12.5	 - - 30	 - - 70
Equivalent Redwood No.1 Viscosity at 37.8°C (100°F)	-	33 approx	250 max	1000 max	3500 max
Freezing point °C / °F	Below -40	Below -40	Below -40	Below -40	Below -40
Cloud point °C max	-	-2.2	-	-	-
Gross calorific values KJ/kg approx. Btu/lb approx. KWh/litre approx. Therms/gallon approx. kW/kg	 46,520 20,000 10.18 1.58 -	 45,590 19,600 10.57 1.64 12.66	 43,496 18,700 11.28 1.75 12.08	 43,030 18,500 11.22 1.74 -	 42,800 18,400 11.42 1.77 11.89
Sulphur content % wt.	0.2	0.6	2.3	2.4	2.5
Water content % vol.	Negligible	0.05	0.10	0.20	0.30
Sediment content % wt	-	Negligible	0.20	0.03	0.04
Ash content % wt	-	Negligible	0.02	0.03	0.04
Mean specific heat between 0°C - 100°C approx.	0.50	0.49	0.46	0.45	0.45
Volume correction factor per 1°C	0.00083	0.00083	0.0007	0.0007	0.00068
Volume correction factor per 1°F	0.00046	0.00046	0.00039	0.00039	0.00038
Btu/U.S. gallon (US standard)	-	140,000	-	150,000	160,000
Lb/U.S. gallon (US standard)	-	7.01	-	-	7.01
% lighter than water		20%			4%
1 U.S. Gallon of oil / ft of air		1402			

7.7.2 Conversion Factor For Imperial Gas Flow Meters

Required Data: Pressure of gas at meter in “wg

Required gas flow in ft³/min

Calculations: Correction factor = (pressure of gas at meter x 0.00228) + 0.948

Reading on gas meter = required gas flow / correction factor

Example: Pressure of gas at meter = 58” wg

Required gas flow = 95 ft³/min

Conversion factor = (58 x 0.00228) + 0.948 = 1.08

Reading on Meter = 95 / 1.08 = 88 ft³/min

7.7.3 Correction Factor For Burners Significantly Above Sea Level

Note: Above sea level i.e. >200m (1ft = 0.3048m)

Height above sea level in meters, Calculation for correction factor: =

(Pressure of gas at meter x 0.00228) + (0.948 – (height above sea level x 0.0001075))

Example: As above but 250 m above sea level:

Correction factor = (58x0.00228) + (0.948 – (250 x 0.0001075)) = 1.05

7.7.4 Gas Volume Conversion Factors

Assumed gas temperature	10 °C	50 °F
Standard pressure	760 mmHg	101.3612 Kpa
Standard temperature	15.56 °C	
Ambient pressure	101.325 Kpa	

Wg "	PSI	mmH2O	mmHg	Kpa	mBar	Conversion factor
1	0.036	25.4	1.867	0.249	2.49	1.0218
2	0.072	50.8	3.734	0.498	4.98	1.0243
3	0.108	76.2	5.601	0.747	7.47	1.0268
4	0.144	101.6	7.468	0.996	9.96	1.0293
5	0.181	127	9.335	1.245	12.451	1.0318
6	0.217	152.4	11.202	1.494	14.941	1.0343
7	0.253	177.8	13.069	1.743	17.431	1.0368
8	0.289	203.2	14.936	1.993	19.921	1.0393
9	0.325	228.6	16.804	2.242	22.411	1.0418
10	0.361	254	18.671	2.491	24.901	1.0443
15	0.542	381	28.006	3.736	37.352	1.0569
20	0.722	508	37.341	4.981	49.802	1.0694
25	0.903	635	46.677	6.227	62.253	1.0819
30	1.083	762	56.012	7.472	74.703	1.0944
35	1.264	889	65.347	8.717	87.154	1.107
40	1.444	1016	74.682	9.963	99.604	1.1195
45	1.625	1143	84.018	11.208	112.055	1.132

Wg "	PSI	mmH2O	mmHg	Kpa	mBar	Conversion factor
50	1.805	1270	93.353	12.453	124.505	1.1445
55	1.986	1397	102.688	13.699	136.956	1.1571
60	2.166	1524	112.024	14.944	149.406	1.1696
65	2.347	1651	121.359	16.189	161.857	1.1821
70	2.527	1778	130.694	17.435	174.307	1.1947
75	2.708	1905	140.03	18.68	186.758	1.2072
80	2.889	2032	149.365	19.925	199.208	1.2197
85	3.069	2159	158.7	21.171	211.659	1.2322
90	3.25	2286	168.035	22.416	224.109	1.2448
95	3.43	2413	177.371	23.661	236.56	1.2573
100	3.611	2540	186.706	24.907	249.01	1.2698
110	3.972	2794	205.377	27.397	273.911	1.2949
120	4.333	3048	224.047	29.888	298.812	1.3199
130	4.694	3302	242.718	32.379	323.713	1.345
140	5.055	3556	261.388	34.869	348.614	1.37
150	5.416	3810	280.059	37.36	373.515	1.3951
160	5.777	4064	298.73	39.851	398.416	1.4201
170	6.138	4318	317.4	42.341	423.317	1.4452
180	6.499	4572	336.071	44.832	448.218	1.4703
190	6.86	4826	354.741	47.323	473.119	1.4953
200	7.221	5080	373.412	49.813	498.02	1.5204

To use this information:

1) Measure Volumetric flow of gas for 1min in ft^3 (i.e. ft^3/min). Note $1m^3 = 35.31ft^3$
2) Multiply this volume flow by 60 to give volumetric flow per hour (i.e. ft^3/hr).
3) Measure the pressure of the gas supply.
4) Use the table above to obtain a conversion factor.
5) Multiply the volume flow per hour by the conversion factor to obtain a volume at reference conditions.
6) For natural gas, the calorific value is typically 1000 Btu/ft^3. To obtain the firing rate of the boiler at standard reference conditions multiply the volume at reference conditions by 1000.

Represented as an equation:

Firing Rate = (Measured Volumetric flow per minute x 60 x Conversion factor x 1000) Btu/hr

7.8 Gas / Air Pressure Commission

To re-commission the gas and air pressure sensors, select **Commission/Commission** and enter the **Commission Password**. Select **Pressure** on the **Blue Menu Bar** and **Start** to commence a **Pressure Commission**. The MM will then run through the points to store the air and gas pressure values.

If **Options/Burner/Sensors/Fuel Pressure Sensor Mode** is set to **Valve Proving And Pressure Limits** or **Pressure Limits Only**, then the unit will run through this pressure commission during a standard Commission process. The MM will go from Low Fire to High Fire and store the gas pressure values along the curve. Once these values are stored, the upper and lower offset limits will be adjusted to the new commissioned air and gas pressure values.

If **Options/Burner/Sensors/Air Pressure Sensor Type** is set to **Air Pressure Sensor** or **Air Switch And Air Pressure Sensor**, then an **Autoflame Air Pressure Sensor** will be used to measure the air pressure during the purge phase and at each of the Fuel-Air points. To define upper and lower limits for the air pressure during

firing, the **Air Pressure Window** must be changed from its default Zero setting. Once an **Air Pressure Window** is defined the air pressure limits will display on the Air pressure graph and will lockout if the window is exceeded. The **Air Pressure Warning Below/Above Commissioned** may be set to provide warning levels of the air pressure deviating from the commissioned level.

If the burner turns off during the gas/air pressure commission, the gas/air pressure commission process will need to be restarted. This ensures that the MM does not run with an incomplete set of gas/air pressure readings.

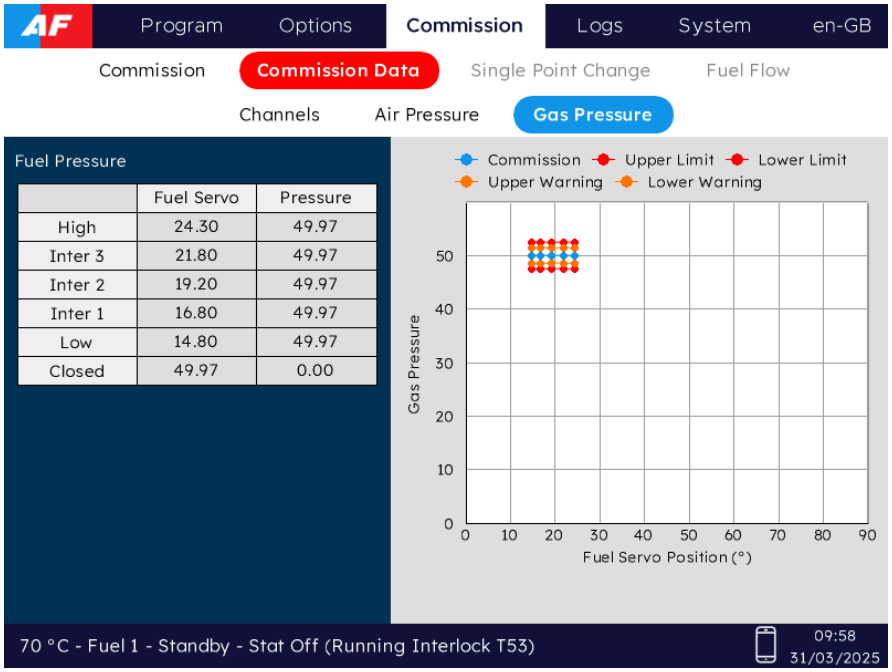


Figure 40 - Gas Pressure Commission

Note: If the gas or air pressure sensor is replaced with the same sensor type (same pressure range) then the sensor will not need to be recommissioned.

Note: For applications where VPS is required after burner shutdown only, then **Options/Burner/Valve Proving/Valve Proving Operation** should be set to **VPS Operates Before Startup** when doing the first gas sensor commission on the system to store the valve proving gas pressure. For normal running, **Options/Burner/Valve Proving/Valve Proving Operation** should then be set to **VPS Operates After Shutdown**.

7.9 Single Point Change

Single Point Change is used to adjust an existing **Fuel-Air** curve or to add **Trim**. When the burner is firing, select **Commission/Single Point Change** and then enter the **Commission Password** to access **Single Point Change** mode. This provides two options allowing the adjustment of the existing **Fuel-Air** curve and the addition or modification of **Trim** data.

7.9.1 Adjust Curve

The **Adjust Curve** option on the **Blue Menu Bar** is used to **Insert/Modify/Delete** individual points on the **Fuel-Air** curve.

When you enter **Single Point Change,** the Mini Mk9 will modulate to the next lower point on the **Fuel-Air** curve. When it reaches this point, it is automatically selected – the point will turn blue on the graph and in the list, the **Insert**, **Modify** and **Delete** buttons will become active.

In the blue box in the bottom right corner of the screen, a scrollable list contains all of the points on the commissioned **Fuel-Air** curve. If you wish to update a different point on the curve, select it from the list. The selection highlights in blue and the **Insert** and **Modify** buttons will become inactive, while the **Go To** button becomes active.

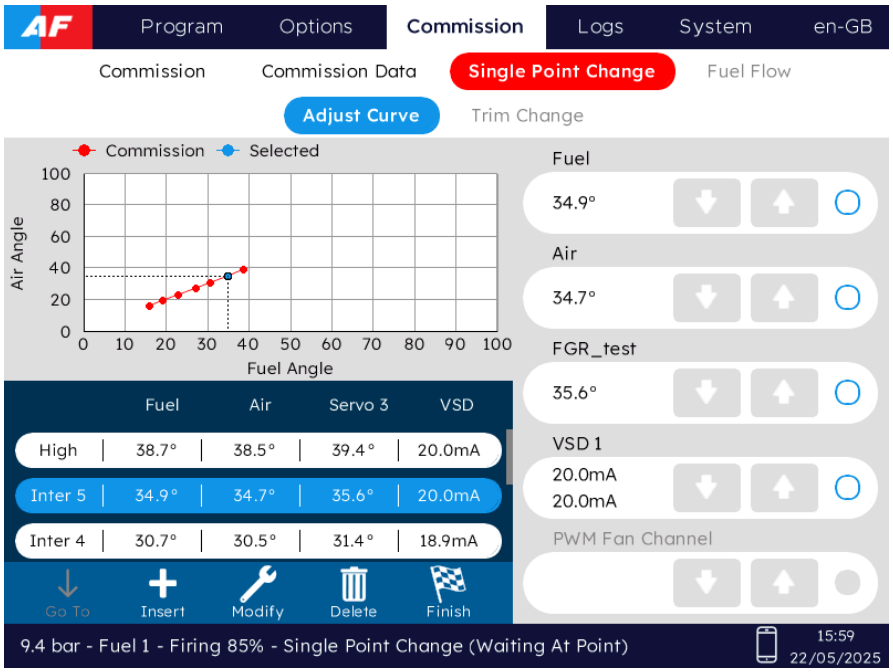


Figure 41 - Single Point Change Screen

Select **Go To** in order to modulate to the new point – once there, the **Insert**, **Modify** and **Delete** buttons will become active. To add a new point to the curve, select **Insert**.

The servo  buttons become active allowing you to move the combustion to a new position, which may be off the existing curve. Once you have moved far enough away from the original point, the **Enter** button becomes active allowing the new position to be stored.

The **Cancel** button replaces the Insert button and may be selected if you no longer wish to add a point.

To alter the position of a point, select **Modify**.

The servo  buttons again become active allowing you to move the combustion to a new position. The **Enter** button is always active allowing the modified position to be stored.

Note that in both cases, you can only drive the Fuel servo to 0.5° from the next higher or lower point on the curve.



Note that you are changing the current firing point and care should be taken when moving it. When increasing the firing rate, the air servo should be moved first, followed by the fuel servo, in order to maintain safe, air-rich combustion. Conversely when decreasing the firing rate, move the fuel servo first. Any movement to a new desired point should be achieved in small steps, changing the **Fuel-Air** ratio slightly each time in order to keep tight control of the combustion. The exhaust gases should be continually monitored during this process to ensure that safe combustion is maintained. It is the commissioning engineer's responsibility to ensure that a safe combustion curve is defined for the system and maintained at all times.

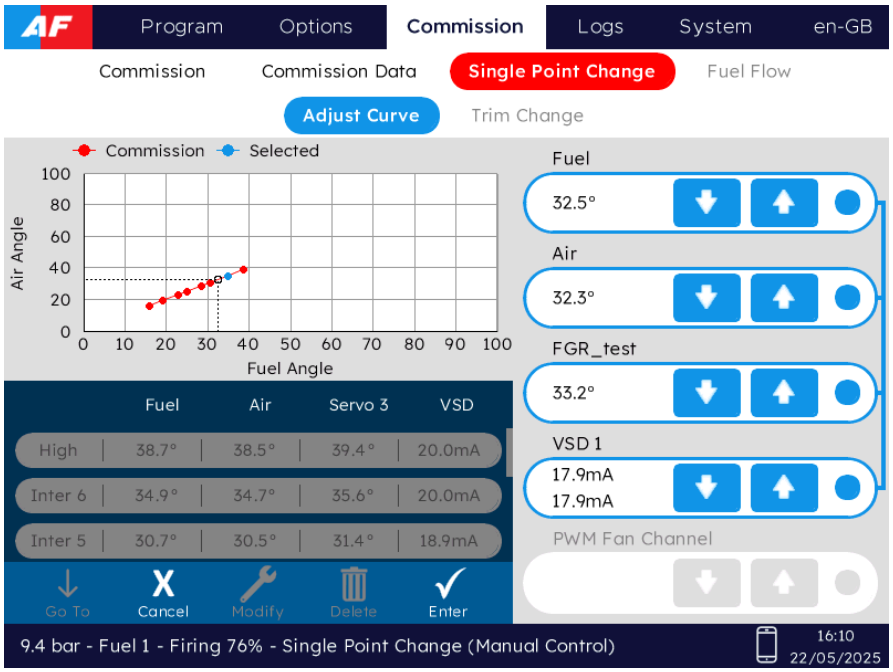


Figure 42 - Inserting A New Point

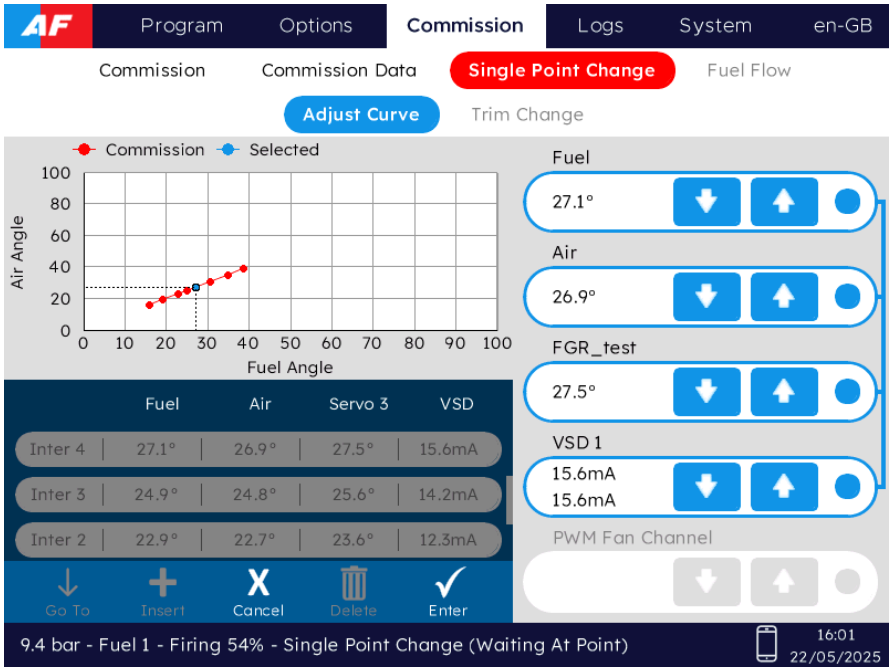


Figure 43 - Modifying A Point

The **Delete** button becomes active once a point is selected. Selecting it changes the button to **Cancel** which may be selected to change your mind. The **Enter** button becomes active and confirms the delete if selected. The point will then be removed from the list.

Note that you can delete a selected point on the curve without actually moving to it.

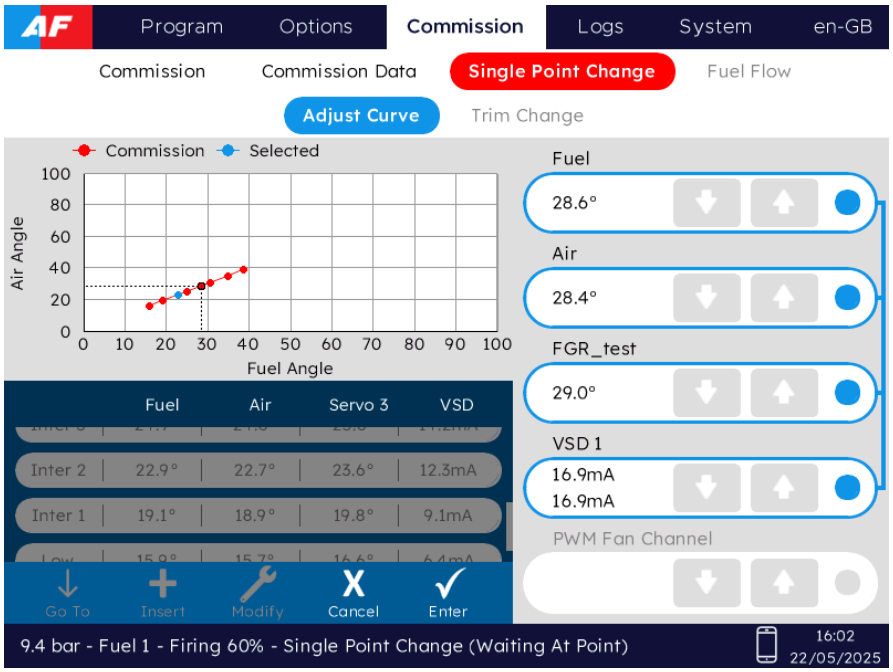


Figure 44 - Delete A Point

Once the **Insert/Modify/Delete** of a point has been confirmed by pressing **Enter**, the **Finish** button becomes active. Selecting this brings up a pop-up which allows you to Save or Discard the changes before exiting Single Point Change, or go back and continue editing.

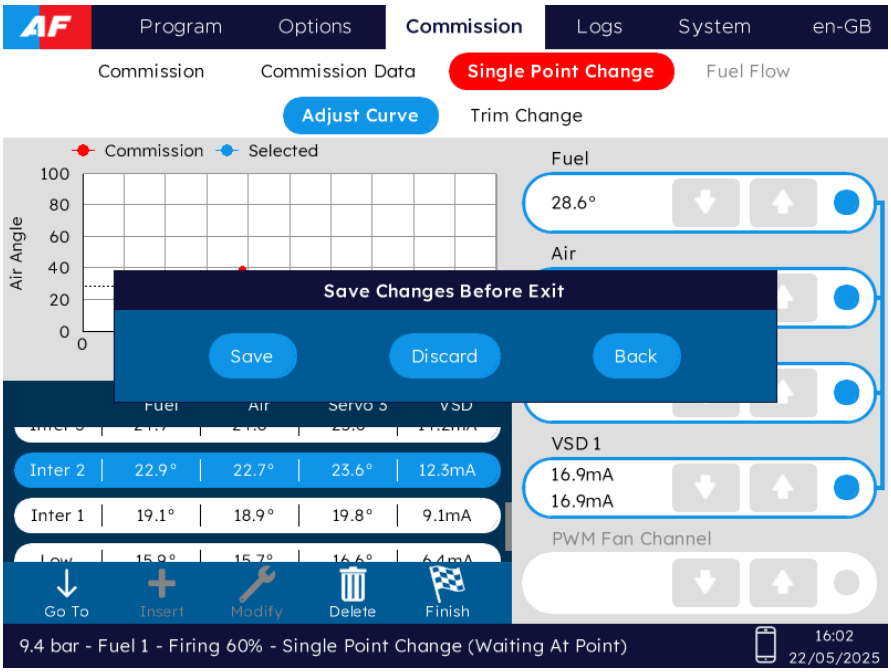


Figure 45 - Save Changes

Note in **Single Point Change**, the requirement to have a minimum of 5 points and a maximum of 20 on the **Fuel-Air** curve still holds true. Therefore if there are only 5 points on the curve, the delete function will not be active. Similarly, if 20 points have been defined it will not be possible to insert a new point.

Note that if the **Low Fire**, or **High Fire** points are moved, deleted, or a new **Low Fire** or **High Fire** point is defined, then any existing **Fuel Flow** calibration will be invalid and the **Fuel Flow** will need to be recommissioned. Altering points other than the **Low Fire** or **High Fire** does not require an existing **Fuel Flow** curve to be recommissioned.

7.9.2 Trim Change

In the Mini Mk9 MM, changing the **Trim** commission of a point has been separated out from adjusting the curve under **Single Point Change**. **Trim** is used to maintain the combustion at a commissioned setting even when there are changes to atmospheric conditions or fuel pressures. A feedback loop allows the MM to adjust the air damper away from the main fuel-air curve in order to maintain the combustion at the desired level.

The Mini Mk9 supports three types of trim:

- 3 parameter EGA Trim – Measuring the exhaust gases using an Autoflame Exhaust gas Analyser and adjusting the combustion to maintain them at the levels defined during a trim commission.
- O2 trim – Using an O2 sensor input to measure the exhaust gas and adjust the combustion to maintain the O2 at the level defined during a trim commission.
- UV Trim – Using a UV Trim Scanner to look at changes in the flame to adjust the combustion and maintain the commissioned performance.

Note that UV Trim provides a rapid response to changes in the flame and so is much quicker to respond to and correct changes in the combustion. UV Trim requires an EGA or O2 sensor feedback to ensure the adjustments remain locked on to the ideal combustion. Autoflame have obtained patent protection for the UV Trim process.

The **Commission**/**Single Point Change**/**Trim Change** option allows Trim data to be added to the points on the curve. Note that Trim is never added during a full commission, so this process is the only way of adding trim to the curve.

Once in the **Trim Change** page, all the points on the **Fuel-Air** curve are shown in the list on the left hand side. The trim data table is shown on the right hand side for the three gases **O2**, **CO2** and **CO**, plus **UV** if **Options**/**EGA**/**Trim**/**UV Trim Enable** is set to **Enabled**. Initially the table will be blank if no trim has been added. Tab buttons above the exhaust gas table allow the trim data at each of the gases or the UV signal to be viewed.

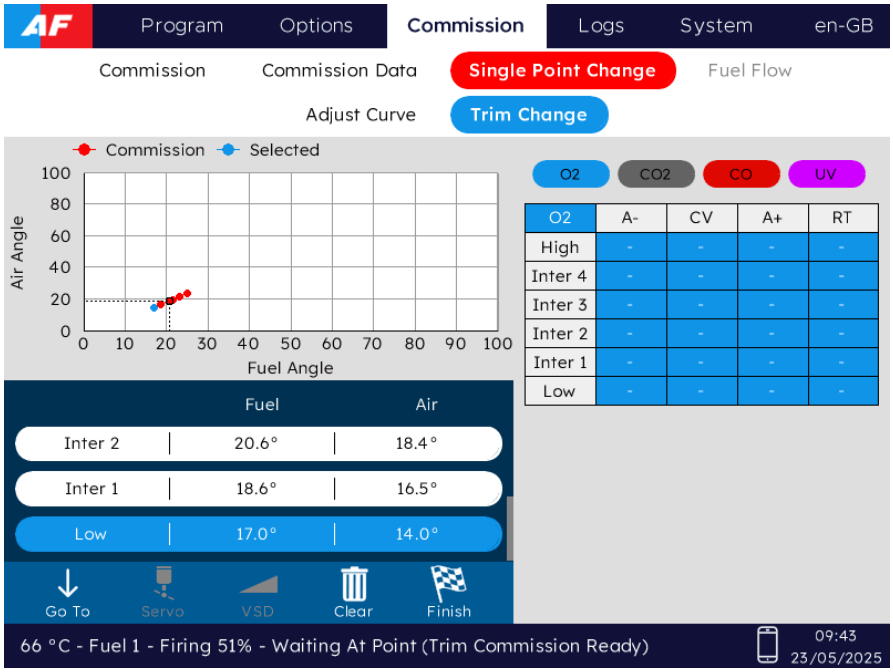


Figure 46 - Selecting A Point To Trim

To add trim, navigate to a point on the **Fuel-Air** curve by selecting it in the list of points (indicated by turning blue) and navigating to it by selecting the **Go To** button.

The Mini Mk9 allows either the **Servo** or a **VSD** to be changed to provide the variation in the air supply when trimming. Note that a **PWM** channel may be used instead of the **VSD** be setting **Options**/**EGA**/**Trim**/**VSD or PWM Channel Used For Trim** to **Trim Using PWM Channel**.

The decision as to which to use is made by the user selecting **Servo** or **VSD**. The MM will then clear any existing trim data and run through the trim process of measuring the EGA levels at the commission value (CV), fuel-rich (A-) and air-rich (A+) trim angles and will store the trim values for this position. It is expected that

Servo trim will be more effective at low firing rates where the change in servo angle has a bigger effect on the air change. VSD Trim may become more effective at high firing rates.

Note: VSD trim should be avoided where the VSD input is close to the 4mA or 20mA VSD input levels as this may not allow room for the VSD to change enough for effective trimming.

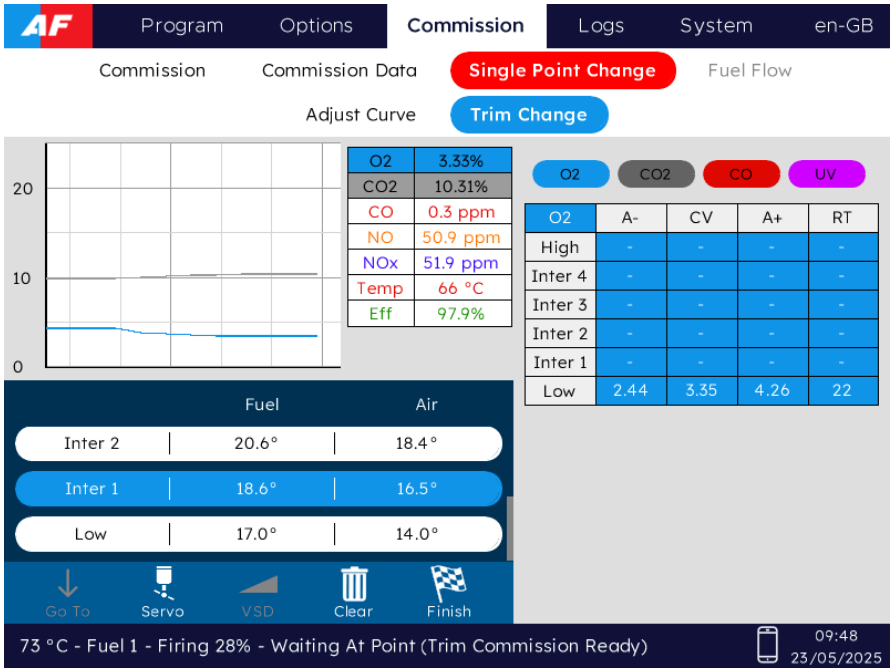


Figure 47 - Adding Trim

You can swap between **Trim Change** and **Adjust Curve** to set up the points on the curve and their trim properties accurately. It is recommended to used **Adjust Curve** to fine tune the exhaust gas levels carefully for optimum performance and then to add trim using **Trim Change**.

In the **Trim Change** page, you can use the **O2**, **CO2**, **CO** and **UV** buttons to swap between the Trim readings taken for the different gases and the UV. Graphs for the different values can be accessed by tapping on the graph and using the commission screen options as defined in Table 6.

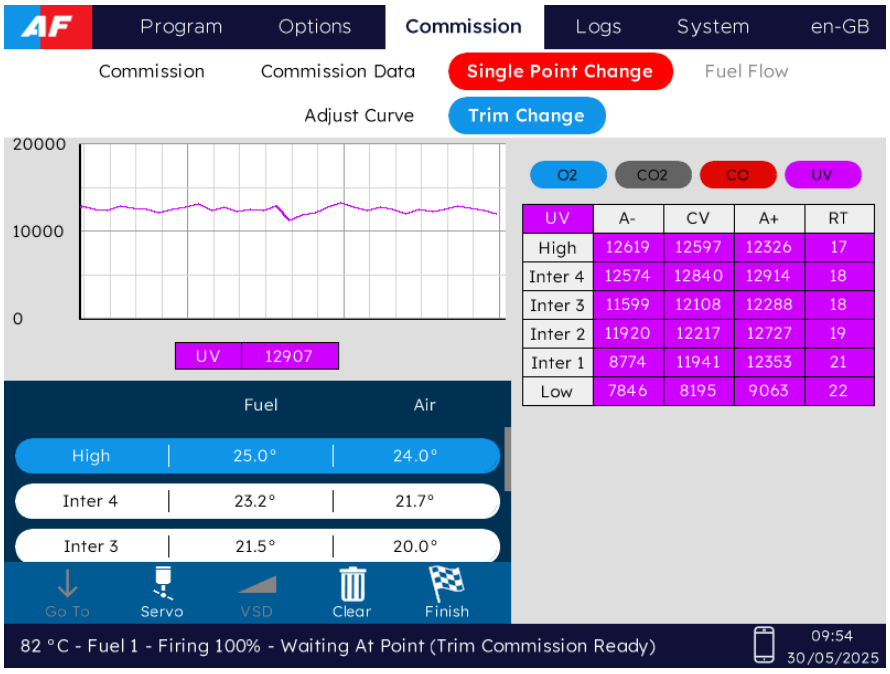


Figure 48 - UV Trim Readings

For **UV Trim**, it is especially recommended to try and have the CV O2 levels closely aligned for adjacent points on the curve to produce a neat trim map to improve the interpolation for combustion between defined points.

Note: When using VSD trim in particular, it may not be possible to add trim if the settings are close to the 4mA or 20mA ends of the VSD range. In this case the **Fuel-Rich** or **Air-Rich** settings may be outside of the VSD range and the trim point would not be stored.

To exit **Single Point Change** select the **Finish** button and a pop-up will allow you to **Save**, **Discard** the trim data before exiting, or go **Back** to continue trim editing.

The **Fuel Flow** commissioning must be re-done if EGA trim data has been added.

UV Trim requires that there is a gradient across the **A-**/**CV**/**A+** points so that it can uniquely define the current position on the trim map. If the flame is partially obscured, the UV signal may not be fully measured and a suitable set of **UV Trim** values may not be obtained. In this case the values will be recorded, but will be highlighted in red as shown below, indicating that **UV Trim** will not operate for that point. If this is the case, either:

- Redo the trim at that point to see if a valid trim may be obtained – changing the firing rate slightly may result in a better assessment of the flame.
- Try moving the scanner to a different location to see if a better view of the flame can be obtained – this requires redefining the complete **UV Trim** map.
- Leave as is – the Mini Mk9 will use **EGA** or **O2 Trim** for that point on the curve and seamlessly swap to **UV Trim** where valid trim data exists.

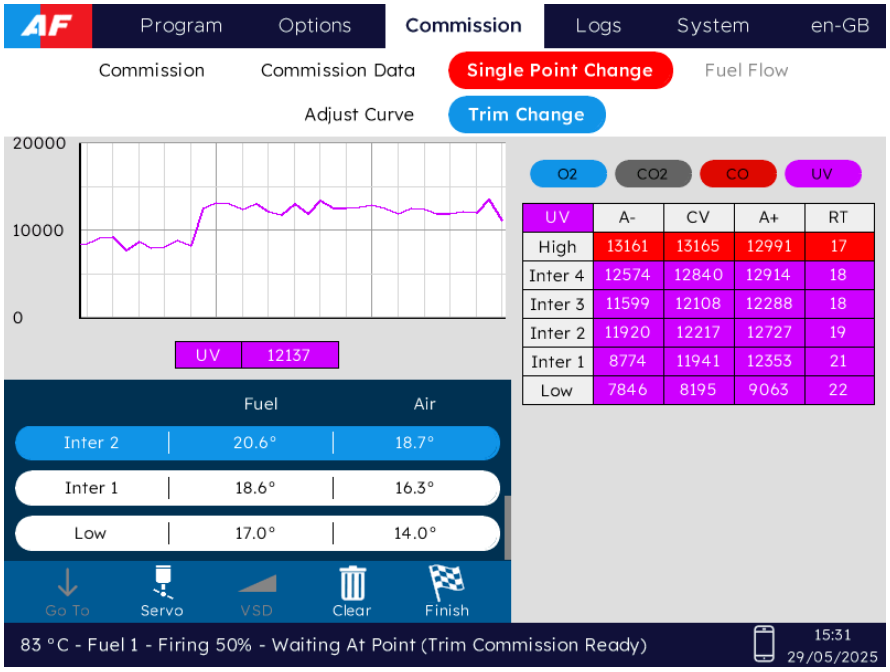


Figure 49 - UV Trim Invalid Point

Read the **Mini Mk9 EGA/UV Trim Setup Guide** technical note for a more detailed explanation of setting up **EGA** and/or **UV Trim**.

8 VALVE PROVING

Valve Proving can be carried out on any gaseous fuels and can be actioned before and/or after firing. The definition of the gas pressure sensor required for valve proving is done in **Options/Burner/Sensors** while the definition of the **Valve Proving** itself is done in **Options/Burner/Valve Proving**.

8.1 Selecting Valve Proving Mode

In **Options/Burner/Sensors/Fuel Pressure Sensor Mode**, a number of options are available to define how and when the gas pressure is monitored as follows:

Table 7 - Valve Proving Setup

Selection	Definition
Not Monitored	Do not carry out VPS or check the pressures during firing.
Valve Proving And Pressure Limits	Carry out VPS using an Autoflame Gas Pressure Sensor and continually test the gas pressure during firing.
Valve Proving With pressure Sensor	Carry out VPS using an Autoflame Gas Pressure Sensor.
Valve Proving With Digital Input	Carry out VPS only with a go/no-go test.
Pressure Limits Only	Do not carry out VPS, but do continually test the gas pressure during firing using an Autoflame Gas Pressure Sensor.
External VPS	Carry out VPS using an external Valve Proving System.

Valve proving can be set independently for each fuel, so if you have one gas fuel and one oil fuel, only set it for the gas fuel.

If you have 2 gas fuels with independent valves, you will need two gas sensors, one on each fuel train. These can both be wired in to T31 to T34. Use **Options/Burner/Sensors/Fuel Pressure Sensor Serial Number** to define which gas pressure sensor is for which fuel.

8.2 Setting Up Valve Proving

Options/Burner/Valve Proving is used to define how **Valve Proving** operates. In this section, **Valve Proving Operation** defines whether **Valve Proving** will operate before start-up, after shutdown, or both.

Vent Valve Configuration sets whether a **Vent Valve** is present and how it is configured – this should be set to match the configuration of the vent valve on your burner.

The remainder of the options define the timings for the VPS tests and the gas pressure limits that will be applied. **Static Pressure Limits** are those applied during VPS checks, while **Running Pressure Limits** are applied during firing if optioned in the **Fuel Pressure Sensor Mode**. The **Gas Running Pressure Offset Below (Above) Commissioned Curve** set the levels at which an alarm would occur shutting down the burner. The **Gas Running Pressure Warning Offset Below (Above) Commissioned Curve** produce a warning to tell the user that the gas pressure has varied but the burner will still run.

8.3 Valve Proving Sequence

If **Valve Proving** is optioned on, then the controller will carry out the following tests during the required VPS phase:

Table 8 - VPS Sequence

Phase	Action	Errors
Void To Air	Open the **Vent Valve** (or the boiler side Gas Valve if No Vent Valve is defined) to allow the pressure between the **Main Gas Valves** to **Vent** and be zeroed.	No Checks made in this stage.
Init Air Proving	Take the initial zeroed gas pressure reading. Then close the Vent Valve (or the boiler side Gas Valve if No Vent Valve is defined) to isolate this zeroed pressure between the **Main Gas Valves**.	This step is measuring the zeroed pressure of the sensor. If the gas pressure is higher than 4% of the sensor range then it is seen to not be reducing enough and a **Fuel Pressure Zero Value Invalid** Alarm will occur. Change the sensor for a different range and/or increase the **Valve Proving Valve Opening Time**.
VPS Air Pressure	Ensure that the gas pressure remains stable for the duration of the **Valve Proving Time**.	If the pressure increases by more than the **Maximum Pressure Change Allowed During VPS** then a **VPS Pressure Increase** Lockout will occur. This indicates that the gas valve on the gas inlet side is not closing properly and that gas is leaking into the gap between the **Main Gas Valves**. This should be investigated thoroughly before trying to fire again.
Void To Gas	Open the **Main Gas Valve** on the gas supply side to allow the pressure to rise to the supply pressure.	No Checks made in this stage.
Init Gas Proving	Take the initial gas supply pressure reading. Then close the **Main Gas Valve** to isolate this supply pressure between the **Main Gas Valves**.	If the gas pressure doesn't increase significantly from the zeroed level then a **Low Pressure Gas Before Start** Alarm will occur followed by a **Gas Proving Pressure Invalid** and the burner will not proceed to firing. This should be investigated thoroughly before trying to fire again.
VPS Gas Pressure	Ensure that the gas pressure remains stable for the duration of the **Valve Proving Time**.	If the pressure decreases by more than the **Maximum Pressure Change Allowed During VPS** then a **VPS Pressure Decrease** Lockout will occur. This indicates that the gas valve on the burner side is not closing properly and that gas is leaking into the burner from the gap between the **Main Gas Valves**. This should be investigated thoroughly before trying to fire again.

If VPS is set to operate after firing and an **Alarm** or **Lockout** occurs in either **VPS Before Firing** or **VPS After Firing**, then when the alarm is cleared it will complete the **VPS After Firing** check before recycling and trying to start again. The **VPS Before Firing Test** will then operate as normally (if defined) on the next restart.

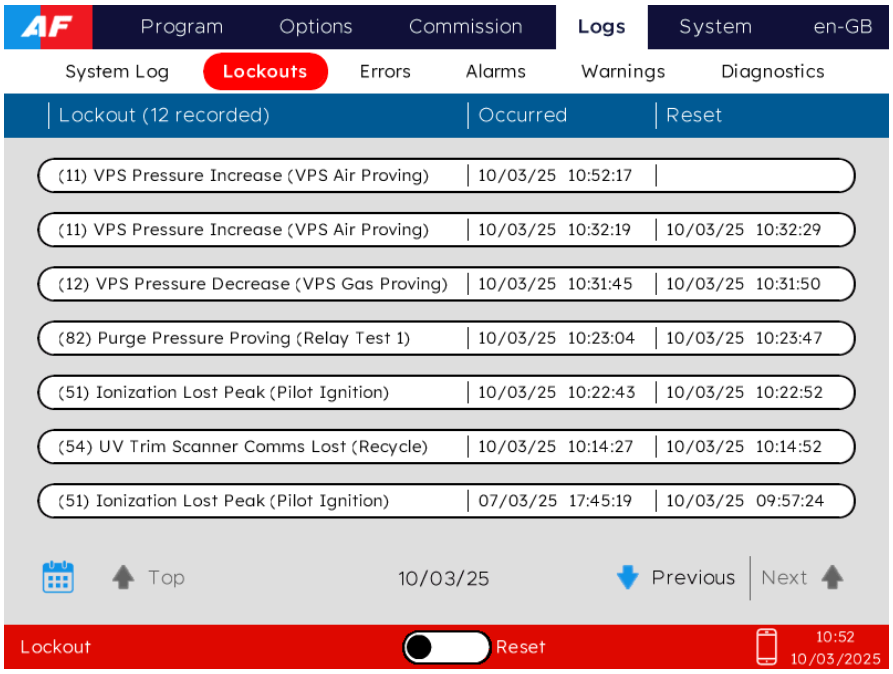


Figure 50 - VPS Lockout

8.4 Pressure Limits

In **Options/Burner/Sensors/Fuel Pressure Sensor Mode**, if **Valve Proving And Pressure Limits** or **Pressure Limits Only** are selected, then the pressure sensor will check the running pressure against the commission and ensure that it stays with the allowable error bands.

8.5 External Valve Proving

External Valve Proving requires an input to be made on the **CPI/POC** terminal (T55 for fuel 1 or T97 for fuel 2) to confirm that **VPS** has been completed. The Mini Mk9 sits at the **Wait for CPI** stage until the input is made. A **CPI Input** lockout occurs after 10 minutes if no input made.

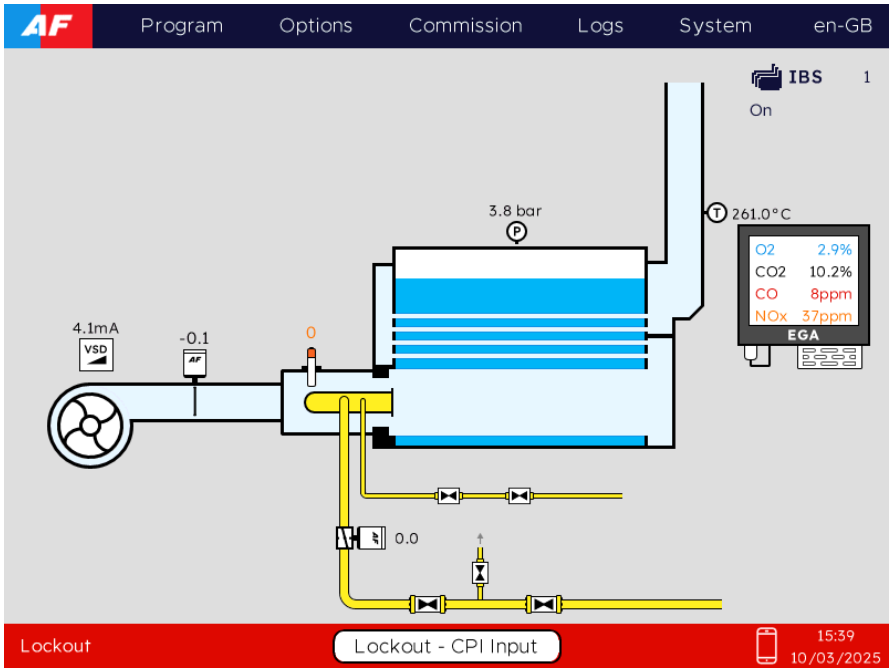


Figure 51 - External VPS Lockout

9 GENERAL FEATURES

9.1 Calibrating The Load Sensor's Actual Value

The load sensor value may be calibrated to fine tune its response. In **Options/Load/Load Sensor**, the **Load Sensor Adjustment** allows the temperature/pressure sensor value to be adjusted in a range of 80.0% and 120.0% of its nominal value. The setting can be unlocked for change using the On-Line Changes password.

The percentage change may not be linear to the current temperature/pressure, i.e. 80% of 100°C may not show 80°C.

For example, if the actual temperature was showing as 83°C on the MM, but the true temperature was 69°C, change the **Load Sensor Adjustment** until the correct temperature is displayed on the MM. The **Scaled Load Sensor Value** is shown at the top of the pop-up box.

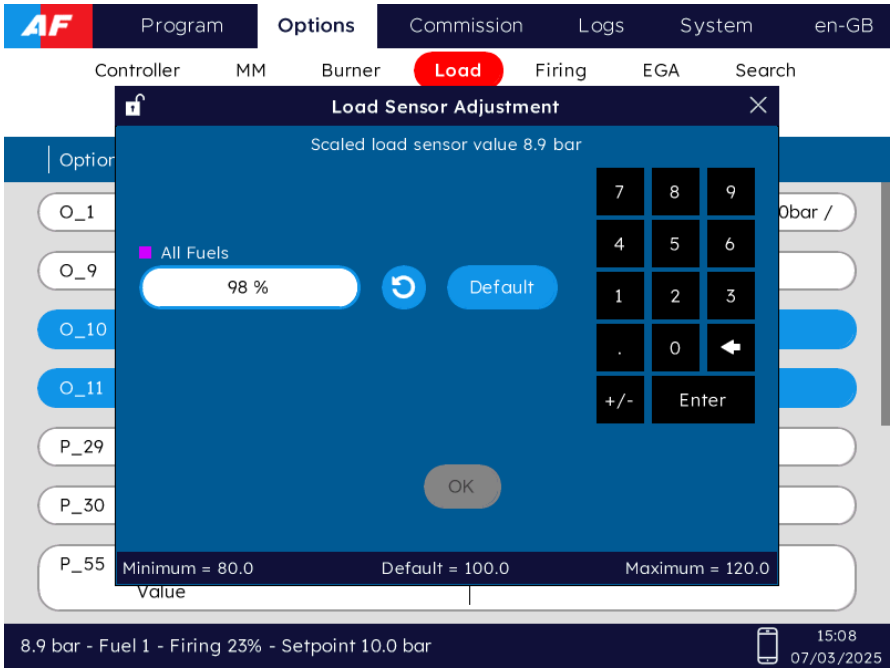


Figure 52 - Load Sensor Adjustment

9.2 External Modulation

External Modulation may be **Enabled** under **Options/Firing/Modulation**. For **External Modulation** to operate, **Options/Load/Load Sensor/Internal STAT Operation** must be set to **Internal STAT Always Closed**.

The internal PID control is then disabled and the firing rate is set by an input control signal on terminal 37, 38 as appropriate for 0 – 10V and 2 – 10V. **Options/Firing/Modulation/External Modulation Input Control Range** sets whether the external signal is defining **Low To High** fire or **Zero To High** fire. **External Modulation Input Range** sets whether the input is 2-10V or 0-10V. To use a 4-20mA or 0-20mA signal, a 500Ω resistor should be placed across terminals 37 and 38 in addition to the external input.

External Modulation may be '**Enabled By Input**' in which case an input signal will need to be made on T98 and **Options/MM/Terminals/T98 Function** set to **External Modulation Select**.

Fuel Flow metering must be commissioned for **External Modulation** to work correctly.

9.3 HAND MODE, LOW FLAME HOLD AND AUTO

9.3.1 Hand Mode

Hand Mode operation enables the firing rate to be set to a specific position, in the range of low to high fire, when the burner is firing. **Fuel Flow** metering must be commissioned. An individual MM will drop out of the **Sequencing Loop** if it is in **Hand Mode**.

The Mini Mk9 MM will go into **Hand Mode** when the hand mode soft slider is moved to the right on the **Fuel-Air** screen shown in Figure 53 or is an input is made on terminal T98 with **Options/MM/Terminals/T98 Function** set to **Hand Mode**. The Arrows below the graph will then become active (turn blue) and can be used to increase and decrease the firing rate. Once **Hand Mode** is deactivated, by moving the slider back to the left or removing the T98 input, the MM will go to auto mode and fire according to normal modulation. The transfer between **Hand Mode** and **Auto Mode** is always seamless.

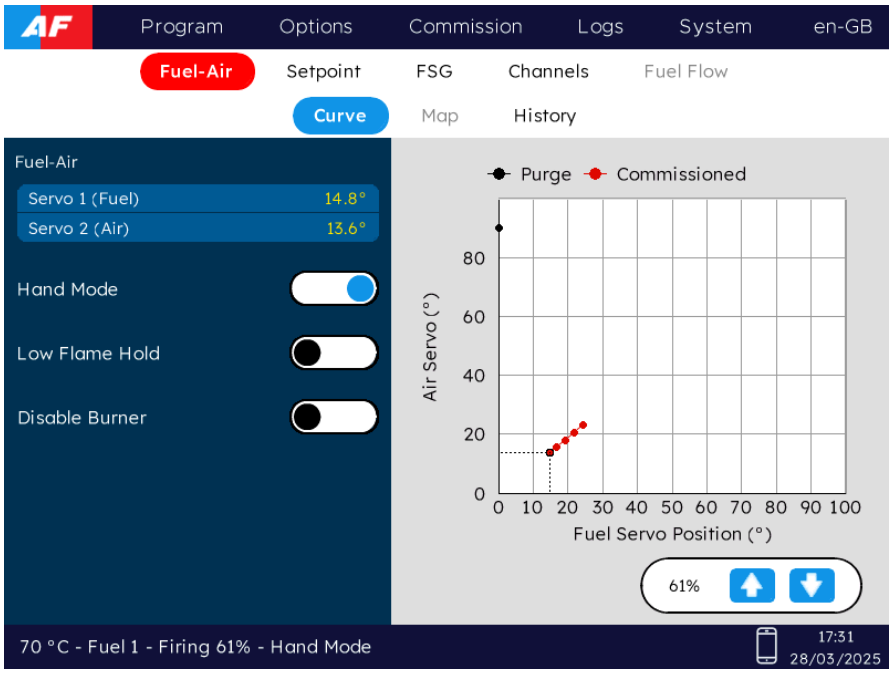


Figure 53 - Hand Mode

Hand Mode will take precedence over **Low Flame Hold** if that has also been activated.

9.3.2 Low Flame Hold

Low Flame Hold is the state when the MM's firing rate is held in its low fire position, while the burner is firing. **Fuel Flow** metering must be commissioned. An individual MM will drop out of the **Sequencing Loop** if it is in **Low Flame Hold**.

To put the Mini Mk9 MM into **Low Flame Hold**, go to the Fuel-Air screen and move the low flame hold soft slider to the right. Alternatively an input on T98 with **Options/MM/Terminals/T98 Function** set to **Low Flame Hold** may be used to activate **Low Flame Hold**. Once out of low flame hold, the MM will return to normal modulation.

If the **Hand Mode** slider is active on the **Fuel-Air** screen then it will take precedence over a **Low Flame Hold** input.

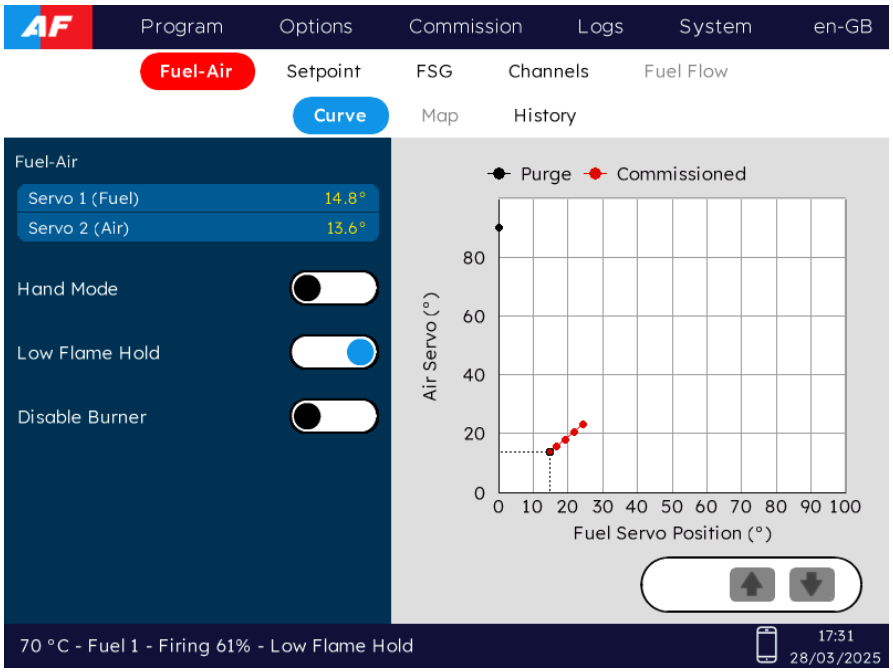


Figure 54 - Low Flame Hold

9.3.3 Auto Mode

The Mini Mk9 MM is in **Auto Mode** at all times, unless **Hand Mode** or **Low flame Hold** are activated, or **External Modulation** is enabled.

The MM **Auto Mode** operation enables the burner modulation to maintain the setpoint, modulating the firing rate according to how far away the actual temperature or pressure is from the required setpoint. The firing rate is determined from the **Fuel Flow** metering which is activated in **Options/MM/Fuel/Fuel Flow Metering** and must be commissioned. The more accurate the fuel flow metering, the more accurate the firing rate.

9.3.4 Disable Burner

The **Disable Burner** slider on the **Fuel-Air Curve** page will cause the burner to shut down, and be held there whilst activated.

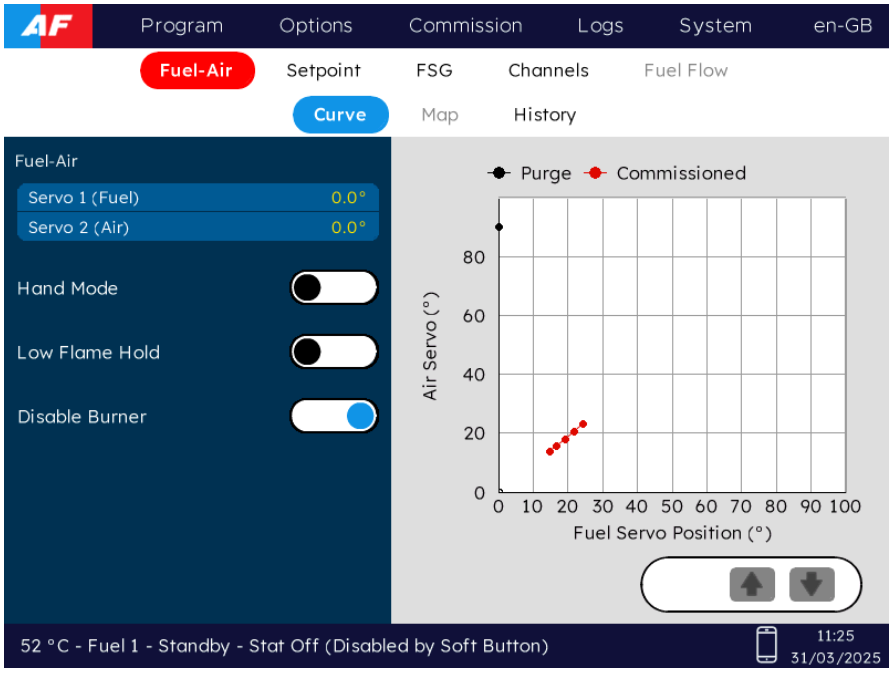


Figure 55 - Disable Burner

If **Options/Load/Setpoint/User Burner On/Off Control** is set to **Locked**, then the **Disable Burner** slider is held in its current position. This may be used to either:

- Prohibit the use of the **Disable Burner** function by locking it in the **Inactive** position
- Preventing anyone without the **On-Line Changes Password** from starting up the burner if it is locked in the **Active** position.

9.3.5 Cold Start Routine

The Mini Mk9 may be configured to start a burner up slowly if it is starting from cold to mitigate the possibility of thermal shock damaging a boiler if it is heated too quickly.

The controls for **Cold Start** are set in **Options/Firing/Start-Up**. Two threshold, the **Cold Start First Setpoint Fraction** and the **Cold Start Second Setpoint Fraction** define two levels at which the burner will fire at set rates for the duration of the **Cold Start Routine** time as follows:

- The burner will be held at **Low Fire** if the load sensor is below the **Cold Start First Fraction** percentage of the Setpoint (e.g. If the Setpoint is set to 100 PSI and the **Cold Start First Fraction** is set to its default 30%, then the burner will be held in **Low Fire** is the Load value reads less than 30PSI.
    - Note that if the Load moves above the threshold before the time has elapsed, the burner will move to the Mid-Fire position as described below.
- The burner will then be held at Mid-Fire if the load sensor is below the **Cold Start Second Fraction** percentage of the Setpoint (e.g. If the Setpoint is set to 100 PSI and the **Cold Start Second Fraction** is set to its default 60%, then the burner will be held in **Mid-Fire** is the Load value reads less than 60PSI.
- When the timer elapses, or the load value rises above the **Cold Start Second Fraction** percentage of the Setpoint, then the burner is released to modulate.

If the MM progresses through **the Cold Start Routine** to modulating and the burner then shuts down, a **Cold Start** will not occur if the burner starts up again within the **Cold Start Inhibit Time**. This allows the burner to move straight to normal modulation in situations where the demand has increased drastically and the load value drops fast, but the boiler is still warm from the earlier firing.

9.4 Servomotor Operation, VSDs and PWM Fans

The Mini Mk9 is very flexible in the setting up and control of the channels.

Each of the 3 **Servo Motors** may be set in one of 4 modes:

- Disabled.
- Fuel Channel.
- Air Channel.
- Independent Channel (e.g. Draught Servo).

Note only 1 channel may be set to control the **Fuel** input. Multiple channels may be set to control **Air** input.

Similarly a **VSD** may be set in one of 4 modes:

- Disabled.
- Enabled As VSD.
- Enabled As Servo (Fuel) – i.e. a 4-20mA servo control.
- Enables As Servo (Air) – i.e. a 4-20mA servo control.

The allowed variation in the VSD feedback is defined by **Options/MM/VSD/VSD1 Feedback Fault Tolerance**. Two possible methods of generating a VSD feedback error are as follows:

- A small deviation for a long time – The feedback is off by more than the defined tolerance for 3 seconds.
- A large deviation for a short time – The feedback is off by more than 1.5 x the defined tolerance for 1 second.

Finally the **PWM** fan may be enabled with or without feedback.

The default settings are for Servo 1 to be the Fuel Channel, Servo 2 to be the Air Channel and all other channels disabled.

This flexibility means that the Mini Mk9 may be used to control systems where the air is controlled only by a **VSD** or **PWM** fan (single servo mode).

It may also have 2 servos set as air, for a system where the air input comes from 2 separate ducts, each controlled by a damper.

There may even be only 1 channel set as Fuel, whether that be controlled from one of the servos, or as a 4-20mA input on the VSD channel,

Note: Set up the channels carefully and ensure that you are clear as to which channel is used for fuel and which for air, especially if they are changed from their default settings. It is good practise to ensure all the channels are labelled correctly, so that they are easily identified and there is no confusion as to which channel is used for which purpose. The channel settings and labels are set in **Options/Controller/Boiler**. Where convenient, it is recommended to remain with the default settings and use Servo 1 for Fuel and Servo 2 for Air.

Note care should be taken to ensure that the servomotor purge positions are set correctly in **Options/MM/Servo**. Fuel channels should be set to **Remain Closed For Purge** and Air channels should be set to **Purge At Open Position**. Similarly **Options/MM/VSD/VSD 1 Purge Position** should be set to **Purge At Open Position** if it is being used to control the **Burner Fan** or as an **Air Servo**, but should be set to **Purge At Closed Position** otherwise.

9.4.1 Single Servomotor Operation

The Mini Mk9 may be set up for applications where only the **VSD** or **PWM** fan controls the air going into the burner, with no requirement for an air servomotor. The **Fuel-Air** curve will show **VSD** (or **PWM** Fan) output against Fuel servomotor angle. The MM will make changes to the fuel servomotor and **VSD** (or **PWM** Fan) in synchronisation as the firing rate modulates up and down.

When using a single servomotor with VSD, the MM checks that the VSD feedback is within the fault tolerance bands set in **Options/MM/VSD/VSD 1 Feedback Fault Tolerance** as the fuel servomotor drives open to increase the firing rate. If the VSD feedback is not higher than the tolerance band at that servomotor angle, then the servomotor will wait until the VSD ramps up to meet this limit at minimum as shown in Figure 56. This prevents the burner from being too fuel rich as the firing rate increases. As the fuel servomotor closes, there is a natural lag in the VSD feedback as it slows down; the fuel servomotor still waits for the VSD but does not modify the target VSD speed.

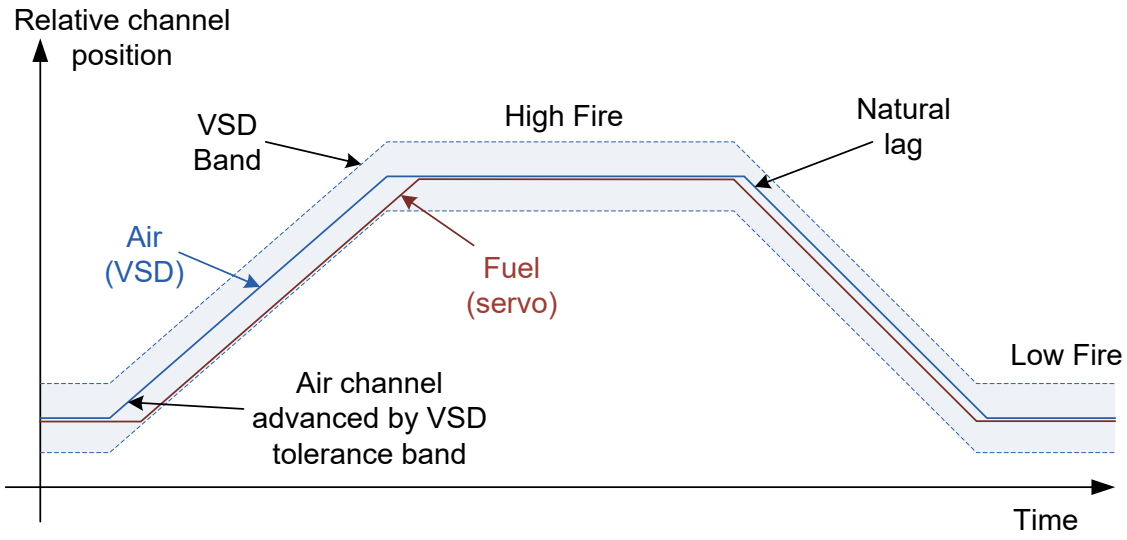


Figure 56 - Single Servomotor with VSD

Only 1 of the servo channels should be set to **Fuel Channel** in **Options/MM/Servo**, with the others **Disabled**. **Options/MM/VSD/VSD 1 Enable** must be set to **Enabled As Servo (Air)**. The other VSD settings in **Options/MM/VSD** must be set according to the VSD requirements.

The commissioning procedure remains the same, however only the fuel servomotor position and VSD position need to be entered for each point. In Run mode the system will show the servomotor position and VSD input and output signals.

Options/MM/VSD/VSD 1 Purge Position should be set to **Purge At Maximum Output** and the **VSD 1 Output At Closed** set to **Minimum Output At Closed**.

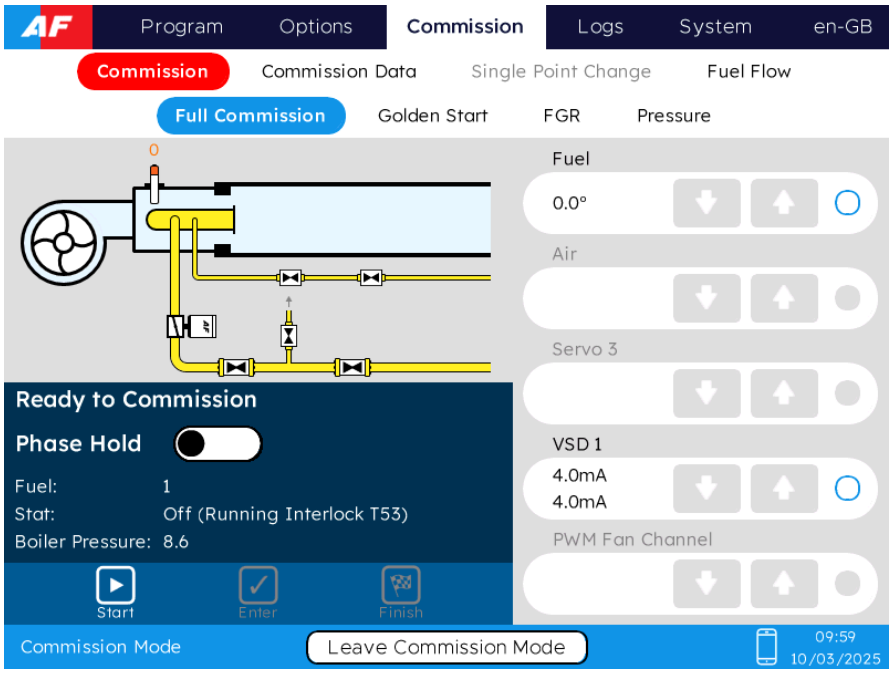


Figure 57 - Single Servomotor With VSD

9.5 PWM Motor Control

In applications with fans/blowers that use Pulse Width Modulation (**PWM**) control, the Mini Mk9 MM can be set up in single servomotor mode with the air being controlled by driving the **PWM** fan directly. Terminals T99 to T102 are used to connect the fan as follows:

Terminal	Function	Description
T99	0V	0V supply to the Fan Driver
T100	PWM Out	PWM drive signal to set the fan speed
T101	Tacho In	Feedback Tacho signal from the fan
T102	12V	12V supply to the Fan Driver

The **PWM Out** and **Tacho Feedback** signals control of the PWM Fan. **Options/MM/PWM/PWM Fan Input Pulses Per Revolution** defines the expected feedback from the fan. The commissioning procedure is the similar to that of a **VSD** with the fan being driven to a percentage of its full speed.

In Run mode the system will show the **PWM Out** and **Tacho In** signals. Power to the Fan control circuit is provided from terminals T99 and T102.

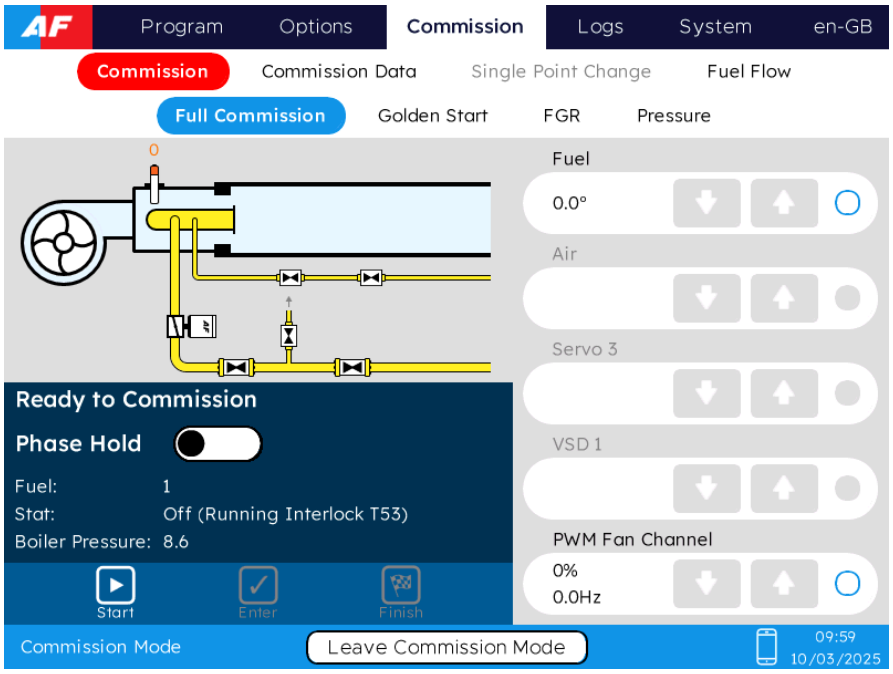


Figure 58 - Single Servomotor With PWM Fan

9.6 No Air Servomotor

Some burner applications use natural draught to supply air for combustion without the need for an air blower for forced draught, meaning there is no air damper and the air supplied to the burner is at atmospheric pressure. In such applications there is no need for control on the air channel and only the fuel channel requires commissioning.

The Mini Mk9 MM allows the burner to be commissioned with a single channel (**Servomotor** or **VSD As Servo (Fuel)**) to control the fuel flow. This configuration can also be used for pre-mix burners where the fuel to air volume ratio is not varied. In these applications, the single channel is used to vary the volume of combined air and fuel.

The selected channel is wired as normal to the MM and all other channels are set to disabled.

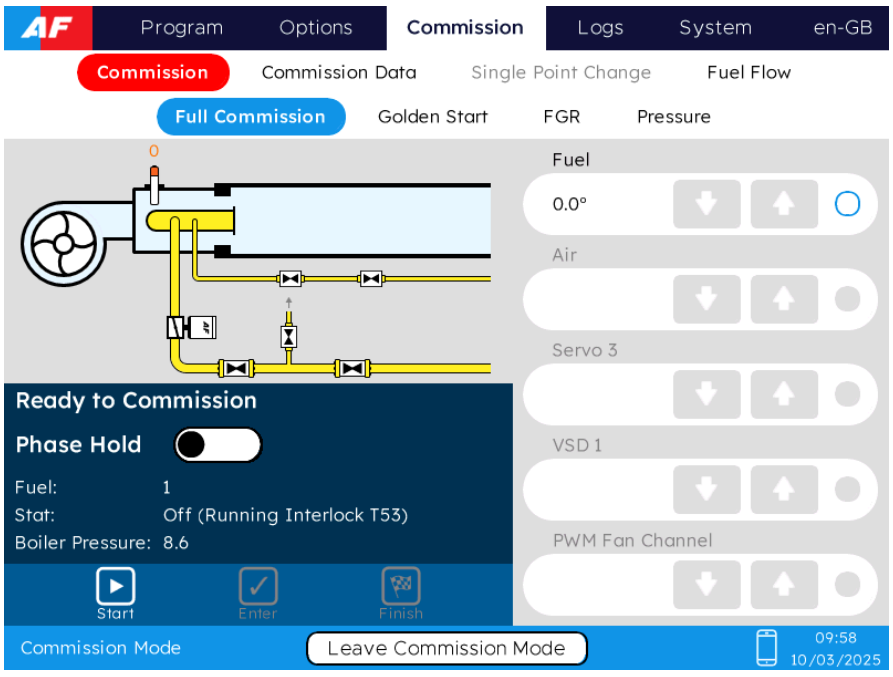


Figure 59 - Fuel Channel Only

The commission procedure follows the normal steps but with a single fuel channel only.

For more information on using the Mini Mk9 MM on an atmospheric burner or pre-mix burner and the required limit switches or purge delay, please contact Autoflame Engineering.

9.7 No Pre-Purge

It is possible to minimise the burner start-up time by bypassing the **Pre-Purge** stage. The major advantage of this control is that the operational boiler efficiency is increased by minimising the heat loss to the stack during a purge cycle. With no **Pre-Purge** the burner starts-up quicker, reaching the required setpoint in a reduced time. According to the EN676 European regulation, the burner is allowed to restart without a **Pre-Purge** if the burner has recycled normally, due to reaching operational temperature/pressure. When the burner is stopped by a lockout then this procedure is not allowed and the controller will force a **Pre-Purge** on start-up. In order for no **Pre-Purge** to be active, valve proving must take place and complete successfully. If the valve proving operation is successful then the burner may start-up without a **Pre-Purge**.

Set **Options/Burner/Purge/Bypass Pre-Purge** to **No Pre-Purge** to initiate the no **Pre-Purge** feature. During commissioning, or on the first start-up after a power reset, the burner will always start with a **Pre-Purge**. Once the burner has started successfully, it will subsequently start-up every time as follows:

- If the burner goes above its setpoint and turns off on high temperature/pressure, then the next time the burner starts-up, it will go through the VPS operation and light off without a **Pre-Purge** since the burner has shut down in a controlled manner and the gas valves have been checked for integrity.
- If the burner shuts down in an abrupt manner (e.g. due loss of power to the unit or a lockout), then a **Pre-Purge** will be initiated the next time the burner starts-up.

According to the EN676 regulation, the burner is only allowed to work in this manner if VPS operation has been set to operate before the burner starts up, so **Options/Burner/Valve Proving/Valve Proving Operation** must be set to **VPS Operates Before Startup**.

The start sequence without **Pre-Purge** is as follows:

1. The system goes through its internal tests and relay checks.
2. Call for heat on Terminal 57 activates and the system will go through the VPS operation.
3. If this operation is successful then the MM will drive the channels to the light off/start position.
4. Once all channels reach the start position then the burner will light off.

If **No Pre-Purge** is enabled, a complete **Pre-Purge** will be initiated the next time the burner starts up if one or more of the following conditions occur:

- Burner lockout.
- Loss of power to the MM.
- VPS checks fail.
- MM has been in standby for 24 hours or more.

Note: No Pre-Purge is only available on fuels which are optioned as gaseous. Therefore **Options/MM/Fuel/Fuel Type** must be set correctly.

9.8 Flame Detection

The Mini Mk9 has a range of **Flame Detection** options all defined under **Options/Burner/Flame Scanner**. It can detect a flame using any of the following methods:

- UV (Standard or Self-Check) – Also comes in Standard and High Sensitivity.
- Ionization.
- Ionization/UV Switchover.
- IR (solid state IR scanner with electronic self-check).
- Flame Trim (solid state UV scanner with electronic self-check).
- Flame Switch.

The UV and Ionization scanners share the same circuitry so cannot be used in parallel except where the changeover option is selected.

All the other scanners can be used in parallel and so multiple flame sensors may be defined and used at the same time. When using multiple scanners, the following settings in the **Flame Scanner** selection define how they operate:

- **AND** - All scanners must detect the flame and loss of flame on any single scanner results in a no-flame lockout. This defines the maximum safety level as all of the scanners must agree as to the status of the flame.
- **OR** - Any single scanner needs to detect the flame for the burner to continue firing. This is used where there are difficulties seeing the main or pilot flames and two scanners are used to look at each flame individually.

Please check the Autoflame Flame Scanners Guide for further details about flame detection options.

9.8.1 UV Scanners

UV discharge bulb scanners are the most common flame detection system used on industrial burners. Autoflame UV standard and high sensitivity scanners are wired into terminals T50 & T51.

Note: on the Mini Mk9, the shield from the scanner should always be connected to the S terminal on the Mini. This results in a more stable UV count as it allows the circuit to account for the stray capacitance of the cable. Having a cable length of at least 3m also helps to provide a stable signal response. If the UV signal is unstable, then a capacitor may be added across the terminal T51 to Shield to stabilize the response (contact Autoflame for details).

If **Options/Burner/Flame Scanner/UV Flame Scanner Type** is set to **Self-Check** then the self-check motor must also be wired into T21 & T22. The motor momentarily drives a paddle to block the UV light reaching the discharge bulb so that there is confirmation that the bulb is not in a runaway failure mode and is correctly detecting the flame. The interval between self-checks is set in option **UV Shutter Test Interval**. **Maximum Allowed UV Self-Check Errors** sets how sensitive the test is to failures. Setting this greater than one limits the possibility of a false error due to the paddle not fully blocking the UV light from the flame by requiring a confirmation.

Self-check must be used on any boiler that may fire continuously for over 24 hours. The correct operation of a standard discharge bulb is checked by the boiler switching on and off regularly and the bulb correctly detecting the change in the flame. The standard UV scanner will force a burner shutdown and restart if it runs continuously for 24 hours. The combination of **UV Shutter Test Interval and Maximum Allowed UV Self-Check Errors** will ensure that self-check fails result in a lockout within a maximum of 1 hour, which is the worst case mandated in any of the approvals codes.

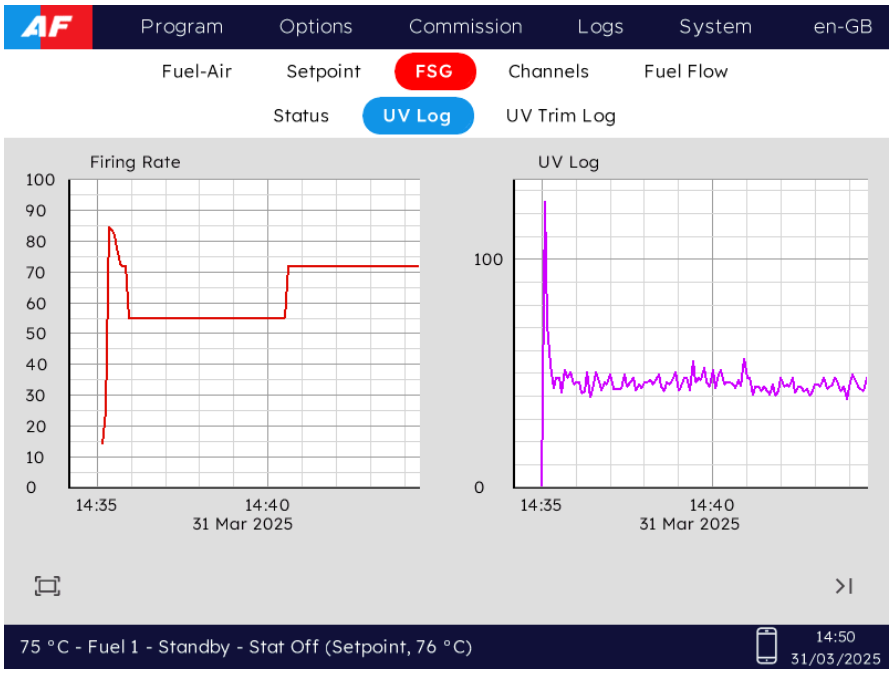


Figure 60 - Flame Scanner Log

A log of the flame scanner readings with time is given in **AF/FSG/UV Log** and may be viewed alongside the firing rate. Note that the logs will match the available flame scanners.

9.8.2 Ionization

An ionisation signal/flame rod is wired into terminal T64 and the cable shield must be connected at the Mini Mk9.

For ionisation, the flame will be indicated as present when the rectification voltage is above 30Vdc. The maximum sensed rectification voltage is 540Vdc, above which a Lockout will be generated.

9.8.3 Ionization To UV Switchover

Where there is difficulty in detecting the pilot flame with the main UV flame scanner, an Ionisation/Flame Rod may be used to detect the pilot flame. The Ionization circuit is active during the **Pilot Proving** phase, but switches over to the UV circuit for **Main Flame Proving**. These two scanners share the same circuit, so must be used in sequence and the AND/OR flame scanner selection functions cannot be used with these two scanners. **Options/Burner/Pilot/Pilot Mode** must be set to **Interrupted Pilot** when using **Ionisation/UV Switchover**.

9.8.4 IR

The IR flame scanner uses a solid-state wafer to detect in the infra-red band. The data comms is wired into T29 & T30 and the power to T48 & T49. A magnetic reed switch on the scanner is activated by a magnet in the mounting bracket, ensuring that power is curt to the scanner if it is removed from the boiler.

The scanner only reacts to flame flicker so is insensitive to any background refractory heating.

The IR scanner has a bult-in electronic self-check function which confirms the correct operation of the circuitry every 30 minutes so can be used in situations requiring self-check.

9.8.5 Flame Trim

The Flame trim scanner uses a solid-state wafer to detect in the UV band. The data comms is wired into T29 & T30 and the power to T48 & T49. Note that the data link can be shared with the IR scanner allowing both to be operated simultaneously.

The flame trim scanner has been specifically designed for providing UV trim on the Mini Mk9, but it also provides the flame safety function.

The flame trim scanner has a bult-in electronic self-check function which confirms the correct operation of the circuitry every 30 minutes so can be used in situations requiring self-check.

9.8.6 Flame Switch

The Mini Mk9 allows the use of an external flame switch for flame detection. Live inputs on any two of the burner control programmable inputs T80, T81 & T82 are used to wire in the flame switch.

In **Options/MM/Terminals**, any two of the **T80 Function**, **T81 Function** and **T82 Function** must be set to **Flame Switch** and **Flame Switch Inverse Input** and wired into the flame switch accordingly.

The **Flame Switch** terminal must see a mains voltage input (110/230 VAC) when there is a flame signal and 0VAC when there is no flame.

The **Flame Switch Inverse Input** is used to check the correct operation of the **Flame Switch** input and must show the inverse response. If the **Flame Switch Inverse Input** does not show the inverse of the **Flame Switch** input, then a lockout will occur.

Within the Mini Mk9 MM there is a latency of 250 milliseconds on the monitoring of the terminals. Any attached flame switch must there be set to respond within 750 milliseconds to comply with the 1 second overall flame failure response time defined in the approval's requirements.

Flame switches often provide a volt free changeover contact to indicate the flame status. Alternatively, they may provide a pair of `inverse' outputs. If the flame switch only provides a single output terminal, a relay must be installed between the flame switch and the MM to provide a set of volt free changeover contacts.

9.9 Input Terminals

9.9.1 Burner Control Input Terminals

On the Mini Mk9 the burner control inputs on terminals T80, T81 and T82 are fully configurable and are setup within the **T80 Function**, **T81 Function** and **T82 Function** settings in **Options/MM/Terminals.** The selected option is triggered when a mains voltage input (110/230 VAC) is detected on the selected terminal.

Each terminal may provide any of the following functions:

#	Selection	Description
0	**Not Used**	Terminal disabled
1	**Start Position Interlock**	Allows an additional safety check on the valves and damper to ensure that they are in the correct position for burner start using an end limit switch. Please check Autoflame Valves Guide for further details. For a Flame Safeguard unit, this acts as a live input in response to a mechanical end stop. For more information, please check the Autoflame Flame Safeguard manual.
2	**Purge Position Interlock**	Acts as an input for a mechanical end stop on the air damper. It must be made for the purge phase to start and must remain made for the whole of the timed purge and post purge phases, otherwise a **Purge Limit Switch** lockout is triggered. If **Options/Burner/Purge/Timeout For Reaching Purge** is set, then a **Timeout Reaching Purge** lockout will occur if this input is not made within the set time. This input must not be made while not at purge. The unit will stop indefinitely at the end of the **Run To Ignition** phase if the input remains made, never getting to light off.
3	**Valve Proving**	A low-pressure switch may be wired to the terminal for **Valve Proving**. **Options/Burner/Sensors/Fuel Pressure Sensor Mode** must be set to **Valve Proving With Digital Input**. Please refer to the Sensors Guide for further details
4	**Delay To Purge**	A **Delay To Purge** input to indicate that the system is ready to move to the purge phase. The system will be stuck in '**Delay To Purge**' indefinitely if this input remains low unless a timer is enabled in **Options/Burner/Purge/Delay To Purge Timeout**. The MM will lockout if the **Delay To Purge** input is not made within the **Delay To Purge Timeout**. Setting the timeout to 0 will disable it, so the MM would sit indefinitely in **Delay To Purge**.
5	**Purge Pressure Proving**	A **Purge Pressure Switch** input which must be made continuously for the full purge time before proceeding from purge. If it drops out during purge, the purge timer restarts. To confirm the input is working correctly, it must not be made before the blower motor starts, resulting in a lockout if this is not the case. **Options/Burner/Purge/Purge Pressure Proving Timeout** adds an optional timer to this phase. The MM will lockout if the **Purge Pressure Proving** input is not made within the **Purge Pressure Proving Timeout.** Setting the timeout to 0 will disable it, so the MM will be in the purge phase indefinitely.
6	**Flame Switch**	An input from a **Flame Switch** which must see an input when a flame is detected and no input when there is no flame.
7	**Flame Switch Inverse Input**	The inverse of the **Flame Switch** input to confirm correct operation of the flame switch. Note that options 6 and 7 must be wired into a **Flame Switch** and both enabled on any 2 of the 3 input terminals for a **Flame Switch** to function.
8	**Night Setback**	An input results in the setpoint being reduced by the value set in **Options/Load/Setpoint/Night Setback Offset**. The Setpoint Screen display will change the **Current Setpoint** to the **Reduced Setpoint** level.

9	**Reduced Setpoint Select**	The MM will fire to meet the reduced setpoint set via the MM status screen if an input is made on the defined terminal. The **Setpoint Screen** display will swap to use the **Reduced Setpoint** gauge.
10	**Lockout Reset**	An input on this terminal allows a button or switch on the control panel to be used to reset any active lockouts. This should be a non-latching switch as a **Permanent Lockout Reset** lockout occurs if the input is made continuously
11	**Valve Proving (Secondary Fuel Output)**	A low-pressure switch may be wired to the terminal for valve proving on the 2nd fuel when the **Options/Burner/Terminals/ Fuel Valve Output Configuration** is set to **Two Sets Of Outputs** (either **No Changeover Relays** or **Change On The Fly (COF)**). **Options/Burner/Sensors/Fuel Pressure Sensor Mode** must be set to **Valve Proving With Digital Input** for fuel 2. Please refer to the Sensors Guide for further details

The **Purge Pressure Proving** (option 5) works as follows:

- The MM stays indefinitely in the purge position (pre-purge or post-purge) until an input is detected on the defined terminal.
- Once the input is detected, the MM waits for the purge timer to runout and proceeds to the next phase as normal.

An input on the defined terminal must NOT be detected during the MM start-up stage (before pre-purge), otherwise a lockout will occur.

If **Purge Pressure Proving** is set, then:

- If the **Purge Pressure Proving Timeout** set to 0 (disabled), the MM stays in the purge position indefinitely, or until an input is detected on the defined terminal.
- If the **Purge Pressure Proving Timeout** set to >0, a lockout is generated if this timer elapses before an input is detected on the defined terminal.

Note: **Purge Pressure Proving** only works with **Normal Post Purge** as set in **Options/Burner/Purge/Post Purge Type**. It does **NOT** work with **NFPA Post Purge.** An input on the defined terminal will have no effect on **NFPA Post Purge**.

9.9.2 FAR Input Terminal

An additional input terminal T98 connects directly to the FAR processor on the Mini Mk9 and provides a further set of optional functionality when a mains voltage input (110/230 VAC) is detected as follows:

#	Selection	Description
0	**Not Used**	Terminal disabled.
1	**COF Enable**	Activates **Change-On-The-Fly** mode to seamlessly swap between two fuels without purging the boiler.
2	**Lead Boiler Select**	An input causes the MM to be **Lead Boiler** when running sequencing. Note only 1 MM may have such an input active at any one time.
3	**External Modulation Select**	Used to activate **External Modulation** when **Options/Firing/Modulation/External Modulation** is set to **Enabled By Input**.
4	**External Firing Rate Limiter Select**	Used to activate **External Firing Rate Limit** when **Options/Firing/Modulation/External Firing Rate Limiter** is set to **Enabled By Input**. The **External Firing Rate** input would use the terminals T1 to T3 that have not been defined as the VSD input in **Options/MM/VSD/VSD 1 Input Mode**. Control of the input is defined by the settings **External Firing Rate Limiter Input Control Range** and **External Firing Rate Limiter Input Range**.
5	**External Setpoint Select**	Used to activate **External Setpoint** when **Options/Load/Setpoint/External Setpoint** is set to **Enabled By Input**. The **External Setpoint** input would use the terminals T1 to T3 that have not been defined as the VSD input in **Options/MM/VSD/VSD 1 Input Mode**. Control of the input is defined by the settings **External Setpoint Input Range.**
6	**Low Flame Hold**	The firing rate moves to **Low Flame**, and remains held there whilst the input is made. When no input is detected the burner will return to normal modulation.
7	**Hand Mode**	The firing rate moves to the **Hand Mode** firing rate defined on the **Setpoint Screen** and remains there whilst the input is made. When no input is detected the burner will return to normal modulation.
8	**Night Setback**	An input results in the setpoint being reduced by the value set in **Options/Load/Setpoint/Night Setback Offset**.
9	**Warming STAT**	An input on the terminal will stop the MM warming when **Options/Load/Sequencing/Sequencing For Low Pressure Steam** is set to **Without Non-Return Valves**. When no input is detected, the MM will go into warming.
10	**Manual Purge**	The control will hold the channels in their purge positions, on the next start-up process for the duration of this input being active. When it is released the burner will recycle before starting up if T53 is made. If the burner was firing prior to the switch being made then it will continue to fire as normal, but hold in the purge position on the next burner start-up.
11	**Fixed Firing Rate Limit Enable**	Used to activate a **Firing Rate Limit** when **Options/Firing/Modulation/Firing Rate Limit Enable** is set to **Enabled By Input.** This switches on the Internal Firing Rate Limit.
12	**Reduced Setpoint Select**	An input on the terminal will cause the setpoint to change from the **Main Setpoint** to the **Reduced Setpoint** as set on the **AF/Setpoint/Status** screen.

9.9.3 VSD Input Function

The VSD inputs use terminals T1, T2 and T3 allowing a 0-10V (T2, T3) or 4-20mA (T1, T3) input. Both inputs may be used in parallel, allowing 2 different functions to be implemented simultaneously. The list of possible inputs is as follows:

#	Selection	Description
0	**VSD Channel 1 Feedback**	Normal operation as a VSD.
1	**External Modulation**	Sets the firing rate under **External Modulation** control. The internal **PID** control is disabled.
2	**External Setpoint**	Sets the required **Setpoint**. **Internal Setpoint** control is disabled.
3	**External Firing Rate Limit**	Provides an external limit to the highest firing rate.
4	**O2 Trim Signal**	Takes an input from an **O2 Sensor** which can be used for trimming instead of an **EGA**.

9.9.4 Load Sensor Input Function

The Load Sensor input terminals T37 & T38 take a 0-10V input and may be used for the following functions:

#	Selection	Description
0	**Load Sensor Input**	Normal operation for these inputs for Autoflame or external Temperature and Pressure sensors.
1	**External Modulation**	Sets the firing rate under **External Modulation** control. The internal **PID** control is disabled.
2	**External Setpoint**	Sets the required **Setpoint**. **Internal Setpoint** control is disabled.
3	**External Firing rate Limit**	Provides an external limit to the highest firing rate.
4	**O2 Trim Signal**	Takes an input from an **O2 Sensor** which can be used for trimming instead of an **EGA**.

Note: Converting any of the voltage inputs to use a 4-20mA signal requires placing a 500Ω resistor across the terminals in parallel to the device connection.

Note: These functions are yet to be implemented on the Mini Mk9, but will be enabled in a future software update.

9.10 DTI Control

9.10.1 Mk8 DTI Control

A Mini Mk9 may be connected to a Mk8 DTI via an RS485 connection using terminals T27/T28. Once connected the boiler graphic should appear on the Mk8 DTI under the boiler name defined by the **Options/Load/Sequencing/Sequencing Id** setting.

With **Options/Load/Sequencing/Sequencing Enable** set to **DTI Enabled** then the DTI may also control the Mini Mk9, altering the **Setpoint**, **Firing Rate** or controlling **Sequencing**. For more details on this control see the **Mk8 DTI Manual**.

From the Mk8 DTI it is the Remote Setpoint that is changed and this is labelled as DTI control on the Setpoint screen.

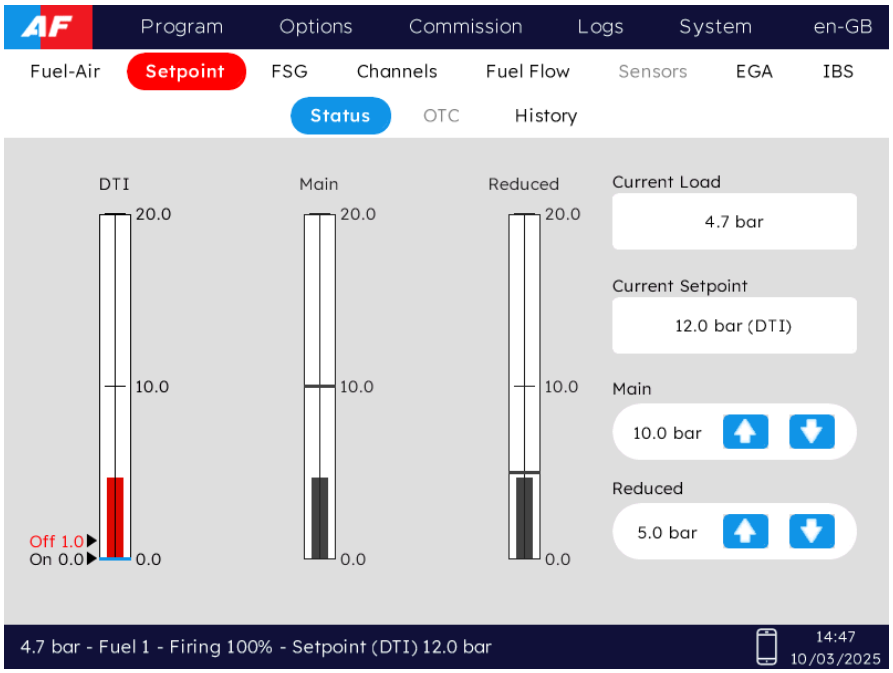


Figure 61 - DTI Setpoint Control

9.10.2 Mk9 Software DTI Control

Alternatively a Mini Mk9 may be networked to the **Mk9 Software DTI** via an ethernet cable.

Note: It is not possible to connect both a **Mk8 DTI** and a **Mk9 Software DTI** as they would be in conflict for control of the Mini Mk9.

A password must first be set in **Options/Controller/Passwords/Remote Client Password.** This is initially undefined so must be set before use. It is the end users' responsibility to ensure that any password meets the password requirements of the installation site.

To allow control from the **Mk9 Software DTI**, **Options/Load/Sequencing/Software DTI Over Ethernet** must be set to **Enabled**. The **Mk9 Software DTI** will then be able to alter the **Setpoint**, **Firing Rate** or control **Sequencing.**

From the **Mk9 Software DTI** you have direct control of the main Setpoint. You can also place the Mini Mk9 into Low Flame hold or Hand Mode where you would change the Firing Rate from the **Mk9 Software DTI.**

Refer to the **Mk9 Software DTI Manual** for more details on its features, set-up and operation**.**

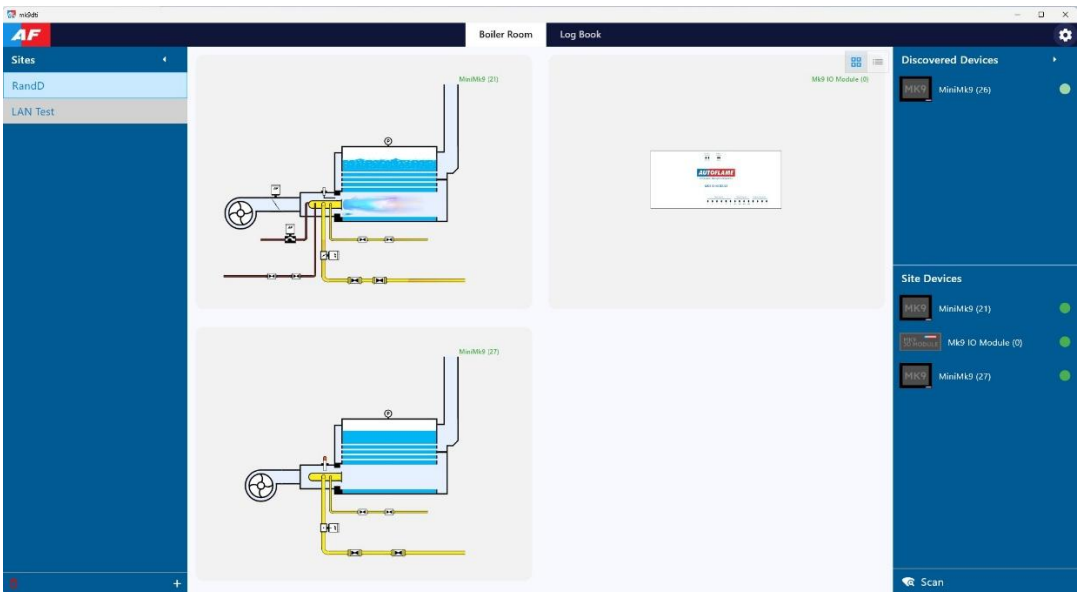


Figure 62 - Mk9 Software DTI

10 PID CONTROL

The standard algorithm used by Autoflame to control the **Fuel-Air** ratio is **PID** (**Proportional-Integral-Derivative**) control. The control algorithm compares the actual measured temperature or pressure to the user specified setpoint temperature or pressure. Depending on the measured and setpoint values, the MM's **PID** control will then either modulate the burner up or down. The rate of change or speed of the burner modulation in relation to changes in measured temperature or pressure is dependent on the settings of the **PID** control. The **PID** control action is the sum of the "**Proportional**" + "**Integral**" + "**Derivative**" actions of the **PID** control. Each contributes to how the 3 term **PID** control modulates the burner as outlined below.

Most applications can be controlled effectively using just the **Proportional** and **Integral** settings - a PI control setup. The **PID Derivative Time** is set to 0 by default meaning that the D term is not normally used.

Note: **PID** control is a fine-tuning process. Settings must be carefully and precisely adjusted by a qualified combustion engineers with thorough understanding of the combustion process. Load requirements, overall system response and all other parameters must be taken into consideration when adjusting the **PID** settings. Otherwise the changes to the system setup can make the controller operate in an unstable and potentially unsafe manner.

The **PID** settings are accessed under **Options/Load/PID**.

10.1 Proportional Band

The **Proportional Term** is specified in by defining the **PID Proportional Band** setting. The P-Band is simply an offset from the setpoint pressure or temperature. Outside and below the P-Band, the MM's PID control will modulate the burner at maximum flame. Upon reaching the P-Band (**Required Setpoint** – **PID Proportional Band** setting), it will then modulate the burner linearly down.

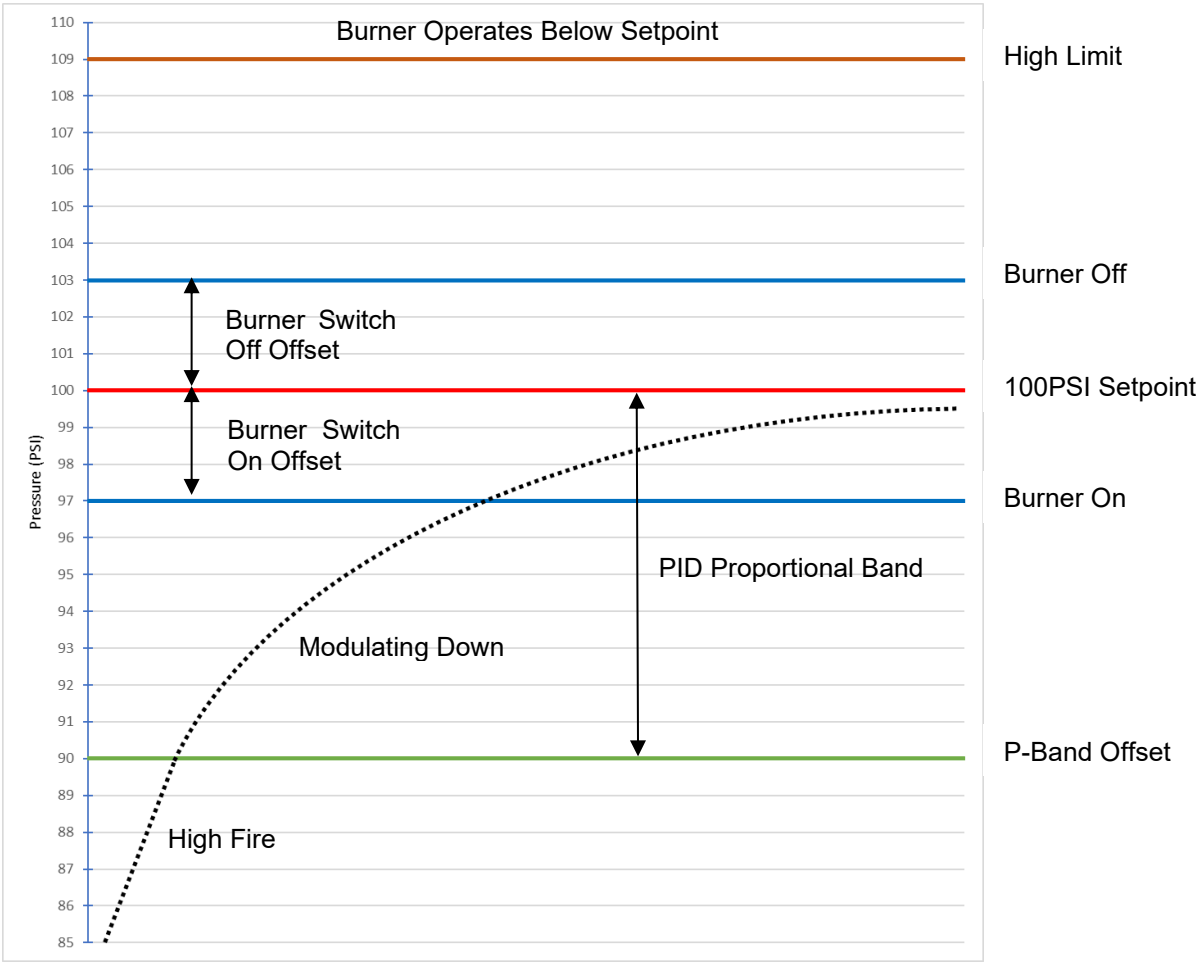


Figure 63 - Proportional Band

10.2 Integral Control

The **PID Integral Time**, also known as “reset time”, operates within threshold of the **PID Proportional Band** and has the effect of increasing or decreasing the burner firing rate by a specific amount every “n” seconds.

The threshold for the **PID Integral Time** being active is set by the **PID Integral Band**, which is 80% of the **PID Proportional Band** by default.

At every interval set in the **PID Integral Time** (default 60s), the firing rate is adjusted by 10% of the difference between the measured temperature or pressure values and the required setpoint. This difference is added to the current proportional value when below the setpoint, or removed when above the setpoint. This has the effect of ensuring the measured Temperature or Pressure homes in on the required setpoint where possible.

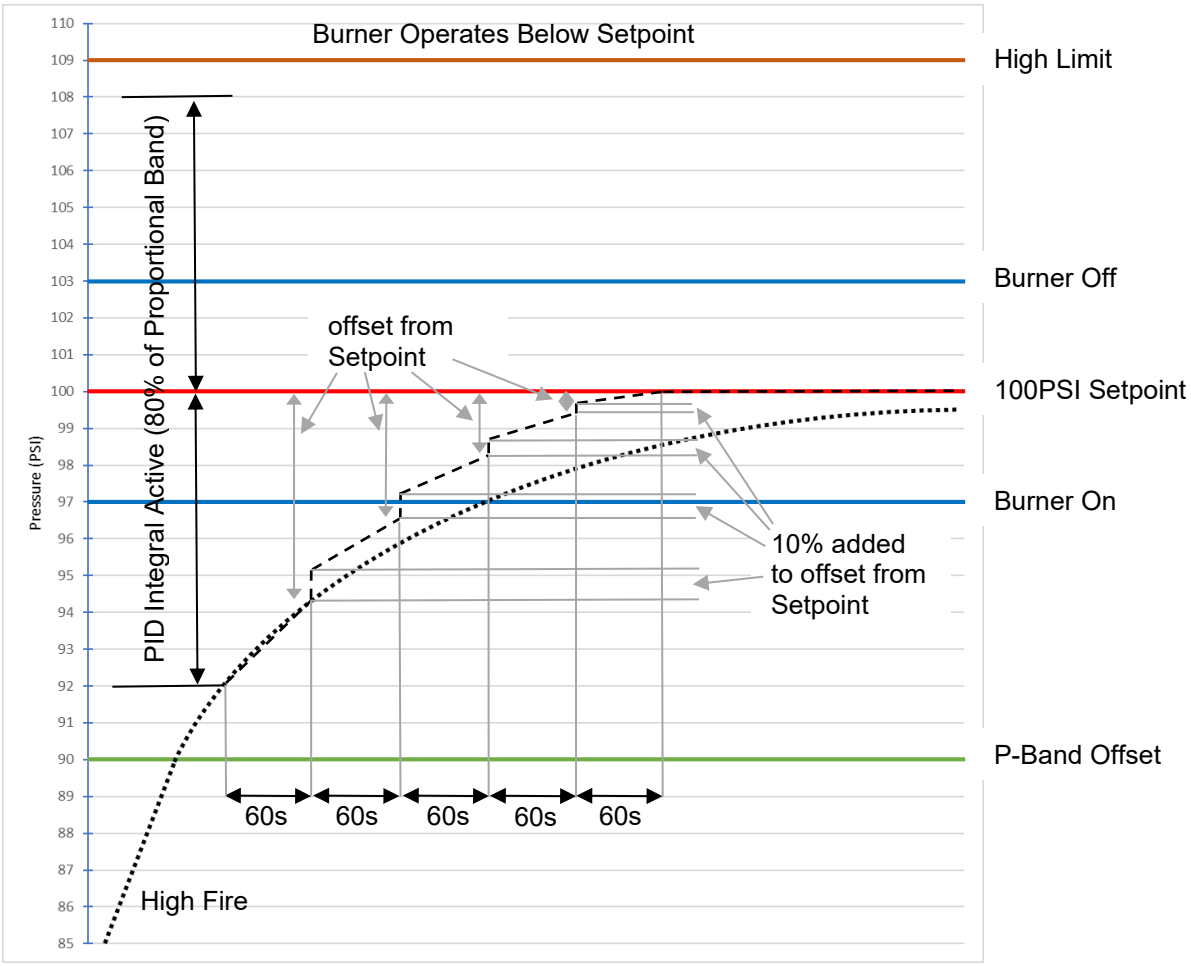


Figure 64 - Integral Control

10.3 Derivative Control

The Derivative term of the control system analyses the rate of change in the difference between the measured temperature or pressure and the required setpoint. The time interval over which the compared and measured temperature or pressure values are taken is set in the **PID Derivative Time**. The **PID Derivative Deadband** sets the margin above and below the required set point in which no derivative action occurs.

The derivative response sensitivity is set as default to 10% of the firing rate. The **PID Derivative Time** is the time taken to add/remove an additional 10% to the firing rate based on the actual value and the required value. **NOTE:** The derivative action occurs at all points outside of the **Derivative Deadband**. This includes within the proportional band.

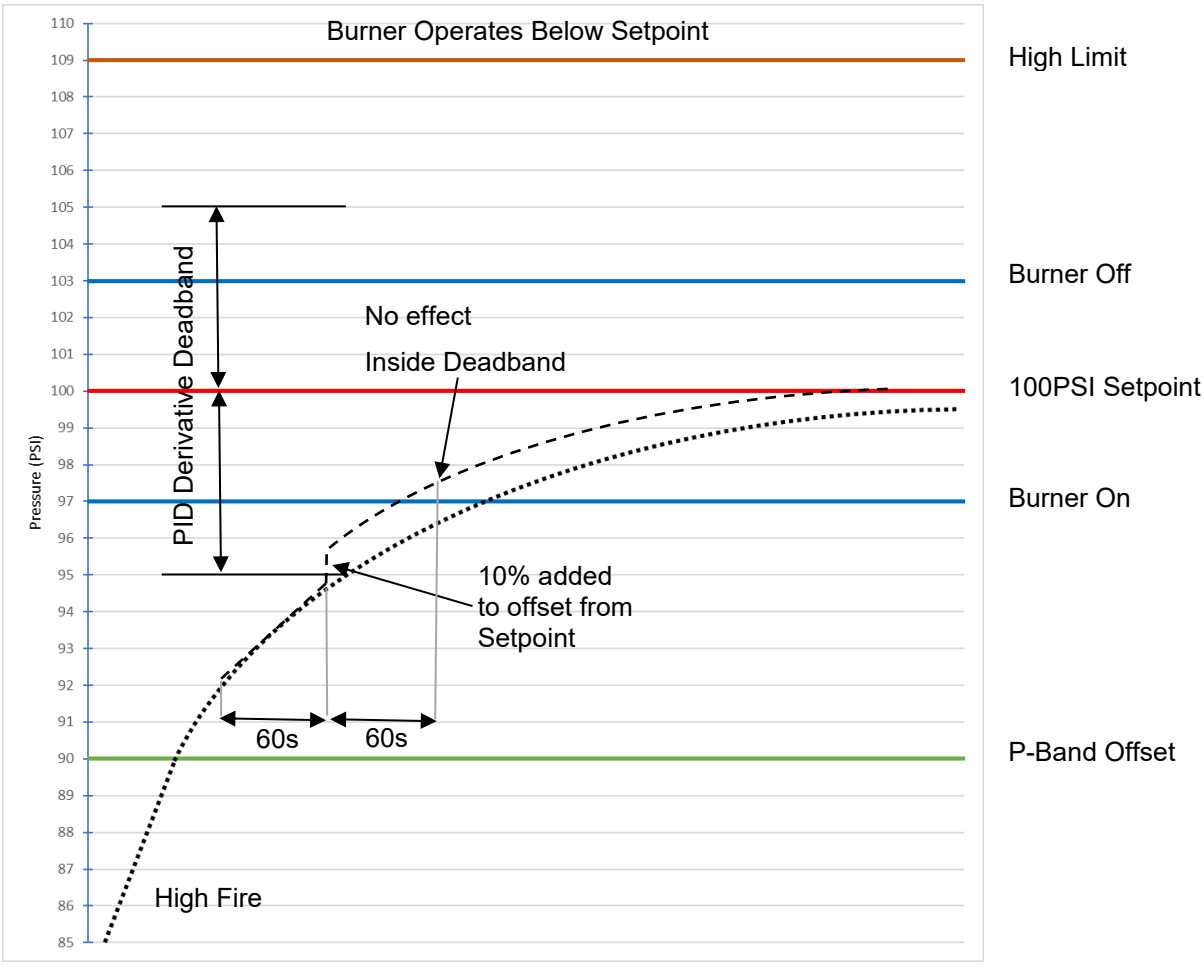


Figure 65 - Derivative Control

Note: Autoflame recommend leaving the Derivative terms at their default values.

11 OPERATION

11.1 Home Screen

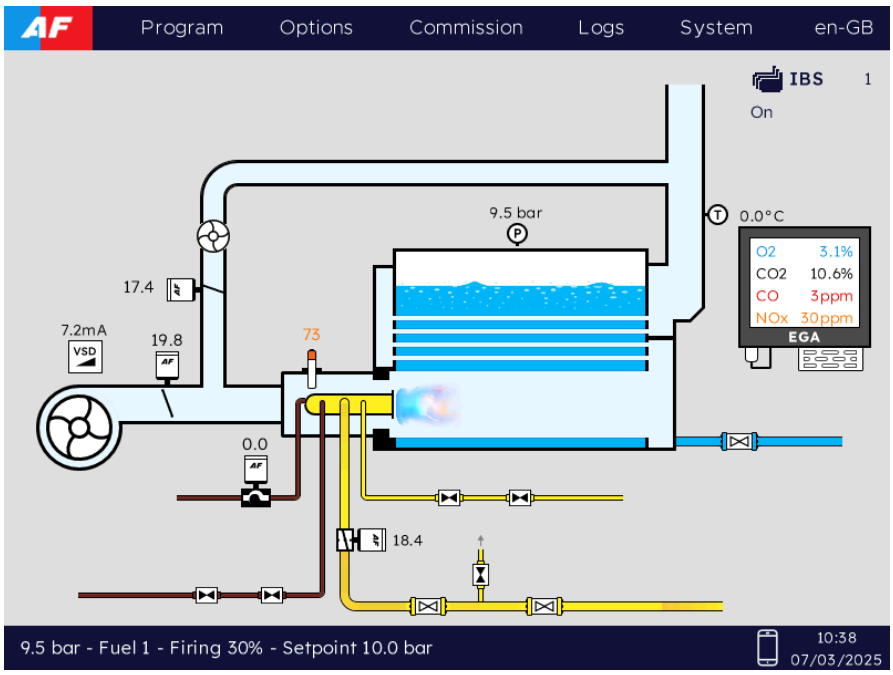


Figure 66 - Home Screen

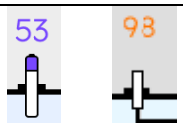
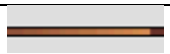
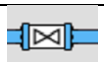
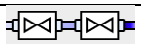
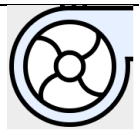
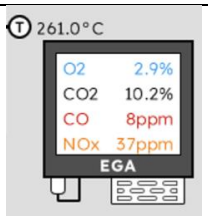
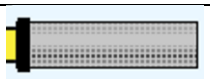
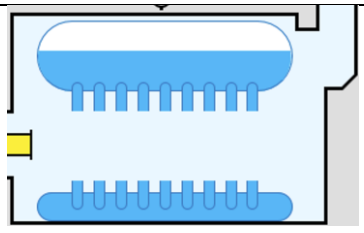
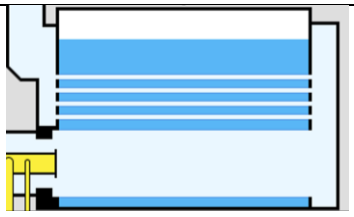
The **Home Screen** displays the current boiler setup. It provides operating information for each component of the burner/boiler in real time. Pressing on various components will display further information e.g. pressing on the servomotor image will show the servomotor position and a graph of its history. This information can also be accessed by pressing the **Home Button** in the top-left corner of the screen to bring up the component options on the **Red Menu Bar**.

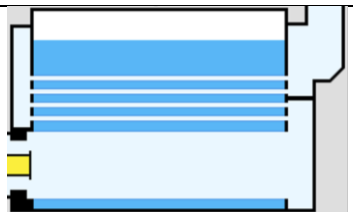
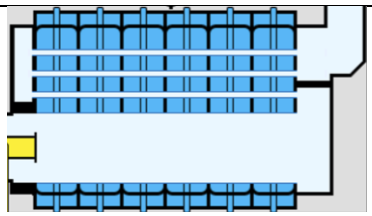
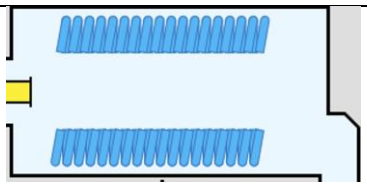
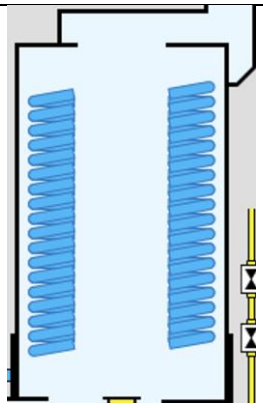
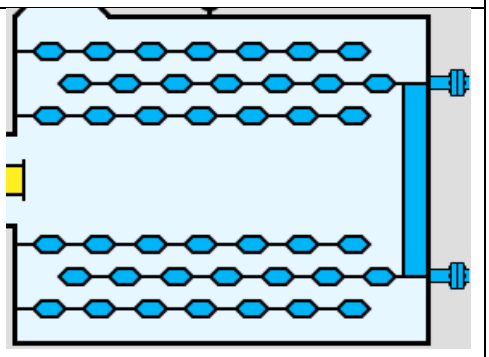
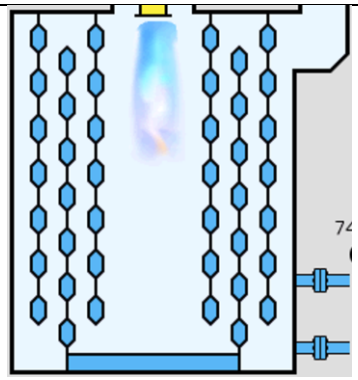
The Main Menu functions are always available in the **Main Menu Bar** across the top of the screen.

Information on the burner status and the time and date are also always shown on the **Info Bar** across the bottom of the screen.

This boiler room setup can be configured to display what is actually on site, please see **Options/Controller/Boiler** for the configuration options, with the graphics components being shown in section 11.1.1 below. The Boiler options settings only control the picture that is displayed, allowing a representative picture of the actual boiler to be constructed. The configuration of the actual components such as servo motors, VSDs, sensors etc are all defined within other options pages.

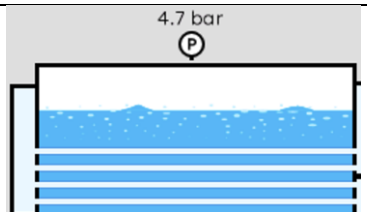
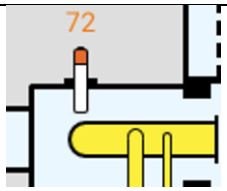
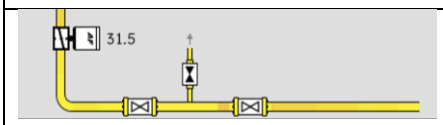
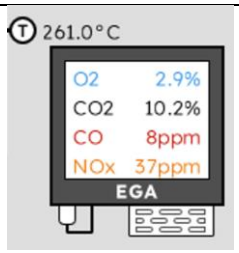
11.1.1 Home Screen Components

Servomotor		VSD	
Flame Detector		Gas Pressure Sensor	
Air Pressure/ Boiler Steam Pressure Sensor		Boiler Temperature Sensor	
Gas Pipe – gas flowing		Gas Pipe – no flow	
Oil Pipe – oil flowing		Oil Pipe – no flow	
Fuel Control Valve – open		Fuel Control Valve – closed	
Feed Water Valve		Steam/ Air Atomisation	
FGR/ Induced Draft Valve		Air Damper	
Combustion Air Fan		EGA Information	
IBS Information		Induced draft	
Gas Flame		Oil Flame	
Rotary Cup Burner		Mesh Burner	
Water Tube		Two-Pass Fire Tube	

Three-Pass Fire Tube		Four-Pass Fire Tube	
Cast-Sectional Tube		Horizontal Coil Tube	
Vertical Coil Tube		Horizontal Condenser	
Vertical Condenser		Kiln	TBD
Crucible	TBD		

11.1.2 Home Screen Buttons

The **Boiler Screen** constructed as described in section 11.1.1 comprises of various components that can be selected to navigate through the information screens of the MM. Depending upon the configuration the components in the table below may be touched to provide access to a series of more detailed screens detailing the performance of the system. This information can also be accessed by pressing the **Home Button** in the top-left corner of the screen to bring up the component options on the **Red Menu Bar**.

Button	Component	Description
	**Fuel-Air**	The current firing rate will display below the flame, pressing the flame gives access to the Fuel-Air Screen, see section 11.2.1.1.
	**Setpoint**	The current boiler temperature/pressure is displayed next to the temperature/pressure detector. Pressing on the boiler or the load detector gives access to the Status screen, see section 11.2.1.2.
	**FSG (Flame Safeguard)**	The number of counts will be displayed for the flame scanner used. This button gives access to the Flame Safeguard screen, see section 11.2.1.3.
	**Channels**	This button is animated to display the current angular position of the servomotor, and gives access to the Channels screen, shown in section 3.5.
	**Fuel Flow**	Pressing on the gas/oil pipe gives access to the Fuel Flow screen, see section 3.8.
	**Sensors**	This button is animated with the current measured gas pressure, and gives access to the Gas Sensor screen, see section 3.6.
	**EGA**	The EGA box will show the current exhaust gas and temperature, and efficiency values. This button gives access to the EGA screen, see section 3.10.
	IO	Details of the inputs and outputs of a connected Mk9 IO unit
	**IBS**	The IBS box will show the ID number of the M.M., and its status, and if it is the lead boiler. This button gives access to the IBS screen, see section 3.9.
	Network	Details the Ethernet connection and performance.
	**OTC (Outside Temperature Compensation)**	This temperature sensor is animated with the current outside temperature. This button gives access to the OTC screen, see section 3.11.

11.2 Main Menu Options

The **Main Menu Bar** across the top of the screen provides access to 5 main functions as well as the **Home Button** and **Language Select**. These functions are described below moving across the **Main Menu Bar** from left to right.

11.2.1 Home Button

Identified by the AF logo, this button has two main functions:

- Returns the user to the **Home Screen** from any other screen, displaying the main boiler graphic.
- If already in the **Home Screen**, it brings up the Home Screen buttons list on the **Red Menu Bar** allowing easy access to all the boiler information. Due to the large number of items in this bar under the AF selection, it occupies 2 lines. When a selection is made, only the items on the same line as the selection remain in the **Red Menu Bar**, and the appropriate **Blue Menu Bar** selections become visible.

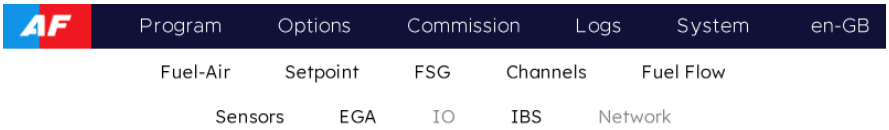


Figure 67 - Double Line Red Bar

Select AF to get back to the full **Red Menu Bar** selection**.**

11.2.1.1 Fuel-Air

Pressing the **Flame** on the **Home Screen** boiler graphic or **AF/Fuel-Air** brings up the **Fuel-Air Curve**, showing the commissioned points as red dots joined by a line. The current firing position is indicated by the black ring with dotted lines down to the servo positions. The actual servo and VSD values are listed in the Fuel-Air table.

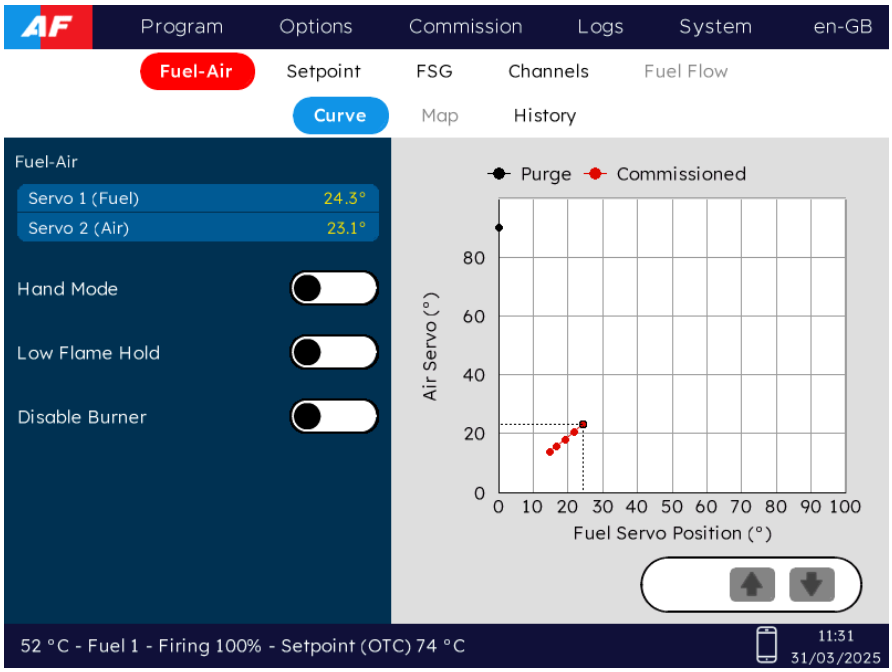


Figure 68 - Fuel-Air Curve

The **Fuel-Air** screen also allows control of the firing rate using a series of soft-slider buttons which are activated by sliding them to the right. Inactive slider buttons will not show, only appearing when they have been enabled in the **Options** (e.g. **Fixed Firing Rate Limit** and **External Modulation** buttons do not show in the above figure). The sliders are detailed as follows:

Hand Mode	Allows the firing rate to be set and adjusted by the user. When activated the  buttons are used to move the firing rate up and down. A **Fuel Flow** commission must have been completed for **Hand Mode** to operate. If **Intelligent Boiler Sequencing** is active, then activating **Hand Mode** drops the boiler out of the sequence loop. Once **Hand Mode** is deselected, the boiler will return to the sequence loop after the next scan time.
Low Flame Hold	Causes the burner to modulate to the **Low Flame** position and remain there until it is deselected. **Hand Mode** takes priority over **Low Flame Hold** if it is also active. If **Intelligent Boiler Sequencing** is active, then activating **Low Flame Hold** drops the boiler out of the sequence loop. Once **Low Flame Hold** is deselected, the boiler will return to the sequence loop after the next scan time.
Fixed Firing Rate Limit	The control slider is made active if **Options/Firing/Modulation/Firing Rate Limit Control** is set to **Enabled** or **Enabled by Input**. If activated, the **Firing Rate Limit**, is limited to the value defined in **Options/Firing/Modulation/Fixed Firing Rate**. **Enabled by Input** requires a voltage on T98 and **Options/MM/Terminals/T98 Function** set to **External Firing Rate Limiter Select**.
External Modulation	The control slider is made active if **Options/Firing/Modulation/External Modulation** is set to **Enabled** or **Enabled by Input**. If activated, control switches to **External Modulation** requiring an input on the VSD1 Current or Voltage Inputs or the Load Sensor Input with the appropriate settings defined under **Options/MM/Terminals**. **Enabled by Input** requires a voltage on T98 and **Options/MM/Terminals/T98 Function** set to **External Modulation Select**.
Disable Burner	Causes the burner to switch off and remain off until deselected. Once deselected the burner will restart as normal if the load requires. **Options/Load/Setpoint/User Burner On/Off Control** is used to lock the **Disable Burner** button in its current position. If set to **Locked** with the **Burner Disabled**, it will not be possible to set the burner to active without unlocking this setting first – this allows a burner to be locked in a disabled position unless the **Online Changes** password is entered.

If **Trim** is enabled, then selecting the **Map** button on the **Blue Menu Bar** selects the **Trim Map** which shows any adjustment of the air from the commissioned value. The **Trim Map** has the commissioned points down the centre line (**CV**) with each of the points marked from **Low** to **High fire**.
The controller can trim the burner to add or remove air, changing the combustion. The graph shows the percentages of **Excess Air**. Note that the change in O2 measured by the EGA will be less than the change in **Excess Air**. A commission that had an excess O2 level of 3%, will have a **Fuel Rich** (**A-**) point with 2.1% O2 and an **Air Rich** (**A+**) point with 3.8% O2.

The List on the left hand side provides information on the status of the trim functions. It defines if EGA or UV Trim is running and counts down to the next trim phase.

The table of trim points on the left hand side of the screen can be scrolled up and down to see all of the data. Also selecting between the O2, CO2, CO and UV buttons changes which set of data is shown in the table.

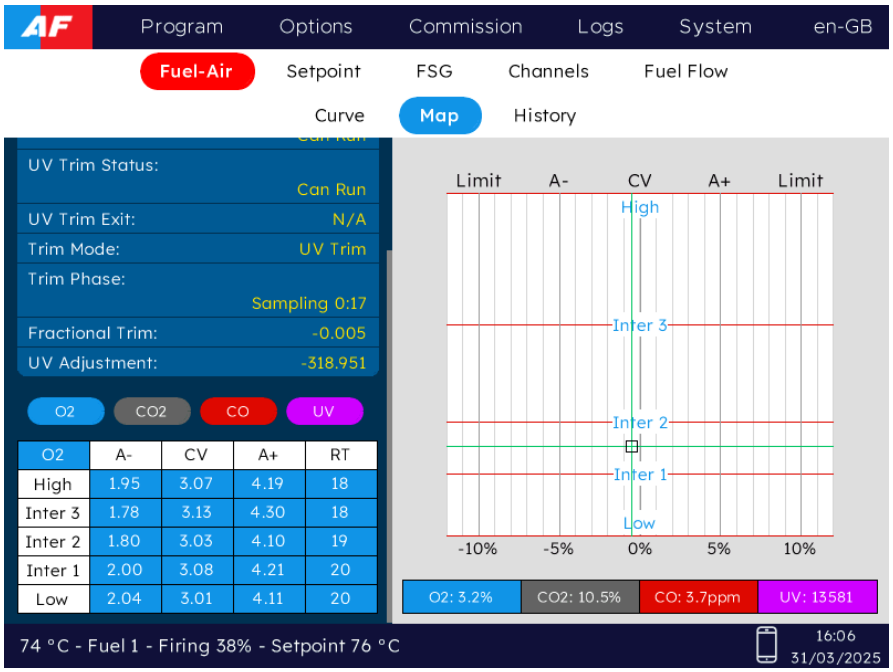


Figure 69 - Fuel-Air Map

Showing the percentage **Excess Air** level allows both servo trim and **VSD** (or **PWM**) trim to be shown on the same graph. Servo trim is achieved by moving the servo angle by an amount calculated to provide the desired excess air. The **VSD** or **PWM** trim is achieved by changing the input directly by 5%.

The **Fuel-Air** History screen records the **Firing Rate** and change in **Air Damper Angle** over time.

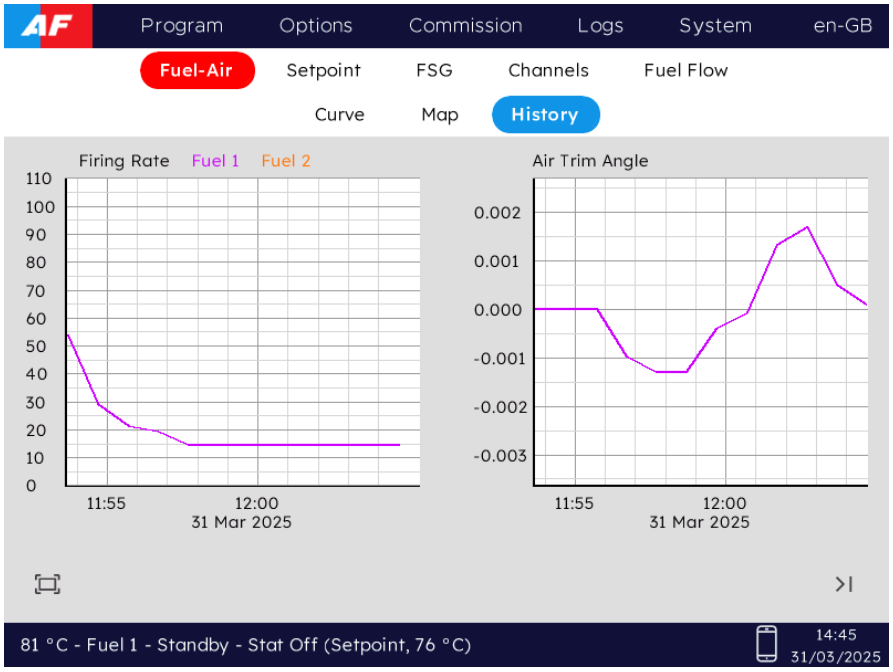


Figure 70 - Fuel-Air History

11.2.1.2 Setpoint

The **Setpoint** **Status** screen, accessed from pressing the **Load** image on the boiler graphics or **AF/Setpoint**, allows control of the setpoint.

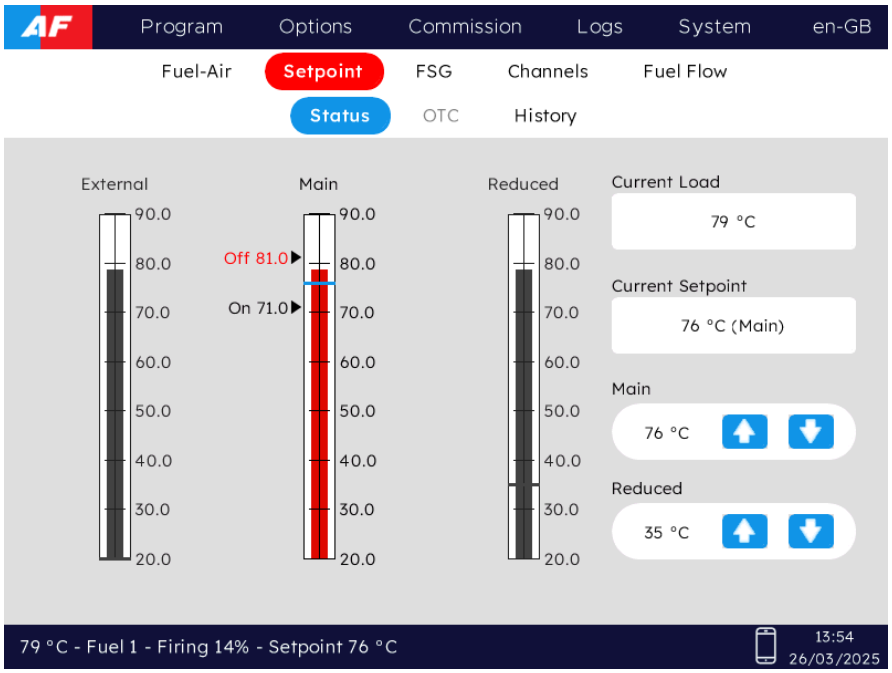


Figure 71 - Setpoint Status Screen

Three gauges are shown detailing the **External Setpoint**, the **Main Setpoint** and the **Reduced Setpoint**. The currently active setpoint will be highlighted in red with the required setpoint indicated by the blue line. On and Off values will be displayed as set by the **Options/Load/Load Sensor/Burner Switch Off Offset** and **Options/Load/Load Sensor/Burner Switch On Offset**.

The current load value is displayed in the top-right box and is also indicated by the height of the bars in the gauges.  are used to increase or decrease the required main or reduced setpoints. The blue line and On/Off values will move up and down the scale as set. The gauges will also rescale automatically to fit in the defined setpoints and the current load position.

External setpoint is defined by the external controller so is just displayed as a gauge on this screen which turns red if active.

The values will change between temperature and pressure according to the **Boiler Load Sensor Type**.

The **OTC** tab becomes active if **Options/Load/Setpoint/Outside Temperature Compensation** is **Enabled**. It can be **Enabled Using OTC Unit**, **Using MM Sensor** or **Using Internet Weather Data** (This latter requires a software update).

The **OTC** screen can also be accessed by touching the 

weather symbol on the main boiler screen which displays the current outside temperature.

The following information is displayed:

- **Current Outside Temperature** – measured from the OTC unit, sensor or internet data.
- **Current Required Setpoint** – calculated from the set limits and the current outside temperature.

In addition the **OTC** configuration defined under **Options/Load/Setpoint** is also displayed:

- **Minimum Temperature.**
- **Setpoint At Minimum Temperature.**
- **Maximum Temperature.**
- **Setpoint At Maximum Temperature.**

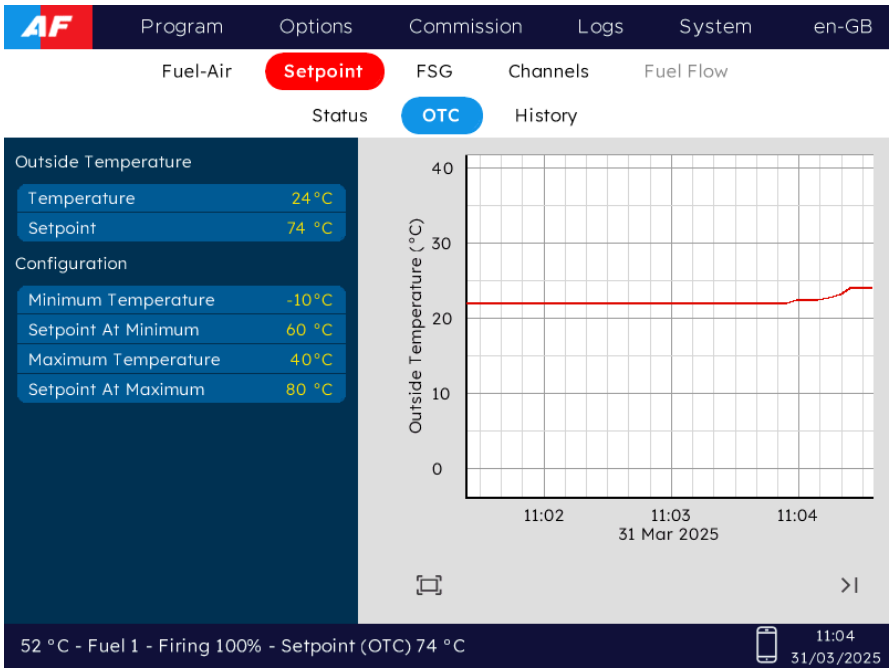


Figure 72 - OTC - Temperature, Setpoint

The graph shows the variation in the **Outside Temperature** over time.

The setpoint will interpolate between the Minimum and Maximum values as the **Outside Temperature** varies.

Selecting the **History** tab displays two graphs logging the history of the **Firing Rate** and **Load Sensor Value** over time.

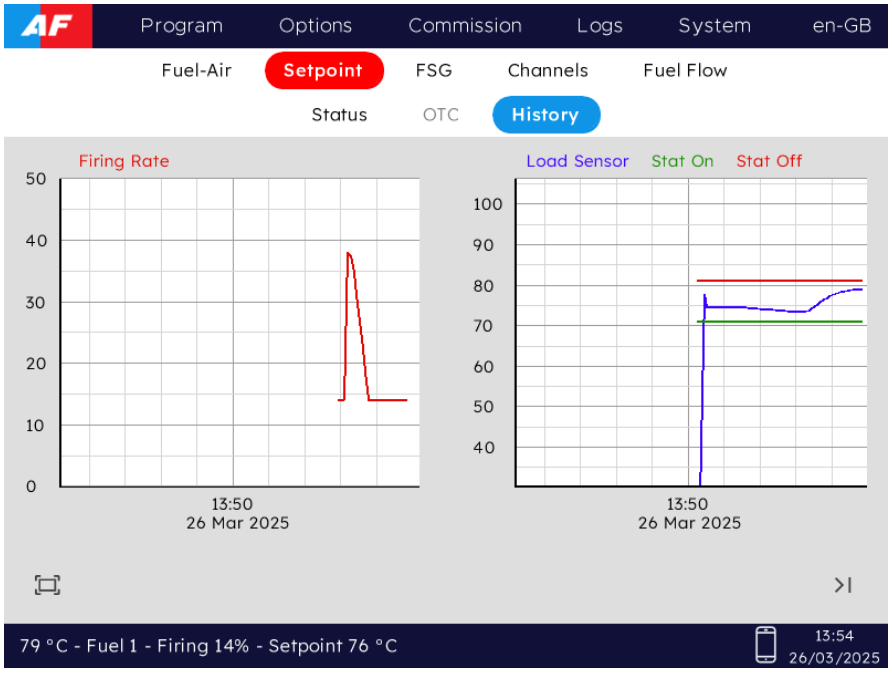


Figure 73 - Setpoint History Screen

The data is logged at day and hour resolution indefinitely on the MM. 15 minute resolution data is stored for 5 years and 1 minute resolution data for 7 days. The graph is zoomable using two-finger pinch and the  and  allow zoom to the extents of the data and the last 10 minutes respectively. The graph shows the last minute of data by default.

11.2.1.3 FSG

Press on the **Flame Detector** on the **Home Screen** graphic or select **AF/FSG** to view the **Flame Safeguard** screen.

The **Flame Safeguard** screen gives a graphical view of the current status of the controls for firing the burner safely. The items in the graphics table are:

Item	Graphic	Action
Post-Purge	Text	Bar turn red when in Post-Purge
Pre-Purge	Text	Bar turn red when in Pre-Purge
Air Servo		Air Damper angle moves and red bar moves up and down to indicate modulation
Main Fuel Valves		Bowtie section is black when closed and white when the valves are open
Pilot Valves		Bowtie section is black when closed and white when the valves are open
Ignition		Flashes Yellow when the ignition is on
Fan Motor		Fan rotates when on.

Throughout the firing sequence a vertical dotted line moves horizontally across the screen showing the current position in the sequence. Active sections light up in red, and return to grey when inactive. The graphical components animate to indicate their status as described in the table above.

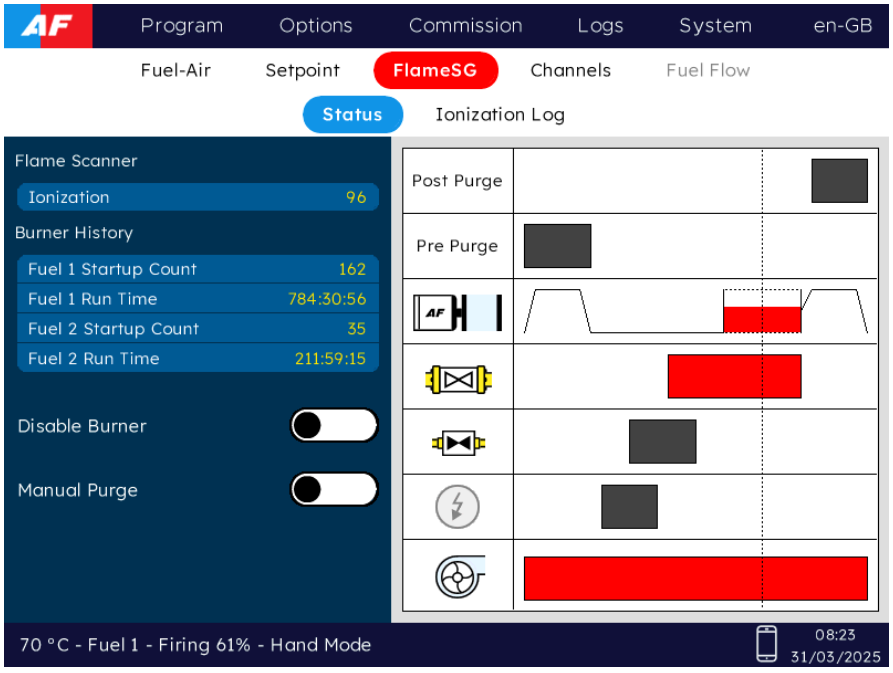


Figure 74 - Flame Safeguard Screen

In addition, the active flame scanners are listed and their status shown. **UV**, **Ionization**, **IR** and **UV Trim** scanners will show their respective counts and the **Flame Switch** will show On/Off.

Finally information on the burner is also displayed in terms of:

- The current active fuel and type.
- The burner starts and run times on each fuel.

A **Log** tab is available for each active flame scanner, which shows graphs of the **Firing Rate** and the change in the flame signal over time so that the strength of the flame signal can be tracked against changing combustion levels.

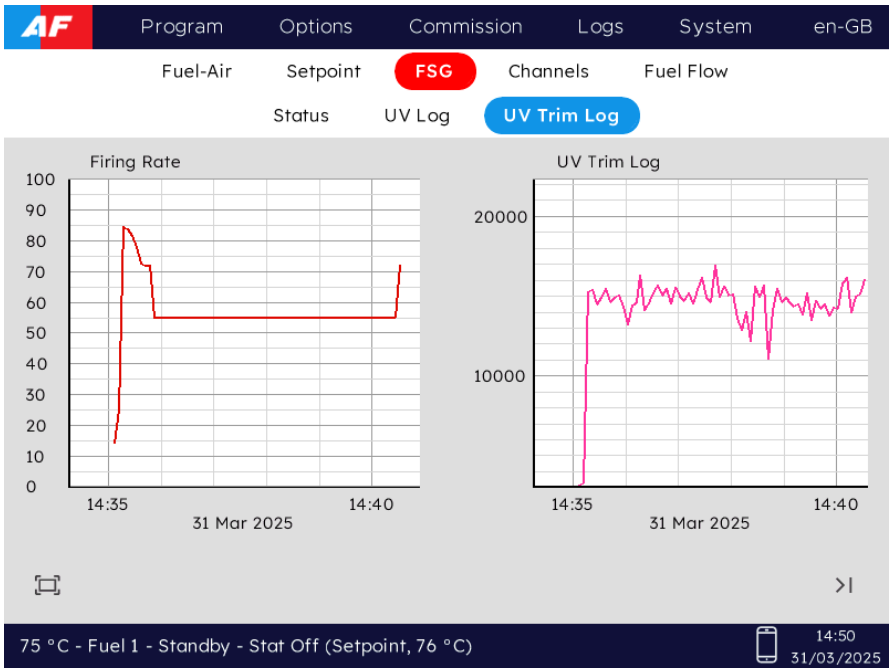


Figure 75 - UV Trim Flame Scanner Log

On the **FSG** screen, a soft slider button allows the unit to be placed in **Manual Purge**. This is intended to provide an extended purge time to cool the burner down. As such it is not intended to be part of the normal start up routine. Activating **Manual Purge** will hold the burner at the **Purge Position** during the next burner start-up.

Note that if the burner is currently firing when the **Manual Purge** button is activated, then the burner will continue to fire as normal. The **Manual Purge** will only become active at the next Start-Up. Care should be taken when moving to **Manual Purge** immediately after a shutdown, to ensure that the flame has fully extinguished and you will not be adding oxygen to a combustible mixture.

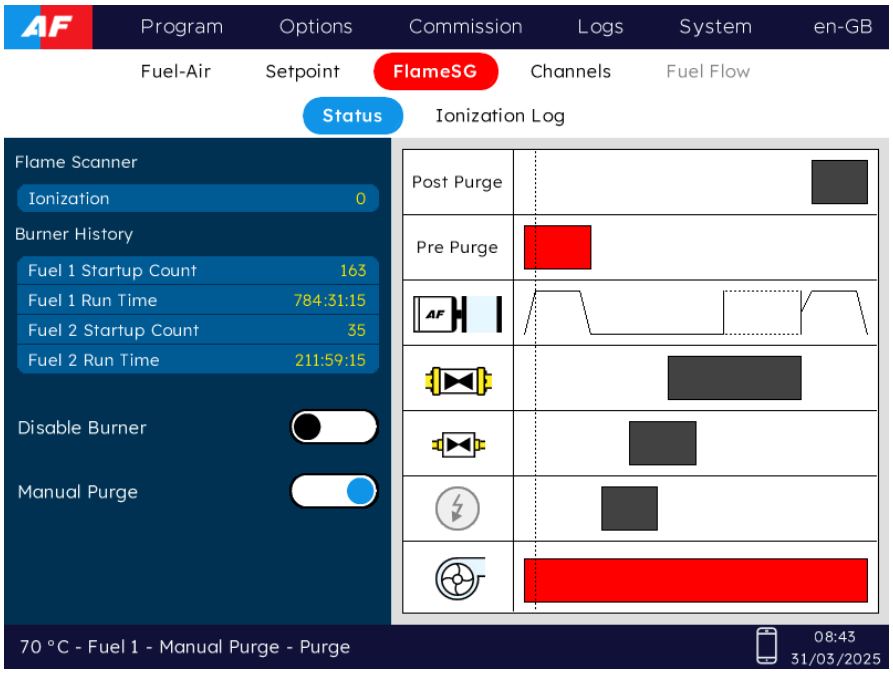


Figure 76 - Manual Purge

Note: If **Options/Load/Setpoint/User Burner On/Off Control** is set to **Locked** then the **Manual Purge** button will be locked in its current state and cannot be switched on or off with the slider button.

11.2.1.4 Channels

Press on a servomotor or VSD on the **Home Screen** graphic or select **AF/Channels** to view the **Channels** screen.

Three tabs are provided on the **Blue Menu Bar** giving access to the **Servomotor**, **VSD** and **PWM** channel information. Selections are greyed out and not accessible if not defined for this system.

On the **Servos** screen, the graph provides a time chart of servo angle for all enabled servo channels. The current angle for each channel is given in the table. The graph is zoomable using two-finger pinch and zoom.

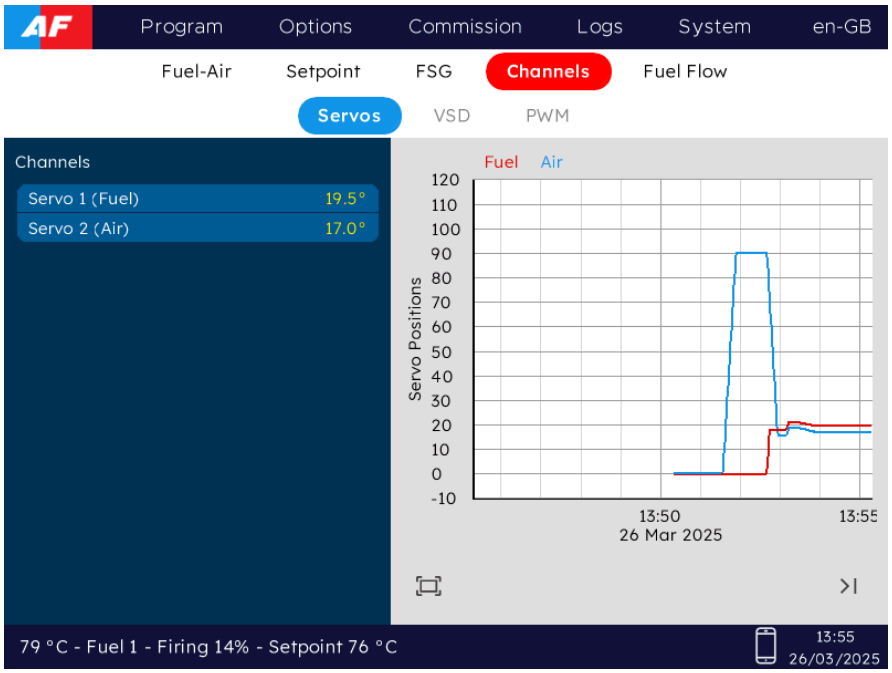


Figure 77 - Servo Channels Screen

The data is logged at day and hour resolution indefinitely on the MM. 15 minute resolution data is stored for 5 years and 1 minute resolution data for 7 days. The graph is zoomable using two-finger pinch and the  and  allow zoom to the extents of the data and the last 10 minutes respectively. The graph shows the last minute of data by default.

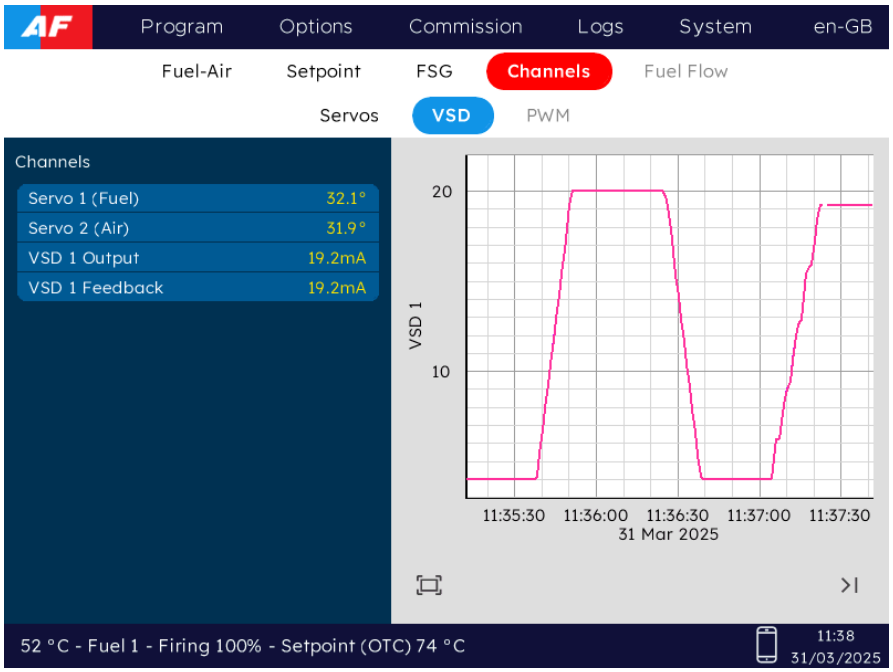


Figure 78 - VSD Channel Screen

Graphs of the **VSD** and/or **PWM** are also available if they are optioned on. The **VSD** graph shows the output and feedback (input) signals from the **MM** to the **VSD**. The **PWM** will show the output drive signal and the tacho feedback.

11.2.1.5 Fuel Flow

Press on a fuel line on the **Home Screen** graphic or select **AF/Fuel Flow** to view the **Fuel Flow** screens.

Under the **Commissioned** tab on the **Blue Menu Bar**, the graph shows the 10 fuel flow points as commissioned against fuel servo angle. These are also listed in the table. In addition the current fuel servo angle and fuel flow rate are shown.



Figure 79 - Fuel Flow Screen

The **Totalized** tab on the **Blue Menu Bar** brings up a graph of fuel flow against time. In addition the burner **Startup Count**, total **Run Time** and **Totalized Fuel** use is shown for each fuel.

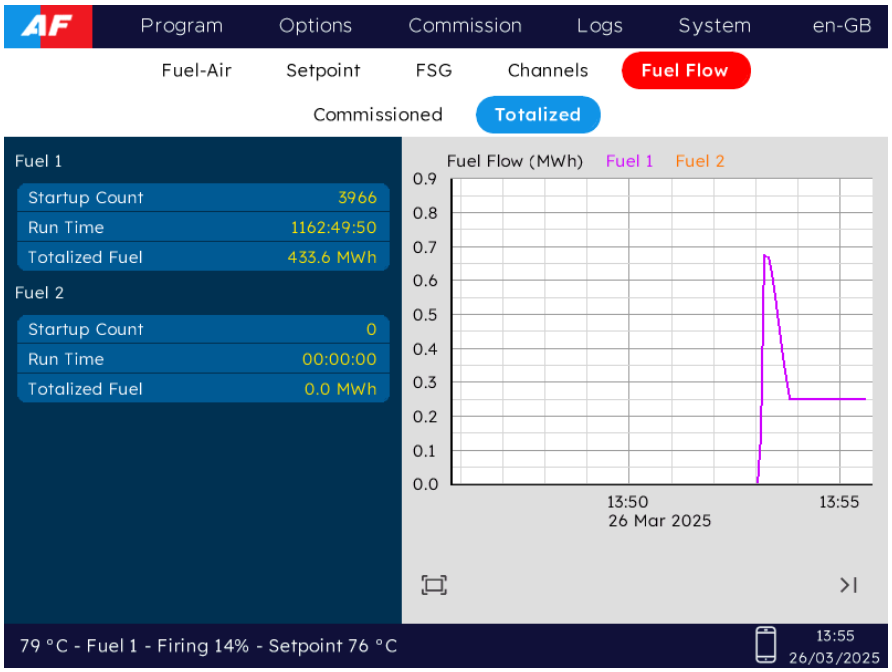


Figure 80 - Fuel Flow Totalized Screen

The data is logged at day and hour resolution indefinitely on the MM. 15 minute resolution data is stored for 5 Years and 1 minute resolution data for 7 days. The graph is zoomable using two-finger pinch and the  and  allow zoom to the extents of the data and the last 10 minutes respectively. The graph shows the last minute of data by default.

11.2.1.6 Sensors

Press on any of the air or gas pressure sensors on the **Home Screen** graphic or select **AF/Sensors** to view the **Sensors** screen.

Four tabs are then available on the **Blue Menu Bar** providing access to the:

- **Air Sensor** screen
- **Air History** screen
- **Gas Sensor** screen
- **Gas History** screen

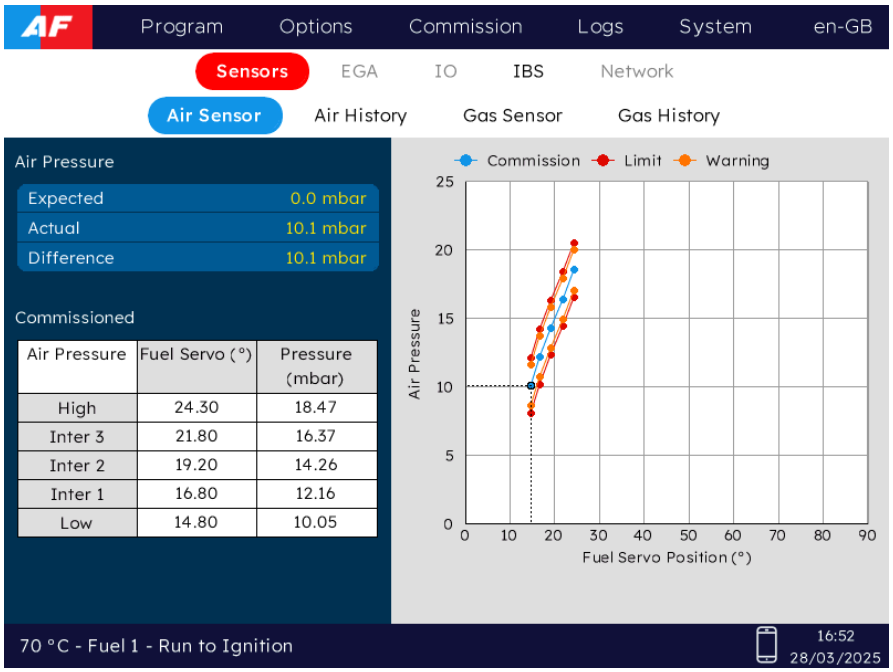


Figure 81 - Air Sensor Screen

The graph on the **Air Sensor** screen shows the commissioned air pressure sensor values against fuel servo angle, together with any upper and lower limits that may be set in **Options/Burner/Sensors/Air Pressure Error Window, Options/Burner/Sensors/Air Pressure Warning Offset Below Commissioned** and **Options/Burner/Sensors/Air Pressure Warning Offset Above Commissioned.**

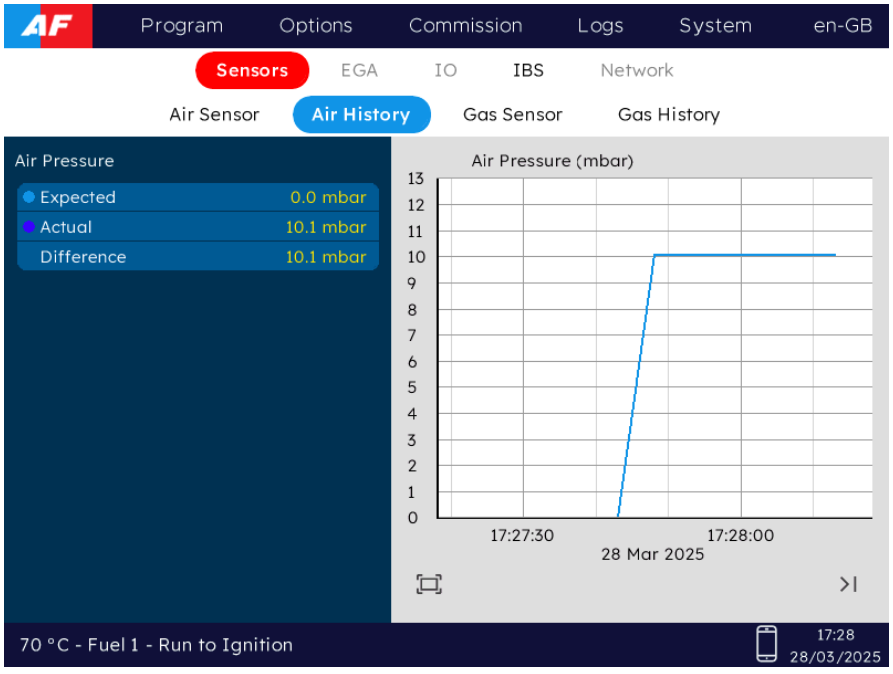


Figure 82 - Air History Screen

Selecting **Air History** displays a time graph of the actual and expected air pressures. The data is logged at day and hour resolution indefinitely on the MM. 15 minute resolution data is stored for 5 years and 1 minute resolution data for 7 days. The graph is zoomable using two-finger pinch and the  and  allow zoom to the extents of the data and the last 10 minutes respectively. The graph shows the last minute of data by default.

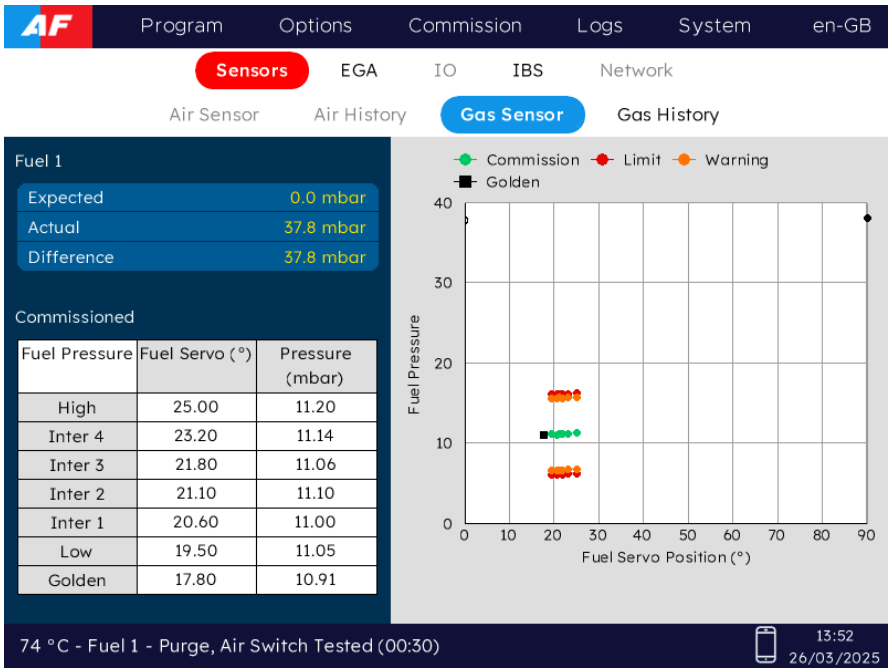


Figure 83 - Gas Sensor Screen

The graph on the **Gas Sensor** screen shows the commissioned gas pressure sensor values against fuel servo angle, together with any upper and lower limits that may be set in **Options/Burner/Valve Proving**.

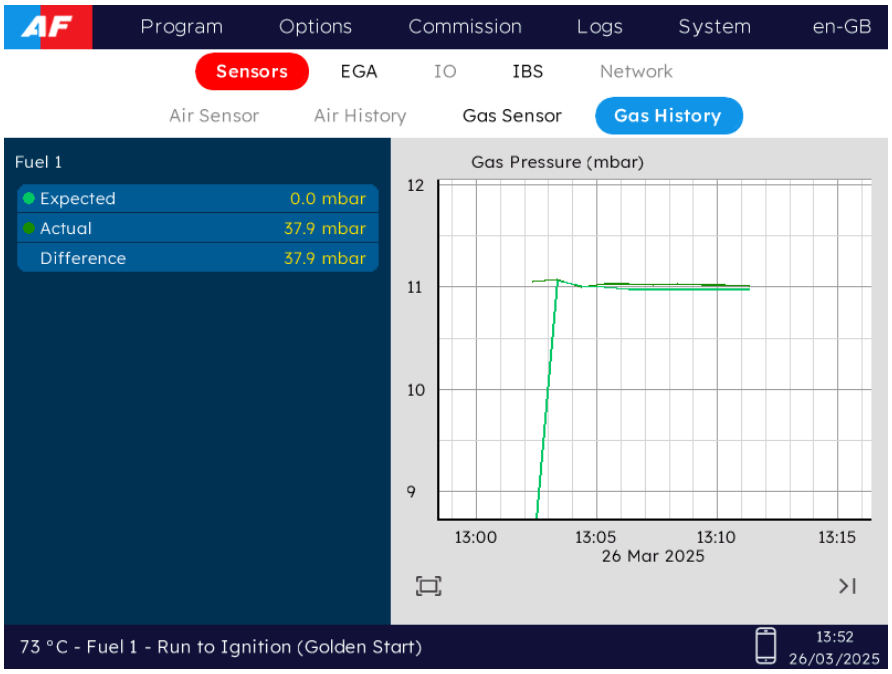


Figure 84 - Gas History Screen

Selecting **Gas History** displays a time graph of the actual and expected gas pressures. The data is logged at day and hour resolution indefinitely on the MM. 15 minute resolution data is stored for 5 years and 1 minute resolution data for 7 days. The graph is zoomable using two-finger pinch and the  and  allow zoom to the extents of the data and the last 10 minutes respectively. The graph shows the last minute of data by default.

11.2.1.7 EGA

Selecting the **EGA** on the **Home Screen** graphic or accessing **AF/EGA** opens the **Exhaust Gas Analyser** screens.

The **Gas** tab displays the **EGA Exhaust Gas Data**. The top graph shows the **O2** and **CO2** levels as percentages against time and the lower graph shows the **CO** and **NO** as ppm against time.

The table lists the instantaneous readings for each of the available gases as well as the exhaust (stack) temperature, the ambient temperature and the combustion efficiency. All these values are determined by the **EGA** and communicated to the MM over an RS485 link.

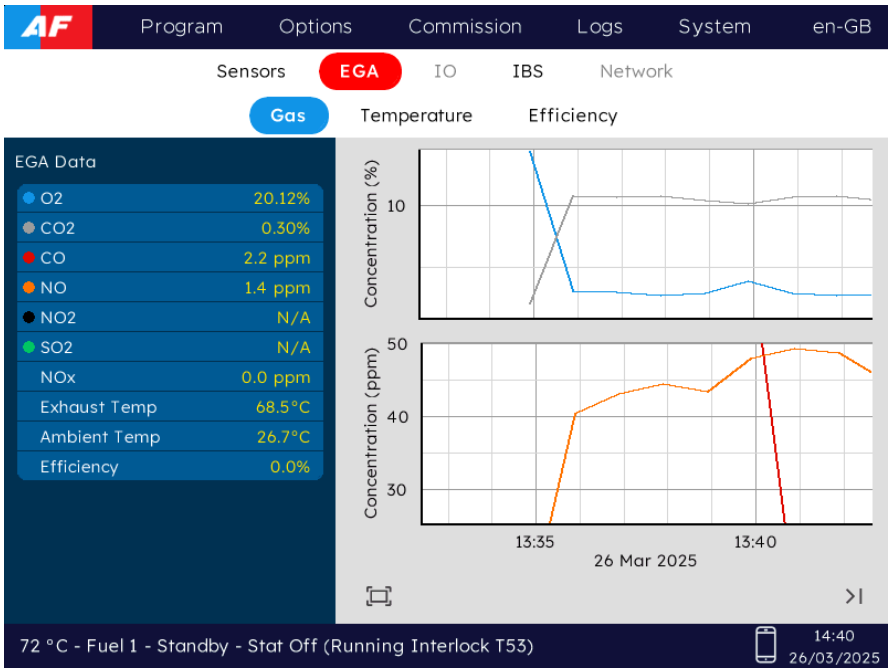


Figure 85 - EGA Gas Screen

Selecting the **Temperature** tab changes the graph to displaying the exhaust (stack) temperature and the ambient temperature against time. The data in the table remains the same on all **EGA** screens.

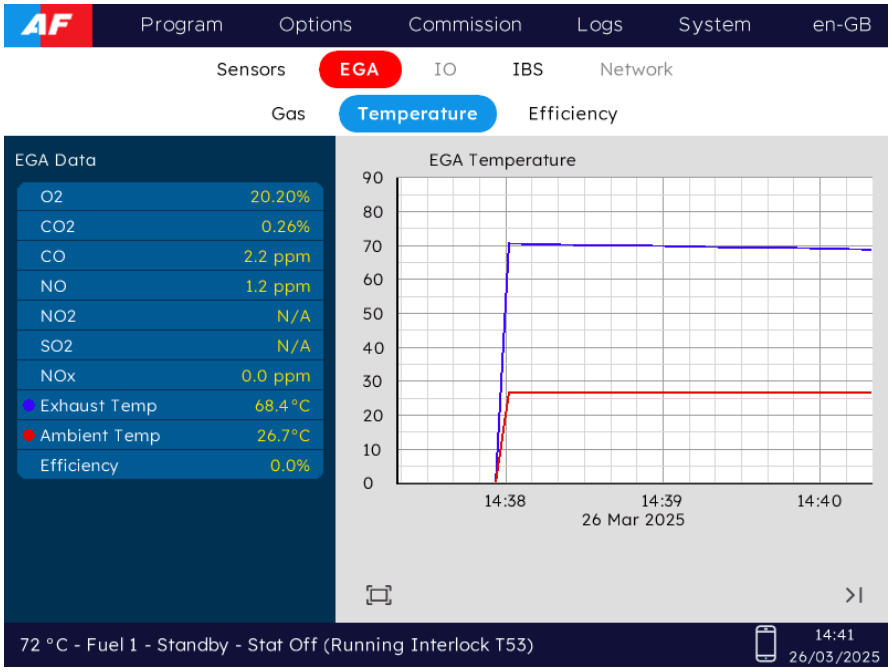


Figure 86 - EGA Temperature Screen

Finally selecting **Efficiency** changes the graph to display the calculated combustion efficiency calculated by the **EGA**.

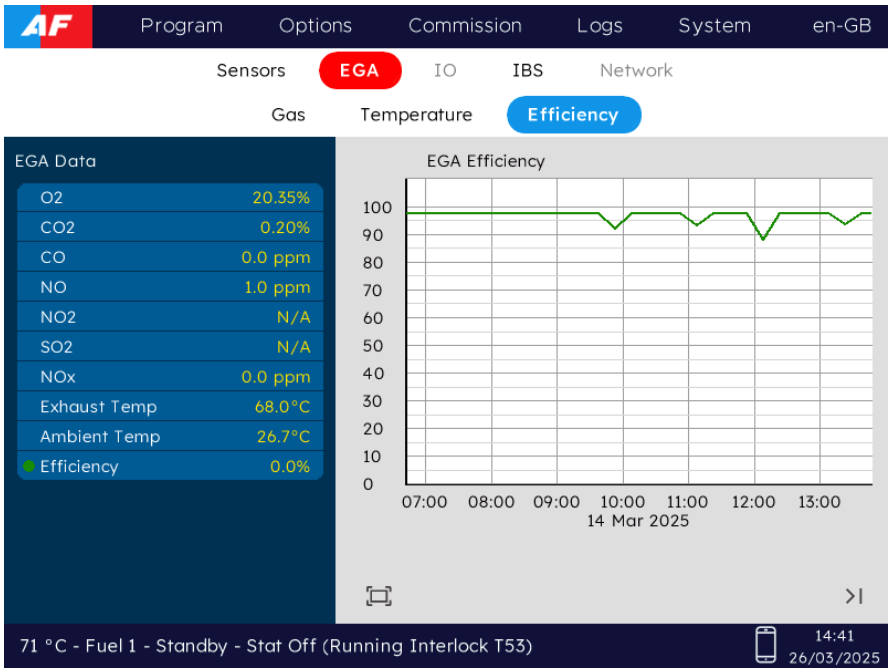


Figure 87 - EGA Efficiency Screen

The data for all three screens is logged at day and hour resolution indefinitely on the MM. 15 minute resolution data is stored for 5 years and 1 minute resolution data for 7 days. The graph is zoomable using two-finger pinch and the and allow zoom to the extents of the data and the last 10 minutes respectively. The graph shows the last minute of data by default.

11.2.2 Program

Selecting **Program** gives access to the **Run Times** and **Setpoint Programs**.

11.2.2.1 Run Times

Run Times allow the user to set three possible states for the boiler setpoint in a weekly calendar. The states are:

State	Description
ON	Firing according to the Main Setpoint
Reduced	Firing according to the Reduced Setpoint
Off	Not Firing

Two programs may be defined under the **Run Times 1** and **Run Times 2** tabs. This allows a standard **Run Times** schedule to be defined together with an alternative schedule to be used for example during a business shut-down period without having to alter the standard schedule.

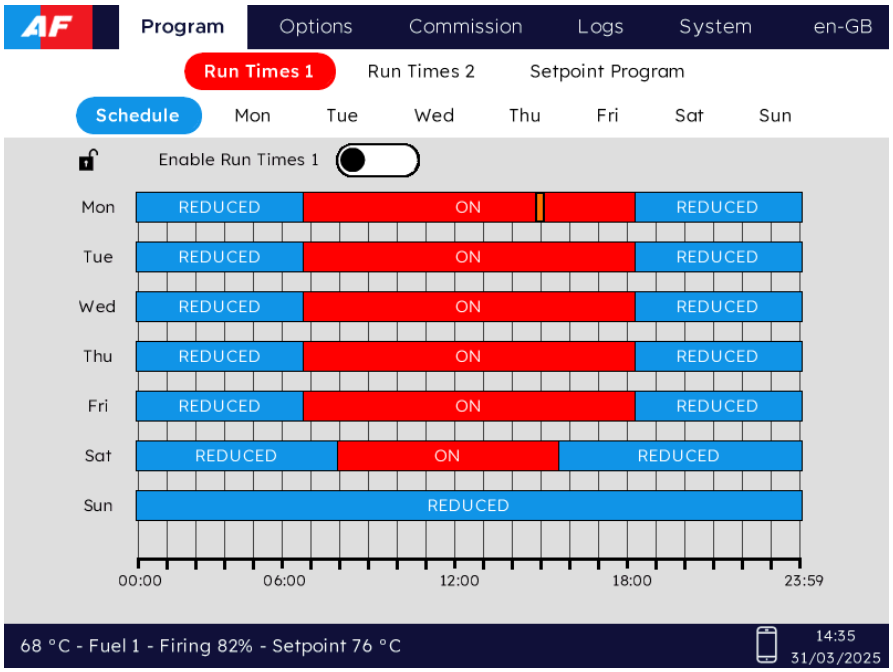


Figure 88 - Run Times Off

Selecting **Run Times 1** or **Run Times 2** displays the **Schedule** for that option and allows the schedule or individual days to be accessed through the **Blue Menu Bar**. The **Schedule** is initially locked as indicated by the padlock. A disabled **Run Times** program is shown by the **Enable Run Times** soft slider button being to the to the left and being coloured black or grey.

To make any changes to the schedule, or to enable it, it will first need to be unlocked by tapping on the padlock. You will then be prompted to enter the **On-Line Changes** password.

Having successfully entered the password, selecting an individual day brings up the edit screen for that day.

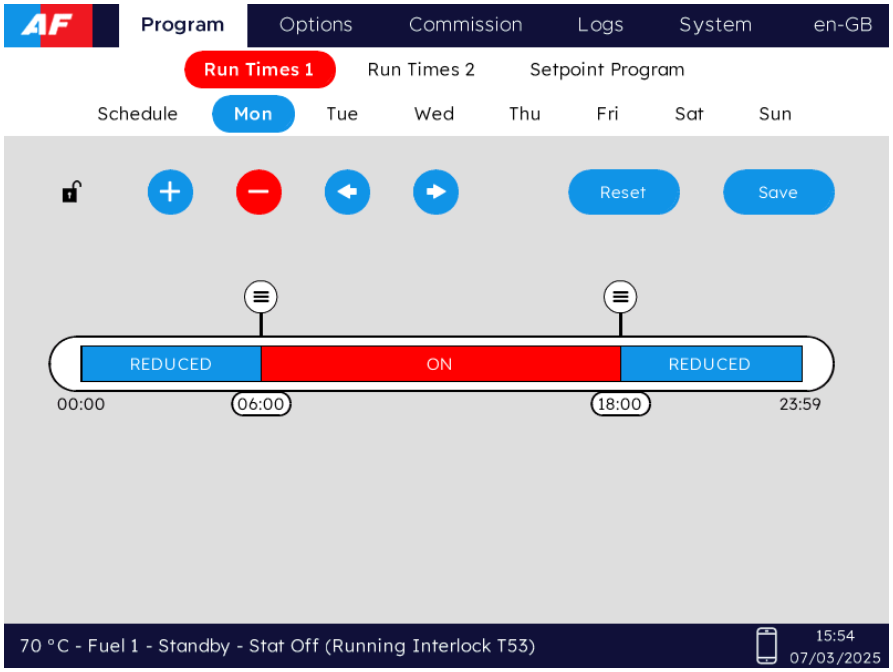


Figure 89 - Run Times Edit

In edit mode, with **Run Times** unlocked, the following options are available:

- adds a new marker at the 00:00 point which can then be moved to any position in the day by placing your finger on the marker and moving it left or right. The marker indicates transition points

between setpoint states. The currently active marker is blue. It turns black if a new marker is added or a different existing marker is selected.

-  deletes the current active marker.
-  move the active marker left or right in 15 minute steps. This is the same as dragging the marker but may provide more fine control of the position. Note that the resolution for marker positions is 15 minutes, so no 2 markers may be closer in time that this.
- The **Reset** button removes all markers and sets the whole day to **ON**.
- Selecting a section on the bar in the centre of the display toggles between the **ON**, **REDUCED** and **OFF** states, defining the schedule.
- The **Save** button allows the edited schedule to be saved. It brings up the **Save Confirmation** pop-up box with the edited day highlighted in blue. Other days may be selected before pressing save to store this schedule in multiple days. In Figure 90, Monday through to Friday have been highlighted to set the schedule for all weekdays. This allows weekday and weekend schedules to be easily set as two separate schedules. Different schedules may be set for each individual day if required.



Figure 90 - Run Times Save Confirmation

The **Run Times** schedule is enabled by moving the slider across to the right (it turns blue when active), when in the Schedule screen and **Run Times** is unlocked.

Note: Enabling **Run Times 1**, disables **Run Times 2** and vice versa, since only one program may be active at any given time. It will also disable any active **Setpoint Program**, so care should be taken when activating a **Run Times Schedule** to ensure that you are not overriding an important ongoing process.

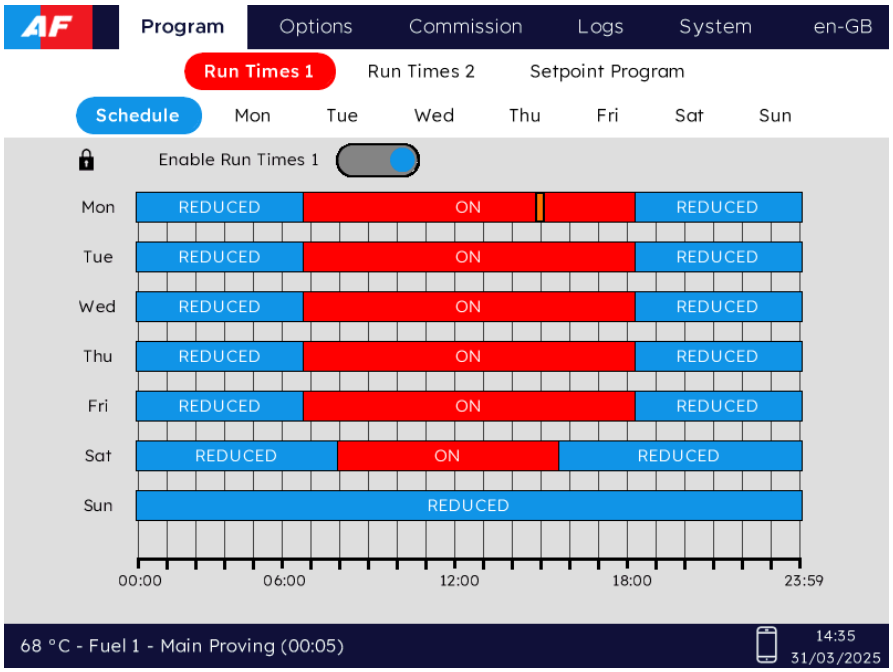


Figure 91 - Enable Run Times

Moving to a different screen, such as by pressing the **Home Button** will lock **Run Times** against further changes.

The Vertical Orange bar shows the current time on the schedule allowing quick identification of the current place in the schedule and what the setpoint should be (**ON**/**REDUCED**/**OFF**).

11.2.2.2 Setpoint Program

The **Setpoint Program** allows finer control of the setpoint, with a timed sequence of setpoint changes, including ramping the setpoint up or down. This may be used to define a setpoint profile for a particular process. Up to 10 setpoint programs may be defined with new ones added to the list of options.

Selecting **Setpoint Program** opens the list of currently defined programs. The screen will be initially locked for editing as indicated by the closed padlock, with the **Run** and **Edit** functions greyed out.

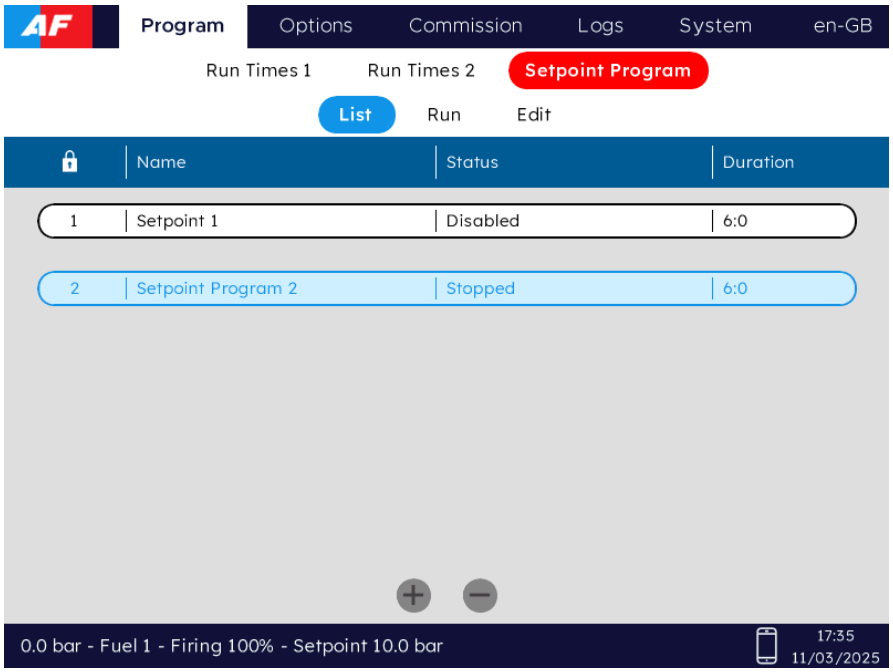


Figure 92 - Setpoint Program Locked And Idle

Touching the padlock, unlocks **Setpoint Programs** via the **Online Changes Password** screen.

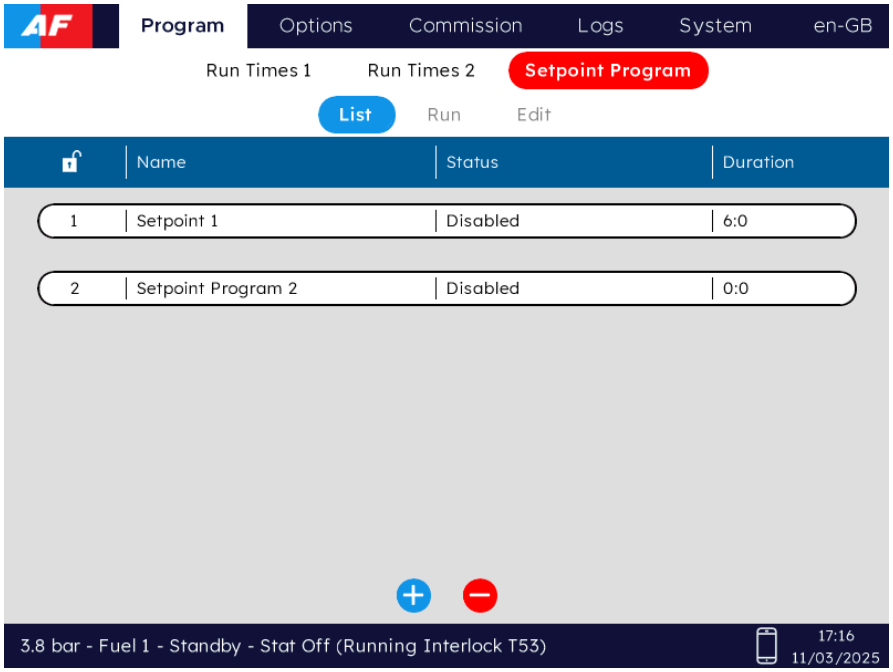


Figure 93 - Adding New Setpoint Programs

The  buttons allow new programs to be added or removed from the list. Touch the  to add a new program. Select an existing program to highlight it in blue and press  to delete it.

Selecting a program and pressing **Edit** brings up the screen to edit the profile for the selected program.

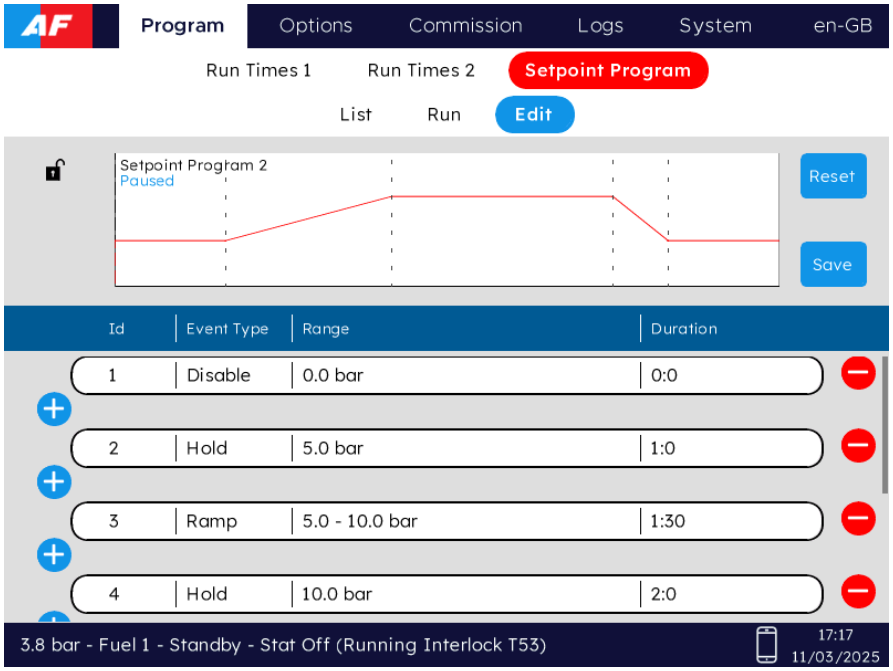


Figure 94 - Setpoint Program Edit

The **Edit** screen brings up a list of setpoint events for the selected program. New events are added or removed using the  to insert an event between two others by pressing the appropriate  or deleting an event by pressing the adjacent . The graph shows the timeline with the setpoint changes shown by the red line. The dotted vertical lines mark the transitions between events.

The **Reset** button will remove all steps added to a program and leave it blank and ready for editing.



Figure 95 - Adding A Setpoint Program Step

Touching an individual event brings up the **Edit Event** pop-up box. In the pop-up, 3 **Setpoint Modes** are available across the top of the box:

- **Hold:** The setpoint will be held at a constant value. Only the Setpoint (Start) is entered together with the duration (the Setpoint (End) box is not editable)
- **Ramp:** The Setpoint (Start) and Setpoint (End) values are entered together with a duration to ramp the setpoint from one value to the another. The setpoint will change linearly over the given duration between the setpoints.
- **Disable:** The Setpoint is automatically set to zero and just a duration is entered.

To enter a value, tap on the appropriate box, the number pad will become active (turn black). Type in the new value and then press **Enter** to store the value. When all the data has been entered press **OK** to return to the edit screen.

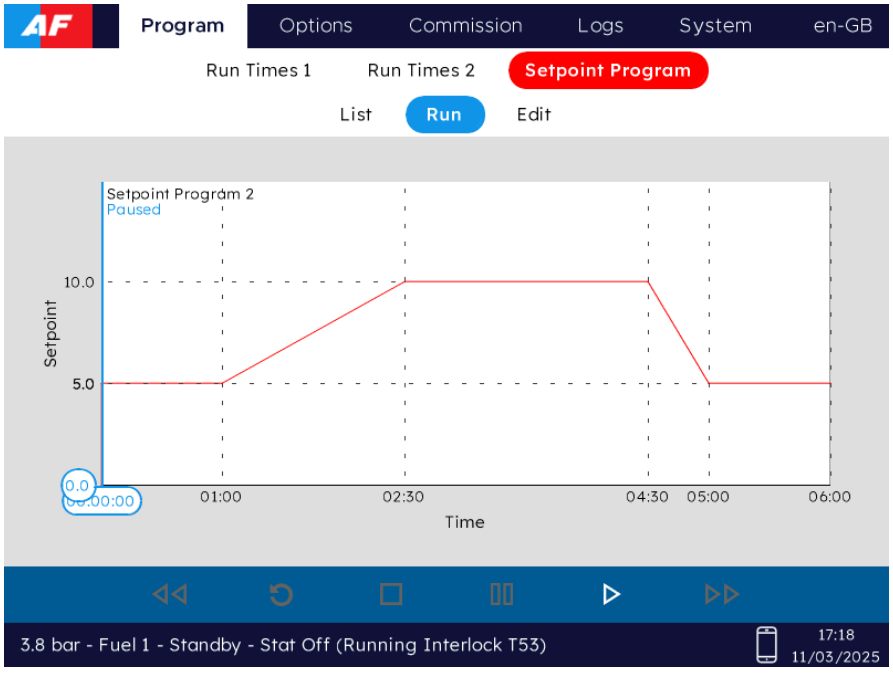


Figure 96 - Setpoint Program Profile

The **Setpoint Program** shown above has been defined to hold the setpoint at 50°C for 1 hour, then to ramp it up to 80°C over the next 2 hours, hold at this value for 1 hour 30 minutes and finally ramping it back down to 50°C over the next 2 hours and hold it there for ½ hour before switching off.

Any number of transitions can be made, with the time extending as the program is generated.

Pressing the **Save** button brings up a pop-up box allowing the name of the program to be defined. As default it will be called **Setpoint Program 1** etc where the number is the next in the list. The user could change the name to match the process for which they are using the program.

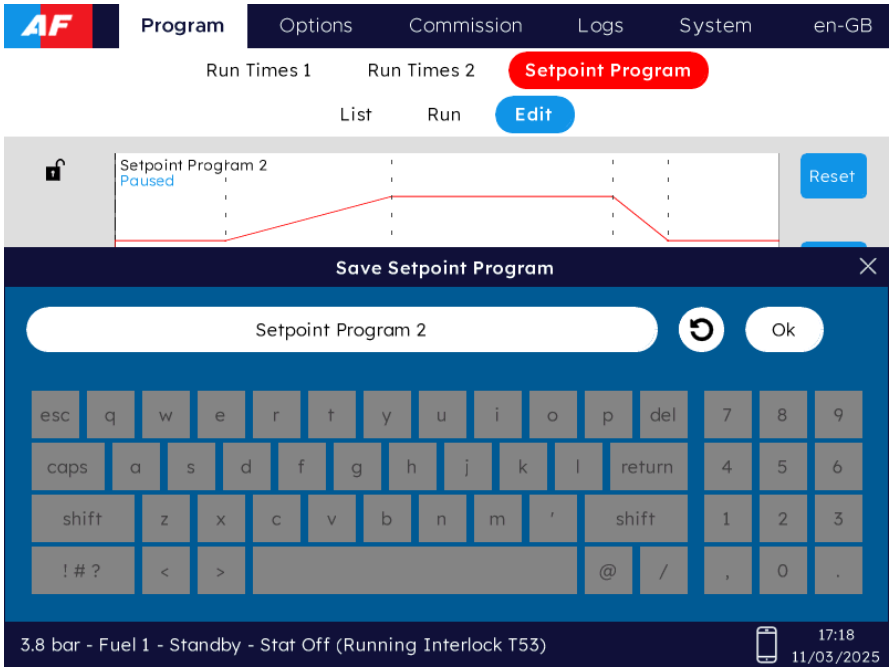


Figure 97 - Saving A Setpoint Program

To run a **Setpoint Program**, select it in the list and press the **Run** tab to bring up the **Run Screen**.

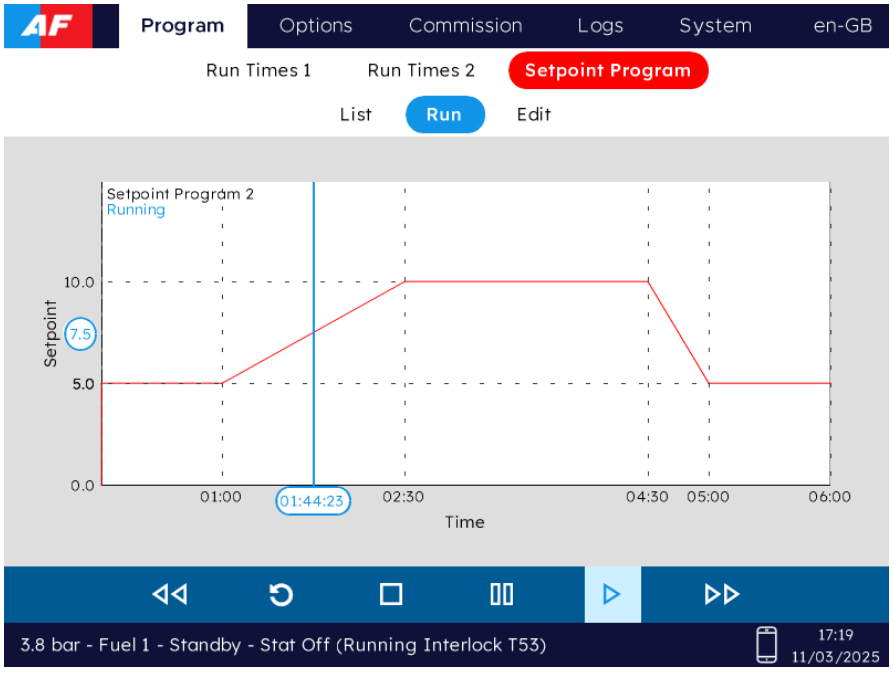


Figure 98 - Running A Setpoint Program

The graph of the Setpoint program profile fills the screen together with a set of control buttons as follows:

Symbol	Function	Description
	Rewind	Move the current position back through the program in steps
	Restart	Move back to the start of the program and continue playing
	Stop	Stop the program and move back to the start
	Pause	Pause the program at its current position
	Play	Start the program from its current position
	Fast Forward	Move the current position forward through the program in steps

The Blue line with timer tracks across the program as it is running to show the current state.

11.2.3 Options

The **Options** tab provides access to all the settings of the controller to define its operation. The access to the settings and the list of all the options are defined in section 6 of this document.

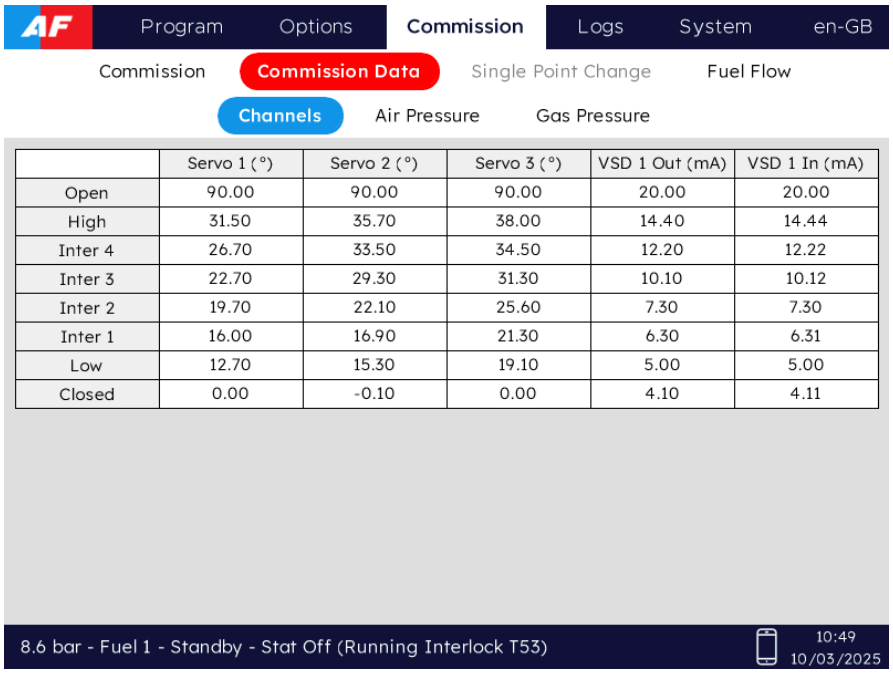
11.2.4 Commission

The **Commission** tab provides access to all the commission processes of the controller.

Commissioning a burner, viewing the **Commission Data**, making changes to the commission using **Single Point Change** and carrying out a **Fuel Flow** commission are all defined in section 7 of this document.

11.2.4.1 Commission Data

The **Commissioned Data** can be viewed at any time by selecting **Commission/Commission Data**. This defaults to the **Channels** screen which provides a table of the settings for all the defined channels (**Servos/VSD/PWM**) against the **Fuel-Air** curve points. This table will expand or contract depending on the number of channels used and the number of points defined on the curve and will be scrollable if required to fit all the information.



	Servo 1 (°)	Servo 2 (°)	Servo 3 (°)	VSD 1 Out (mA)	VSD 1 In (mA)
Open	90.00	90.00	90.00	20.00	20.00
High	31.50	35.70	38.00	14.40	14.44
Inter 4	26.70	33.50	34.50	12.20	12.22
Inter 3	22.70	29.30	31.30	10.10	10.12
Inter 2	19.70	22.10	25.60	7.30	7.30
Inter 1	16.00	16.90	21.30	6.30	6.31
Low	12.70	15.30	19.10	5.00	5.00
Closed	0.00	-0.10	0.00	4.10	4.11

Figure 99 - Commission Data - Channels

Tabs provide access to the **Air Pressure** and **Gas Pressure** calibrations if they are available. These show both a graph of the air or gas pressure against fuel servo angle and a table of the data.

Upper and Lower limits and warning levels are displayed if they are set in the options under **Options/Burner/Sensors** for the **Air Pressure Limits** and **Options/Burner/Valve** Proving for the **Gas Pressure Limits**.

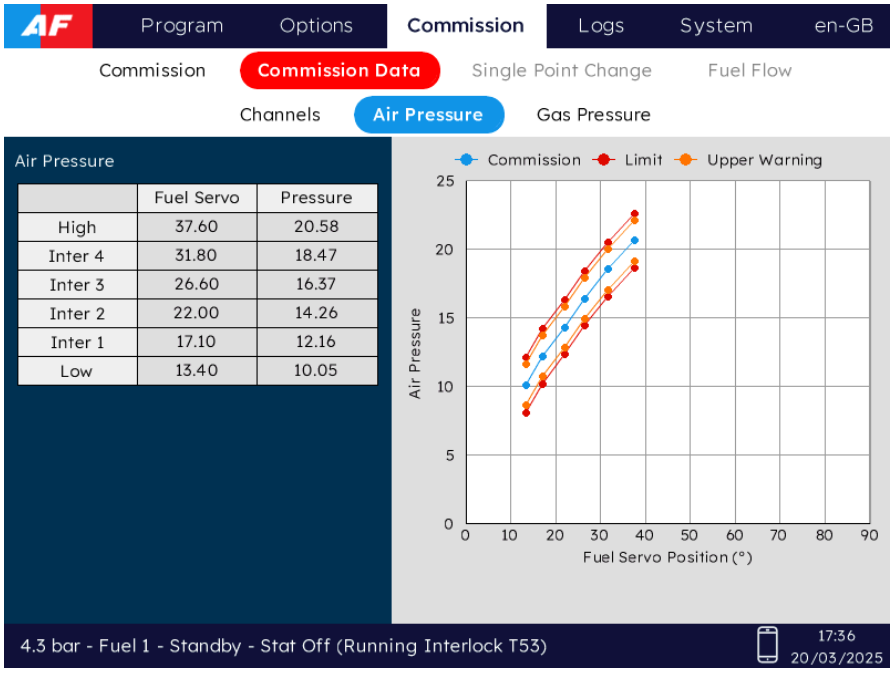


Figure 100 - Commission Data - Air Pressure

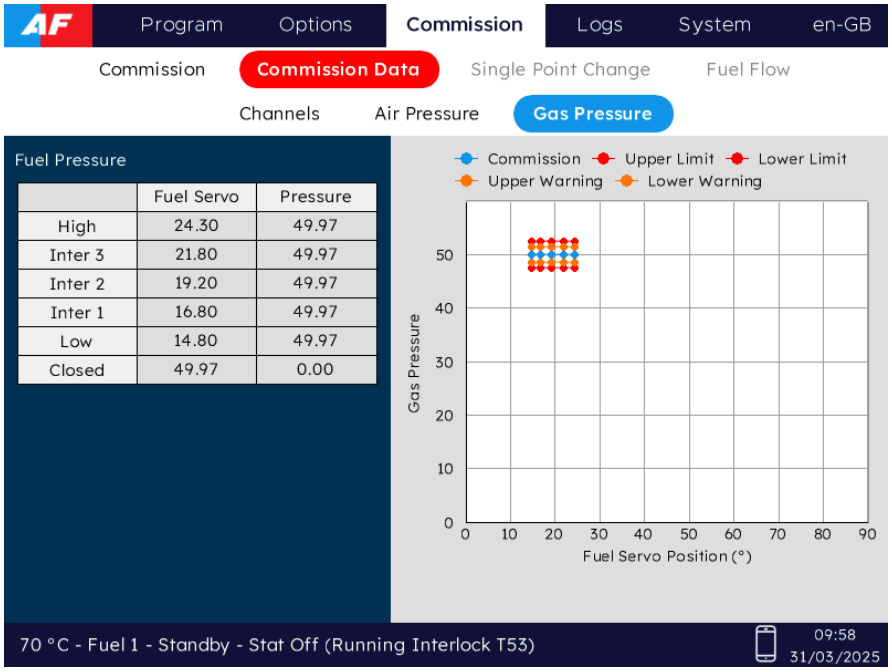


Figure 101 - Commission Data - Gas Pressure

11.2.5 Logs

The Logs tab gives access to a number of different logs which record the operation and performance of the controller/burner as follows:

11.2.5.1 System Log

The **System Log** is the main log for the Mini Mk9 and contains a complete list of all events, including changes to the STAT status, modifications of any settings and all the fault logs.

Each individual log contains a description of the event together with the date and time at which the event occurred.

A count is maintained at the top of the list indicating how many items are in each log.

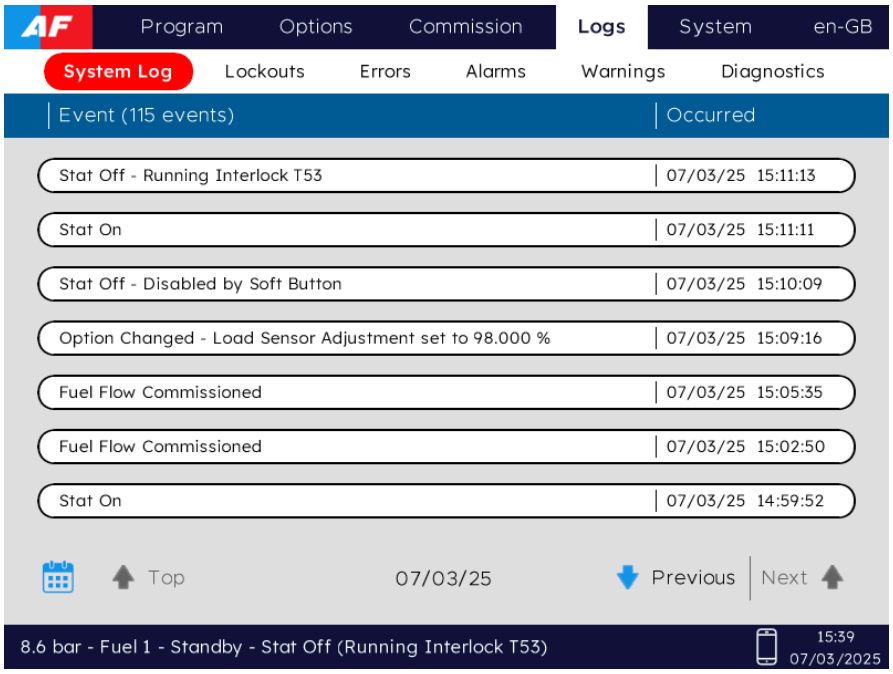


Figure 102 - System Log

The most recent entry shows when you first select the log.

The navigation buttons along the bottom of the log allow the following actions:

Icon	Title	Description
	Calendar	Opens up a calendar to move to a particular date in the log.
	Top	Moves back to the lot of the log (i.e. the latest entry).
	Previous	move to the previous date in the log.
	Next	move to the next date in the log.

Note that the number of logs for a particular date may be more than can fit on a single page. You can scroll through the events in the log by placing your finger on the screen and swiping up/down to move the whole log.

More details of a particular event, lockout, error, alarm or warning may be obtained by selecting that event from the list. As shown below, a Servo Movement Error log can be examined to see that it was Servo 2 giving the error and that it occurred while trying to move to the purge position.

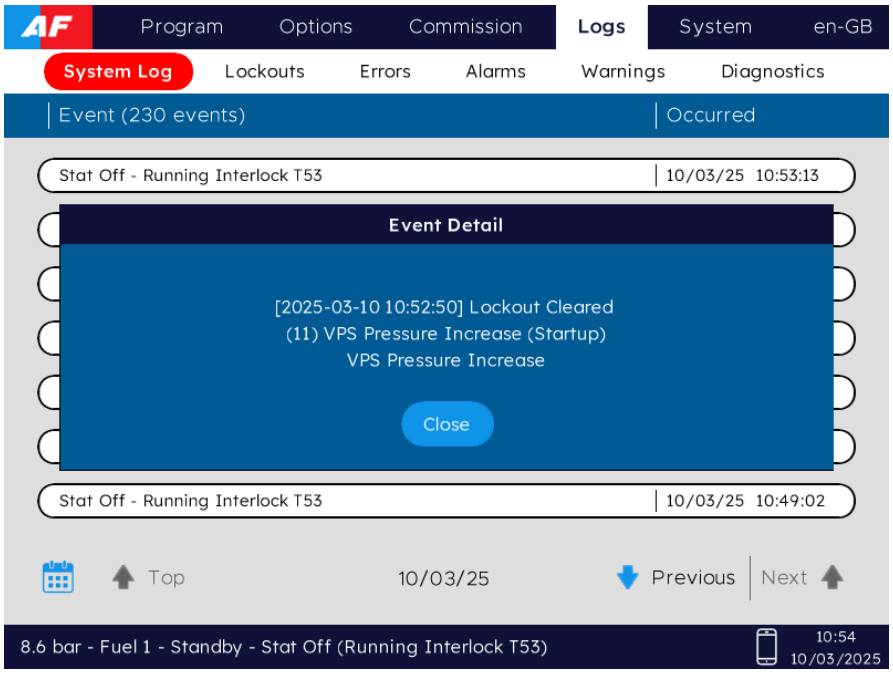


Figure 103 - Log Event Detail

11.2.5.2 Lockouts

When a **Lockout** Occurs, the **Information Bar** turns red and the **Lockout** description is displayed as shown below.

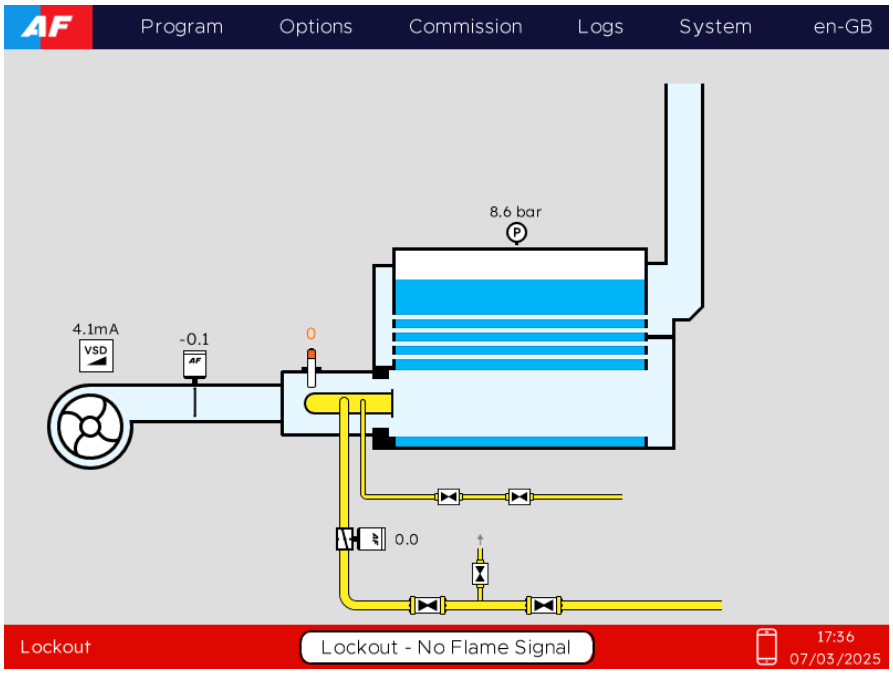


Figure 104 - System in Lockout

Selecting the description opens the **Logs/Lockouts** page allowing the details of the **Lockout** to be checked by selecting it to open up the **Event Details**. Move the slider to the right to clear the **Lockout**. If the reason for the **Lockout** has been removed, then the unit will continue with normal operation. If the reason for the **Lockout** persists, then the **Lockout** will re-occur.

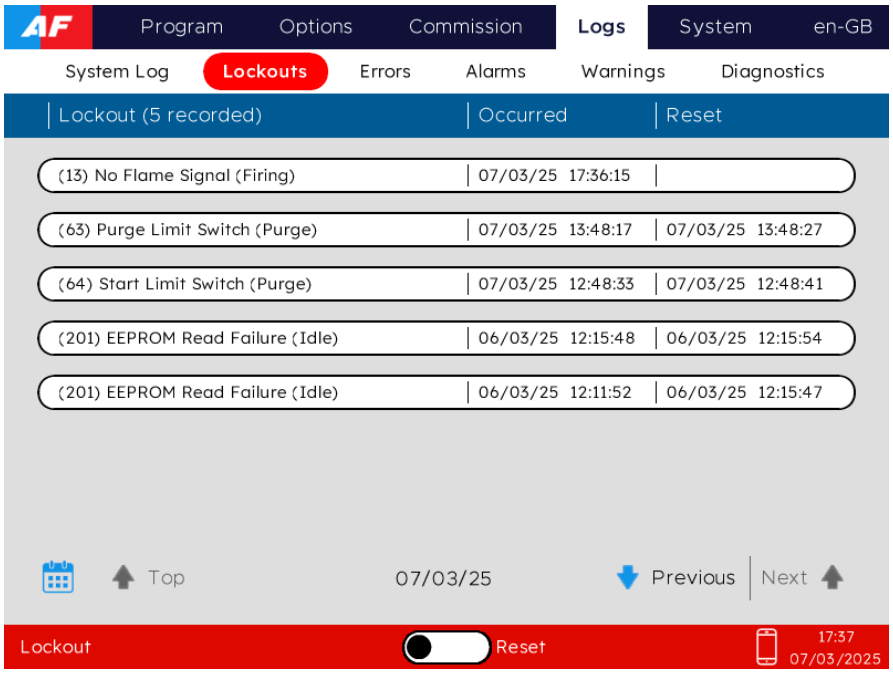


Figure 105 - Resetting a Lockout

If an attempt is made to clear the **Lockout** 5 times in a row without success then a **Lockout Reset Disabled** message is shown together with a countdown timer and the **Reset** button is disabled for 15 minutes to prevent an automatic external **Lockout Reset** input from continually clearing the **Lockout** without fixing the root cause.

Selecting the **Logs**/**Lockouts** tab filters the **System Log** to only show the **Lockouts** that have occurred. Each line in the list details:

- the **Lockout** cause.
- the phase in which it occurred.
- the date and time that it occurred and also at which it was cleared.

The last entry in the line will remain blank if the **Lockout** is still active.

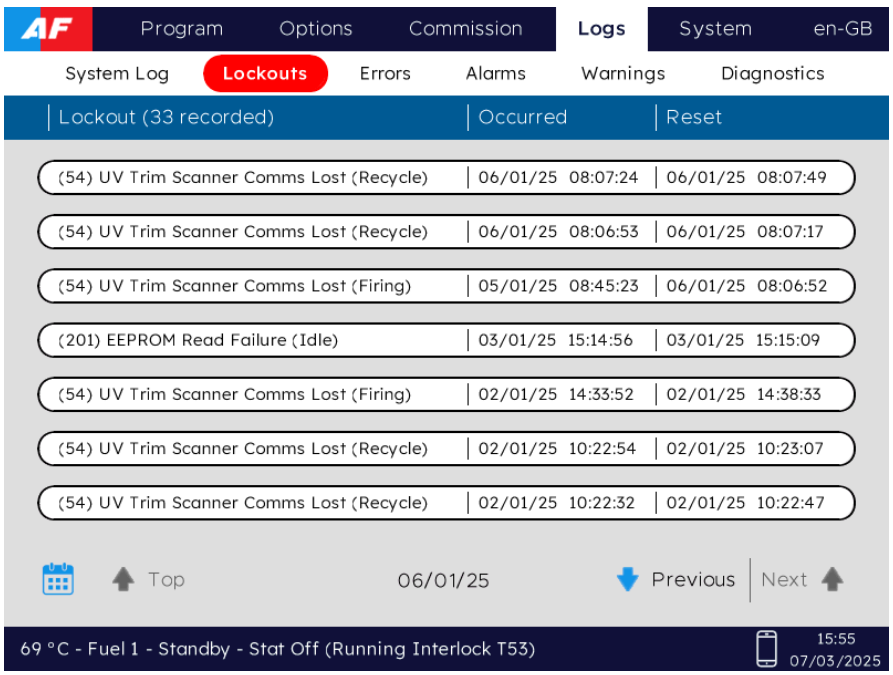


Figure 106 – Lockouts Log

11.2.5.3 Errors

Active **Errors** turn the **Information Bar** red and are detailed in the same way as **Lockouts**. Selecting the **Error** takes you to the **Logs**/**Errors** page where the error can be reset using the slider button. The **Error** will persist if the reason for it has not cleared.

Selecting the **Logs**/**Errors** tab filters the **System Log** to only show the errors that have occurred. Each line in the list details:

- the **Error** cause.
- the phase in which it occurred.
- the date and time that it occurred and also at which it was cleared.

The last entry in the line will remain blank if the **Errors** is still active.

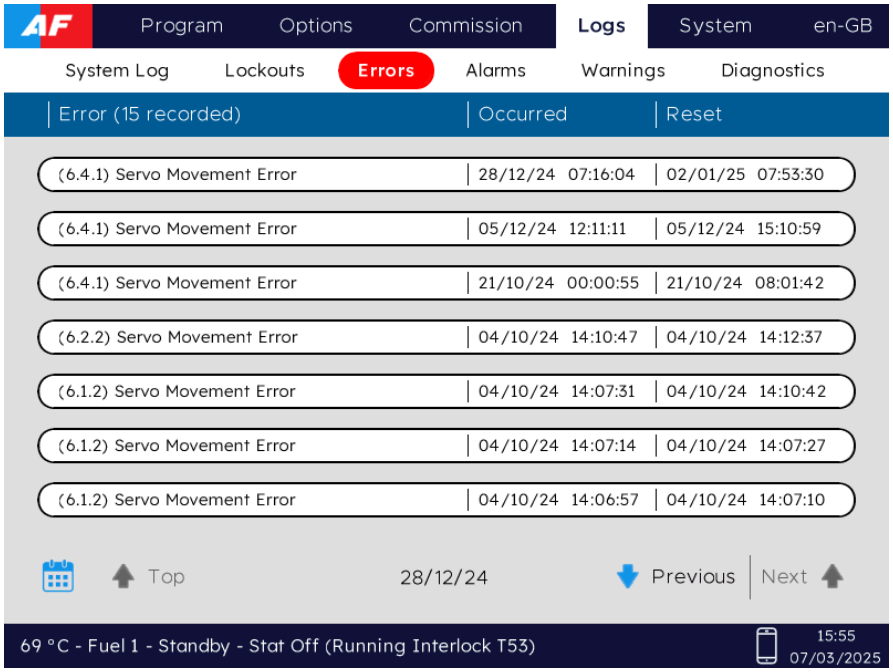


Figure 107 – Errors Log

11.2.5.4 Alarms

Active **Alarms** turn the **Information Bar** red and are detailed in the same way as **Lockouts**. Selecting the **Alarm** takes you to the **Logs**/**Alarms** page where the **Alarm** can be reset using the slider button. The **Alarm** will persist if the reason for it has not cleared.

Selecting the **Logs**/**Alarms** tab filters the **System Log** to only show the **Alarms** that have occurred. Each line in the list details:

- the **Alarm** cause.
- the phase in which it occurred.
- the date and time that it occurred and also at which it was cleared.

The last entry in the line will remain blank if the **Alarm** is still active.

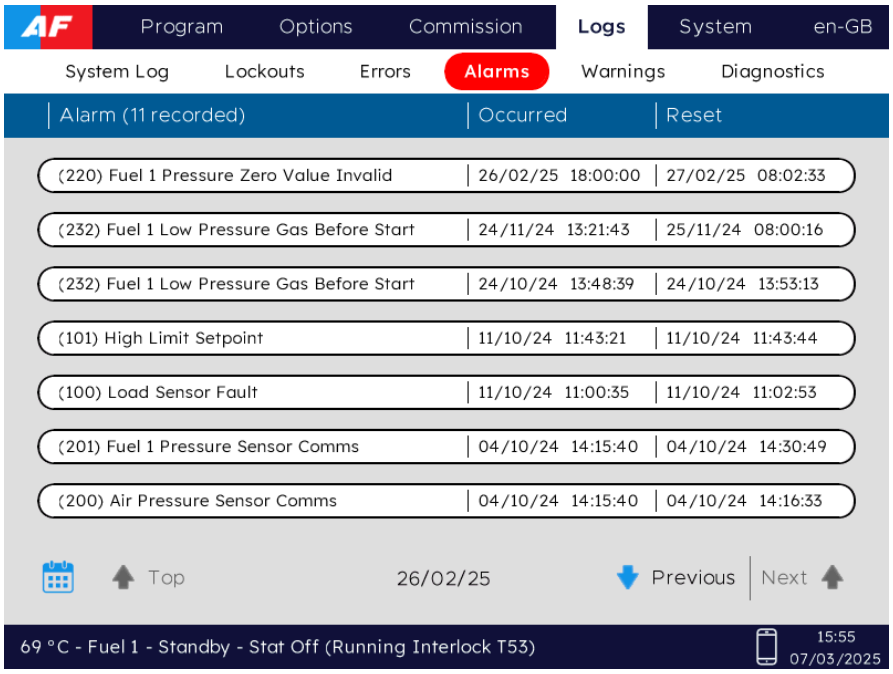


Figure 108 - Alarms Log

11.2.5.5 Warnings

Active **Warnings** turn the **Information Bar** red and are detailed in the same way as **Lockouts**. Selecting the **Warning** takes you to the **Logs**/**Warnings** page where the **Warning** can be reset using the slider button. The **Warnings** will clear as it has been acknowledged. It will only reappear, if the reason for the warning was removed and then came back again.

Selecting the **Warnings** tab filters the **System Log** to only show the **Warnings** that have occurred. Each line in the list details:

- the **Warnings** cause.
- the phase in which it occurred.
- the date and time that it occurred and also at which it was cleared.

The last entry in the line will remain blank if the **Warning** is still active.

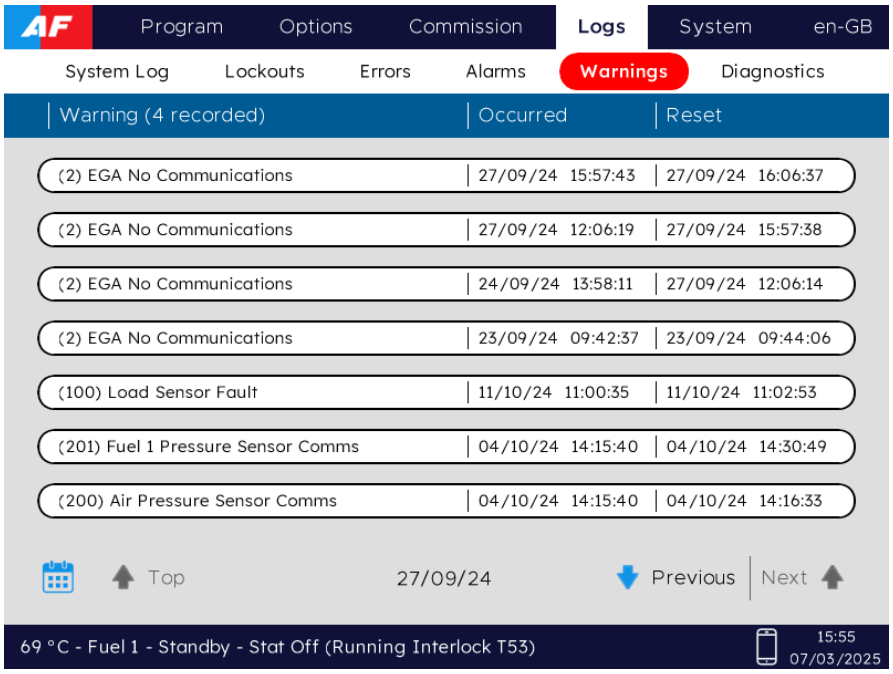


Figure 109 – Warnings Log

11.2.5.6 Diagnostics

Logs/Diagnostics gives access to details of how the controller is functioning. A number of diagnostic groups are accessible as tabs on the **Blue Menu Bar** giving access to a range of logged functions as follows:

- **System**: Details performance data of the controller electronics.
- **Load PID**: Tracks how the PID changes over time during operation.
- **Trim**: Tracks the trim data to show why the controller made a particular trim change.
- **Display**: Diagnose issues with the display interface.

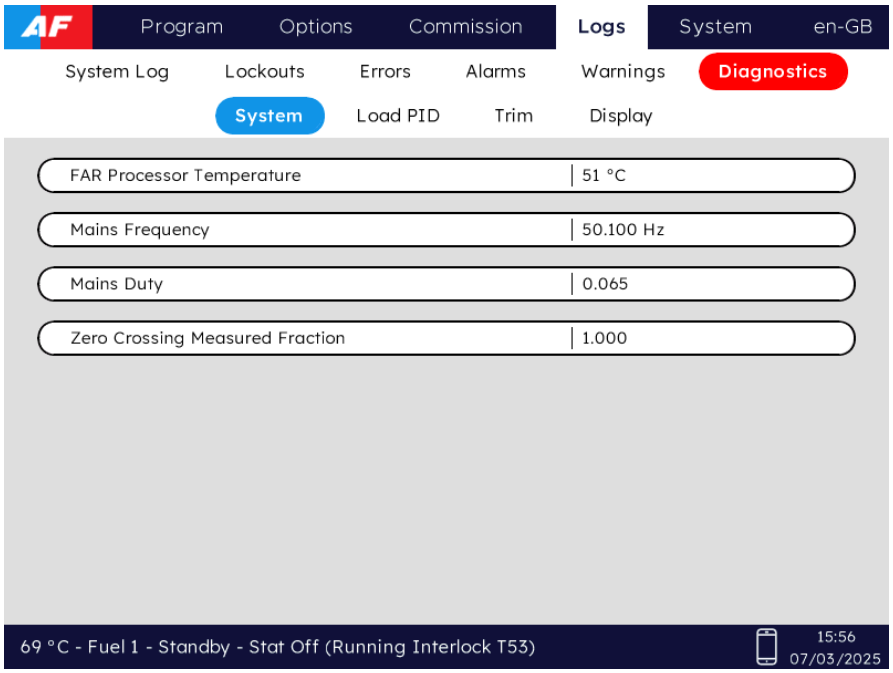


Figure 110 - Diagnostics List

Selecting an item from the list brings up a diagnostics graph which shows that value against time. Pinch to zoom may be used to change the scale or timeline of the graph to aid in diagnosing an issue.

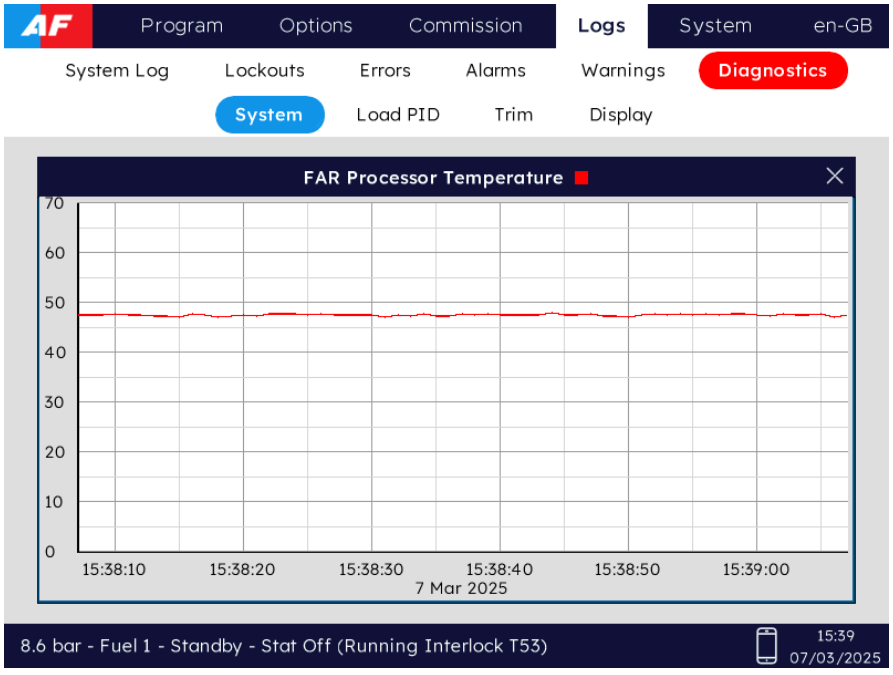


Figure 111 - Diagnostics Graph

11.2.6 System

Selecting the **System** tab on the **Main Menu Bar** accesses six options on the **Red Menu Bar**, namely **Set Clock**, **Manual**, **WiFi**, **Backup & Restore**, **Support** and **About**.

11.2.6.1 Set Clock

Set Clock screen allows the time and date to be set by the user with changes made using the & arrows. They will each be updated on pressing the **Set Date** and **Set Time** buttons. The setting of the Clock is protected behind a password. This password is permanently set to '**1010**', in line with the Clock Password from the Mk8 devices. This allows the clock to be changed at daylight saving transitions by boiler room staff who would not have the **Commission** or **On-Line Changes** passwords.

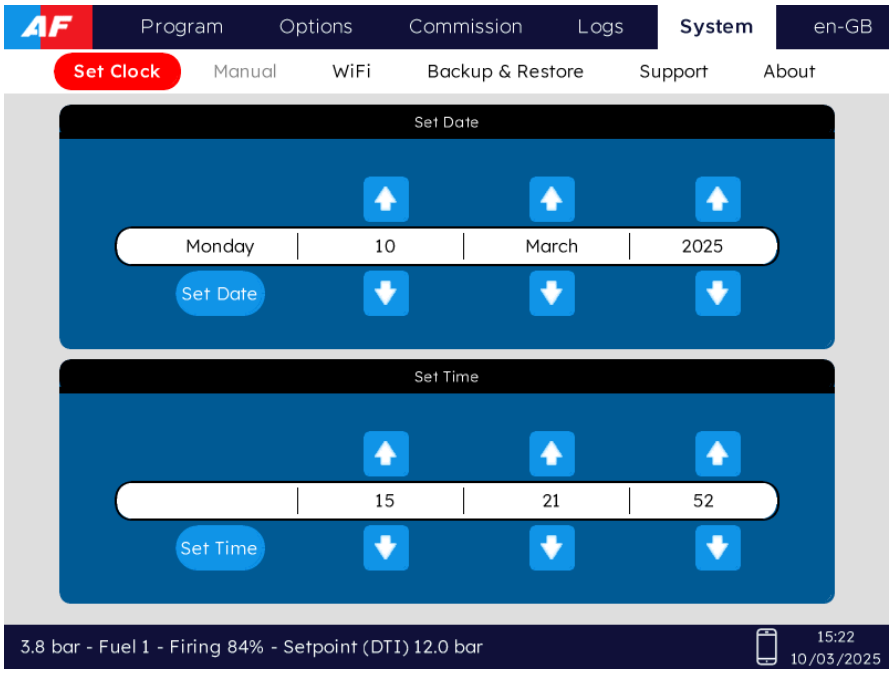


Figure 112 - Time And Date Setting

Alternatively the time may be set from the **Download Manager App**. Select **System**/**WiFi** and enter the **Commission Password** to enter the upload screen. When in this screen, open the **Download Manager App** and select Upload Date Time from the menu options. The current Date & Time as defined on your device running the App is displayed. Select Find Network and connect to the Mini Mk9 using the displayed WiFi name. Then select Upload date Time to push the mobile devices time to the Mini Mk9.

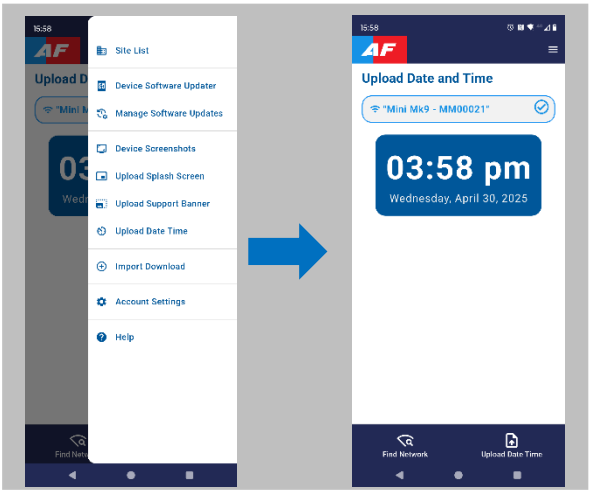


Figure 113 - Upload Date & Time

The MM contains a backup battery which maintains the **Time** and **Date** during power outages.

11.2.6.2 Manual

This manual is embedded in the Mini Mk9 for quick reference and can be browsed by selecting **System**/**Manual** which brings up the Manuals contents page as shown below.

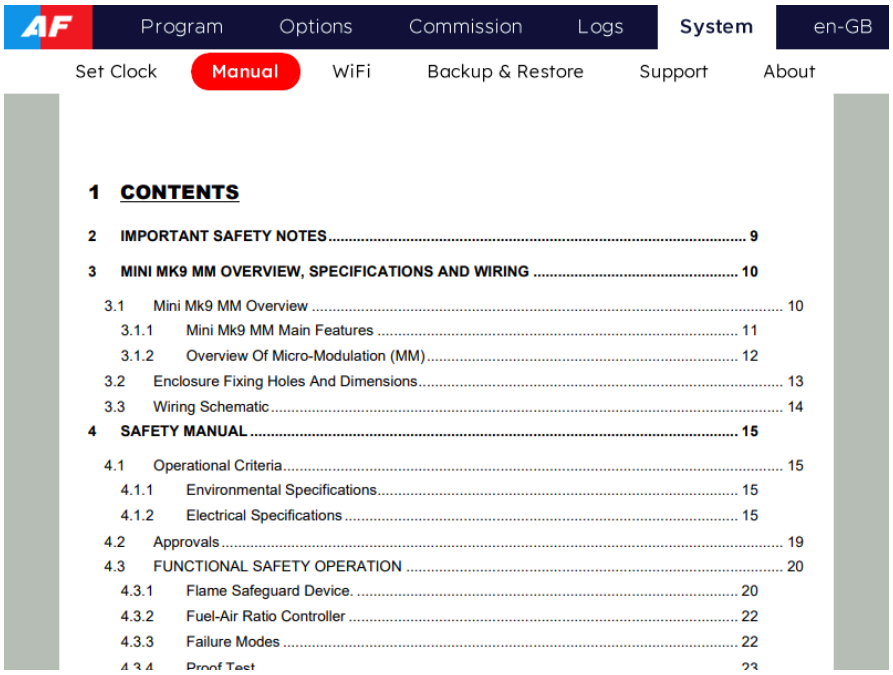


Figure 114 - Manual Contents Page

You can step through pages in the manual by pressing the grey section on the right hand side to go forward a page and on the left hand side to go back a page.

Selecting a line in the contents, opens that particular page in the manual. The selection is highlighted and then the page opens.

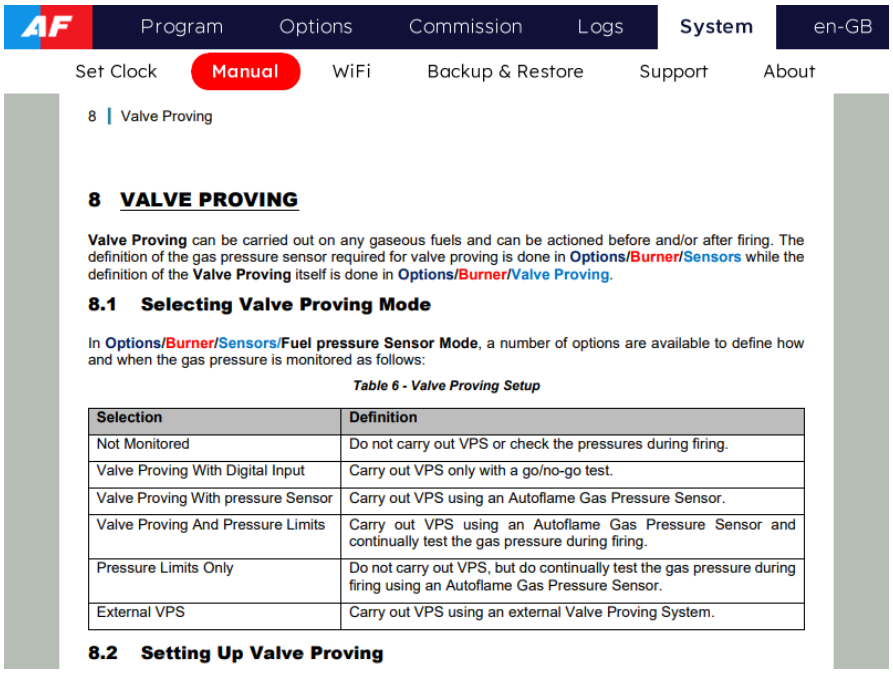


Figure 115 - Manual Page Open

To get back to the contents at the top of the manual touch the **Manual** button again.

11.2.6.3 WiFi

The built-in **WiFi** allows the Mini Mk9 to connect with a phone or tablet running the **Autoflame Download Manger App** in order to carry out a range of functions detailed below. The App runs on IOS or Android devices. Contact Autoflame for details on obtaining the App.

The operation of the **WiFi** may be set to the following states in **Options**/**Controller**/**Network**/**WIFI Operation**:

Table 9 - WiFi Settings

Setting	State	Functionality
Always On	The Mini Mk9 WiFi is discoverable.	All WiFi functions are operational.
Off Until Needed	The Mini Mk9 WiFi is normally off. It will switch on and become discoverable when any of the System/WiFi screens are accessed.	A link may be established while in one of the WiFi screens. This is then maintained if you navigate to any other screen allowing the screen shot and download functions to be used. Once disconnected, the WiFi will switch off if not in a WiFi screen.
Always Off	The Mini Mk9 WiFi is permanently off.	None of the App functions may be used.

If required, the **WiFi** could be turned to one of the '**On**' options for a short while, whilst uploading settings or updating the software and then reverted back to **Always Off** once completed.

When the **WiFi** is active, but no device is connected the transmitting sign  is shown in the bottom right corner of the display. This changes to a phone symbol  when a connection has been established. Seeing this symbol on the Mini Mk9 confirms which unit you are connected to.

11.2.6.3.1 Upload

An **Upload** has the ability to change the selected options and the combustion curve of the unit, so this function is protected behind the **Commissioning Password**. Selecting **System**/**WiFi**, brings up the **Commissioning Password** screen and enters the **Upload** screen once the password has been successfully entered.

If the unit is not in **Standby Mode**, a **Not Ready For Commission Mode** pop-up will be shown and access will be refused.

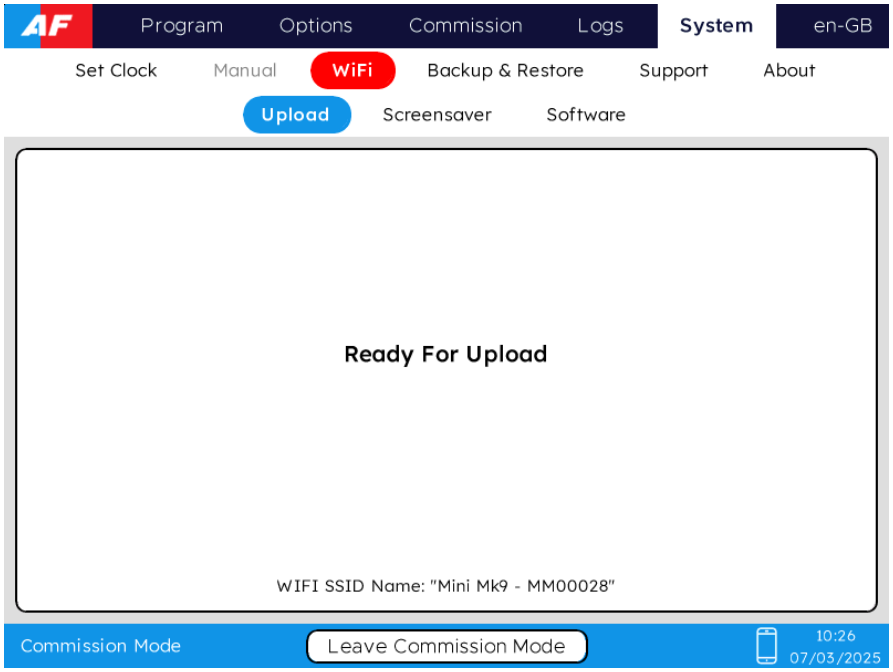


Figure 116 - Upload Screen

Once in the Upload Screen, open the **Autoflame Download Manager App** to push the Upload to the unit as follows:

1. Navigate to the **Site List**.
2. Select the required **Site** from the list.
3. Select the **Download** that you wish to **Upload** from those available in the **Site List**.
4. Select 

to access the **Upload to Device** screen.
5. Select 

to enter the **WiFi** connection list. Select the **SSID** of the Mini Mk9 – this should be in the form of Mini Mk9 *****, where ***** is the device serial number. This can be changed in ***Options/Controller/Comms/WIFI SSID Name***. If you have more than one Mini Mk9 in the boiler room ensure that you are connected to the correct mini and that all mini's have unique SSID names. There will be a tick in the WiFi connection box 

to indicate connected.
6. Close the screen to return to the **Upload to Device** screen.
7. Select 

to complete the link to the Mini Mk9. 

is ticked when ready.
8. The Data bars show the items that will be uploaded. Change the slider between selected ( ) to deselected( ) in order to choose which items to upload.
9. Select 

to push the **Upload** to the Mini Mk9.

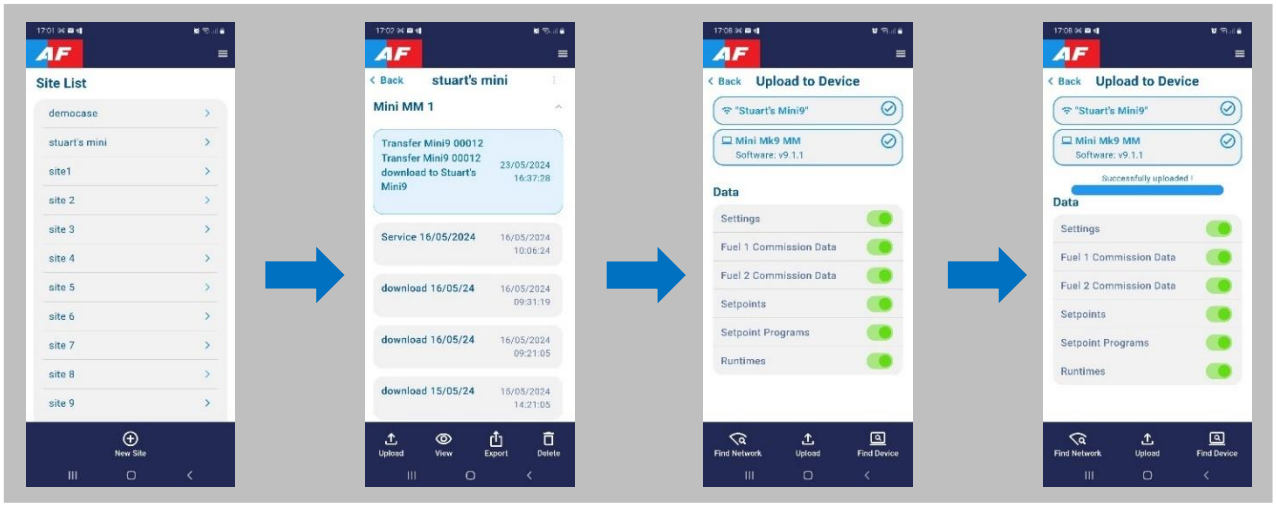


Figure 117 - Uploading To A Mini Mk9

The Mini Mk9 will briefly display **Upload Successful** once complete before power cycling to restart the unit with the new settings.

Note: To upload settings from one Mini Mk9 to another without using the App, a copy of the SD card may be taken and placed in the new Mini Mk9. Then **Restore From SD Card** to the main **NAND Flash** in the **System/Backup & Restore** screen as described in section 7.6.9 to Upload these settings.

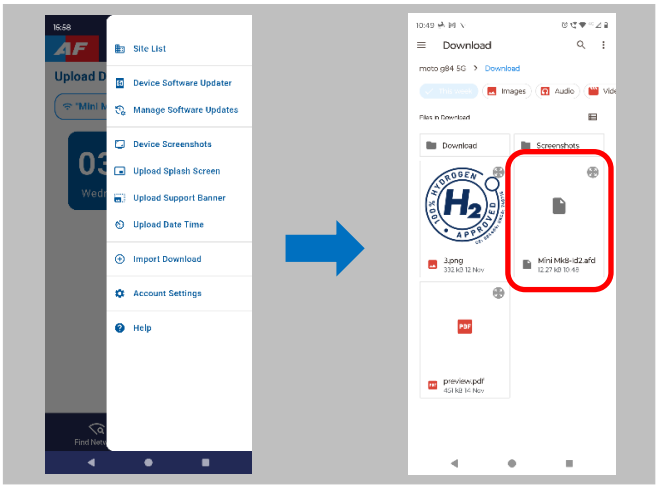


Figure 118 - Import Download

If upgrading from a Mini Mk8, the settings and commission curve may be transferred across. In the App menu reached by selecting the ☰ button, **Import Download** may be selected. A Mini Mk8 Download, saved to the device on which the App is running may be selected. In then appears in the download list and may be uploaded to the Mini Mk9 as described above.

11.2.6.3.2 Screensaver

Any picture, such as a company logo may be uploaded to the Mini Mk9 for use as the splash screen or screensaver using the **Download Manager** app. The screen is 800 x 600 pixels, so any picture of this size will completely fill the screen. Any image which is of different dimensions will leave some white boarders around the edge. On the Mini Mk9, select **System/WiFi** and enter the commission password. Then select **Screensaver** on the Blue Menu Bar to see a picture of the currently loaded screensaver.

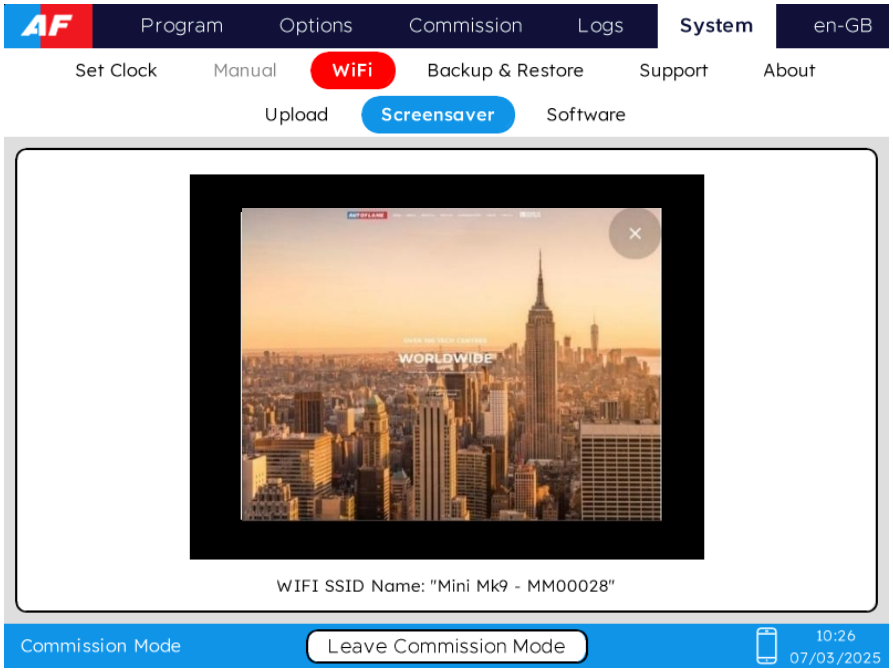


Figure 119 - Screensaver Update Screen

Open the **Download Manger App** and carry out the following procedure:

1. In any of the screens, select the ☰ menu button in the top right corner of the screen.
2. Select Upload Splash Screen
3. Press Select Splash Image and navigate on your device to the required image.
4. The 🔍 ——●—— 🔍 can be used to scale the image as required.
5. Press Find Network to select the Mini Mk9 SSID.
6. Press Upload Splash to push the new image to the device

Alternatively, select Reset Splash to set the splash screen back to the default setting.

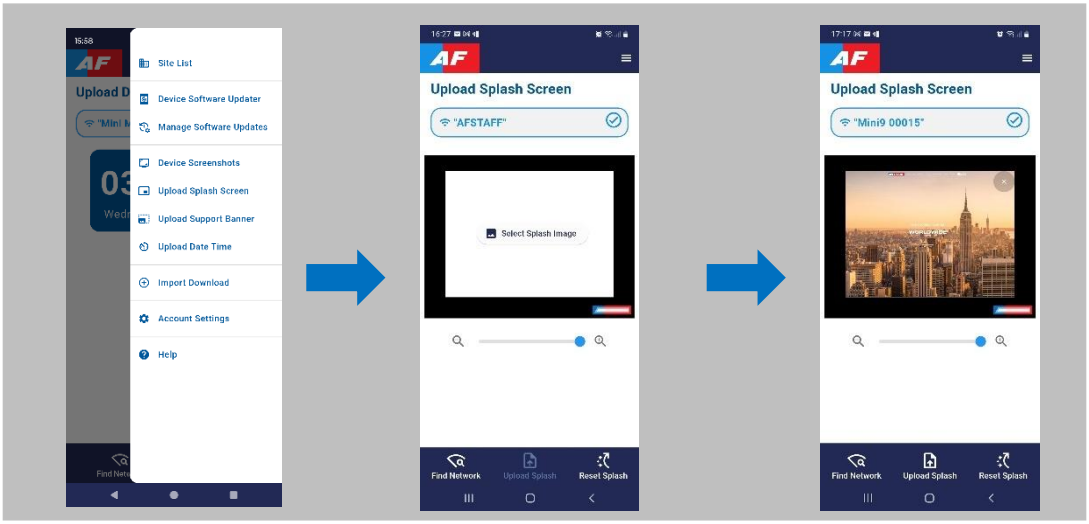


Figure 120 - Splash Screen Update

11.2.6.3.3 Software Update

Ensure the burner is not firing and the Mini is in standby mode, then select **System/WiFi** and enter the **Commission** password. Then select **Software** to place the Mini Mk9 into software update mode. The requirement for entering the **Commission** password ensures that only authorised and trained personnel can carry out a software update.

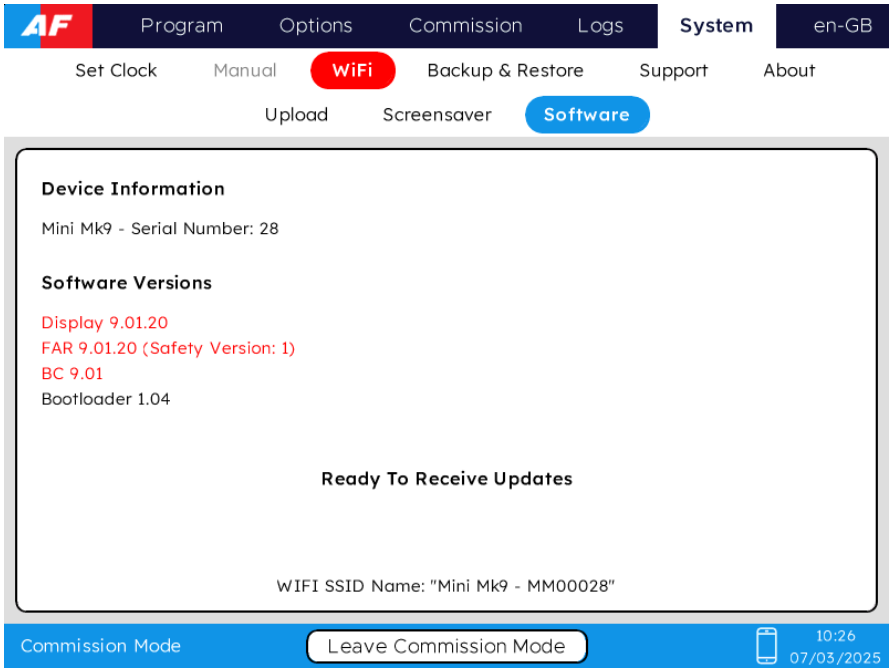


Figure 121 - Software Update Page

Once in the **Software** update screen, open the **Autoflame Download Manager App** on an IOS or Android phone/tablet to push the new software to the device as follows:

1. In any of the screens, select the menu button in the top right corner of the screen.
2. Select the **Manage Software Updates** tab.
3. With an internet connection on your mobile device, select **Check Cloud** to see if new software is available.
4. Any new software will be shown. Select Download update file to pull the latest software to the phone/tablet.

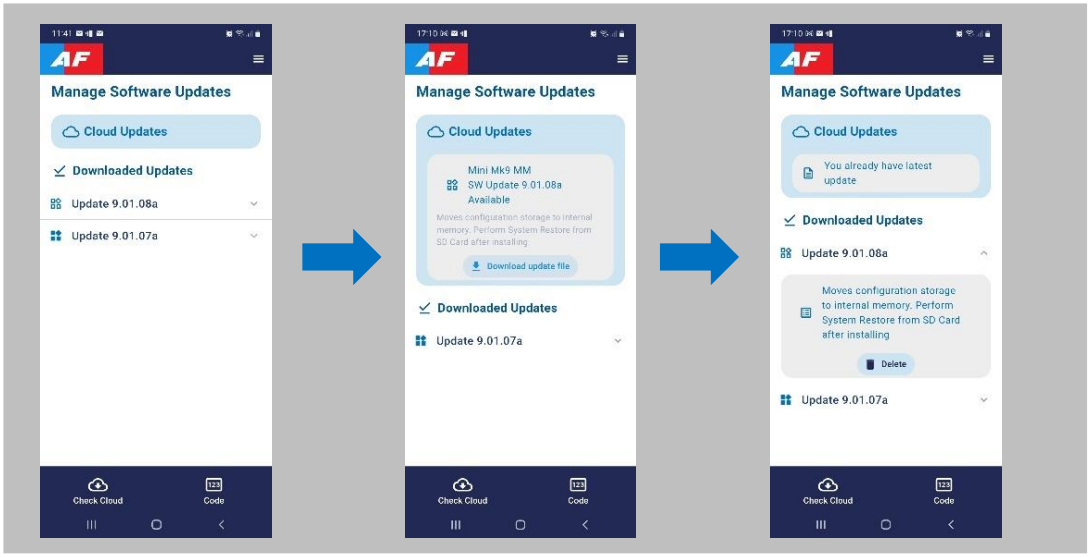


Figure 122 – Check for New Software

Once you have the latest available software on your device, transfer it to the Mini Mk9 as follows:

1. Select the **Device Software Updater** page.
2. Select Find Network to bring up the list of possible WiFi connections. Select the **SSID** of the Mini Mk9 – this should be in the form of Mini Mk9 *****, where ***** is the device serial number. This can be changed in **Options/Controller/Comms/WIFI SSID Name**. If you have more than one Mini Mk9 in the boiler room ensure that you are connected to the correct mini and that all mini's have unique SSID names.
3. Return to the **Upload to Device** screen.
4. Select Find Device to complete the link to the Mini Mk9.
5. Select Upload to push the push the new software to the Mini Mk9. An Upload Complete message will appear when done.



Figure 123 - Pushing New Software From The App

Selecting **Upload** on the app initiates the transfer of the new software to the device and the progress can be seen on the Mini Mk9 **Updater** screen. It will go through Receiving, Unpacking, Checking and Installing phases before restarting with the new software in place.

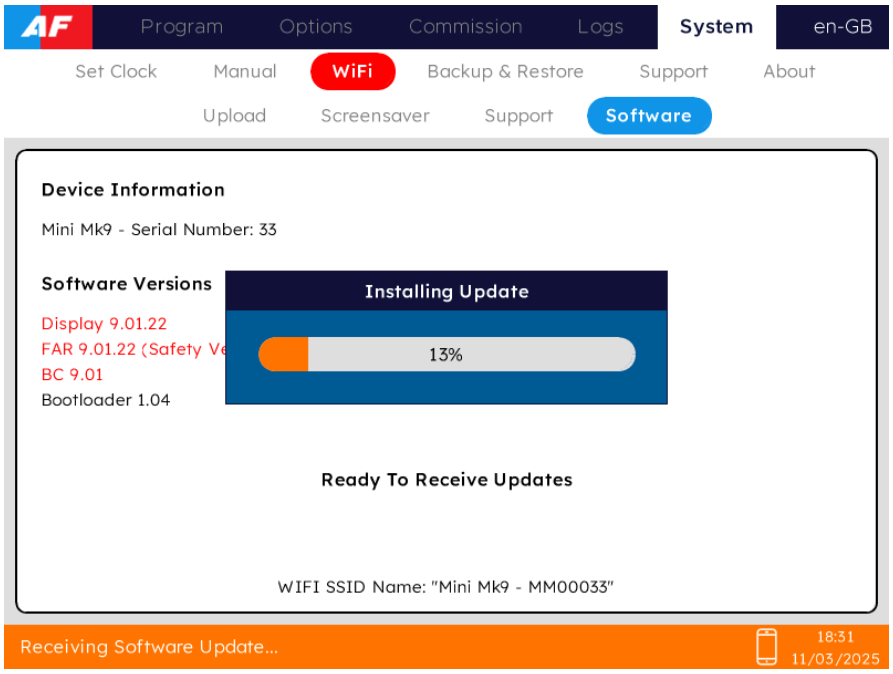


Figure 124 - Software Update Progress

Alternatively, the Software update may be carried out by from SD card, by obtaining the Software Update files from Autoflame, placing them on a blank micro SD card and carrying out the following steps:

1. Power down the Mini Mk9
2. Place the SD card in the SC card holder.
3. Power on the Mini Mk9
4. Wait for the White and Yellow loading bars to complete and the screen to go entirely green
5. Replace the original SD card back into the SD card slot and power cycle the unit.
6. The software update will happen automatically.

11.2.6.4 Backup & Restore

Copying the **Commission Data**, **Options** settings and **Logs** from the internal **NAND Flash** to the **SD Card**, or **Restoring** a backup from the **SD card** to the main **NAND Flash** is done in the **System/Backup & Restore** screen and is described in section 7.6.9.

This also give access to the **Decommission** function, which will wipe the unit of all data, carrying out a factory reset.

Note: Decommission erases all settings and commission data from the unit's internal memory. Only **Decommission** a unit if you intend to reset it to its factory settings.

Note: If a **Backup To SD Card** has been completed, then this is not erased in a **Decommission**, and may be used to restore the settings. It is advised to always carry out a **Backup To SD Card** if settings or commissioning data are changed.

11.2.6.5 Support

Register your Mini Mk9 by scanning the QR code on the **System**/**Support**/**Warranty** page and following the instructions on the link. Registering unlocks an extended warranty for the device.



Figure 125 - Register Device

Note: The **Warranty** option disappears once the unit has been registered.

The Autoflame support emails and phone numbers are to be found by selecting **System**/**Support**/**Autoflame.**

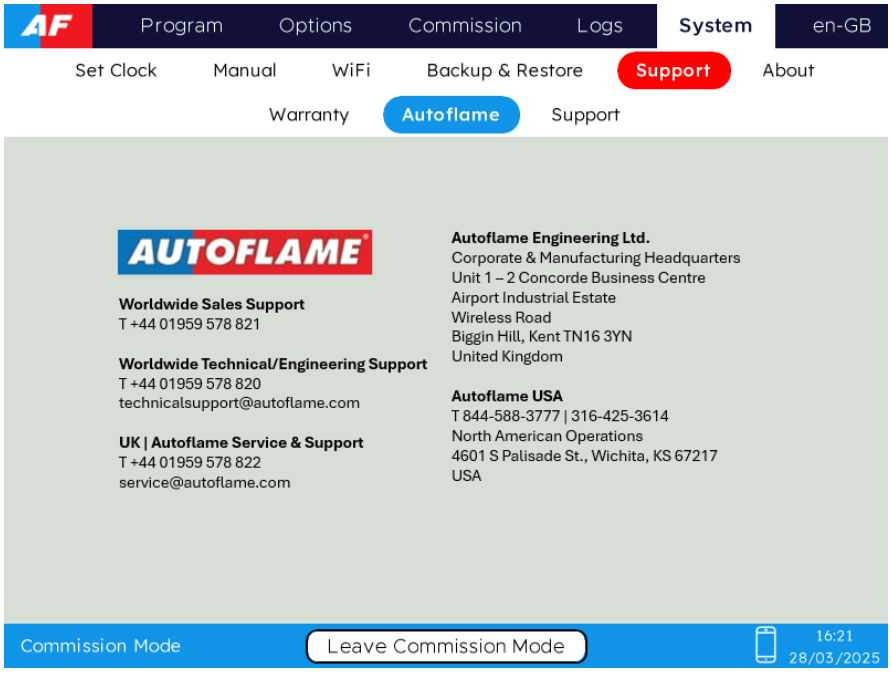


Figure 126 - Autoflame Support Details

Tech Centres or OEMs may upload their own support details to a Mini Mk9 as follows.

The Support image can be set on the Download Licence Manager, which then allows the same image to be available on all Download Managers App devices licenced through that portal. By navigating to **System**/**WiFi**/**Support** on the Mini Mk9 and selecting Upload Support Banner from the menu on the Download Manager App, the Support image may be pushed to a device.

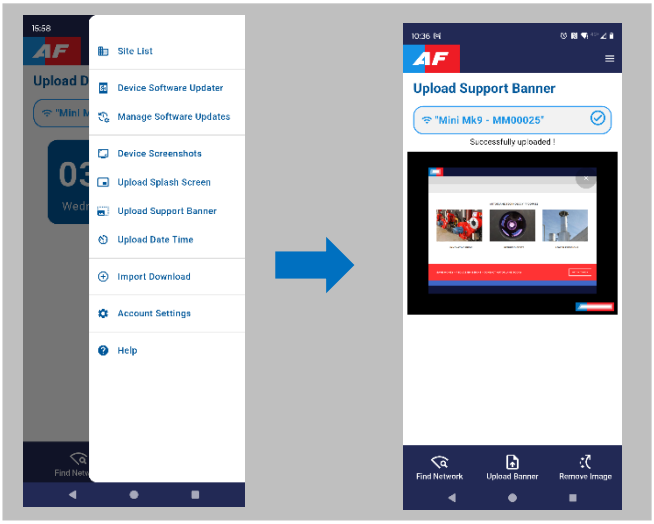


Figure 127 - Uploading Support Banner

Once uploaded, the Support details are accesses under **System/Support/Support**.

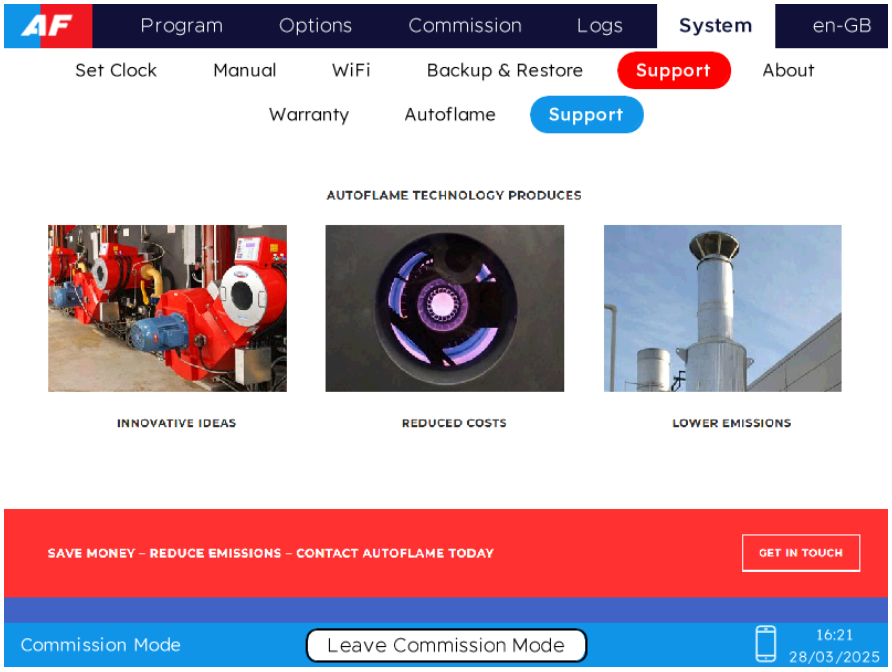


Figure 128 - User Defined Support Page

11.2.6.6 About

The **About** screen displays the currently loaded software versions.

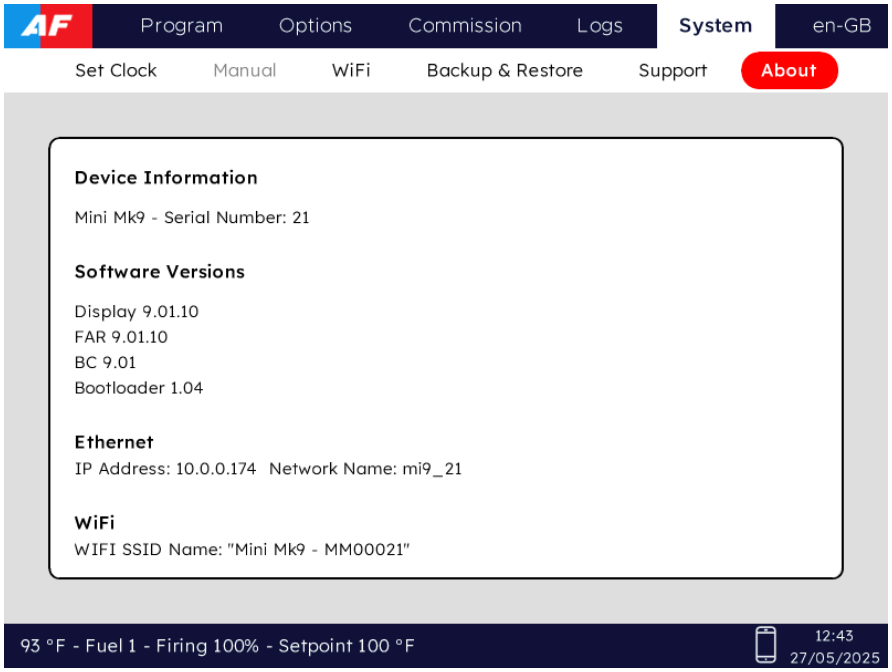


Figure 129 - Software Versions

11.2.7 Language

The currently selected language is displayed in the top-right corner of the **Main Menu Bar**. Selecting this brings up a list of available languages for selection. If your desired language is not available, or there are improvements which can be made to the installed languages, please contact Autoflame directly.

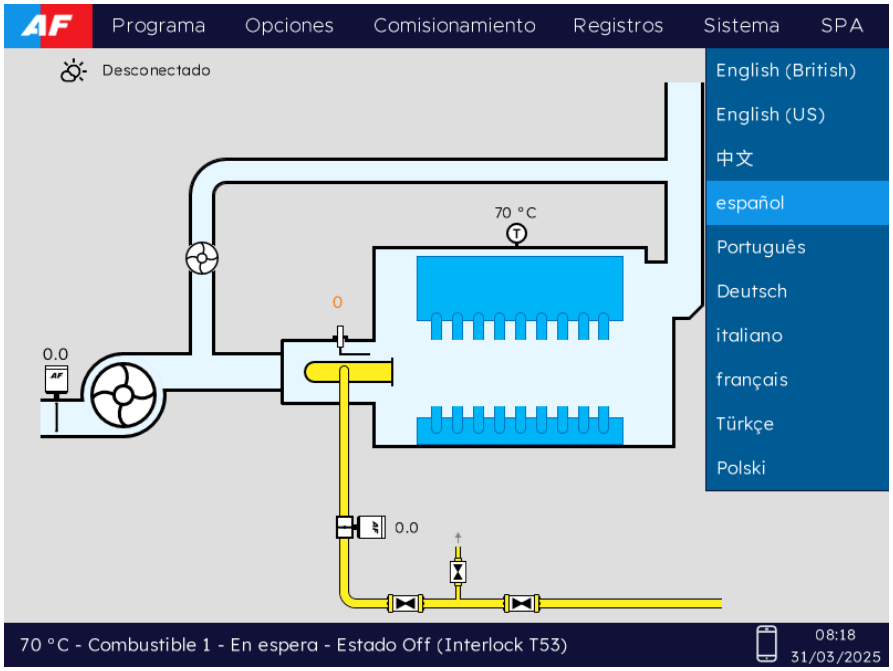


Figure 130 - Language Selection

11.3 Download Manager App

In addition to the **Upload**, **Screensaver** and **Software Update** functions described in section 11.2.6.3 which require interaction with the Mini Mk9 WiFi screen, the **Download Manager App** has the following functions which both require the **Options**/**Controller**/**Network**/**WIFI Operation** to be set to **Always On**. Neither of these functions interfere with the operation of the Mini Mk9, so they can be done at any time, even while firing and do not require the entering of a password on the Mini.

11.3.1 Download

A download may be taken from any screen using the **App** as downloads do not interfere with the operation of the unit. The Mini Mk9 carries out **Download** of **Options**, **Commissioning Data** and **Logs** over a WiFi connection using a connected **Download Manager App** by carrying out the following steps:

1. Navigate to the **Site List**.
2. Select the **Site** if it's already in the list or select New Site to add a **New Site**.
3. Select Download to enter the **New Download** page.
4. Fill in the details including a name for the download.
5. If System Logs and/or Long Term Logs are required, activate the sliders and select dates for downloading the data.
6. Select Connect to choose the SSID of the Mini Mk9 from the WiFi list.
7. Select Download to take the Download of the data. The app briefly flashes up Completed to confirm success.

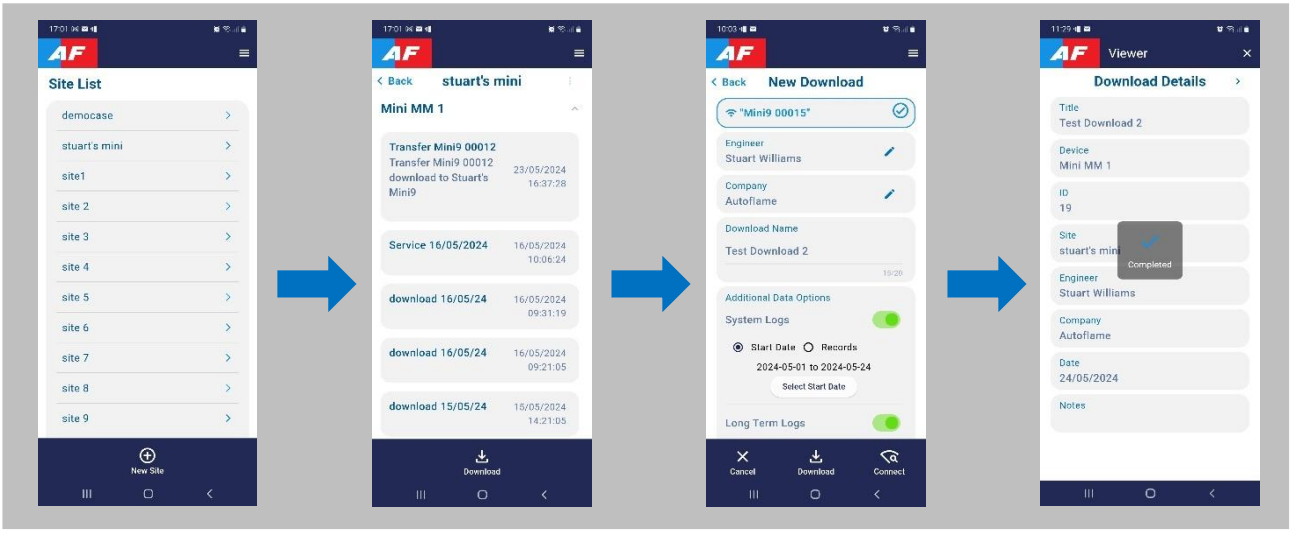


Figure 131 - Taking A Download

11.3.2 Screenshot

In order to take a screenshot using the App, **Options**/**Controller**/**Network**/**WIFI Operation** must be set to **Always On**. A screenshot of the active screen may then be taken at any time as follows in the app:

1. Navigate to Device Screenshots
2. Select Find Network to choose the SSID of the Mini Mk9 from the WiFi list.
3. Close down the WiFi selection page once connected.
4. Press Screenshot to take a Screenshot. After a few seconds the screen image will appear. This can then be saved to file or shared over email using the Share button.

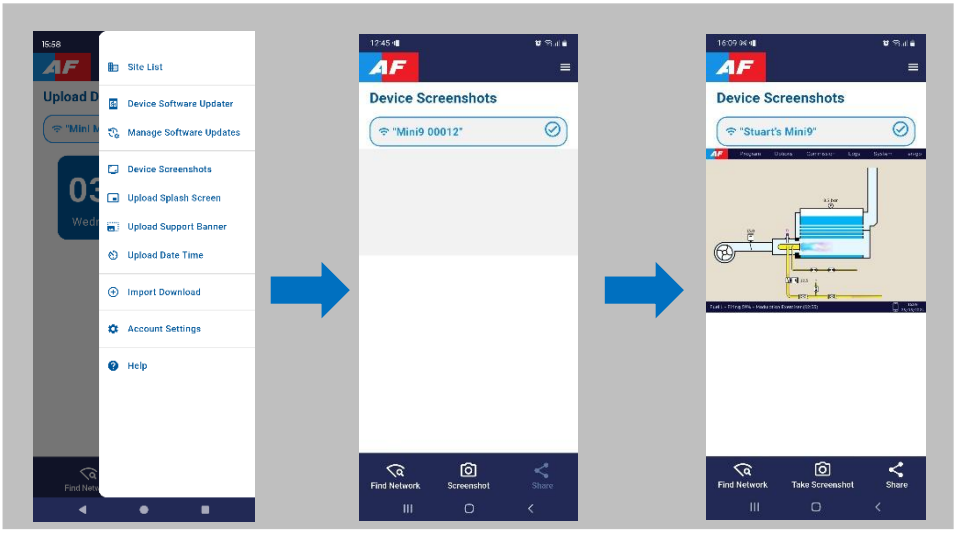


Figure 132 - Taking a Screenshot

12 FLAME SAFEGUARD OPERATION

A **Mini Mk9** may be purchased as a locked **Flame Safeguard Only** device under the code **MMM9002/FSG**.

Alternatively, a standard **Mini Mk9** (**MMM9002**) may be set into **Flame Safeguard** mode by setting **Options**/**MM**/**Terminals**/**Flame Safeguard Mode** to **Enabled**.

This mode encompasses all the functions required for reliable **Flame Safeguard** management. Built into this system is a fully automated flame safeguard and valve proving system, **MODBUS**/**BACnet** connectivity, and a touchscreen interface. The Mini Mk9 **System Log** records the status of the unit, including lockouts with a date/time stamp.

This system monitors the **Flame Safeguard**, as it checks on the flame of the burner from the use of a UV, Ionisation, IR, UV Trim or Flame Switch Scanner.

In **Flame Safeguard** mode, the majority of the Mini Mk9s screens are greyed out and inaccessible (e.g. **Fuel-Air**). The Mini Mk9 will use the **Flame Safeguard** screen as the **Home Screen**.

The **Run Times** programs are still available, but can only switch the boiler ON/OFF. There is no REDUCED Setpoint mode.

If the Mini Mk9 has been purchased as a Flame Safeguard only unit, it may be unlocked to a full Mini Mk9 by purchasing an unlock code – please contact Autoflame Sales for details.

12.1 Flame Safeguard Mode Inputs

The three Burner Control Inputs **T80**, **T81** and **T82** must then be set to provide interlocks as follows:

Interlock	Setting
Start Position Interlock	Acts as a live input in response to a mechanical end stop. Allows an additional safety check on the valves and damper to ensure that they are in the correct position for start/low fire using end limit switch. Please check Autoflame Valves Guide for further details. When set up as an On/Off burner this is a live input after the completion of the purge sequence to initiate the start-up process.
Purge Position Interlock	Acts as a live input in response to a mechanical end stop. It must be made for the whole of the timed purge and post purge phases, otherwise a lockout is triggered. This input must not be made while not at purge. When set up as an On/Off burner this is a live input after a 5 second delay to run the burner start up purge sequence.
Valve Proving (Optional)	A low-pressure switch can be wired to the terminal for valve proving; see section 8 for Valve Proving options. Please refer to the Sensors Guide for further details.



Note: In the Mini Mk9 **T80**, **T81** and **T82** are configurable inputs. Any of the three inputs can be set to any of the three inputs defined in the table above. It is the Installation Engineers responsibility to ensure that the setting and the wiring match each other. The schematics in this Manual define **T80** as the **Start Position Interlock**, **T81** as the **Purge Position Interlock** and **T82** as the **Valve Proving Input**.

12.2 Flame Safeguard Control Schematics

The following schematic shows the wiring of the Mini Mk9 and Relay box to a single servo and pressure controller in Flame Safeguard Only mode.

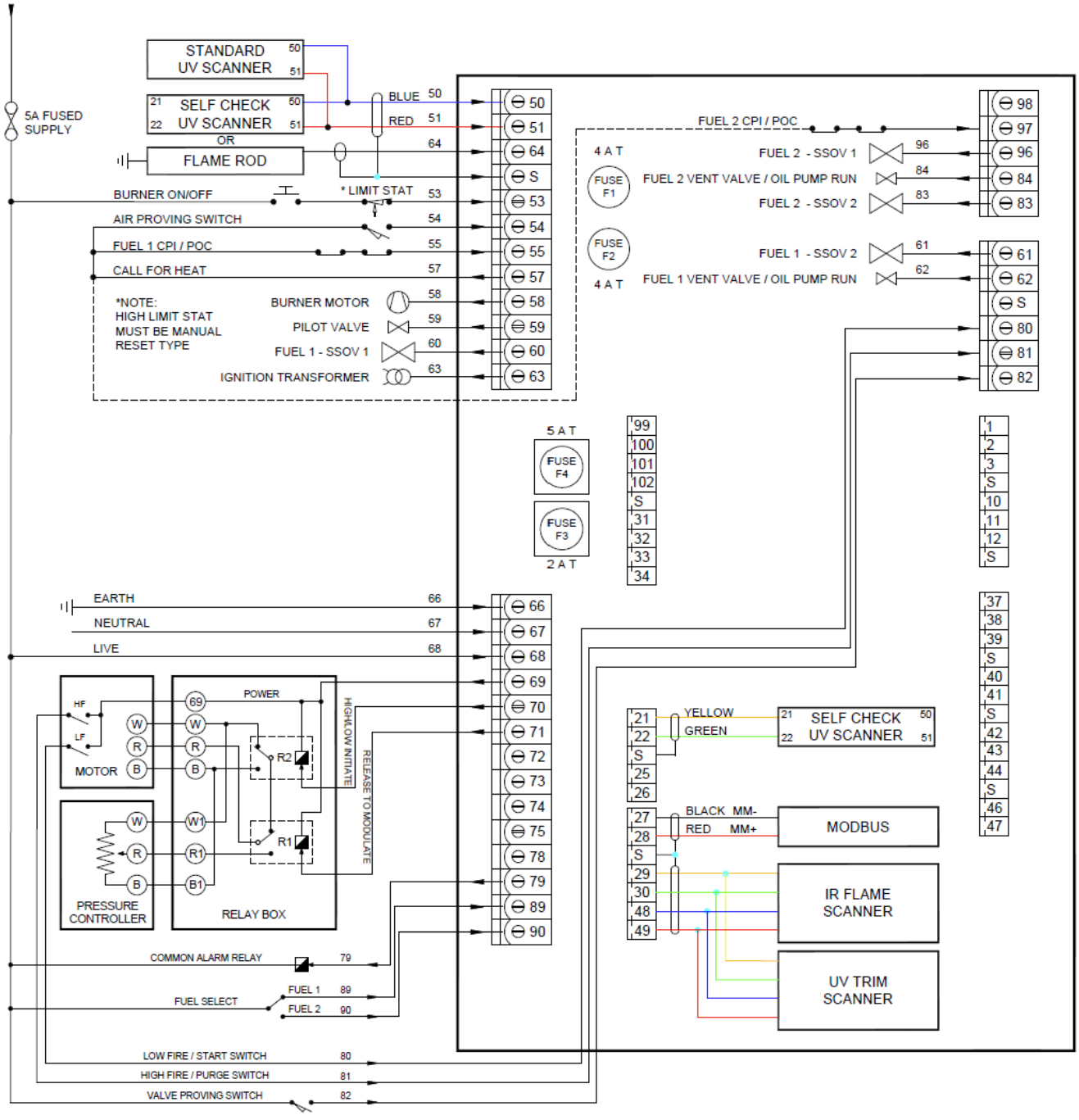


Figure 133 - Servo Motor Control Flame Safeguard Schematic

For use with an On/Off burner the schematic is simplified as follows:

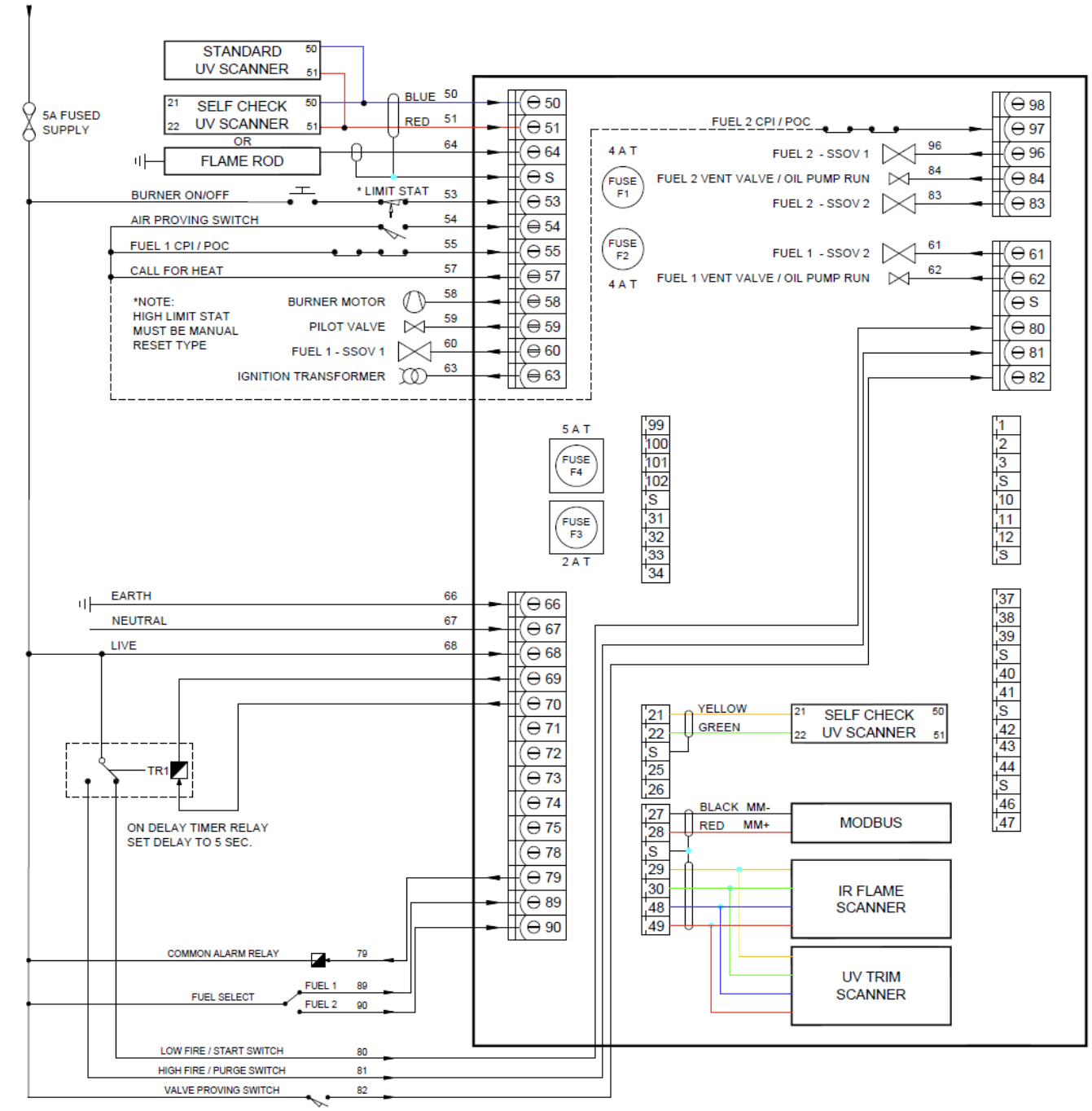


Figure 134 - On/Off Burner Flame Safeguard Schematic

Note: Care must be taken to follow the wiring diagrams and connect the **Flame Safeguard** and relays correctly. Ensure that the specified functions for **T80**, **T81** and **T82** are wired to the correct terminals.

Do Not wire a servo motor to any of the outputs when using **Flame Safeguard** mode

12.3 Relay Box

The **Relay Box** (SP80070, SP80070/110) provides all the connections shown in section 12.2 figure 133 for wiring between a servo motor with high and low limit switches and the **Flame Safeguard** controller. It also provides for the switchover of control to a load sensor allowing the burner to modulate once the flame has been established. The **Flame Safeguard** unit will continue to monitor the status of the flame and initiate a safety shutdown in the event of any issues.

PLEASE NOTE – There are two different versions of the flame safeguard relay adaptor (230V & 110V). The following part number used, for these voltages are SP80070 for 230V & SP80070/110 for 110V.

12.3.1 Relay Box Terminal Description

The Connections in the Relay Box are as follows:

Table 10 - Relay Box Connection

Terminal	Description
T69	Mains voltage output, power to Relay Box (SP80070, SP80070/110).
T70	Switched neutral – High/Low Initiate output.
T71	Switched neutral – Release to Modulate output.
B1	Connection to a controller (Common Voltage Input)
R1	Connection to a controller (Common Voltage Input)
W1	Connection to a controller (Common Voltage Input)
B	Connection to a motor (Common Voltage Input)
R	Connection to a motor (Common Voltage Input)
W	Connection to a motor (Common Voltage Input)
LOUT	Fused mains voltage output (F1) – for end switches to the motor (the common for T80 & T81)

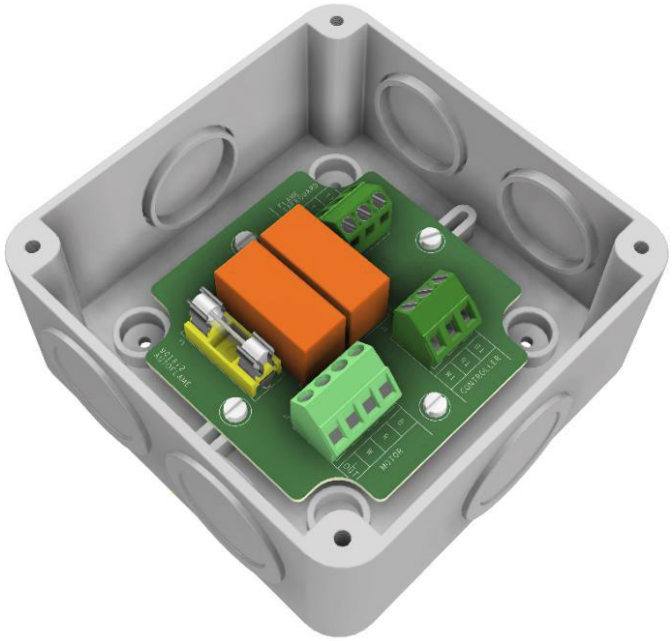


Figure 135 - Relay Box

The Relay Box (SP80070, SP80070/110) is available from Autoflame to provide all the correct connections for ease of installation. If using other relays, ensure that you conform to the wiring schematic provided.

12.4 Single Servo Burner Set Up

In order to drive the servo motor to the purge and start positions and to allow a load sensor to take over control once firing, the outputs and inputs used in **Flame Safeguard Mode** are as follows:

Outputs:

- T70 (Switched Neutral) is the High/Low Initiate output.
- T71 (Switched Neutral) is the Release to Modulate output.
    - When T71 is low, and T70 is High, the motor moves to Purge.
    - When T71 is Low and T70 is Low, the motor moves to Light Off.
    - When T71 is High, the Motor releases to Modulate via the external Pressure sensor.

Inputs:

- T80 **Start Position Interlock** is the Low/Fire Start Switch, which is made when the motor start position mechanical switch has been made.
- T81 **Purge Position Interlock** is the High Fire/Purge Switch, which is made when the motor purge position mechanical switch has been made.

The wiring is to be completed as shown in the schematic in Figure 133.

12.5 On/Off Burner Set Up

With a simple On/Off burner, the wiring is simplified to provide the following outputs and inputs:

Outputs:

- T70 (Switched Neutral) is the High/Low Initiate output. This starts a timer relay when high to initiate the purge sequence after a short delay and confirms the start position when it goes low.

Inputs:

- T80 **Start Position Interlock** is the Low/Fire Start Switch, which is made when the timer relay is driven low.
- T81 **Purge Position Interlock** is the High Fire/Purge Switch, which is made after a delay of 5 seconds when the timer relay is driven high.

The wiring is to be completed as shown in the schematic in Figure 134. A simple ON-delay timer relay such as Allen-Bradley 700-FEA6TU23 or 700-FEM6TU23 set in mode (A) with a 5 second delay is required.

12.6 Converting a Flame Safeguard unit to an Autoflame Flame Safeguard

The tables below list the connections on other flame safeguard devices and the corresponding Autoflame terminal to be used in an upgrade.

12.6.1 Converting Honeywell Flame Safeguard Units

12.6.1.1 EC7810A

Honeywell Terminal # (EC7810A)	Abbreviation	Autoflame Terminal #	Type	Description
G	-	-[1]	Input	FLAME SENSOR GROUND
Earth G	-	66	Input	EARTH GROUND
N	-	67	Input	LINE VOLTAGE COMMON (NEUTRAL)
3	L1	68	Input	LINE VOLTAGE SUPPLY (L1)
4	AL	79[2]	Output	ALARM (NORMALLY OPEN)
6	RT	53	Input	LIMITS AND BURNER CONTROL
8	PV1	59	Output	PILOT VALVE 1 (INTERRUPTED)
9	MV	60,61[3]	Output	MAIN FUEL VALVE
10	IGN	63	Output	IGNITION
F (11)	-	-[1]	Input	FLAME SIGNAL
-	HI	B/B1[4]	Output	FIRING RATE HIGH FIRE
13	COM	R[4]	Output	FIRING RATE COMMON
14	MOD	R1[4]	Output	FIRING RATE MODULATE

-	LO	W/W1[4]	Output	FIRING RATE LOW FIRE
16	-	57	Output	CONTROL VOLTAGE
17	ES2	55	Input	PREIGNITION INTERLOCK INPUT
18	ES1	80	Input	LOW FIRE SWITCH INPUT
-	ES3	81	Input	HIGH FIRE SWITCH INPUT
20	LOS	53	Input	LOCKOUT INPUT
21	PV2	59	Output	PILOT VALVE 2 (INTERMITTENT)
22	SHTR	-[1]	Output	SHUTTER

12.6.1.2 EC7829A

Honeywell Terminal # (EC7820A)	Abbreviation	Autoflame Terminal #	Type	Description
G	-	-[1]	Input	FLAME SENSOR GROUND
Earth G	-	66	Input	EARTH GROUND
N	-	67	Input	LINE VOLTAGE COMMON (NEUTRAL)
3	AL	792	Output	ALARM (NORMALLY OPEN)
4	FAN	58	Output	BURNER/BLOWER MOTOR
6	RT	53	Input	LIMITS AND BURNER CONTROL
7	LD2	54	Input	AIRFLOW SWITCH INPUT
8	PV1	59	Output	PILOT VALVE 1 (INTERRUPTED)
9	MV	60, 61[3]	Output	MAIN FUEL VALVE
10	IGN	63	Output	IGNITION
F (11)	-	-[1]	Input	FLAME SIGNAL
-	HI	B/B1[4]	Output	FIRING RATE HIGH FIRE
13	COM	R[4]	Output	FIRING RATE COMMON
14	MOD	R1[4]	Output	FIRING RATE MODULATE
-	LO	W/W1[4]	Output	FIRING RATE LOW FIRE
16	-	57	Output	CONTROL VOLTAGE
17	ES2	55	Input	PREIGNITION INTERLOCK INPUT
18	ES1	80	Input	LOW FIRE SWITCH INPUT
-	ES3	81	Input	HIGH FIRE SWITH INPUT
20	LOS	53	Input	LOCKOUT INPUT
21	PV2	59	Output	PILOT VALVE 2 (INTERMITTENT)
22	SHTR	-[1]	Output	SHUTTER

12.6.1.3 EC850A

Honeywell Terminal # (EC7850A)	Abbreviation	Autoflame Terminal #	Type	Description
G	-	-[1]	Input	FLAME SENSOR GROUND
Earth G	-	66	Input	EARTH GROUND
N	-	67	Input	LINE VOLTAGE COMMON (NEUTRAL)
3	AL	79[2]	Output	ALARM (NORMALLY OPEN)
4	L1	68	Input	LINE VOLTAGE SUPPLY (L1)
5	FAN	58	Output	BURNER/BLOWER MOTOR
6	RT	53	Input	LIMITS AND BURNER CONTROL
7	LD2	54	Input	AIRFLOW SWITCH INPUT
8	PV1	59	Output	PILOT VALVE 1 (INTERRUPTED)
9	MV	60, 61[3]	Output	MAIN FUEL VALVE
10	IGN	63	Output	IGNITION
F (11)	-	-[1]	Input	FLAME SIGNAL
12	HI	B/B1[4]	Output	FIRING RATE HIGH FIRE
13	COM	R[4]	Output	FIRING RATE COMMON
14	MOD	R1[4]	Output	FIRING RATE MODULATE
15	LO	W/W1[4]	Output	FIRING RATE LOW FIRE
16	-	57	Output	CONTROL VOLTAGE
17	ES2	55	Input	PREIGNITION INTERLOCK INPUT
18	ES1	80	Input	LOW FIRE SWITCH INPUT
19	ES3	81	Input	HIGH FIRE SWITCH INPUT

20	LOS	53	Input	LOCKOUT INPUT
21	PV2	59	Output	PILOT VALVE 2 (INTERMITTENT)
22	SHTR	-[1]	Output	SHUTTER

Notes

1: Any flame sensing device will need to be replaced with an Autoflame sensor. For more details, please see the Autoflame Flame scanner guide.

2: Switched neutral output should be connected to neutral side of relay coil.

3: Terminal 60 = Main Fuel Valve 1, Terminal 61 = Main Fuel Valve 2. On Autoflame FSG.

4: The connections shown assume the use of an Autoflame relay box. Please consult the wiring diagram, if alternative relays are used.

12.6.2 Converting Fireye Flame Safeguard Units

12.6.2.1 Fireye E110:

Fireye Terminal # (E110)	Autoflame FSG Terminal #	Type	Description
L1	68	Input	HOT – 120 VAC
L2	67	Input	GROUND – NEUTRAL
-	66	Input	EARTH GROUND
S1	-[1]	Input	SCANNER (+)
S2	-[1]	Input	SCANNER (-)
3	55	Output	PRE-IGNITION INTERLOCKS (FUEL VALVE END SWITCH)
M	58	Output	BLOWER MOTOR
D	80	Input	LOW FIRE START INTERLOCK
P	54	Input	RUNNING INTERLOCKS (AIR FLOW SWITCH)
5[2]	63	Output	5 SEC EARLY SPARK TERMINATION
6[2]	59	Output	10 SEC INTERUPTED PILOT
7	60, 61[3]	Output	MAIN FUEL VALVE
8	81	Input	OPEN DAMPER PURGE INTERLOCK
A	79[4]	Output	ALARM
X	B/B1[5]	Output	MODULATION HIGH FIRE
10	R[5]	Output	MODULATION COMMON
11	R1[5]	Output	AUTO MODULATION
12	W/W1[5]	Output	MODULATION LOW FIRE
13	53	Input	OPERATING CONTROL INTERLOCK

12.6.2.2 Fireye Burnerlogix:

Fireye Terminal # (E110)	Autoflame FSG Terminal #	Type	Description
L1	68	Input	HOT – 120 VAC
L2	67	Input	GROUND – NEUTRAL
-	66	Input	EARTH GROUND
S1	-[1]	Input	SCANNER (+)
S2	-[1]	Input	SCANNER (-)
3	55	Output	PRE-IGNITION INTERLOCKS (FUEL VALVE END SWITCH)
M	58	Output	BLOWER MOTOR
D	80	Input	LOW FIRE START INTERLOCK
P	54	Input	RUNNING INTERLOCKS (AIR FLOW SWITCH)
5[2]	63	Output	5 SEC EARLY SPARK TERMINATION
6[2]	59	Output	10 SEC INTERUPTED PILOT
7	60, 61[3]	Output	MAIN FUEL VALVE
8	81	Input	OPEN DAMPER PURGE INTERLOCK
A	79[4]	Output	ALARM
X	B/B1[5]	Output	MODULATION HIGH FIRE
10	R[5]	Output	MODULATION COMMON
11	R1[5]	Output	AUTO MODULATION
12	W/W1[5]	Output	MODULATION LOW FIRE
13	53	Input	OPERATING CONTROL INTERLOCK

Notes

1: Any flame sensing device will need to be replaced with an Autoflame sensor. For more details, please see the Autoflame Flame scanner guide.

2: The pilot configuration may vary for Terminals W, 5 & 6. Check which connects to the ignition transformer.

3: Terminal 60 = Main Fuel Valve 1, Terminal 61 = Main Fuel Valve 2. On Autoflame FSG.

4: Switched neutral output should be connected to neutral side of relay coil.

5: The connections shown assume the use of an Autoflame relay box. Please consult the wiring diagram, if alternative relays are used.

12.7 Unlocking Flame Safeguard Only Mode

An **MMM9002/FSG** unit locked in **Flame Safeguard** mode may have all the **Mini Mk9** features unlocked by purchasing an unlock code from Autoflame Sales. You will need to provide the serial number of the unit which you wish to unlock.

A QR code will be generated and sent to you. Scanning this code opens the **AF Download Manager** app on the **Upload Unlock Codes** page, with the new code displayed. Previous **Unlock Codes** sent to you remain listed if you select the serial Number drop down list.

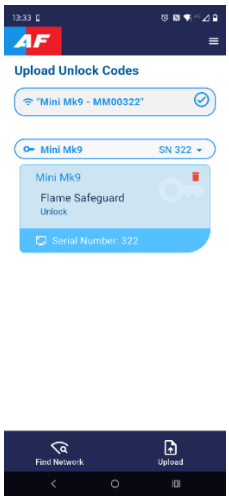
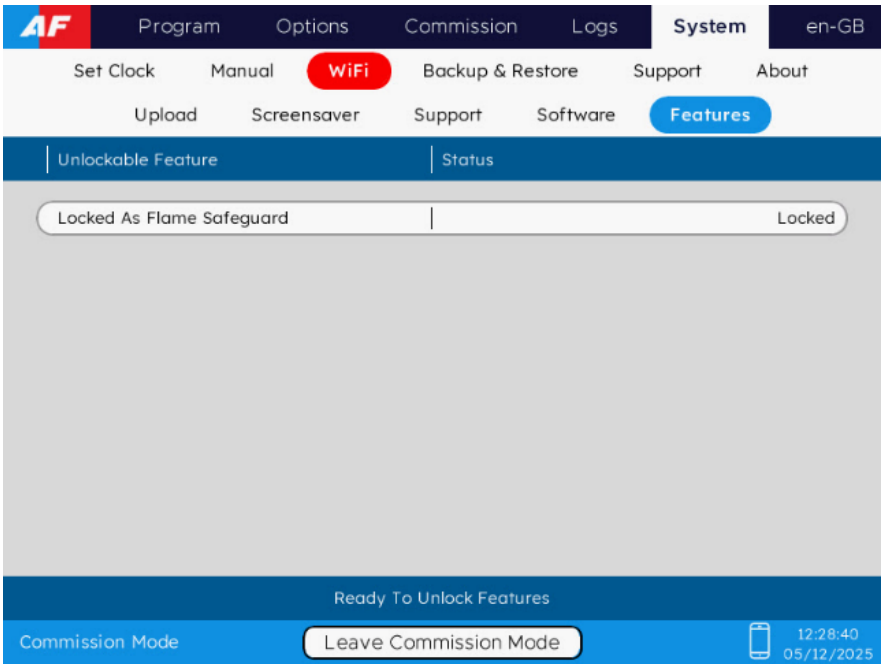


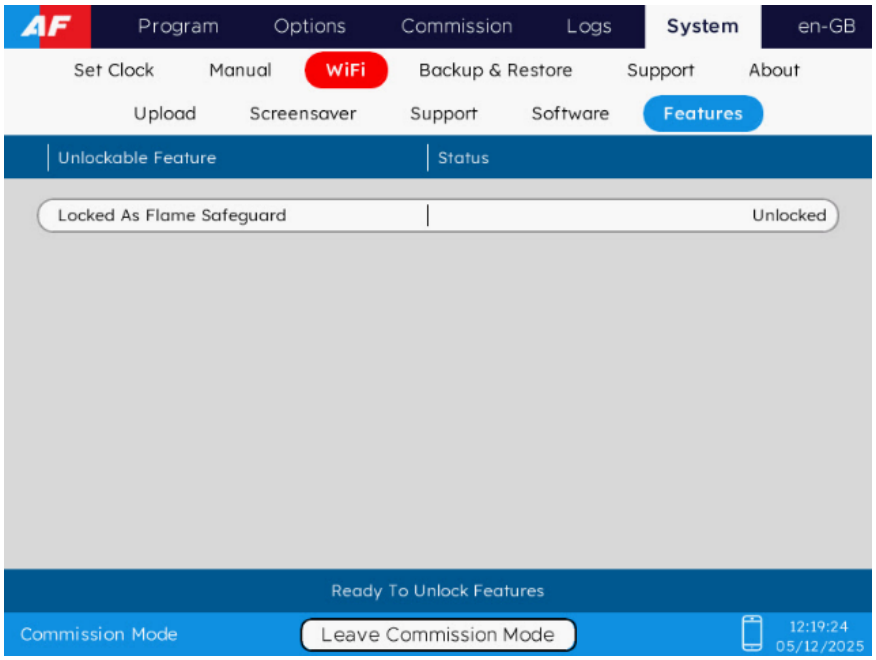
Figure 136 - Upload Unlock Codes

To upload the code, select **System**/**WiFi** and enter the **Commission Password**, then select the **Features** button to see all the Lockable features and their status.



On the app, connect to the Mini Mk9 by selecting the relevant WiFi under the Find Network option and press Upload.

The status of the feature should change to unlocked.



Note: Although it is now unlocked, the unit will still be in **Flame Safeguard Mode**. To open up all the features of the **Mini Mk9**, select **Options**/**MM**/**Terminals** and set **Flame Safeguard Mode** to **Disabled**. The standard **Mini Mk9** features will now all be available.

13 BURNER START-UP SEQUENCE

The MM goes through a series of internal and flame safeguard checks before starting up the burner. The required checks may vary with different option settings to match the burner application.

Any errors or lockouts which might occur in the start-up sequence will be recorded in the logs with the time and date they have occurred, together with the phase the controller was in. Any errors or lockouts should be checked for root cause and cleared by a competent person trained in the use of the Mini Mk9 MM controller. If any errors or lockouts occur and cannot be cleared, please contact Autoflame Engineering Ltd or your local Autoflame Tech Centre.

The following start-up sequence is an example and may vary to suit different sites, burners and applications.

The system described herein has been set up with the following burner control features:

- Firing on gas.
- 2-valve proving system – no vent valve, single valve pilot.
- Interrupted pilot.
- UV scanner.
- Air pressure sensor.
- Gas pressure sensor – VPS and pressure limits checked.
- VPS operates before start-up.
- Pre-purge and post-purge.
- No Golden Start.
- No FGR Start.

The burner start-up sequence will follow the process defined in sections 13.1 to 13.12 below.

13.1 Standby

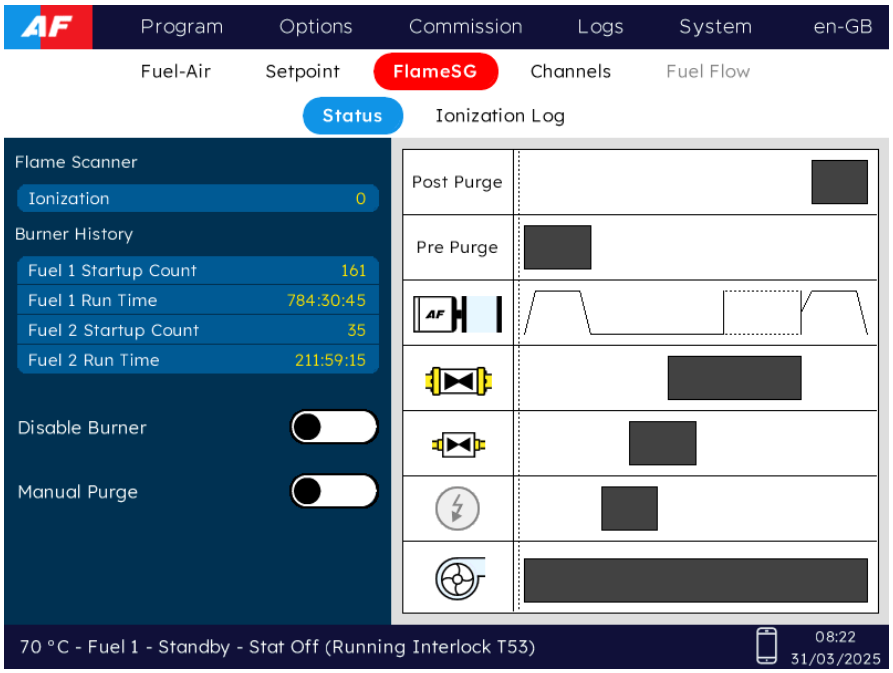


Figure 137 - Standby Phase

When first powered on, or completely idle, the burner will move to the **Standby** state shown above, carrying out safety checks on the system.

The **UV Scanner** checks that there is no flame, and if a flame is detected, the lockout '**Simulated Flame**' will occur, since there should not be any flame detected in **Standby** mode.

The MM will remain in this phase waiting for a call to start via the internal stat, subject to the required setpoint and load demand. The external safety interlock circuit is tied into T53 and must also be active for the burner to be switched on.

With T53 on, the MM will move to the next phase when the actual temperature/pressure of the system is below the burner on range, set as an offset value of the required temperature/pressure. See **Options/Load/Load Sensor** for setting these levels.

The **Standby** phase is also part of the **Intelligent Boiler Sequencing**. The MM could be in **Standby** because it is a lag boiler and not required to contribute to the system. See section 14 for **Sequencing** definition.

The MM will also remain in **Standby** if the burner has been **Disabled** (see section 9.3.4). The MM can also be disabled remotely - see section 18 **Remote Control**.

13.2 Internal Relay Tests

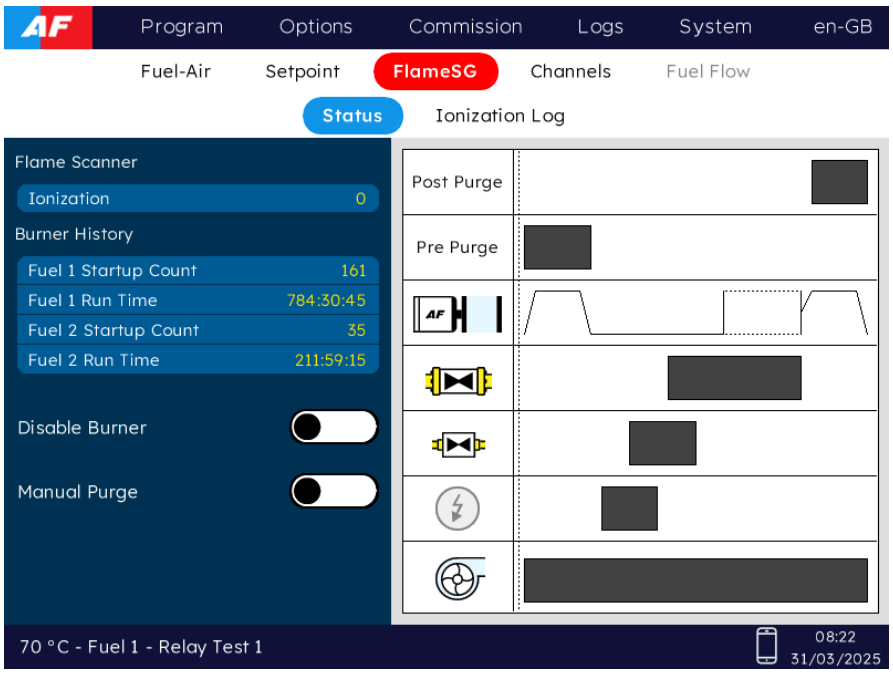


Figure 138 - Relay Tests

During the **Internal Relay Tests** phase, the MM will perform 5 tests on the internal flame safe relays. Should any lockouts occur for the relay tests such as '**FSR Test 1A**' this is an indication of an internal fault within the MM. These tests confirm the correct operation of the 2 safety relays, ensuring that power can be cut to all the relay outputs if a fault is encountered.

If a voltage is detected on terminal 57 (**Call For Heat**) during these checks when there should not be, the lockout '**Fail Safe Relay Fault**' will occur. Please check the 5A fuse.

13.3 CPI Input

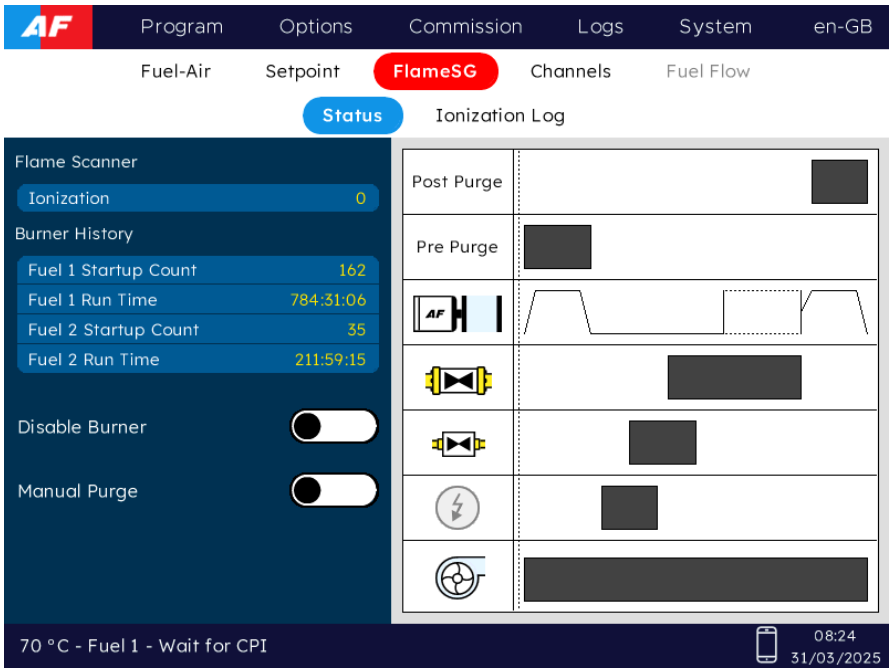


Figure 139 - Wait For CPI Input Phase

In the **Wait For CPI** phase, a check is made on terminal T55 for the proof of closure switch. If T55 does not see an input within 20 seconds, the lockout '**No CPI Reset**' will occur. The Timer will wait for 10 minutes if **External VPS** is enabled.

13.4 Valve Proving

In this example, the MM has **No Vent Valve** and has **Single Valve Pilot** optioned. **2 Valve Proving** is used to check the integrity of the gas for any leaks. See **Options/Burner/Valve Proving/Vent Valve Configuration** for defining the **Vent Valve** setup.

During the **VPS Void To Air** phase shown in Figure 140, the **Main Gas Valve 1** is checked. The **Main Gas Valve 1** output is off (closed), and the **Main Gas Valve 2** output is on (opened), so that the void between the main gas valves can vent to atmosphere. The **Gas Pressure Sensor** is now zeroed. If the **Gas Pressure Sensor** cannot be zeroed, the lockout '**VPS air zeroing fail**' will occur, since a gas pressure has been detected when venting to atmosphere. This could indicate that there is a fault with the **Main Gas Valve 1** or **2**.

If no voltage is detected when the burner **Main Gas Valve 2** output T61 should be on (and vice versa), the lockout '**Main Gas 2 Output Fault**' will occur.

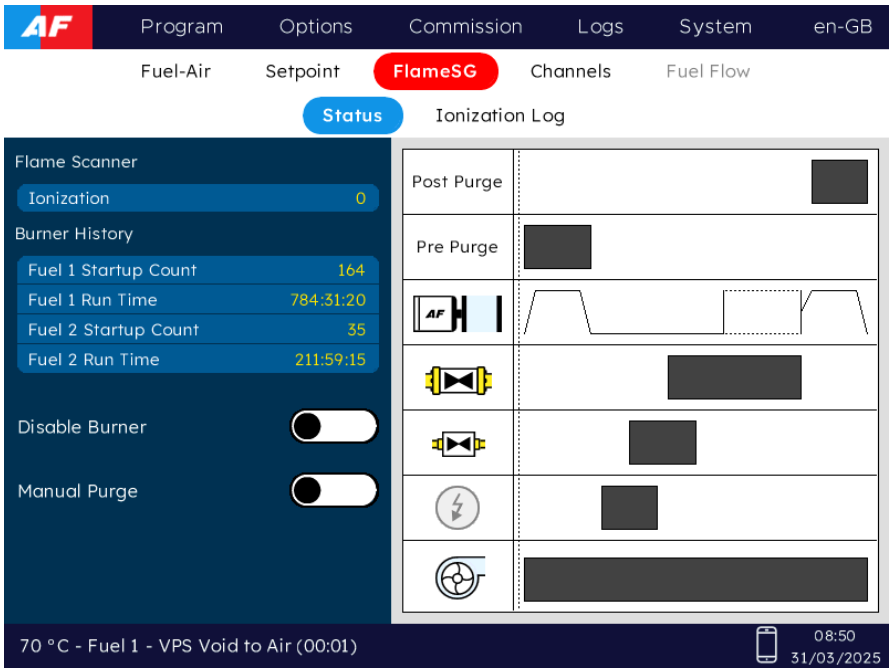


Figure 140 - VPS Void To Air Phase

Note: If valve proving has been optioned with no vent valve and with single valve pilot, then the pilot valve is used for this VPS venting phase.

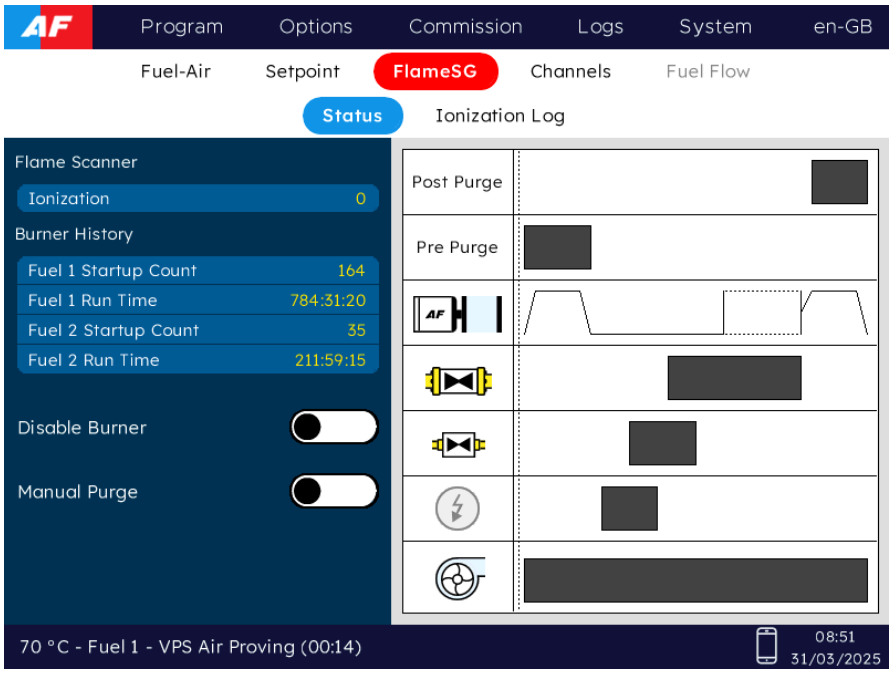


Figure 141 - VPS Air Proving Phase

In the **VPS Air Proving** phase, both the **Main Gas Valve 2** and the **Main Gas Valve 1** outputs are off (closed), to check for a pressure increase.

After the valves close, there is a 1.5 second delay before a pressure reading is taken. If a pressure increase is detected then the lockout '**VPS Air Proving Fail**' occurs since air has been let in between the **Main Gas Valve 1** and **2**, indicating that **Main Gas Valve 1** has failed.

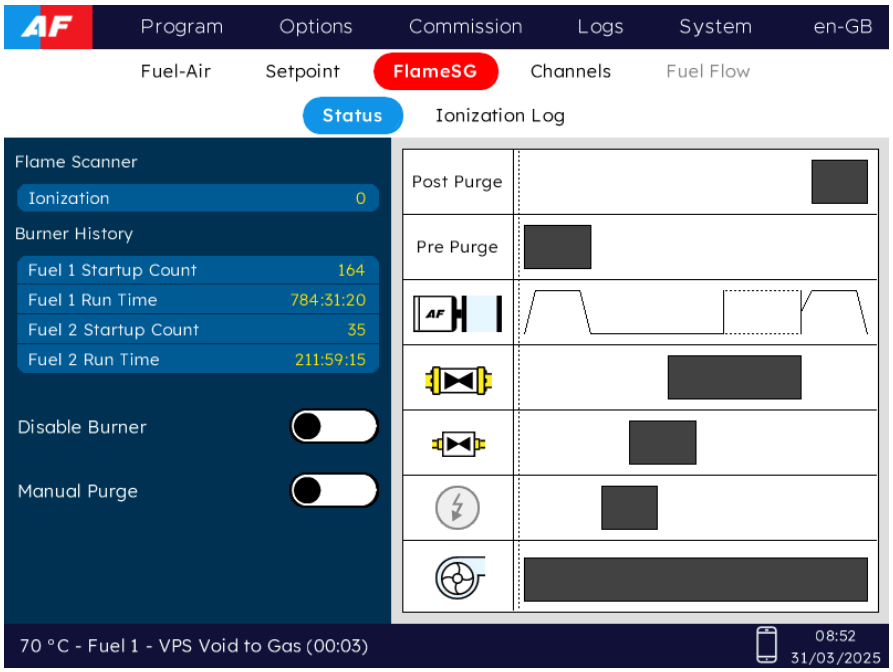


Figure 142 - VPS Void To Gas Phase

In the **VPS Void to Gas** phase, the **Main Gas Valve 1** output is on (open), and the **Main Gas Valve 2** output is off (closed) allowing the gas to fill the void between the valves.

If the measured static line pressure is below the **Options/Burner/Valve Proving/Gas Static Line Pressure Offset Below Commissioned** limit, then a '**Gas Pressure Low Limit**' lockout will occur.

If no voltage is detected when the burner **Main Gas Valve 1** output T60 should be on (and vice versa), the lockout '**Main Gas 1 Output Fault**' will occur.

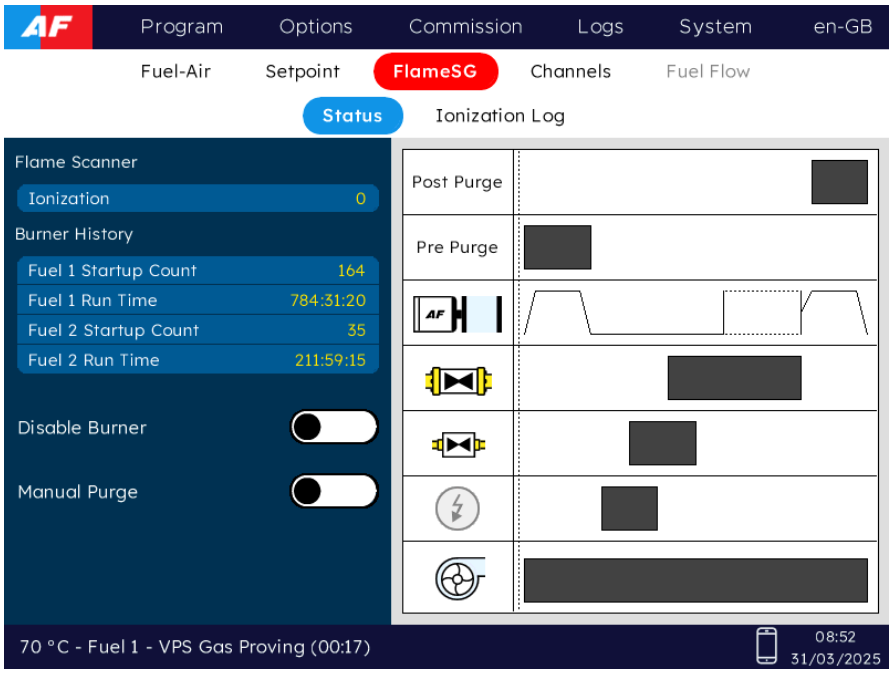


Figure 143 - VPS Gas Proving Phase

In the **VPS Gas Proving** phase, the outputs of **Main Gas Valves 1** and **2** are both off (closed), to check for any gas leaks in the void between the main valves.

After the valves close, there is 1.5 second delay before the initial **Gas Pressure** reading is taken. The reading taken after this delay must be at least 80% of this measured **Static Line Pressure**. If there is a decrease in the **Gas Pressure**, there could be a leak and the lockout '**VPS Gas Proving Fail Low**' will occur. This indicates

that there could be a fault with **Main Gas Valve 2**. The **Maximum Pressure Change Allowed During VPS** is set in **Options/Burner/Valve Proving**.

If the lockout '**VPS Gas Input Too High**' occurs, this indicates that an increase in pressure has been detected, indicating that there could be a fault with **Main Gas Valve 1.** Check **Main Gas Valve 1**, and ensure the **Options/Burner/Valve Proving/Valve Proving Valve Opening Time** is set correctly.

If the measured static line pressure is below the **Options/Burner/Valve Proving/Gas Static Line Pressure Offset Below Commissioned** limit, then a lockout '**Gas Pressure Low Limit**' will occur.

13.5 Zero Air Sensor

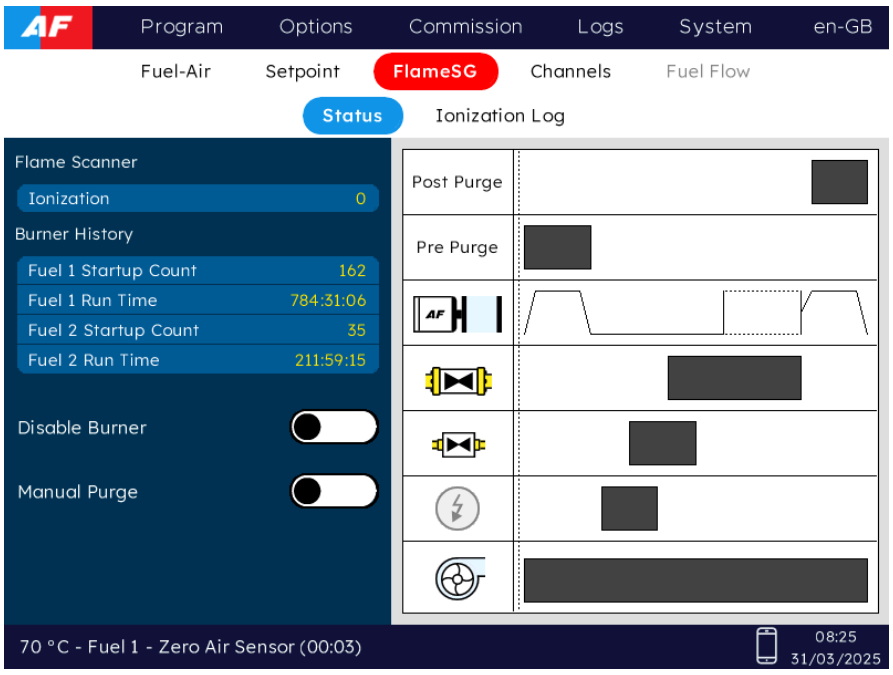


Figure 144 - Zero Air Sensor Phase

Once the **VPS Checks** are competed, the air pressure is checked before the burner motor starts up in the **Zero Air Sensor** screen shown above. The air pressure sensor will look for zero air pressure. If the measured air pressure is greater than 5mbar above the air pressure sensor's zero value, then the lockout '**Air Sensor Zero**' will occur.

If an **Air Switch** is used on T54, the MM will go to the **Wait for Air Switch** phase. If a reset of voltage is not seen and the MM is in this phase within 2 minutes, the lockout '**Wait Air Switch Timeout**' will occur.

If both an **Air Pressure Sensor** and **Air Switch** are optioned in **Option/Burner/Sensors/Air Pressure Sensor Type**, then both must read low before the '**Wait for Air Switch**' phase can be passed.

13.6 Purge

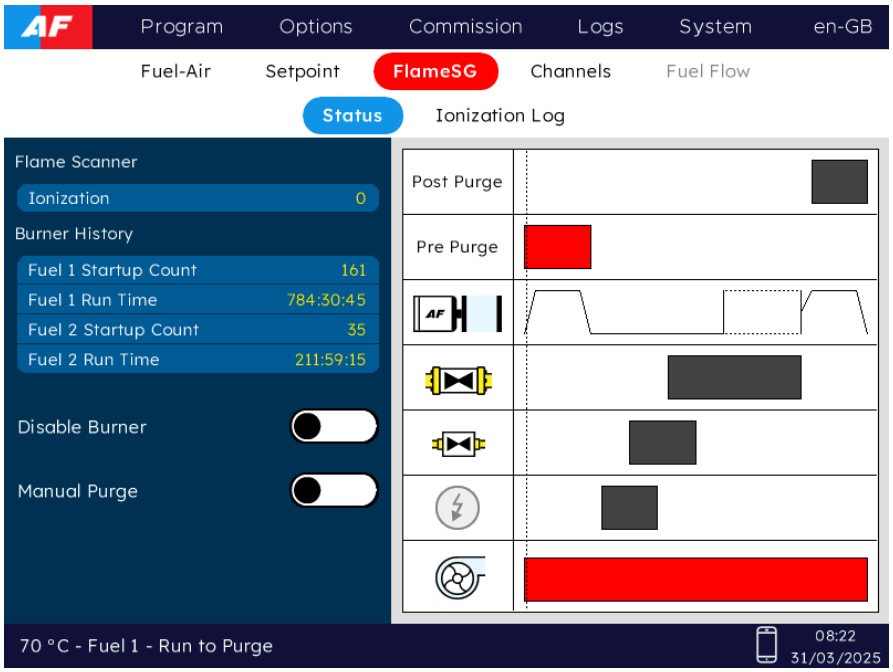


Figure 145 - Run To Purge Phase

Once all the **Internal Relay** and **VPS** checks have been made, the channels move to their commissioned purge positions in the **Run to Purge** phase shown in Figure 145.

The burner motor output is switched on as indicated by the fan graphic spinning and the bottom bar turning red. If a **VSD** is fitted and the feedback does not match the commissioned signal, the MM will sit at **Run to Purge** indefinitely without a lockout.

If no voltage is detected when the burner motor output T58 should be on (and vice versa), the lockout '**Motor Output Fault**' will occur.

Note: A **Delay To Purge** input can be used on one of the burner control input terminals T80, T81 or T82 by setting **Options/MM/Terminals/T80 Function** etc. A timeout can also be optioned for this input using **Options/Burner/Purge/Pre-Purge Time**.

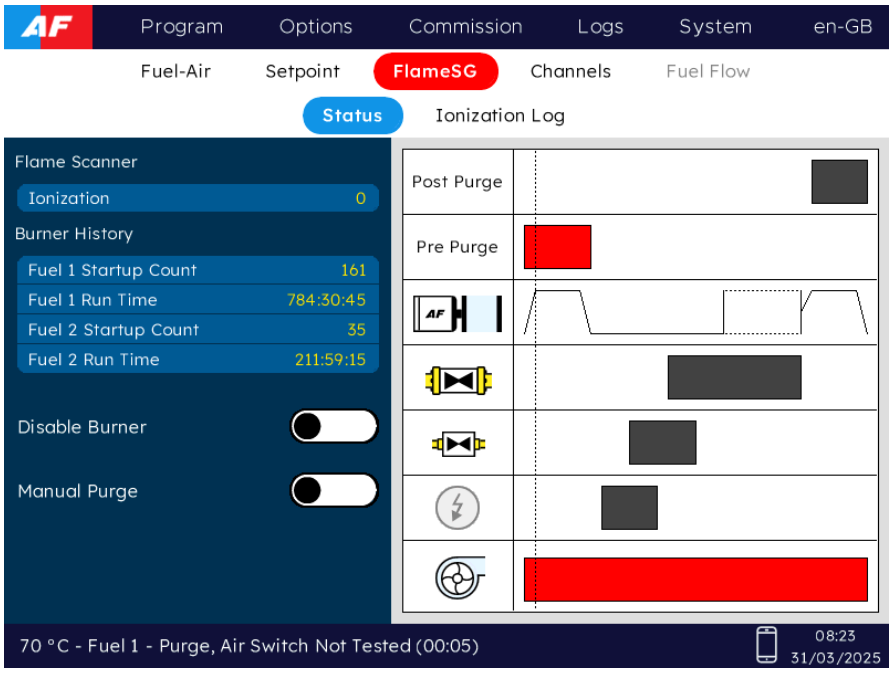


Figure 146 – Purge, Air Switch Not Tested Phase

The **Purge, Air Switch Not Tested** phase allows a delay before the **Air Switch/Air Pressure Sensor** is checked. This delay is set using **Options/Burner/Purge/Delay From Start Of Pre-Purge Until Air Switch Checked** which may be set to between 5 (default) and 10 seconds.

Note: A purge position interlock can be connected to one of the burner control input terminals T80, T81 or T82 by setting **Options/MM/Terminals/T80 Function** etc. This input must be made in order for the system to begin the purge phase.

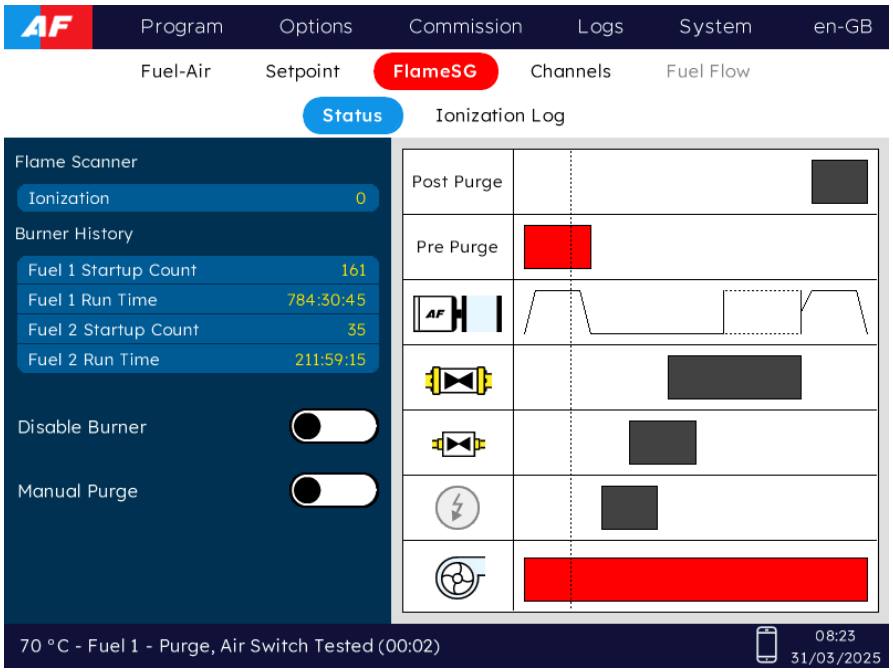


Figure 147 - Purge, Air Switch Tested Phase

Once the '**Delay From Start Of Pre-Purge Until Air Switch Checked**' has elapsed, the **Air Pressure Sensor** checks for a minimum air pressure in the **Purge, Air Switch Tested** phase shown in Figure 147. If the **Air Pressure Sensor** does not detect sufficient air, then the lockout '**No Air Proving**' will occur. See **Air Proving Pressure Threshold** and **Purge Proving Pressure Threshold** in **Options/Burner/Sensors** for the air pressure proving limit settings.

If using an **Air Switch**, a line voltage must be present and maintained on T54 throughout the purge cycle until the burner enters the **Recycle** phase on **Shut Down**.

Purging the burner/boiler forces fresh air to flow through the combustion chamber in order to clear out any fuel remnants or residual combustion gases. The **Options/Burner/Purge/Pre-Purge Time** should be set according to boiler manufacturing guide and local codes and regulations, to ensure that the boiler is safely cleared of fuel or gas remnants.

Note: A purge pressure proving input can be used on one of the burner control input terminals T80, T81 or T82 by setting **Options/MM/Terminals/T80 Function** etc. to **Purge Pressure Proving.** This input is checked after the **Purge, Air Switch Not Tested** delay. A timeout on this delay may be set using **Options/Burner/Purge/Purge Pressure Proving Timeout**.

13.7 Ignition

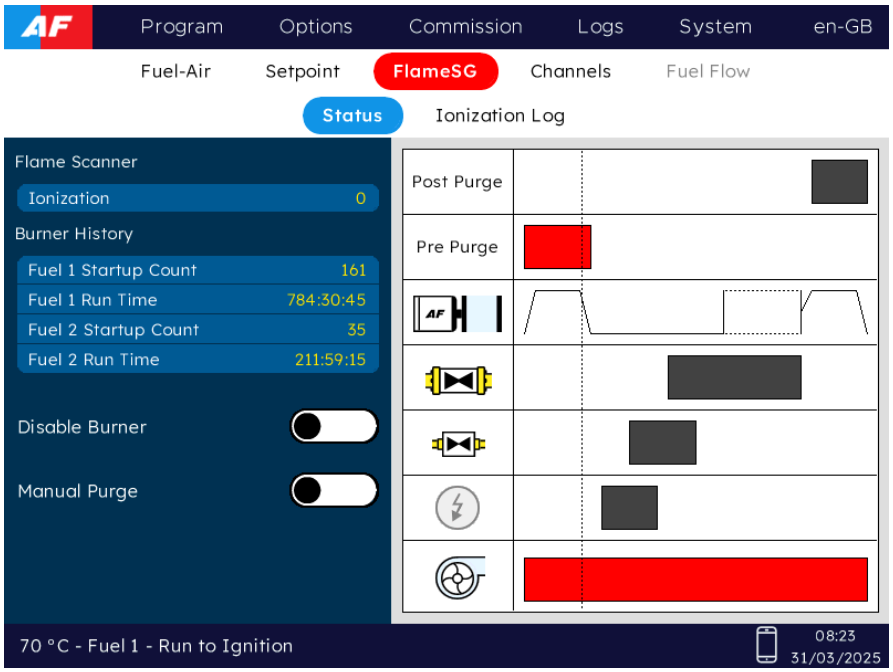


Figure 148 - Run To Ignition Phase

In the **Run to Ignition** phase, the channels will move to their commissioned start positions. If a VSD is fitted and the feedback does not match the commissioned signal, the MM will sit at **Run to Ignition** indefinitely without a lockout.

Note: If the system has been commissioned with **Golden Start** then the MM will run to the **Golden Start** position. If **FGR has been commissioned**, then the MM will run to the **FGR** start position. **Golden Start** takes priority if both are commissioned.

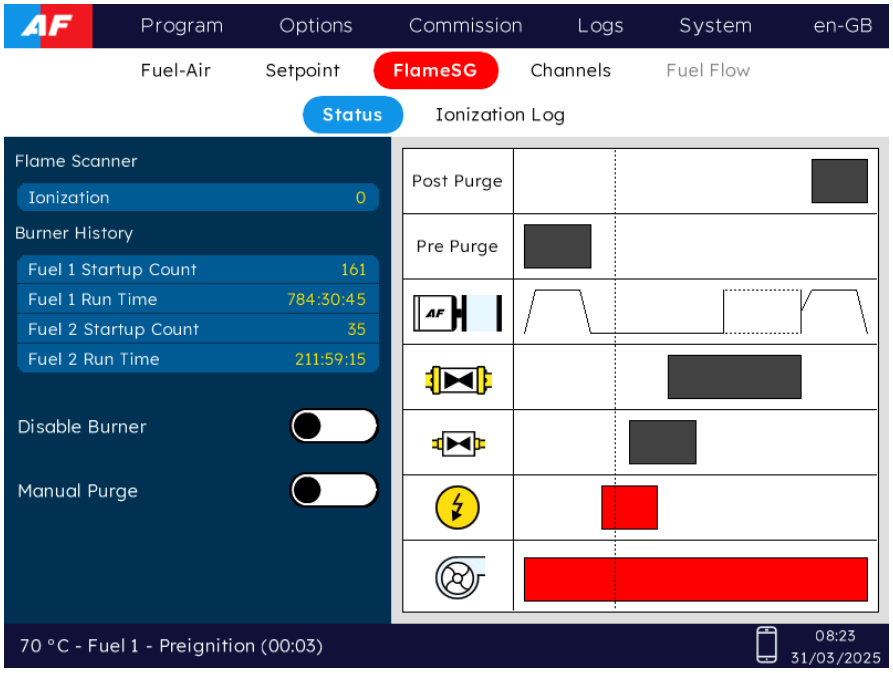


Figure 149 - Preignition Phase

The **Ignition Transformer Output** is switched on in the **Preignition** phase, prior to the **Pilot Gas Valve** being switched on (open) to ensure there is a spark to light before any fuel is introduced. The **Pre-Ignition Time** is set in **Options/Burner/Timings**.

If no voltage is detected when the **Ignition Output** T63 should be on (and vice versa), the lockout '**Ignition Output Fault**' will occur.

If the gas valves **Proof Of Closure** switch output T55 is opened during ignition, the lockout '**CPI Input Wrong State**' will occur.

13.8 Pilot

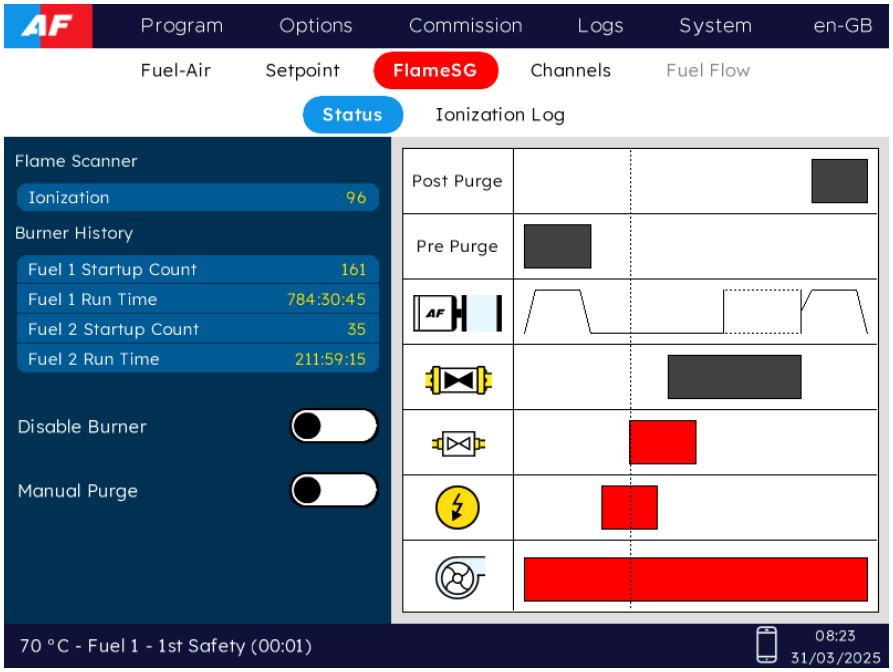


Figure 150 - 1st Safety Phase

The **Pilot Gas Valve** is switched on (open) in the **1st Safety** phase. The **Options/Burner/Timings/1st Safety Time** is the period when the **Pilot Valve** is open before the flame is checked.

If no voltage is detected when the **Pilot Valve** output T59 should be on (and vice versa), the fault '**Start Gas Output Fault**' will occur.

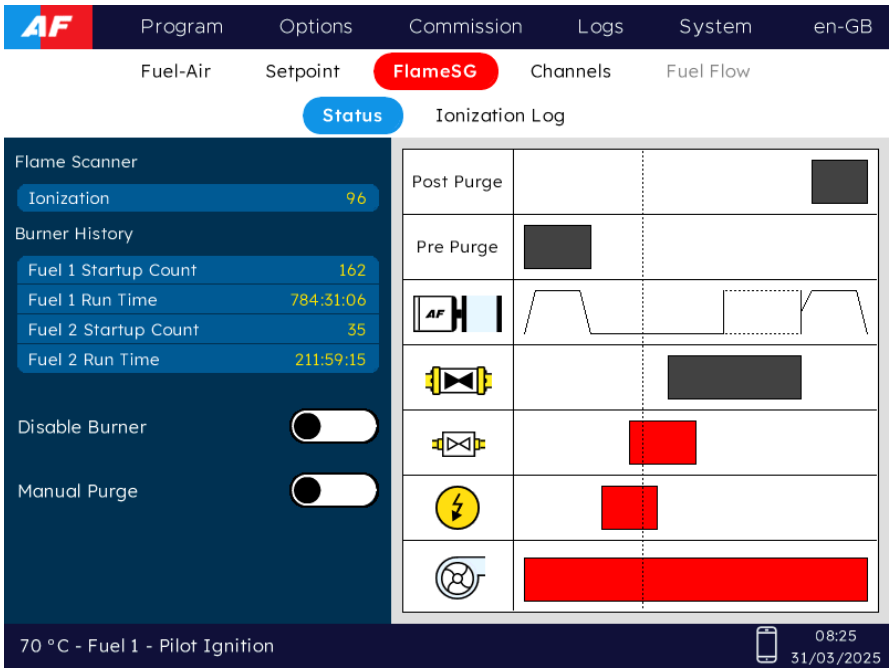


Figure 151 - Pilot Ignition Phase

At the end of the **1st Safety Time** period, the **Pilot Flame** is checked by the UV scanner in the single valve **Pilot Ignition Phase** shown in Figure 151. If the **Pilot Flame** goes out, the lockout '**No Flame Signal**' will occur.

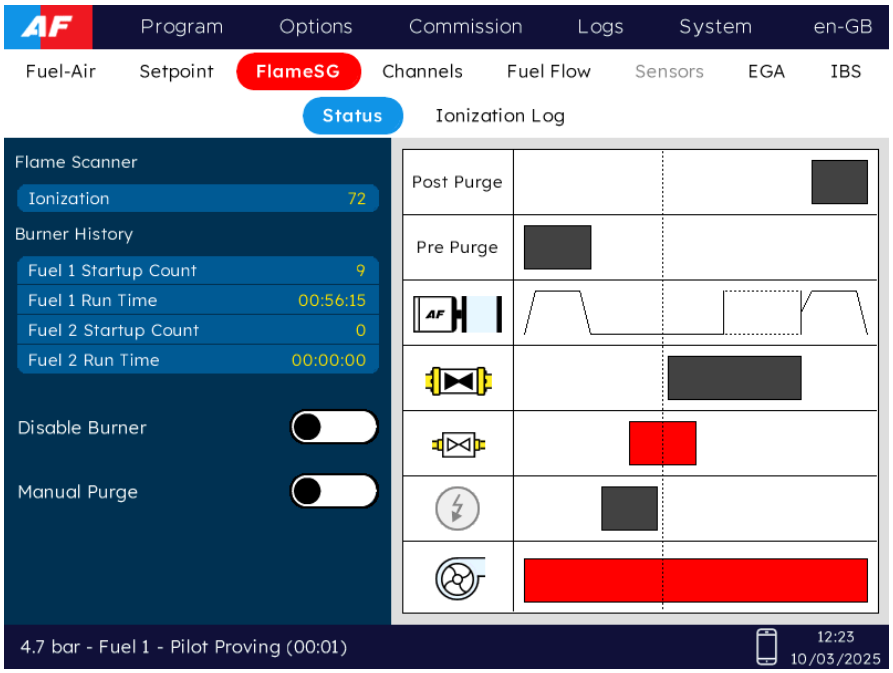


Figure 152 - Pilot Proving Phase

The **Ignition Transformer** output is switched off after the pilot ignition, in the **Pilot Proving** phase shown in Figure 152. This proving period, set in **Options/Burner/Timings/Pilot Proving Time,** gives the **Pilot Flame** a chance to stabilise. The flame is checked to ensure the pilot is strong. If the pilot goes out, the lockout '**No Flame Signal**' will occur.

13.9 Proving

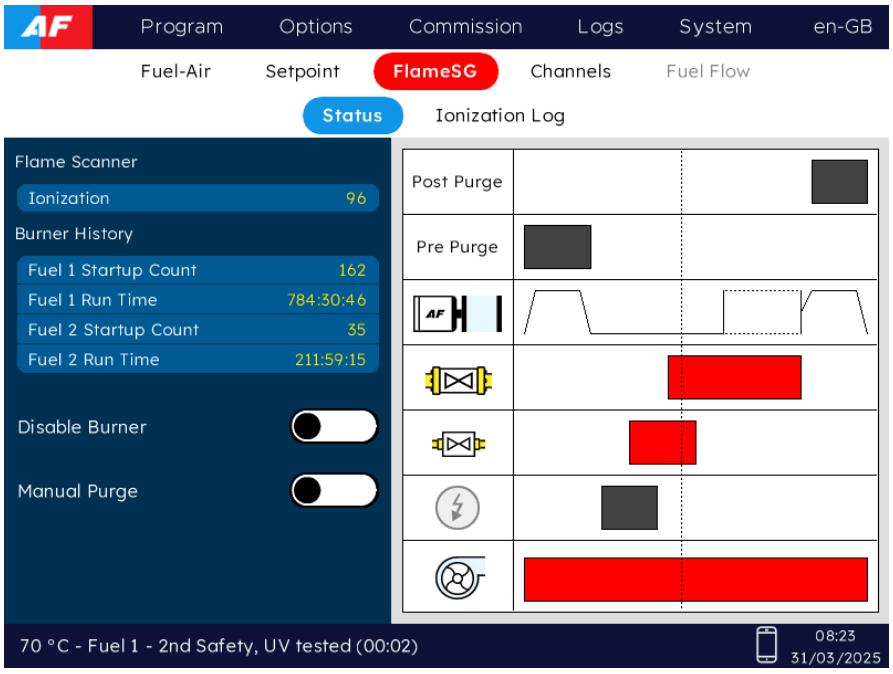


Figure 153 - 2nd Safety Phase

The **2nd Safety Time** begins, where the flame is not checked in the **Interrupted Pilot 2nd Safety** phase shown above.

The **2nd Safety Time** is the period where the **Pilot** & **Main Valves** are open at the same time. The outputs of the **Main Gas Valves 1** and **2** are switched on (opened), while the **Pilot Valve** output is maintained on (opened). This **2nd Safety Time** allows the **Main Flame** to light, prior to the **Pilot Valve** output being switched off (closed). See **Options/Burner/Timings/2nd Safety Time** where the default is set to 3 seconds. If the flame is not strong enough, the lockout '**No Flame Signal**' will occur.

If no voltage is detected when the burner **Main Gas Valve 1** output T60 should be on (and vice versa), the lockout '**Main Gas 1 Output Fault**' will occur.

If no voltage is detected when the burner **Main Gas Valve 2** output T61 should be on (and vice versa), the lockout '**Main Gas 2 Output Fault**' will occur.

The **CPI/POC** input T55 is now no longer checked through the firing cycle.

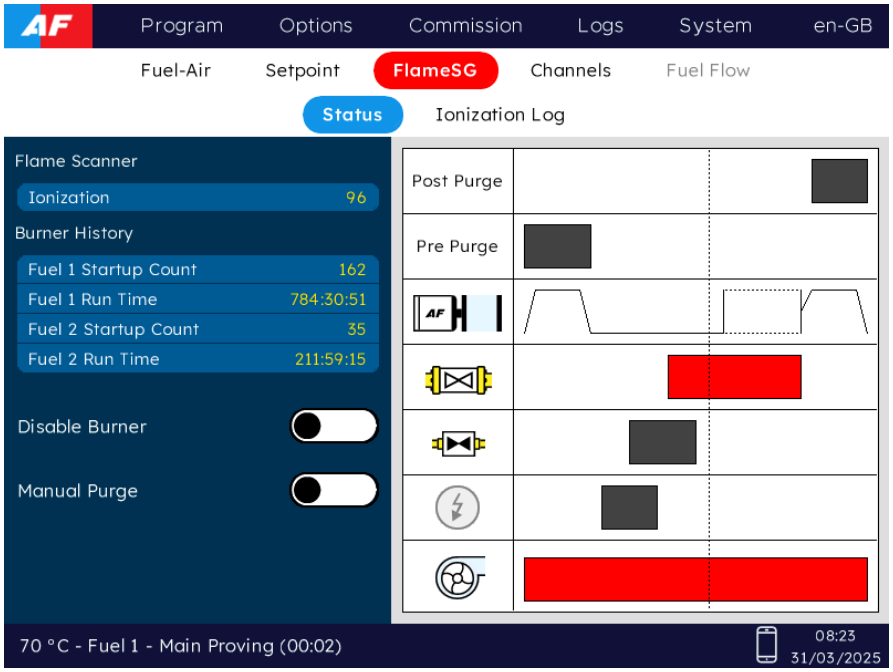


Figure 154 - Main Flame Proving Phase

In the **Interrupted Pilot Main Proving** phase shown in Figure 154, the pilot gas valve output is switched off (closed). There is a time delay, set in **Options/Burner/Timings/Main Flame Proving Time** to allow the main flame to stabilise before the burner proceeds to normal modulation. If the main flame fails now, the lockout '**No Flame Signal**' will occur.

After the **Second Safety Time**, the **Gas Pressure Limits** are checked in the **Main Flame Proving** phase. See **Gas Running Pressure Offset Below Commissioned Curve** and **Gas Running Pressure Offset Above Commissioned Curve** in **Options/Burner/Valve Proving** for the **Gas Pressure Limits**.

13.10 Firing

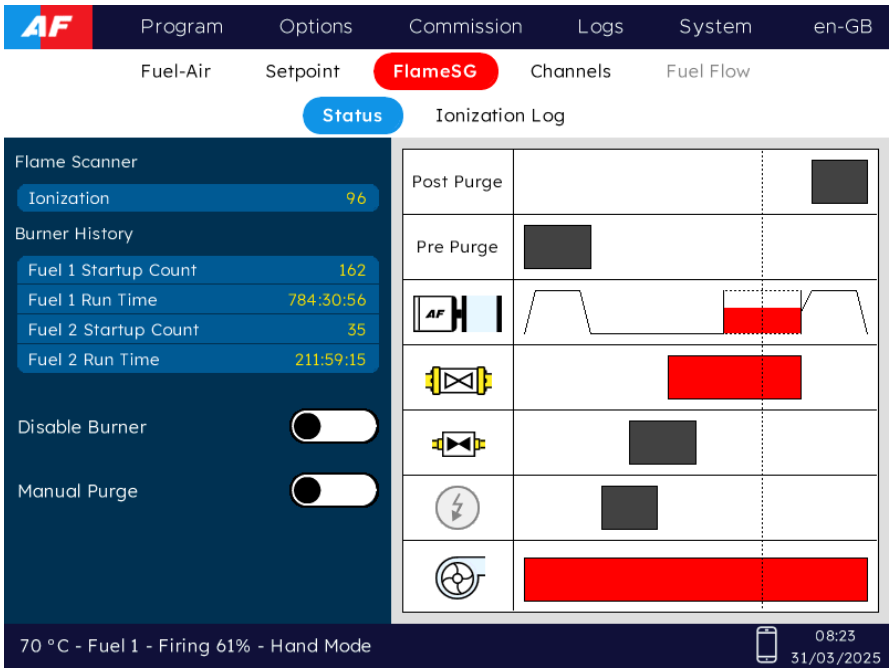


Figure 155 - Firing Phase

The burner has now completed the **Start-Up Sequence** and fires normally according to its set operation in the **Firing** phase. If using **Internal PID**, the burner will modulate its firing rate up and down based on how far away its actual **Temperature/Pressure** is from meeting the required **Temperature/Pressure**.

The **Gas** and **Air Pressure Limits** are continually monitored in this example. If the **Gas Pressure** exceeds the upper limit or is below the lower limit, the lockouts '**Gas Pressure High**' or '**Gas Pressure Low**' will occur, respectively. If the **Air Pressure** is outside of the limits, the lockout '**Air Pressure Out of Window**' will occur. See **Gas Running Pressure Offset Below Commissioned Curve** and **Gas Running Pressure Offset Above Commissioned Curve** in **Options/Burner/Valve Proving** for the **Gas Pressure Limits** and **Options/Burner/Sensors/Air Pressure Window** for the **Air Pressure Limits**.

13.11 Post Purge

The **Post Purge** phase is optioned on in this example. When T53 is switched off and the burner is off, the MM will purge fresh air through the burner/boiler when the burner shuts down in normal conditions (internal/external stat). The outputs of the main gas valves 1 and 2, and the pilot valve are switched off (closed). **The Post Purge Time** and **Post Purge Type** are set in **Options/Burner/Purge**.

The **Post Purge Time** begins once the channels have moved to their **Post Purge** positions and the **Purge Position Interlock** has been if optioned. **Purge Position Interlock** may be optioned on terminal T80, T81 or T82 by setting **Options/MM/Terminals/T80 Function** etc to **Purge Position Interlock**. This does not apply to **NFPA Post Purge**.

After **Post Purge**, the MM will go back to the **Recycle** phase and then move to Standy after the Recycle Time has elapsed. From Standby, the burner will commence the start-up sequence when required.

Note: If **NFPA Post Purge** is selected, then the burner will also perform a **Post Purge** in the event of a lockout/error at any time after the **Ignition** phase, and the **Purge Position Interlock** is not checked even if optioned.

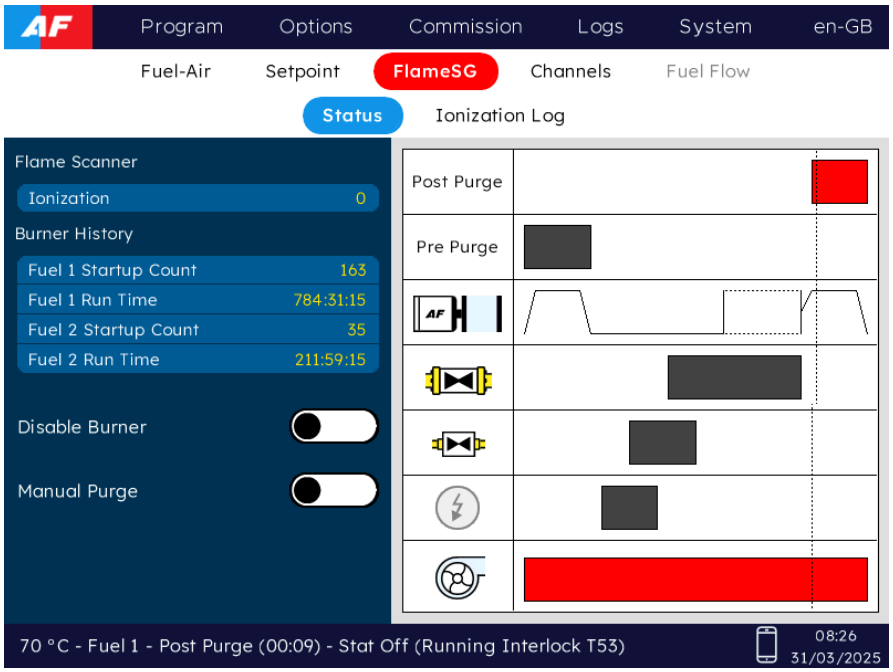


Figure 156 - Post Purge Phase

13.12 **Recycle**

When the burner enters the **Recycle** phase, all the channels go to their respective commissioned 'closed' positions, and the burner is not firing. The burner returns to **Standby** once the **Recycle Time** has been completed.

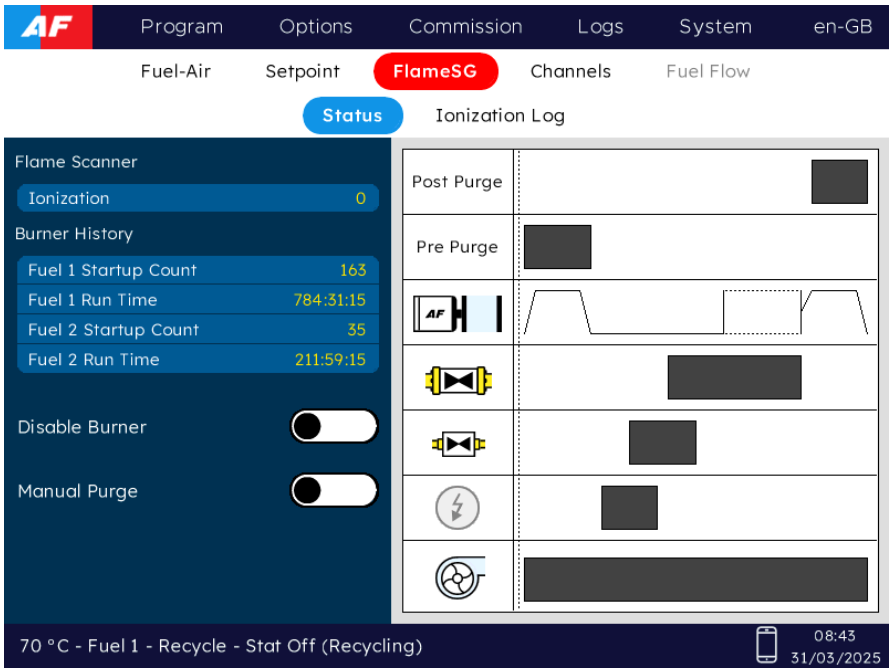


Figure 157 - Recycle Phase

As the burner is off in **Recycle**, there should not be any flame detected. The **UV Scanner** checks that there is no flame, and if a flame is detected, the lockout '**Simulated Flame**' will occur. This could be a result of after burn and must be investigated. A post-purge could be necessary and can be set up using **Post Purge Time** and **Post Purge Type** in **Options/Burner/Purge**.

While the MM is in the **Recycle** phase, if T53 is switched ON, there will be time delay before the burner starts up. See **Options/Burner/Timings/Recycle Time** with the default set to 10 seconds.

14 INTELLIGENT BOILER SEQUENCING (IBS)

Intelligent Boiler Sequencing (**IBS**) ensures that in multi-boiler installations, the heat or steam requirement imposed upon the boiler plant is satisfied by the operation of the minimum number of boiler/burner units at any one time. The benefits from using **IBS** include:

- An increase in overall plant efficiency.
- An increased savings in electrical costs.
- A reduction in thermal stress on the lag boilers.

Sequencing can be operated in one of three modes:

- **Steam Sequencing.**
- **Low Pressure Steam Sequencing.**
- **Hot Water Sequencing.**

These variations of **IBS** and all the options defining how it works are set in **Options/Load/Sequencing**. These can be configured under **Online Changes** to allow the commissioning engineer to implement/adjust sequencing after the individual burners have been commissioned.

There are also four ways in which the units requiring **Sequencing** may be interconnected defining the boiler network for a Mini Mk9 as follows:

- Any combination of Mini Mk9 MMs, Mini Mk8 MMs and Mk8 MMs may be interconnected by a two wire screened data cable (RS485 link) using terminals T27 & T28. Each MM must have **Options/Load/Sequencing/Sequencing Enable** set to **Sequencing Enabled**.
- As above but also connected to a Mk8 DTI with **Options/Load/Sequencing/Sequencing Enable** set to **Sequencing And DTI** in each MM. The Mk8 DTI can then control sequencing for the attached MM network.
- A Group of Mini Mk9's connected via Ethernet will allow them to act as a sequencing network. Each MM must have **Options/Load/Sequencing/Sequencing Enable** set to **Sequencing Enabled**.
- A Group of Mini Mk9's connected via Ethernet to the **Mk9 Software DTI** with **Options/Controller/Network/Software DTI Over Ethernet** set to **Enabled** will allow the **Mk9 Software DTI** to control sequencing for the attached network.

Note that Sequencing Over Ethernet requires a future software upgrade. Mini Mk9s sequenced over an RS485 link may also be connected to the Mk9DTI over ethernet with limited sequencing functionality. Enhanced sequencing feature will be rolled out.

A maximum of ten MMs (in any combination of Mini Mk9 MMs, Mini Mk8 MMs, Mk8 MMs) may be interconnected by a two wire screened data cable (RS485 link). Alternatively, up to 10 Mk9 MM's may be connected via an ethernet network. Please refer to section 4.4.4 for the Sequencing Connection Diagrams.

Any one of the interconnected MMs may be selected as the **Lead Boiler** for sequencing. **Note**: only one MM may be designated as **Lead Boiler** at any one time. If more than 1 is selected as lead MM, then the MMs will ignore the sequencing loop commands and return to independent firing. This is seen on any of the **IBS** screens by the **Lead Boiler** being set to **None**. The lead boiler can be selected by:

- Activating the Lead Boiler soft slider on the MM's IBS screen.
- Via Mk8 DTI or using the DTI Manager software if connected to a Mk8 DTI.
- Via the Mk9 Software DTI if connected that way.
- Via a Modbus or BACnet write instruction.

For sequencing, or when connected to a DTI/Modbus/BACnet interface, each MM must have a unique **Sequencing ID** set to avoid conflicts. The highest MM ID number should be set for the sequencing loop using **Sequenced MM Count**, so that the system only looks for communications with the connected MMs. The maximum number of MMs that can be in a sequence loop is 10. If there is a Mk8 DTI or Mk9 Software DTI in the network, then **Shuffle Sequencing** must be **Enabled** allowing control the sequence loop via the DTI

The MMs will normally be sequenced in their numerical order. The sequence order of the MMs in the loop can be changed either by changing their ID numbers or by changing the order on the Mk8 DTI or Mk9 Software DTI.

Enabling **DTI**, **Modbus** or **BACnet** allows remote control of the **Individual** and **Global Setpoint**; **Lead Boiler Select**; **Sequence Order**; **Enable/Disable Burner** and **Firing Rate**. If an individual MM's firing rate is set from the **DTI**, **Modbus** or **BACnet**, then that MM will not follow the sequencing loop.

Sequencing can be used with an external load detector, but it cannot be used with external modulation.

As sequencing is based on the firing rate, all MMs must have fuel flow metering commissioned - see section 7.7. The total capacity of the system at any given time is the ratings sum of all the sequenced on boilers.

14.1 Hot Water Sequencing

14.1.1 Implementing Hot Water Sequencing

For **Hot Water Sequencing**, a temperature detector must be fitted to all the boilers and **Options/Load/Load Sensor/Load Sensor Type** must be set to either **Temperature (MM10006, 0 - 400°C / 752°F)** or **External Temperature**.

Each MM in the sequencing loop will be in one of two states:

- On: One or more MMs are firing and contributing to the load.
- Off: All remaining MMs are in the Off state.

The following settings shall be made on all the MMs in the sequencing loop:

- **Sequencing Warming Burner Off Time** must be set to **0** to disable the standby warming as this is a steam sequencing feature.
- **Sequencing Mode For Low Pressure Steam** must be set to **With Non-Return Valves**
- **Warming Mode** must be set to **One MM In Warming State**.

If warming is required for lag hot water boilers, then hot water sequencing can function like steam sequencing by setting **Sequencing Mode For Hot Water** to **Three State Hot Water Sequencing (On/Warming/Off)**.

In a sequence loop, there is one lead MM, and the rest are lag MMs. The lead MM identifies its own firing rate by looking at its fuel flow metering data, proportional to the system's load requirements. Having established the percentage firing rate and maximum heating capacity, the lead MM calculates the amount of heat being contributed to the system by this burner.

The **Sequencing Scan Time** sets a timer, after which the firing rates of all MMs in the loop are assessed. The lead MM then looks at its firing rate and sends a command to the lag MMs to either:

- Contribute to the load because it cannot reach the setpoint.
- Stop contributing to the load because the system has met the load demand.

At the end of the **Sequencing Scan Time,** the next lag MM will be brought online if the lead MM cannot cope with the load demand, and its firing rate is above the **Sequencing Change Up Threshold** (set to 95% by default).

Alternatively, if the combined firing rates of the previous two firing MM are less than the **Sequencing Change Down Threshold** (set to 85% by default), then the last firing MM in the sequencing loop will go into standby, warming or off depending on how the **Sequencing Mode For Hot Water** is set.

If a lag MM fails to start when requested, the scan time will be decreased by the offset defined in **Sequencing Scan Time When Unit Goes Offline**, until it is automatically ignored from the sequencing communication loop. If a lag MM fails to modulate after being requested to contribute to the load requirement, then that MM will be ignored from the sequencing communication loop after a time delay set by the **Modulation Timeout**.

After a power recycle, the number of MMs which are initially set on when the MMs start up again, is set by **Number Of Boilers Initially On**.

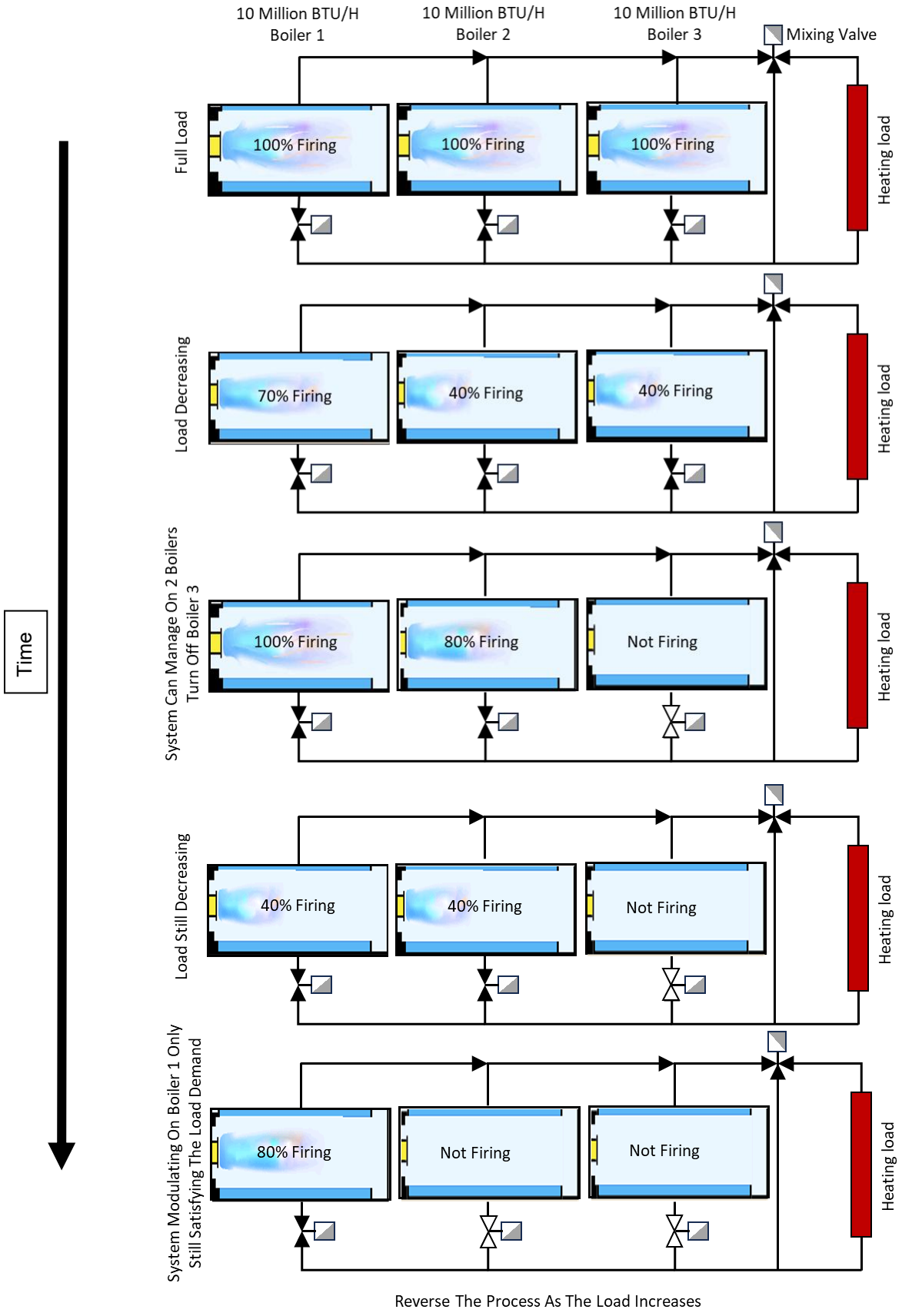


Figure 158 - IBS With Three Hot Water Boilers

14.1.2 Two Port Valve Operation

T78 on the MM is a switched neutral connection for controlling a **Two Port Valve** that would normally be installed in the boilers return pipe connection to the common return header. This works by switching to neutral once the MM has stopped firing but if the temperature of the boiler ever gets above the required set point then T78 will switch back on, even if the boiler is not firing.

- When the **Two Port Valve** is closed on an OFF lag boiler, if at any time, the residual heat in that boiler is above the required setpoint, the valve is opened immediately and the heat is let through the system. The **Two Port Valve** then stays open.
- When the lead boiler recognises that it needs a lag boiler to come online after the **Sequencing Scan Time**, the lag boiler will then run its relay tests. This will open the **Two Port Valve** immediately and it will then stay open.

For the **Two Port Valve** to close, the lag boiler must be in standby mode, and the actual setpoint must be at or below the required setpoint and must remain in this condition for at least one minute.

This facility ensures that boilers that are switched 'offline' do not contribute return temperature water to the flow header thereby diluting the flow temperature to the building.

14.2 Steam Sequencing

14.2.1 Warming Steam Boilers

The difference between **Steam Pressure Sequencing** and **Hot Water Sequencing** is the warming periods; the **IBS** settings explained in section 14.1.1 are the same.

A steam boiler is at risk of thermal shock if not warmed before running at high fire. If the lag boiler is required to contribute to the steam load, then the boiler must be warm in order to contribute quickly and in a safe manner. If the boiler is started from cold and allowed to modulate to a high firing rate straight away, then this may cause damage to the boiler since the tubes will rapidly increase in temperature risking thermal shock. By keeping the lag MMs at low fire in standby/warming, they will not be started from cold when they are requested to come online so will not be at risk of thermal shock.

Additionally, not warming a steam boiler can result in a slow response to meet the system's steam demand. For process applications and critical sites such as hospitals, it is imperative that the steam demand is met efficiently and quickly. If one of the boilers fails, or locks out then it is very important that the next boiler in the sequencing loop gets up to pressure as quickly as possible. Therefore, if the boiler starts up from cold, it will take a long time to get up to pressure safely. By warming this lag boiler, it will maintain a pressure, offset from the required setpoint and will quickly get up to pressure when required.

14.2.2 Implementing Steam Sequencing

The operation of **IBS** for steam boilers is similar to hot water sequencing but with additional features as explained below. In the case of steam boiler sequencing there are four states which are controlled sequentially:

- **On** – the burner fires and modulates freely. The burner will start and stop according to the **Burner Switch On Offset** and **Buner Switch Off Offset** relative to the normal **Setpoint** together with the **Internal STAT Operation** as defined in **Options/Load/Load Sensor**.
- **Standby** – the burner fires at the low fire position. The burner will start and stop according to the **Burner Switch On Offset** and **Buner Switch Off Offset** relative to the **Standby Or Phantom Setpoint Offset** together with the **Internal STAT Operation**.
- **Warming** – the burner fires at the low fire position as in the **Standby** case. However it also runs according to a timer of X minutes firing (**Sequencing Warming Burner On Time**) and Y minutes not firing (**Sequencing Warming Burner Off Time**). If the **Sequencing Warming Burner On Time** is set to 0, then the burner will continually fire at the low fire position to meet the standby setpoint in the warming state.

  The burner can also be controlled by a (warming) thermostat fitted in the boiler shell, wired to terminal T98 (**Options/MM/Terminals/T98 Function** would be set to **Warming STAT**).

- **Off** – the burner does not fire.

As well as the options given in section 14.1.1, the following also need to be set for steam sequencing:

- **Warming Mode** – Sets the behaviour of the lag boilers:
  - **One MM In Warming State**: Only one lag boiler in warming, all the rest are off
  - **All Unused MMs In Warming State**: All the lag boilers after the first lag boiler are kept in warming state and there are no boilers offline.
- **Standby Or Phantom Setpoint Mode**:
  - **Use Fixed Standby Setpoint** sets the **Standby Setpoint** as an absolute value.
  - **Use Phantom Setpoint Offset** sets the **Phantom Setpoint** as an offset below the current setpoint.
  - In sequencing where non-return valves are installed, any lag boilers will aim to maintain this setpoint when in the warming or standby phase.
- **Sequencing Warming Burner Off Time** – This is the time in minutes for how long the boiler will be off for during Warming mode.
- **Sequencing Warming Burner On Time** – This is the time in minutes for how long the boiler will be in low flame hold for the boiler to heat up to its standby setpoint, when in Warming mode.

Hence if the **Required Setpoint** is 10bar and the **Standby Or Phantom Setpoint Offset** is 4bar, then if the **Standby Or Phantom Setpoint Mode** is set to **Use Fixed Standby Setpoint**, the warming boilers will try to maintain 4bar. If however the **Standby Or Phantom Setpoint Mode** is set to **Use Phantom Setpoint Offset**, then the warming boilers will try to main 6bar (The 10bar set point – the 4bar phantom offset).

14.3 Low Pressure Steam Sequencing

For steam boiler plants where check (non-return) valves are not installed, or the required setpoint is less than 2bar (20PSI), it is not possible to use a standby setpoint. Each pressure sensor would read the same pressure value, regardless of the individual boiler pressure. A thermostat (Aquastat) can be installed into the boiler shell, and **Sequencing Mode For low Pressure Steam** must be set to **Without Non-Return Valves**.

With **Options/MM/Terminals/T98 Function** set to **Warming STAT**, a live input on T98 stops/inhibits the burner when the MM is in warming. Removal of this voltage allows the burner to run. The boiler will remain in a warming state based on the **Sequencing Warming Burner On Time** and **Sequencing Warming Burner Off Time**.

14.4 Troubleshooting IBS

If **IBS** is not turning the lag boilers on and off as needed to meet load demand, this indicates that there is an issue with the sequencing timings, communications or with the fuel flow commissioning data.

14.4.1 IBS Timings

If **IBS** is functioning, but not responding to load changes quickly enough, then it may be necessary to adjust the **Sequencing Scan Time.**

This has a critical effect on the responsiveness of the sequencing system. Too long a scan can result in the boilers not coming online quickly enough to meet increasing load demand; too short a scan time (especially one shorter than the burner start-up time) can cause another boiler to be brought online before the previous lag boiler has started firing. The latter can cause boilers to turn on and then quickly turn off again.

The **Sequencing Scan Time** should normally be set to at least the start-up time for the burner as an absolute minimum.

14.4.2 Fuel Flow Metering

Fuel Flow Metering must be set correctly on all the MMs as this is used to determine the firing rate and burner rating which **IBS** looks at to decide whether to bring on or turn off lag boilers. If this is not set correctly, then the system has no idea how much each boiler can contribute to meeting the load.

Take care to provide an accurate **Fuel Flow** commission for each burner in the sequencing loop.

14.4.3 Connections

The MMs must be connected in one of two ways:

- via a Belden 9501 cable in daisy chain configuration as per the sequencing wiring diagrams in section 4.4.4, with the data cable screened at one end only.
- Via an ethernet cable with all MMs connected to the same LAN.

During firing, an MM will be removed from the sequence loop should any of the following occur:

- Communications to the MM has timed out.
- The MM has been disabled remotely via the DTI or a BMS with **DTI Mode** enabled.
- The MM is in an error, burner lockout or alarm state.
- The MM has not started modulating within the required time.
- The DTI is manually controlling the firing rate.
- Modulation exerciser is being used.
- A cold-start routine has been defined.
- The MM is in **Hand Mode** or **Low Flame Hold**.
- The MM has been optioned for Modbus.

The **Diagnostics** screen shows the status of all sequenced MMs. In addition the green circles under each boiler flash intermittently with the communications. If communications is present then both of the circles will flash (Poll and Response). If both circles do not flash then the issue is likely to be communications.

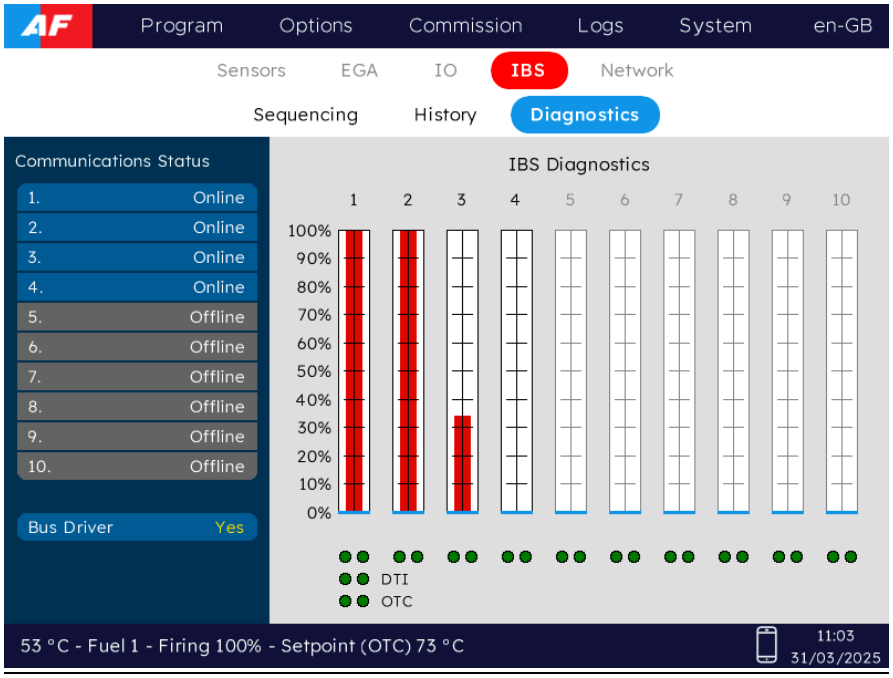


Figure 159 - IBS Diagnostics

When having communications problems between Autoflame MMs connected via a data cable, a simple test with a standard 5V LED can confirm if they are due to hardware or wiring problems.

Take a standard 5V LED and wire it into terminals 27 and 28 of the MM ensuring correct polarity (black connected to the negative leg of the LED). If the MM is communicating, the LED will flash intermittently. If the LED does not flash, check the polarity is correct on the LED. If the LED still does not flash, please contact Autoflame Sales Department. Do this for all the MMs in the sequence.

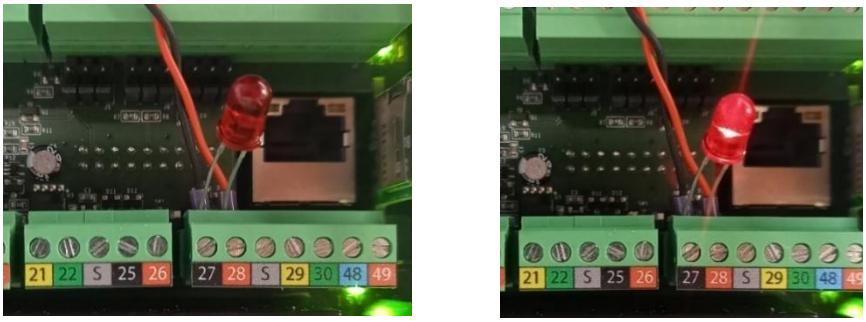


Figure 160 - IBS Comms Link Check

14.5 Sequencing Screen

14.5.1 IBS – Sequencing

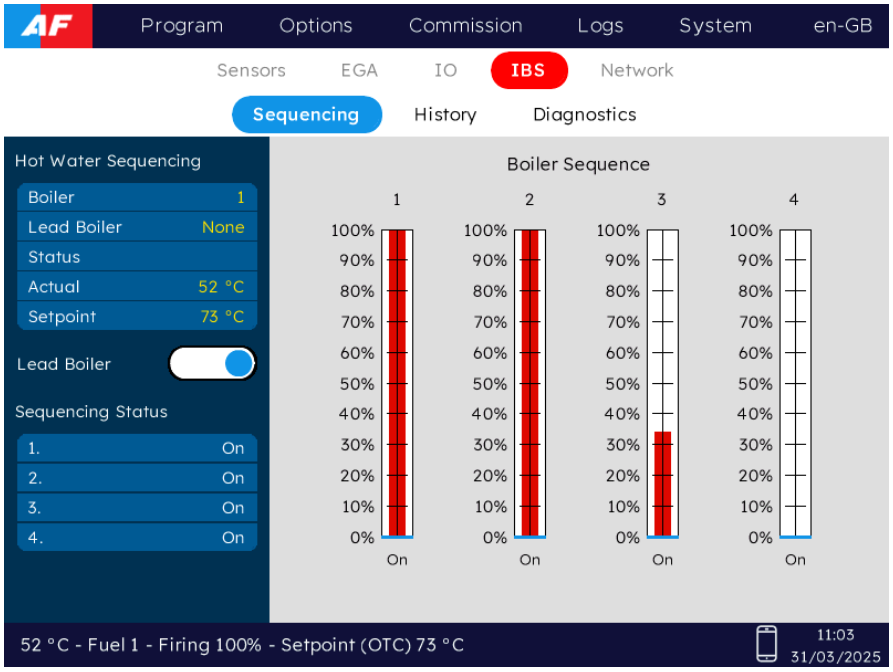


Figure 161 - IBS Status Screen

Press on the **IBS** icon in the Home screen or select **AF/IBS/Sequencing** to view the **IBS Sequencing** screen shown in Figure 161. The following information is displayed:

- Type of sequencing (steam/hot water).
- ID number of the MM (Boiler number).
- Lead boiler status.
- Current status
- Next scan time
- Actual temperature/pressure.
- Setpoint temperature/pressure.
- List of MMs in the sequencing loop and their current status.
- Current firing rates of all the MMs in the loop
- Current status of all the MMs in the loop
- Sequencing communications check

14.5.2 IBS – Lead Boiler

Slide the **Lead Boiler** soft switch shown in Figure 161 to the right in the **IBS Sequencing** screen to select that MM as the Lead Boiler.

Lead Boiler can also be selected using a mains input by setting **Options/MM/Terminals/T98 Function** to **Lead Boiler Select**.

Note: If another MM has already been selected as lead boiler, or no boilers have been selected as lead boiler, then the MMs will fire independently until only one lead boiler has been selected.

14.5.3 IBS – History

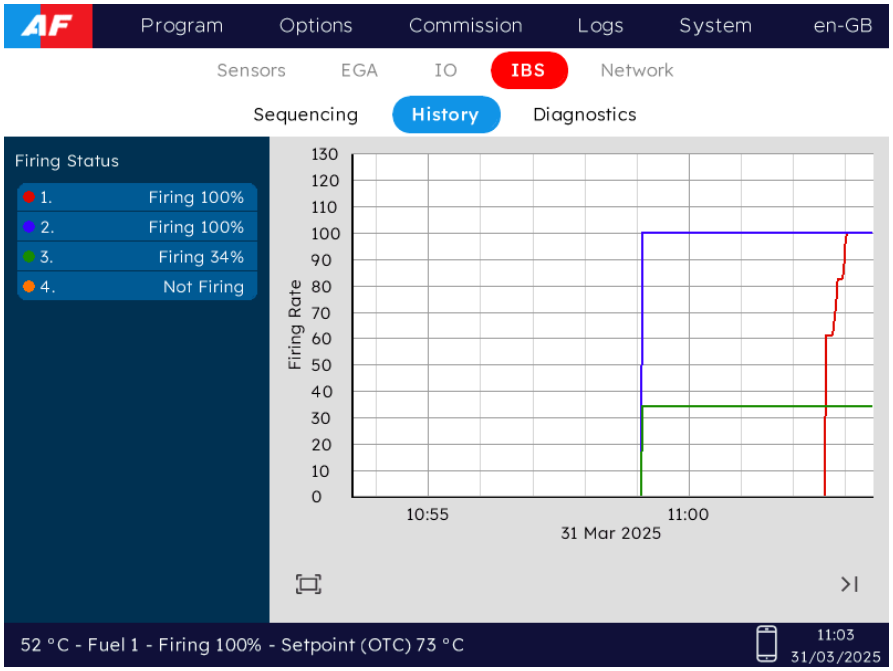


Figure 162- IBS History

Selecting the **History** tab brings up the **IBS History** screen. The firing rate histories for the MMs in the sequencing loop are displayed. This data is logged for 24 hours on the MM.

Use the and to change the scaling of the data displayed on the graph.

This information is logged for 3 years on the DTI when connected with the MM.

Note: Power cycling the MM or changing fuel will reset this data log.

15 CHANGE ON THE FLY

To be implemented in a future software upgrade.

16 STAGED COMBUSTION

To be implemented in a future software upgrade.

17 FIRST OUTS

To be implemented in a future software upgrade.

18 REMOTE CONTROL

18.1 WiFi Settings

The Mini Mk9 has a built-in **WiFi** module which can be used to communicate with the **Autoflame Download Manager App**.

Options/Controller/Network/WiFi Operation can be used to set the **WiFi** module into one of three modes:

- **Always On** : **WiFi** is always visible and anyone with the App can connect to it.
- **Off Until Needed** : **WiFi** module activates when you select any of the **System/WiFi** screens.
- **Always Off** : **WiFi** is always inactive and no-one can connect.

Note: In the **Always Off** state, the **Upload/Download** functions, the **Software Update**, **Screen Saver** and **Screenshot** functions are all unavailable. **Software Update** and **Upload/Download** can still be done via the SD card.

Note: In the **Off Until Needed**, selecting the **System/WiFi screen** and successfully entering the commission password allows a device to be connected over the **WiFi**. Other screens can then be accessed (e.g. to take a screenshot) until the **WiFi** connection is removed on the device, or the device is taken out of range. The **WiFi** will then revert to the **Off** mode.

Note: In order to access the WiFi **Upload** and **Software** screens, the **Commission** password is needed. It is not enough simply to have the app. Without the **Commission** password, only the download and screenshot functions of the App will work.

18.2 Ethernet Settings

The Mini Mk9 retains the RS485 serial connections used in the Mini Mk8, but also includes an RJ45 Ethernet port.

The ethernet connection is enabled and defined in **Options/Controller/Network**. This includes defining what the Ethernet port can be used for with the following options:

- Connection to the Mk9 Software DTI.
- Connection to a Modbus device such as a BMS system (set up in **Options/Controller/Modbus**).
- Connection to a BACnet device such as a BMS system (set **BACnet Over Ethernet** to **Enabled**).

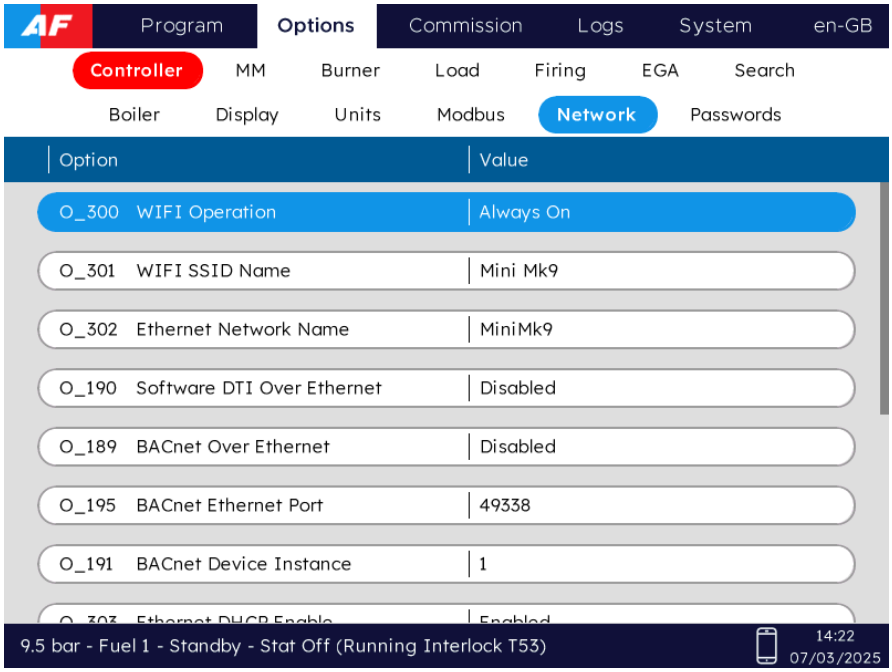


Figure 163 - Network Settings

These options also allows the setup of the ethernet port including **DHCP Enable**, **Static IP Address**, **DNS Mode** and **DNS Servers**.

The **SSID** and Network names will be the settings defined in the options shown above followed by the serial number of the Mini Mk9. Therefore a default **SSID** would be **Mini Mk9 – MM***** (where *** is the serial number). Changing the base name from Mini Mk9 may be useful in a boiler room with more than one mini in order to easily distinguish which one is which without having to check the serial numbers.

18.3 Software DTI

The **Mk9 Software DTI** runs on a PC, Laptop or Tablet and allows up to 10 Mini Mk9s to be connected together over an ethernet network.

The Mini Mk9s must have unique identities set in **Options/Controller/Network/Ethernet Network Name.**

The **Mk9 Software DTI** can display the status of the connected Mini Mk9s and can provide some collective functionality such as:

- Changing between local and global setpoints.
- Enable/Disable individual burners.
- IBS Lead Boiler change and shuffling

18.4 Modbus

The data on a Mini Mk9 MM can be accessed remotely either by connecting the MM to a **Mk9 Software DTI**, a **Mk8 DTI**, or by using **Direct Modbus**. The connection may be either:

- RS485 data link from terminals T27 (-ve) and T28 (+ve). Belden 9501 data cable is recommended.
- Ethernet connection using a Cat 5 or above cable.

There are a limited number of Modbus addresses available on the Mini Mk9 MM which can be accessed directly without the need for a DTI.

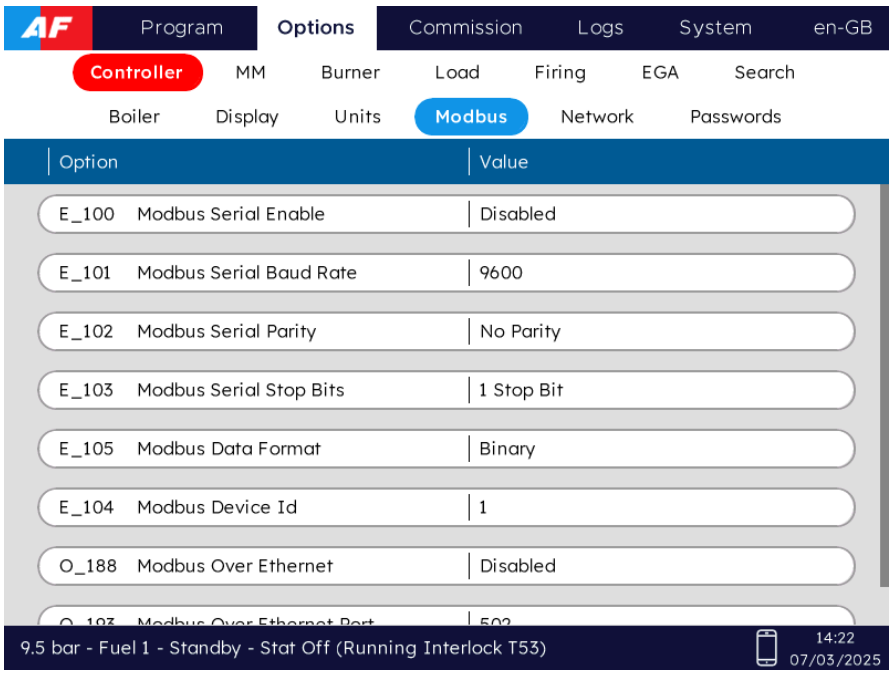


Figure 164 - Modbus Settings

18.4.1 Direct Modbus Configuration

Direct Serial Modbus (Modbus RTU) is enabled using in **Options/Controller/Modbus/Modbus Serial Enable** and uses terminals T27 (RS485 -), T28 (RS485 +) and S (Screen). The format of the **Serial Modbus** message is also defined in the **Options/Controller/Modbus** settings, allowing the **Baud Rate**, **Parity**, **Stop Bits** and **Data Format** to be defined.

Up to 10 MMs can be linked together and connected to a Building Management System (**BMS**). Each Mini Mk9 MM will need to be set with an individual **Options/Controller/Modbus/Modbus Device Id**.

The maximum block of addresses the Mini Mk9 MM can read and write to is 127, as per **Modbus** having a built-in limit of 255 byte packets.

If the MM does not receive any **Modbus** commands for 60 seconds, the **Modbus** goes 'offline.' You can keep the **Modbus** 'online' with a simple instruction, such as polling or setting a single value to that individual MM. If the **Modbus** is 'offline' then remote setpoint and firing rate set via **Modbus** will be disabled. The only exception is the enable/disable burner which changes the disable burner button on the MM on the home screen, as this change will last until the **Modbus** state is changed again or the enable/disable button is pressed again.

If the MM is powered off or the communications is lost, the **Modbus** address values from the unit will not be true.

When using **Direct Modbus** over the serial link, e.g. connecting to a **BMS** from the MM without a DTI, then neither Autoflame Intelligent Boiler Sequencing (**IBS**) nor the DTI can be used.

18.4.2 Modbus Over Ethernet

Alternatively, an **Ethernet Modbus** connection (Modbus TCP/IP) is enabled in **Options/Controller/Modbus/Remote Control Modbus Ethernet** which may be set to **Enabled Read-Only** or **Enabled Read/Write**. The Mini Mk9 should be connected to an **Ethernet Network** using the built in Ethernet connector. The connection will be made using the IP address which can be found on the **System/About** screen. The **Modbus Over Ethernet Port Number** may also be defined.

Any number of Mini Mk9's may be connected to the **Ethernet Network**.

Autoflame Intelligent Boiler Sequencing (**IBS**) with or without a Mk8 DTI remain available when **Modbus Over Ethernet** is being used. The Mk9 Software DTI also remains available over the same ethernet network

18.4.3 Modbus Addresses

There are 4 types of Modbus addresses:

0x Read/Write digital outputs – off/on commands	These are binary values and have a 0/1 value indicating an off/on or no/yes value.
1x Read digital inputs – off/on signals/indications	
3x Read analogue inputs – variable data in	These are multiple integer values and can have a value of 0 to 65534 and do not contain decimal points i.e. channel 1 position Modbus value is 900 which is equivalent to 90.0^{O}
4x Read/Write analogue outputs – variable adjustments	

Address Type:

RWD	=	Read / Write Digital
RD	=	Read Digital
RWA	=	Read / Write Analogue
RA	=	Read Analogue

Table 11 - Modbus Address List

#	Type	Description	Details
00001	RWD	Enable/Disable MM	0 = Enables the Burner 1 = Disables the Burner Value changes state of enable/disable button on MM home screen; changes are kept if MM loses comms with Modbus device sending commands
10001	RD	Device Heartbeat	Output toggles between 0 and 1 every 0.5 seconds.
10194	RD	Running Interlock Status	0 = T53 (STAT) Off 1 = T53 (STAT) On
10217	RD	EGA Optioned	0 = EGA not optioned 1 = Monitoring Only or Applies Trim optioned

#	Type	Description	Details
10218	RD	EGA Is Trimming	0 = EGA not trimming 1 = EGA is trimming Returns value 0 if trimming is prohibited for any reason
10219	RD	EGA Cooler Ready	0 = Cooler is not ready 1 = Cooler is ready Returns value 0 if EGA is an error state
10220	RD	EGA Ambient Temp OK	0 = Temperature not OK 1 = Temperature OK
10224	RD	EGA OK to Sample	0 = EGA is not sampling 1 = EGA is sampling
10233	RD	Hand Mode	0 = MM not in hand mode 1 = MM in hand mode
10234	RD	Low Flame Hold	0 = MM not in low flame hold 1 = MM in low flame hold
10242	RD	Disabled Status	0 = Burner enabled 1 = Burner disabled Returns state of enable/disable button on MM home screen and same value as address 00001
30101	RA	Load Index	Firing rate %
30102	RA	MM Status	Returns a value based on the status of the MM. The return values for the various states are given in Table 12 below.
30104	RA	Burner Rating	Burner rating in MW x 10 Metric units determined from fuel flow metering
30105	RA	Actual Value	Load Sensor Actual Value. Metric: temperature ˚C, pressure Bar x 10, low pressure Bar x 100 Imperial: temperature ˚F, pressure PSI, low pressure PSI x 10
30106	RA	Required Value	Required Setpoint Value. Metric: temperature ˚C, pressure Bar x 10, low pressure Bar x 100 Imperial: temperature ˚F, pressure PSI, low pressure PSI x 10
30107	RA	Selected Fuel	0 = Fuel 1 1 = Fuel 2
30109	RA	Channel 1 Position	Servo 1 angle in degrees x 10 Range is -6.0˚ to 96.0˚
30110	RA	Channel 2 Position	Servo 2 angle in degrees x 10 Range is -6.0˚ to 96.0˚
30111	RA	Channel 3 Position	Servo 3 angle in degrees x 10 Range is -6.0˚ to 96.0˚
30113	RA	MM Error Number	0 = System does not have an error N = error number (See error codes)
30115	RA	EGA Current O_2 Value	O2 reading % x 10
30116	RA	EGA Current CO_2 Value	CO2 reading % x 10
30117	RA	EGA Current CO Value	CO reading ppm x 10
30118	RA	EGA Current Exhaust Gas Temperature	Metric: temperature x 10 ˚C Imperial: temperature x 10 ˚F
30119	RA	EGA Current Efficiency Value	EGA Efficiency reading % x 10
30120	RA	EGA Current NO Value	NO reading ppm x 10
30121	RA	EGA Current SO_2 Value	SO2 reading ppm x 10
30122	RA	EGA Commissioned O_2 Value	Commissioned O2 reading at current firing rate % x 10
30123	RA	EGA Commissioned CO_2 Value	Commissioned CO2 reading at current firing rate % x 10
30124	RA	EGA Commissioned CO Value	Commissioned CO reading at current firing rate ppm x 10

#	Type	Description	Details
30125	RA	EGA Commissioned Exhaust Gas Temperature	Commissioned Exhaust Gas Temperature reading at current firing rate Metric: temperature x 10 ˚C Imperial: temperature x 10 ˚F
30126	RA	EGA Commissioned Efficiency Value	Commissioned EGA Efficiency reading at current firing rate % x 10
30127	RA	EGA Commissioned NO Value	Commissioned NO reading at current firing rate ppm x 10
30128	RA	EGA Commissioned SO_2 Value	Commissioned SO2 reading at current firing rate ppm x 10
30129	RA	EGA Error Code	0 = EGA does not have a fault N = EGA error
30130	RA	Minimum Setpoint	Minimum allowable Setpoint Metric: temperature ˚C, pressure Bar x 10, low pressure Bar x 100 Imperial: temperature ˚F, pressure PSI, low pressure PSI x 10
30131	RA	Maximum Setpoint	Maximum allowable Setpoint Metric: temperature ˚C, pressure Bar x 10, low pressure Bar x 100 Imperial: temperature ˚F, pressure PSI, low pressure PSI x 10
30132	RA	Current Flow Thousands	Instantaneous Fuel Flow Metric kW, imperial MMBTU/hr x 1000 Remainder after whole number of MW or MMBTU/hr x 1000 taken away. E.g. 1.5MW gives 500 value and 15.1MMBTU/hr gives 100 value
30133	RA	Current Flow Millions	Instantaneous Fuel Flow Metric MW, imperial MMBTU/hr Whole number of MW or MMBTU/hr. E.g. 1.5MW gives 1 value and 15.1MMBTU/hr gives 15 value
30134	RA	Fuel 1 Flow Total Thousands	Fuel 1 Totalized Fuel Flow Metric kW/hr, imperial MMBTU/hr Remainder after whole number of MW/hr or MMBTU x 1000 taken away, x 1000. E.g. 1.5MW/hr gives 500 value and 15.1MMBTU gives 100 value
30135	RA	Fuel 1 Flow Total Millions	Fuel 1 Totalized Fuel Flow Metric MW/h, imperial MMBTU Whole number of MW/hr or MMBTU. E.g. 1.5MW/hr gives 1 value and 15.1MMBTU gives 15 value
30136	RA	Fuel 1 Flow Total Billions	Fuel 1 Totalized Fuel Flow Metric GW/hr, imperial MMBTU / 1000 Whole number of GW/hr or MMMBTU E.g. 1.5MW/hr gives 0 value and 15.1MMBTU gives 0 value
30137	RA	Fuel 2 Flow Total Thousands	Fuel 2 Totalized Fuel Flow Metric kW/hr, imperial MMBTU/hr Remainder after whole number of MW/hr or MMBTU x 1000 taken away, x 1000. E.g. 1.5MW/hr gives 500 value and 15.1MMBTU gives 100 value
30138	RA	Fuel 2 Flow Total Millions	Fuel 2 Totalized Fuel Flow Metric MW/h, imperial MMBTU Whole number of MW/hr or MMBTU. E.g. 1.5MW/hr gives 1 value and 15.1MMBTU gives 15 value
30139	RA	Fuel 2 Flow Total Billions	Fuel 2 Totalized Fuel Flow Metric GW/hr, imperial MMBTU / 1000 Whole number of GW/hr or MMMBTU E.g. 1.5MW/hr gives 0 value and 15.1MMBTU gives 0 value

#	Type	Description	Details
30143	RA	EGA Current Ambient Temperature	EGA Ambient Temperature reading Metric: temperature x 10 ˚C Imperial: temperature x 10 ˚F
30144	RA	EGA Current Delta Temperature	EGA Exhaust Gas Temperature - Ambient Temperature reading Metric: temperature x 10 ˚C Imperial: temperature x 10 ˚F
30145	RA	EGA Commissioned Ambient Temperature	Commissioned Ambient Temperature reading at current firing rate Metric: temperature x 10 ˚C Imperial: temperature x 10 ˚F
30146	RA	EGA Commissioned Delta Temperature	Commissioned Exhaust Gas Temperature - Ambient Temperature reading at current firing rate Metric: temperature x 10 ˚C Imperial: temperature x 10 ˚F
30147	RA	UV Counts	UV Count value
30148	RA	IR Counts	IR Count value
30149	RA	Ionisation Counts	Ionization Count value
30150	RA	EGA Current NO_2 Value	NO2 reading ppm x 10
30151	RA	EGA Commissioned NO_2 Value	Commissioned NO2 reading at current firing rate ppm x 10
30804	RA	Channel 4 VSD Output	VSD output in mA x 10 or V x 10
30805	RA	Channel 4 VSD Input	VSD input mA x 10 or V x 10
30830	RA	Lockout Number	0 = System is not in lockout N = lockout number
30831	RA	Fuel 1 Type	0 = Gas 1 = Oil 2 = Biogas 3 = Hydrogen 4 = Solid Fuel
30832	RA	Fuel 2 Type	0 = Gas 1 = Oil 2 = Biogas 3 = Hydrogen 4 = Solid Fuel
30839	RA	Fuel 1 Hours Run	Completed hours on Fuel 1
30840	RA	Fuel 2 Hours Run	Completed hours on Fuel 2
30843	RA	Fuel 1 Start-ups	Start-ups on Fuel 1
30844	RA	Fuel 2 Start-ups	Start-ups on Fuel 2
30847	RA	Current Air Pressure	Air Pressure sensor reading in mbar x 10, “wg x 10
30849	RA	Current Gas Pressure	Gas Pressure sensor reading in mbar x 10, “wg x 10, PSI x 100
32009	RA	Alarm Status	0 = No Alarm 1 = Alarm active
32010	RA	Warning Status	0 = No Warning 1 = Warning active
32012	RA	Alarm Code	0 = System is not in Alarm N = Alarm number
32013	RA	Warning Code	0 = System is not in Warning N = Warning number
40001	RWA	Remote Required Setpoint	Remote Setpoint value. Metric: temperature ˚C, pressure Bar x 10, low pressure Bar x 100 Imperial: temperature ˚F, pressure PSI, low pressure PSI x 10 After 1 minute of no Modbus comms, the M.M. will ignore this value and revert to internal Setpoint

#	Type	Description	Details
40121	RWA	Remote Firing Rate	% 40131 must be set to 1 to change the firing rate remotely
40131	RWA	Remote Firing Rate Enable	0 = Remote firing rate disabled 1 = Remote firing rate enabled

18.4.4 Modbus Address For MM Status (30102)

Modbus address 30102 shows MM State, with the following values returned to identify the current state (this same table also applies to the BACnet Firing Status instance):

Table 12 - MM Status Modbus Codes

Code	Status	Code	Status
1	Recycle	**12**	Pre-Ignition
2	Standby	**13**	Pilot Proving
3	Starting	**14**	Main Flame Proving
4	Wait Secondary Proving	**15**	Golden Start
5	Wait CPI	**16**	FGR
6	Wait Air Switch	**17**	Firing
7	Zero Air Sensor	**18**	Moving to low fire to shut down
8	Valve Proving	**22**	Run to Post-Purge
9	Run to Pre-Purge	**23**	Post-Purge
10	Pre-Purge	**24**	Post-Firing Valve Proving
11	Run to Ignition	**255**	Fault

18.5 BACnet

Direct **BACnet** access can be defined over an **Ethernet** connection by setting **Options/Controller/Network/BACnet Over Ethernet** to **Enabled**. Other settings in this menu define the **BACnet Ethernet Port** and the **BACnet Device Instance**.

Once **Enabled**, the Mini Mk9 will announce itself to any **BACnet** controller on the **Ethernet Network** allowing the data instances in the following table to be accessed:

Table 13 - MM Status BACnet Instances

Type	Name	Details
Analogue Input	Load Index	Firing rate %
	Burner Rating	Burner Rating defined from Fuel Flow metering
	Fuel Flow	Instantaneous fuel flow in MW
	Load Sensor	Load Sensor Actual Value. Metric: temperature ˚C, pressure Bar Imperial: temperature ˚F, pressure PSI
	Current Fuel	Current Fuel Number
	Servo 1 Angle (°)	Servo Position in °
	Servo 2 Angle (°)	Servo Position in °
	Servo 3 Angle (°)	Servo Position in °
	VSD 1 Feedback	VSD signal Feedback level in mA
	VSD 1 Output	VSD signal Output level in mA
	PWM Feedback	PWM signal Feedback level
	PWM Output	PWM signal Output level
	UV or Ionization Flame Count	UV or Ionization Count value
	IR Flame Counts	IR Count value
	UV Trim Flame Count	UV Trim Count value
	Fuel 1 Fuel Flow Total	Fuel 1 Totalized Fuel Flow in MWh

Type	Name	Details
	Fuel 2 Fuel Flow Total	Fuel 2 Totalized Fuel Flow in MWh
Analogue Output	Setpoint	Required Setpoint Value. Metric: temperature ˚C, pressure Bar Imperial: temperature ˚F, pressure PSI
	Remote Load Index	Remote Firing rate %
Binary Input	Running Interlock Status	0 = Running Interlock Off 1 = Running Interlock On
	Main Stat Status	0 = STAT (T53) Off 1 = STAT (T53) On
	Low Flame Hold	0 = MM not in Low Flame Hold 1 = MM in Low Flame Hold
	System Error Status	0 = No Error 1 = Error is active
	Lockout Status	0 = No Lockout 1 = Lockout is active
	Alarm Status	0 = No Alarm 1 = Alarm is active
	Warning Status	0 = No Warning 1 = Warning is active
Binary Output	Burner Inhibit	0 = Burner enabled 1 = Burner disabled
	Remote Load Index Enable	0 = Remote firing rate disabled 1 = Remote firing rate enabled
Device	Device Name	Mini Mk9_**** (where **** = Serial Number)
Multi State Input	Firing Status	Returns a value based on the status of the MM. The return values for the various states are given in Table 12 in the Modbus section above.
	Sequence Status	1 = On 2 = Standby 3 = Warming 4 = Off

19 ERRORS AND LOCKOUTS

19.1 Errors

Errors occur when the MM detects an internal fault, component out of range, internal check failure or power supply issue. To clear an error, the MM must be restarted.

Table 14 - Mini Mk9 Errors

Error	Message	Description
1	Software Error	Software Fault
• Failure of internal software integrity checks. • Install latest software - Contact Autoflame approved local Tech Centre if problem persists.		
2	Burner Control Comms Error	Hardware Fault
• Loss of communications to/from the burner control microprocessor. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
3	VSD Hardware Fault	VSD won't drive to desired level
• Check wiring on terminals T10/T11/T12. • Check cable is screened at MM end only. • Check VSD is operating correctly.		
4	VSD Feedback Error	VSD feedback is out of tolerance
• Check wiring on terminals T1, T2 & T3. • Check cable is screened at MM end only. • Check VSD 1 Feedback Fault Tolerance – increase the tolerance if possible. • Check VSD is operating correctly.		
5	Servo Positioning Error	Servomotor is outside of the commissioned range
• Check Event Detail to determine which Servo has the error. • Check wiring on terminals: Servo 1 - T40/T41/T42; Servo 2 – T40/T41/T43; Servo 3 - T44/T46/T47. • Check signal cable from the MM to the servomotor is screened at MM end only and correct cable type is used. • Check potentiometer is zeroed correctly. • Go into Commission Mode, check the servomotor position and ensure that closed is at 0.0^{O}		
6	Servo Movement Error	Servomotor moves when not expected and vice versa
• Check Event Detail to determine which Servo has the error. • Check wiring and voltages on terminals: Servo 1 - T70/T71; Servo 2 – T72/T73; Servo 3 - T74/T75. • Check servomotors drive in the correct direction. • Check valve/damper is not stuck. • Check Servo feedback cable runs separately to high voltage cables to terminals: Servo 1 - T40/T41/T42; Servo 2 – T40/T41/T43; Servo 3 - T44/T46/T47.		
7	Servo Gain Error	Servomotor position measurement hardware error
• Check Event Detail to determine which Servo has the error. • Check wiring and voltages on terminals Servo 1 - T40/T41/T42; Servo 2 – T40/T41/T43; Servo 3 - T44/T46/T47. Check for any shorts.		
8	CPU Lock-Step Failure	Hardware Fault
• FAR processor Lock-Step operation not in sync. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
9	FAR Program Checksum	Software Fault
• Failure of internal FAR Microprocessor software integrity checks • Install latest software - Contact Autoflame approved local Tech Centre if problem persists.		
10	Digital Power Supply Error	ADC measured 3.3V supply out of range
• Check for noise on the mains input, wiring and voltages on all terminals.		
11	EEPROM Error	Fault communicating with the on board EEPROM
• Likely internal error. Contact Autoflame approved local Tech Centre if the problem persists.		

Error	Message	Description
12	ADC Error	Hardware Fault
• Error in analogue to digital conversion. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
13	Processor Temperature Error	Maximum Processor Temperature Exceeded
• Check ambient temperature of unit does not exceed maximum recommended temperature. • Provide cooling if necessary.		
14	Processor Clock Error	Hardware Fault
• Likely interference issue – check grounding of unit and shielding of cables. • Contact Autoflame approved local Tech Centre if problem persists.		
15	Watchdog Failure	Hardware Fault
• Failure of the Burner Control Watchdog ICs. Likely interference issue – check grounding of unit and shielding of cables. • Contact Autoflame approved local Tech Centre if problem persists.		
16	Watchdog Timeout	Hardware Fault
• Timeout waiting for Burner Control Watchdog IC response - Likely interference issue – check grounding of unit and shielding of cables. • Contact Autoflame approved local Tech Centre if problem persists.		
17	Burner Control Fault	Hardware Fault
• Failure of the Burner Control IC. Likely interference issue – check grounding of unit and shielding of cables. • Contact Autoflame approved local Tech Centre if problem persists.		
18	VSD Servo Positioning Error	VSD operating as a servo is outside of commissioned range
• Check wiring on terminals T1/T2/T3. • Check cable is screened at MM end only. • Check 4/20mA or 0/10V servo is operating correctly. • Go into Commission Mode, check the VSD Servo position and ensure that closed is at 0.0^{O}		
19	Power Supply Error	Power Supply out of tolerance
• Check power supply voltage. • Check mains input for noise and interference. • Install filtering or UPS if necessary.		
20	PWM Feedback Error	PWM feedback is out of tolerance
• Check wiring on terminals T99 - T102. • Check cable is screened at MM end only. • Check PWM fan is operating correctly.		
21	Mains Monitoring Error	Fuel mains input stuck reading low
• Check wiring and voltages on mains voltage terminals T53 – T98.		
22	Display Communications Lost	Hardware Fault
• Comms to the Display IC on the card engine lost. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		

19.2 Lockouts

Lockouts occur when the MM detects a fault with the burner operation such as **VPS**, **Gas/Air Pressure Sensor** and **Flame Scanners**. The **Lockout** must be cleared and investigated on the MM.

Table 15 - Mini Mk9 Lockouts

Lockout	Message	Description
1	CPI Input	Proof of closure switch opened during ignition sequence
• Check wiring on terminal T55. • Check proof of closure switches.		
2	No Air Proving	No air pressure during start/ firing
• Check wiring on terminal T54. • Check air pressure switch/air pressure sensor. • Check air pressures during running. Recommission if pressures have changed.		

Lockout	Message	Description
3	Ignition Output Fault	Voltage detected when output is off (and vice versa)
• Check wiring and voltage on terminal T63. • Check 4A Fuse F1. Check 5A fuse F4.		
4	Motor Output Fault	Voltage detected when output is off (and vice versa)
• Check wiring and voltage on terminal T58. • Check 4A Fuse F1. Check 5A fuse F4.		
5	Pilot Output Fault	Voltage detected when output is off (and vice versa)
• Check wiring and voltage on terminal T59. • Check 4A Fuse F1. Check 5A fuse F4.		
6	Main Gas 1 Output Fault	Voltage detected when output is off (and vice versa)
• Check wiring and voltage on terminal T60. • Check 4A Fuse F1. Check 5A fuse F4.		
7	Main Gas 2 Output Fault	Voltage detected when output is off (and vice versa)
• Check wiring and voltage on terminal T61. • Check 4A Fuse F2. Check 5A fuse F4.		
8	Vent Valve Output Fault	Voltage detected when output is off (and vice versa)
• Check wiring and voltage on terminal T62. • Check 4A Fuse F2. Check 5A fuse F4.		
9	Failsafe Relay	Voltage detected when output is off (and vice versa)
• Check wiring and voltage on terminal T57. • Check 5A fuse F4.		
10	Simulated Flame	Flame is present when it should not be
• Isolate all fuels immediately. • Check the wiring and screening on the Flame Scanner. Replace the Flame Scanner if error persists. • Call a certified Commissioning Engineer to investigate. • If this lockout occurs during shutdown a post-purge may be required for after burn.		
11	VPS Pressure Increase	Leak detected during 'air proving' part of VPS
• Check Event Detail to see pressure change. • Check 1st main gas valve. • Call a certified Commissioning Engineer to investigate.		
12	VPS Pressure Decrease	Leak detected during 'gas proving' part of VPS
• Check Event Detail to see pressure change. • Check **Options/Burner/Valve Proving/Maximum Pressure Change Allowed During VPS**. • Check 2nd main gas valve and vent valve. • Check pilot valve if using single valve pilot. • Isolate gas and call a certified Commissioning Engineer to investigate.		
13	No Flame Signal	No flame detected during ignition/ firing
• Visually check flame – is it present but not being detected. • Check the Flame Scanner(s) and its wiring • Check **Options/Burner/Flame Scanners/Flame Scanner** - are multiple Flame Scanners being used in the AND mode. Activate each scanner separately to see where the issue lies. • Can the scanner(s) see both the pilot and main flame in AND mode. • Call a certified Commissioning Engineer to investigate.		
14	UV Shutter Fault	UV signal detected during shutter operation on self-check
• Check wiring on terminals T21/T22. • Check UV Flame Scanner is a Self-Check type and set **UV Flame Scanner Type** accordingly in **Options/Burner/Flame Scanners**.		
15	NO CPI Reset	Proof of closure switch not made after valves closed
• Check wiring on terminal T55. • Check proof of closure switches.		
16	Permanent Lockout Reset	Lockout Reset Input stuck on
• Check **Options/MM/Terminals/T80 Function, T81 Function or T82 Function** to determine which input is being used for **Lockout Reset.** • Input should only be present for a few seconds to clear a **Lockout**. It cannot remain on to automatically clear all **Lockouts** as they occur. • Check voltage and wiring on terminal T80, T81 or T82 as defined above.		

Lockout	Message	Description
19	VPS Pressure Increase (Fuel 2)	Leak detected during 'air proving' part of VPS
• Check Event Detail to see pressure change. • Check Fuel 2 1st main gas valve. • Call a certified Commissioning Engineer to investigate.		
20	VPS Pressure Decrease (Fuel 2)	Leak detected during 'gas proving' part of VPS
• Check Event Detail to see pressure change. • Check **Options/Burner/Valve Proving/Maximum Pressure Change Allowed During VPS**. • Check Fuel 2 2nd main gas valve and vent valve. • Check pilot valve if using single valve pilot. • Isolate gas and call a certified Commissioning Engineer to investigate.		
21	FSR Test 1A	Safety Relay 1 Feedback failed
• Safety Relay 1 - RL11 stuck on or off. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
22	FSR Test 2A	Safety Relay 1 Feedback failed
• Safety Relay 1 - RL11 stuck on or off. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
23	FSR Test 1B	Safety Relay 2 Feedback failed
• Safety Relay 2 - RL10 stuck on or off. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
24	FSR Test 2B	Safety Relay 2 Feedback failed
• Safety Relay 2 - RL10 stuck on or off. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
25	Digital Output Test (A)	Relay Feedback Internal check failed
• A relay is stuck on. Check wiring and voltages on terminals T50 – T63/T83/T84/T96. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
26	Digital Output Test (B)	Relay Feedback Internal check failed
• A relay is stuck on. Check wiring and voltages on terminals T50 – T63/T83/T84/T96. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
27	FSR Test 3A	Safety Relay 1 Feedback failed
• Safety Relay 1 - RL11 stuck on or off. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
28	FSR Test 3B	Safety Relay 2 Feedback failed
• Safety Relay 2 - RL10 stuck on or off. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
29	FSR Test 4A	Safety Relay 1 Feedback failed
• Safety Relay 1 - RL11 stuck on or off. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
30	FSR Test 4B	Safety Relay 2 Feedback failed
• Safety Relay 2 - RL10 stuck on or off. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
39	Phase Hold Timeout	MM kept in Phase Hold for more than 10 minutes
• MM may only be kept in Phase Hold during commissioning for a maximum of 10 minutes.		
42	Flame Switch True/Inverse	Flame Switch True/Inverse mismatch
• Flame Switch inputs are not a True/Inverse pair – they are both reading on or both reading off. • Check **Options/MM/Terminals/T80 Function, T81 Function** or **T82 Function** to determine which inputs are being used for the Flame Switch pair. • Check voltages on the two inputs. • Check Flame Switch.		
44	Non-Recycling Interlock State	Delay To Purge input lost
• Check **Options/MM/Terminals/T80 Function, T81 Function or T82 Function** to determine which input is being used for **Delay To Purge.** • Once made, this input must remain made for the whole of the Purge, Ignition and Firing stages. • Check voltage and wiring on terminal T80/T81/T82 as defined above.		

Lockout	Message	Description
45	Non-Recycling Interlock Timeout	Delay To Purge Timeout has elapsed
• Check **Options/MM/Terminals/T80 Function, T81 Function or T82 Function** to determine which input is being used for **Delay To Purge.** • Input must be made within the **Options/Burner/Purge/Delay To Purge Timeout.** • Check voltage and wiring on terminal T80/T81/T82 as defined above.		
50	Ionization Simulated Peak	Flame detected when there should not be (secondary test for ionisation)
• Visually check flame, flame rod and wiring to T64. • Call a certified Commissioning Engineer to investigate.		
51	Ionization Lost Peak	No flame detected when there should be (secondary test for ionisation)
• Visually check flame, flame rod and wiring to T64. • Call a certified Commissioning Engineer to investigate.		
52	High IR Ambient	Flame detected when there should not be
• Visually check flame. • Check IR scanner. • Call a certified Commissioning Engineer to investigate.		
53	IR Flame Scanner Comms Lost	Loss of comms with IR scanner
• Check wiring and screen on terminals T29/T30/T48/T49. • Check that the IR scanner is not removed from the magnetic ring socket. Mk9 IR scanners will pulse red if power is applied correctly. • Check IR Scanner.		
54	UV Trim Scanner Comms Lost	Loss of comms with UV Trim scanner
• Check wiring and screen on terminals T29/T30/T48/T49. • Mk9 UV Trim scanners will pulse blue if power is applied correctly (will be solid blue before 1st commission). • Check UV Trim Scanner.		
55	Ionization Self Check	Internal Ionization Self Check Test failed
• Check wiring on terminal T52. • Check Ionization Rod.		
61	UV/ION High Voltage Calibration Failed	Internal check failed for UV dark level
• Check wiring on terminals T21/T22/T50/T51. • Check Ionization Rod/UV Scanner.		
62	UV Counts High	UV counts stuck at 255 (saturation)
• With UV drive signal at minimum, the counts are still at 255 so there is no quenching of the UV circuit. • Check wiring on terminals T21/T22/T50/T51. • Move UV scanner away from flame or change its angle to the flame to get the counts to drop below 255.		
63	Purge Limit Switch	Interlock not made on terminal T80, T81 or T82
• Check **Options/MM/Terminals/T80 Function, T81 Function or T82 Function** to determine which input is set to **Purge Position Interlock**. • Input must be made for the whole of the purge phase and then reset at the end of purge. • Check voltage and wiring on terminal T80/T81/T82 as defined above. • Check the **Limit Switch** on the air damper.		
64	Start Limit Switch	Interlock not made on terminal T80, T81 or T82.
• Check **Options/MM/Terminals/T80 Function, T81 Function or T82 Function** to determine which input is set to **Start Position Interlock**. • Input must not be made during Purge, then must be made to verify the servos are at the start position. • Check voltage and wiring on terminal T80/T81/T82 as defined above. • Check the **Limit Switch** on the air damper.		
65	FSRA Feedback	Safety Relay 1 Feedback Internal check failed
• Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
66	FSRB Feedback	Safety Relay 2 Feedback Internal check failed
• Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
77	Waiting for Air Switch	Voltage has not been reset for 2 minutes
• Check air pressure sensor value during VPS. • Check voltage has been reset on terminal T54 within 2 minutes before **Run To Purge**. • Check wiring and voltage on terminal T54.		

Lockout	Message	Description
79	FSR Test 1C	Relay Enable Feedback failed
• A relay is stuck on or off. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
80	Timeout Reaching Purge	Timeout For Reaching Purge time has elapsed
• Check **Options/Burner/Purge/Timeout For Reaching Purge**. The servo must be able to drive to the Purge Position within this time. Adjust if it is too short. • Check air damper can move freely • Check air damper servo works correctly.		
82	Purge Pressure Proving	Pressure reads above zero before the fan should have started
• Check Event Detail to see air pressure. • Check Pressure sensor and its wiring. • Check air fan. • Call a certified Commissioning Engineer to investigate.		
83	Fuel 2 Main Gas 1 Feedback	Fuel 2 Main Fuel Gas Valve 1 stuck on – Voltage on T96
• Check voltage on Fuel 1 Valve 1 output: T96. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
84	Fuel 2 Main Gas 2 Feedback	Fuel 2 Main Fuel Gas Valve 2 stuck on – Voltage on T83
• Check voltage on Fuel 1 Valve 1 output: T83. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
85	Fuel 2 Vent Valve Feedback	Fuel 2 Vent Valve 1 stuck on – Voltage on T84
• Check voltage on Fuel 1 Valve 1 output: T84. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
97	FAR Interlock	Error with FAR Microprocessor Chip
• Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
99	CPI Input (Inactive Fuel)	CPI/POC input made on inactive fuel
• Check CPI/POC input: T55 if Fuel 1 is active or T97 if Fuel 2 is active • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
100	Ignition Coil Feedback	Ignition Transformer Relay driver in wrong state
• Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
101	Burner Motor Coil Feedback	Burner Motor Relay driver in wrong state
• Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
102	Pilot Coil Feedback	Pilot Valve Relay driver in wrong state
• Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
103	Main Gas 1 Coil Feedback	Fuel 1 Valve 1 Relay driver in wrong state
• Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists..		
104	Main Gas 1 Coil Feedback	Fuel 1 Valve 2 Relay driver in wrong state
• Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
105	Vent Valve Coil Feedback	Vent Valve Relay driver in wrong state
• Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
106	Fuel 2 Main Gas 1 Coil Feedback	Fuel 2 Valve 1 Relay driver in wrong state
• Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
117	Fuel 2 Main Gas 2 Coil Feedback	Fuel 2 Valve 2 Relay driver in wrong state
• Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
118	Fuel 2 Vent Valve Coil Feedback	Fuel 2 Vent Valve Relay driver in wrong state
• Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
120	Mains Input Stuck On (T53)	Burner On/Off stuck on – Voltage on T53
• Check voltage on Burner On/Off input: T53. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
121	Mains Input Stuck On (T54)	Air Proving Switch stuck on – Voltage on T54
• Check voltage on Air Proving Switch input: T54. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
122	Mains Input Stuck On (T55)	Fuel 1 CPI/POC stuck on – Voltage on T55
• Check voltage on Fuel 1 CPI/POC input: T55. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		

Lockout	Message	Description
123	Mains Input Stuck On (T97)	Fuel 2 CPI/POC stuck on – Voltage on T97
• Check voltage on Fuel 2 CPI/POC input: T97. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
124	Mains Input Stuck On (T80)	BC Programmable Input 1 stuck on – Voltage on T80
• Check voltage on BC Programmable Input 1: T80. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
125	Mains Input Stuck On (T81)	BC Programmable Input 2 stuck on – Voltage on T81
• Check voltage on BC Programmable Input 2: T81. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
126	Mains Input Stuck On (T82)	BC Programmable Input 3 stuck on – Voltage on T82
• Check voltage on BC Programmable Input 3: T82. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
131	Mains Input Stuck On (Burner Motor Relay Feedback)	Burner Motor relay stuck on – Voltage on T58
• Check voltage on Burner Motor output: T58. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
132	Mains Input Stuck On (Ignition Relay Feedback)	Ignition Transformer relay stuck on – Voltage on T63
• Check voltage on Ignition Transformer output: T63. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
133	Mains Input Stuck On (Pilot Relay Feedback)	Pilot Valve relay stuck on – Voltage on T59
• Check voltage on Pilot Valve output: T59. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
134	Mains Input Stuck On (Main Gas 1 Relay Feedback)	Main Fuel Gas Valve 1 stuck on – Voltage on T60
• Check voltage on Fuel 1 Valve 1 output: T60. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
135	Mains Input Stuck On (Main Gas 2 Relay Feedback)	Main Fuel Gas Valve 2 stuck on – Voltage on T61
• Check voltage on Fuel 1 Valve 2 output: T61. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
136	Mains Input Stuck On (Vent Valve Relay Feedback)	Vent Valve relay stuck on - Voltage on T62
• Check voltage on Vent Valve 1 output: T62. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
139	Mains Input Stuck On (Vent Valve 2 Relay Feedback)	Vent Valve 2 relay stuck on – voltage on T84.
• Check voltage on Vent Valve 2: T84. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
140	Mains Input Stuck On (Call For Heat)	Call For Heat relay stuck on – voltage on T57.
• Check voltage on Call For Heat: T57. • Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		
201	EEPROM Read Failure	Internal check of EEPROM failed
• Power cycle unit - Contact Autoflame approved local Tech Centre if problem persists.		

19.3 Alarms And Warnings

Alarms and warnings are faults detected with the system operation. If an alarm occurs, the burner will stop running, and if a warning occurs, the burner will continue to run.

The following Options set whether system operation faults are set as alarms or warnings:

- **Options/EGA/Operation/EGA Fault Response**.
- **Options/MM/Terminals/Alarm Response**.

Table 16 - Mini Mk9 Alarms and Warnings

Fault	Message	Description
1	EGA Internal Error	Fault on EGA
• Alarm or warning depending on **EGA Fault Response** setting. • Check EGA for fault description		
2	No EGA Communications	MM has lost communications with EGA
• Alarm or warning based on **EGA Fault Response** setting (warning if **Options/EGA/Operation/EGA Mode** is set to M**onitoring Only**) • Check EGA version is Mk8 or above. • Check EGA Control Mode is selected as 'Controlled by MM'. • Check wiring between EGA and MM (T25/T26 on MM).		
3	EGA O2 Upper Limit	O2 value is above upper limit offset of commissioned value*
• Alarm or warning depending on **EGA Fault Response** setting. • Check exhaust gas readings and **Options/EGA/Limits/O2 Upper Limit Offset**.		
4	EGA O2 Absolute Limit	O2 value is below absolute limit*
• Alarm or warning depending on **EGA Fault Response** setting. • Check exhaust gas readings and **Options/EGA/Limits/O2 Absolute Limit**.		
5	EGA O2 Lower Limit	O2 value is below lower limit offset of commissioned value*
• Alarm or warning depending on **EGA Fault Response** setting. • Check exhaust gas readings and **Options/EGA/Limits/O2 Lower Limit Offset**.		
6	EGA CO2 Upper Limit	CO2 value is above upper limit offset of commissioned value*
• Alarm or warning depending on **EGA Fault Response** setting. • Check exhaust gas readings and **Options/EGA/Limits/CO2 Upper Limit Offset**.		
7	EGA CO2 Absolute Limit	CO2 value is above absolute limit*
• Alarm or warning depending on **EGA Fault Response** setting. • Check exhaust gas readings and **Options/EGA/Limits/CO2 Absolute Limit**.		
8	EGA CO2 Lower Limit	CO2 value is below lower limit offset of commissioned value*
• Alarm or warning depending on **EGA Fault Response** setting. • Check exhaust gas readings and **Options/EGA/Limits/CO2 Lower Limit Offset**.		
9	EGA CO Upper Limit	CO value is above upper limit offset of commissioned value*
• Alarm or warning depending on **EGA Fault Response** setting. • Check exhaust gas readings and **Options/EGA/Limits/CO Upper Limit Offset**.		
10	EGA CO Absolute Limit	CO value is above absolute limit*
• Alarm or warning depending on **EGA Fault Response** setting. • Check exhaust gas readings and **Options/EGA/Limits/CO Absolute Limit**.		
11	EGA NO Upper Limit	NO value is above upper limit offset of commissioned value*
• Alarm or warning depending on **EGA Fault Response** setting. • Check exhaust gas readings and **Options/EGA/Limits/NO Upper Limit Offset**.		
12	EGA Exhaust Temperature Upper Limit	Exhaust temperature is above upper limit offset of commissioned value*
• Alarm or warning depending on **EGA Fault Response** setting. • Check exhaust gas readings and **Options/EGA/Limits/Exhaust Temperature Limit Offset**.		
13	EGA Exhaust Temperature Absolute Limit	Exhaust temperature is above absolute limit*
• Alarm or warning depending on **EGA Fault Response** setting. • Check exhaust gas readings and **Options/EGA/Limits/Exhaust Temperature Absolute Limit**.		
100	Load Sensor Fault	Incorrect/no load sensor detected
• Always an alarm. • Check **Options/Load/Load Sensor/Boiler Load Sensor Type**. • Check wiring on terminals T37 – T39.		
101	High Limit Setpoint	Load Temperature or Pressure exceeds the high limit
• Check event detail to see load temperature or pressure reached. • See **Options/Load/Sensor/Internal High Setpoint Limit** for maximum level.		

Fault	Message	Description
102	External Modulation Input Low	External Modulation Voltage or Current below minimum level
• Check **Options/Firing/Modulation/External Modulation Input Range.** • Check **External Modulation Controller** output range. • Check **Options/MM/Terminals/VSD 1 Current Input Function, VSD 1 Voltage Input Function** or **Load Sensor Input Function** to check which terminals are being used for the input signal. • Check input on: VSD1 Current - T1/T3; VSD 1 Voltage – T2/T3; Load Sensor – T37/T38.		
103	External Firing Rate Limiter Input Low	External Firing Rate Limiter Voltage or Current below minimum level
• Check **Options/Firing/Modulation/External Firing Rate Limiter Input Range.** • Check **External Firing Rate Limiter Controller** output range. • Check **Options/MM/Terminals/VSD 1 Current Input Function, VSD 1 Voltage Input Function** or **Load Sensor Input Function** to check which terminals are being used for the input signal. • Check input on: VSD1 Current - T1/T3; VSD 1 Voltage – T2/T3; Load Sensor – T37/T38.		
104	External Setpoint Input Low	External Setpoint Voltage or Current below minimum level
• Check **Options/Load/Setpoint/External Setpoint Input Range.** • Check **External Setpoint Controller** output range. • Check **Options/MM/Terminals/VSD 1 Current Input Function, VSD 1 Voltage Input Function** or **Load Sensor Input Function** to check which terminals are being used for the input signal. • Check input on: VSD1 Current - T1/T3; VSD 1 Voltage – T2/T3; Load Sensor – T37/T38.		
105	O2 Sensor Input Low	O2 Sensor Voltage or Current below minimum level
• Check **Options/EGA/O2 Sensor/O2 Sensor Input Range.** • Check **O2 Sensor** output range. • Check **Options/MM/Terminals/VSD 1 Current Input Function, VSD 1 Voltage Input Function** or **Load Sensor Input Function** to check which terminals are being used for the input signal. • Check input on: VSD1 Current - T1/T3; VSD 1 Voltage – T2/T3; Load Sensor – T37/T38.		
106	VSD 1 Input Low	VSD 1 Voltage or Current below minimum level
• Check **Options/MM/VSD/VSD 1 Input Mode.** • Check **VSD** output range. • Check **Options/MM/Terminals/VSD 1 Current Input Function,** or **VSD 1 Voltage Input Function** to check which terminals are being used for the VSD input signal. • Check input on: VSD1 Current - T1/T3; VSD 1 Voltage – T2/T3.		
200	Air Pressure Sensor Comms	Air Pressure Sensor comms not working
• Check wiring to pressure sensor, T31/T32/T33/T34. • Check air pressure sensor.		
201	Fuel 1 Pressure Sensor Comms	Gas Pressure Sensor comms not working
• Check wiring to pressure sensor, T31/T32/T33/T34. • Check gas pressure sensor.		
202	Fuel 2 Pressure Sensor Comms	Gas Pressure Sensor comms not working
• Check wiring to pressure sensor, T31/T32/T33/T34. • Check gas pressure sensor.		
205	Draught Pressure Sensor Comms	Draught Pressure Sensor comms not working
• Check wiring to draught pressure sensor, T31/T32/T33/T34. • Check air pressure sensor.		
206	Air Pressure Below Warning Level	Air Pressure dropped below low warning level during firing
• Check Event Detail to see air pressure. • Check air pressure sensor and its wiring. • Check air damper. • Call a certified Commissioning Engineer to investigate.		
207	Air Pressure Above Warning Level	Air Pressure exceed high warning level during firing
• Check Event Detail to see air pressure. • Check air pressure sensor and its wiring. • Check air damper. • Call a certified Commissioning Engineer to investigate.		

Fault	Message	Description
208	Air Pressure Outside Error Window	Air Pressure outside of the error window during firing
• Check Event Detail to see air pressure. • Check air pressure sensor and its wiring. • Check air damper. • Call a certified Commissioning Engineer to investigate.		
209	Air Pressure Zero Value Invalid	Sensor reading above zero at the zeroing phase
• Check Event Detail to see air pressure. • Check air pressure sensor and its wiring. • Check air fan. • Call a certified Commissioning Engineer to investigate.		
220	Fuel 1 Pressure Zero Value Invalid	Initial VPS Air Proving pressure not in expected range
• Check Event Detail to see gas pressure. • Check gas pressure sensor and its wiring. • Check Main Gas Valves. • Call a certified Commissioning Engineer to investigate.		
221	Fuel 2 Pressure Zero Value Invalid	Initial VPS Air Proving pressure not in expected range
• Check Event Detail to see gas pressure. • Check gas pressure sensor and its wiring. • Check Main Gas Valves. • Call a certified Commissioning Engineer to investigate.		
224	Fuel 1 Air Proving Pressure Invalid	VPS Air Proving pressure not in expected range
• Check Event Detail to see gas pressure. • Check gas pressure sensor and its wiring. • Check Main Gas Valves. • Call a certified Commissioning Engineer to investigate.		
225	Fuel 2 Air Proving Pressure Invalid	VPS Air Proving pressure not in expected range
• Check Event Detail to see gas pressure. • Check gas pressure sensor and its wiring. • Check Main Gas Valves. • Call a certified Commissioning Engineer to investigate.		
228	Fuel 1 Gas Proving Pressure Invalid	Initial VPS Gas Proving pressure not in expected range
• Check Event Detail to see actual gas pressure. Compare with Maximum Pressure Change Allowed in VPS and Gas Static Line Pressure Offset Below Commissioned – these must be less than the actual gas pressure. • Check Pressure sensor and its wiring. • Check Main Gas Valves. • Call a certified Commissioning Engineer to investigate.		
229	Fuel 2 Gas Proving Pressure Invalid	Initial VPS Gas Proving pressure not in expected range
• Check Event Detail to see actual gas pressure. Compare with Maximum Pressure Change Allowed in VPS and Gas Static Line Pressure Offset Below Commissioned – these must be less than the actual gas pressure. • Check Pressure sensor and its wiring. • Check Main Gas Valves. • Call a certified Commissioning Engineer to investigate.		
232	Fuel 1 Low Pressure Gas Before Start	Fuel pressure too low to start combustion
• Check Event Detail to see gas pressure. • Check Pressure sensor and its wiring. • Check Main Gas Valves. • Call a certified Commissioning Engineer to investigate.		

Fault	Message	Description
233	Fuel 2 Low Pressure Gas Before Start	Fuel pressure too low to start combustion
• Check Event Detail to see gas pressure. • Check Pressure sensor and its wiring. • Check Main Gas Valves. • Call a certified Commissioning Engineer to investigate.		
236	Fuel 1 Running Pressure High Limit	Fuel Pressure exceed high limit during firing
• Check Event Detail to see gas pressure. • Check Pressure sensor and its wiring. • Check Main Gas Valves. • Call a certified Commissioning Engineer to investigate.		
237	Fuel 2 Running Pressure High Limit	Fuel Pressure exceed high limit during firing
• Check Event Detail to see gas pressure. • Check Pressure sensor and its wiring. • Check Main Gas Valves. • Call a certified Commissioning Engineer to investigate.		
240	Fuel 1 Running Pressure Low Limit	Fuel Pressure dropped below low limit during firing
• Check Event Detail to see gas pressure. • Check Pressure sensor and its wiring. • Check Main Gas Valves. • Call a certified Commissioning Engineer to investigate.		
241	Fuel 2 Running Pressure Low Limit	Fuel Pressure dropped below low limit during firing
• Check Event Detail to see gas pressure. • Check Pressure sensor and its wiring. • Check Main Gas Valves. • Call a certified Commissioning Engineer to investigate.		
244	Fuel 1 Running Pressure High Warning	Fuel Pressure exceed high warning level during firing
• Check Event Detail to see gas pressure. • Check Pressure sensor and its wiring. • Check Main Gas Valves. • Call a certified Commissioning Engineer to investigate if this persists.		
245	Fuel 2 Running Pressure High Warning	Fuel Pressure exceed high warning level during firing
• Check Event Detail to see gas pressure. • Check Pressure sensor and its wiring. • Check Main Gas Valves. • Call a certified Commissioning Engineer to investigate if this persists.		
248	Fuel 1 Running Pressure Low Warning	Fuel Pressure dropped below low warning level during firing
• Check Event Detail to see gas pressure. • Check Pressure sensor and its wiring. • Check Main Gas Valves. • Call a certified Commissioning Engineer to investigate if this persists.		
249	Fuel 2 Running Pressure Low Warning	Fuel Pressure dropped below low warning level during firing
• Check Event Detail to see gas pressure. • Check Pressure sensor and its wiring. • Check Main Gas Valves. • Call a certified Commissioning Engineer to investigate if this persists.		

Fault	Message	Description
300	Clock Is Not Set (Logging Disabled)	Clock still set at default time

- Select **System**/**Set Clock**, enter the **Online Changes Password** and set the clock to the current time and date or Upload Date Time from the App.

*When **Test Combustion Limits** is **Enabled** in ***Options***/***EGA***/***Limits***, the combustion limits are evaluated as follows:

- Once per trim cycle if **EGA Mode** is set to **Applies Trim** in ***Options***/***EGA***/***Operation***.
- Once every **Combustion Limits Interval When Not Trimming** as set in ***Options***/***EGA***/***Limits***.

A combustion limit error will occur if the current exhaust value has crossed the **Combustion Limit** for the number of tests (whichever one is applied as defined above) set in **Trim Samples Before Combustion Limits Triggered** (the default value is 3 cycles) set in ***Options***/***EGA***/***Limits***.

19.4 Setting Conflicts

Some of the **Options** may require another **Option** to be set or disabled, as described in the table below. If a conflict occurs then any settings changes may not be saved, with the only options being to 'Discard Changes' or to 'Continue Editing' to correct the conflict.

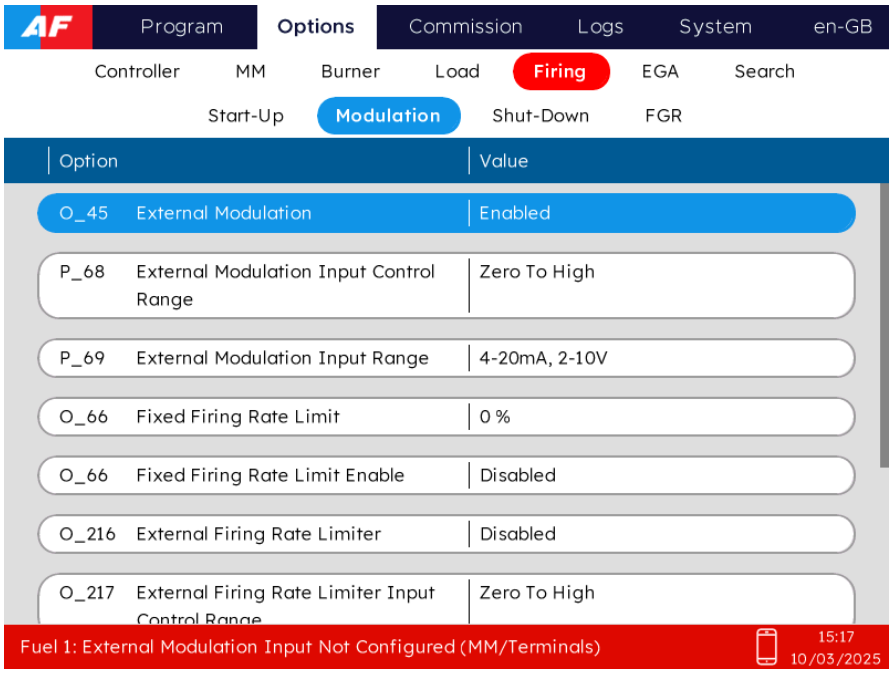


Figure 165 - Settings in Conflict

Table 17 - Mini Mk9 Settings Conflicts

Setting Conflict Message
External Modulation Is Not Configured

- Enabling **Options**/**Firing**/**Modulation**/**External Modulation** requires the Modulation input to be set up.
- Use **Options**/**Firing**/**Modulation**/**External Modulation Input Control Range** to define how the modulation changes with the input.
- Use **Options**/**Firing**/**Modulation**/**External Modulation Input Range** to define the minimum/maximum current/voltage for the input.
- In **Options**/**MM**/**Terminals** set one of **VSD 1 Current Input Function**, **VSD 1 Voltage Input Function** or **Load Sensor Input Function** to be **External Modulation**. Note that all three can be used simultaneously for different inputs so carefully select which input covers which function.

Setting Conflict Message
External Load Sensor Is Not Configured
• Setting **Options/Load/Load Sensor/Boiler Load Sensor Type** to **External Temperature** or **External Pressure** requires configuration of the **External Load Detector**. • In **Options/Load/Load Sensor** set **External Load Detector Minimum Value**, **External Load Detector Maximum Value**, **External Load Detector Minimum Voltage** and **External Load Detector Maximum Voltage** in. • **Options/MM/Terminals/Load Sensor Input Function** must be set to **Load Sensor Input**.
Internal Stat Configured With No Load Sensor
• Setting **Options/Load/Load Sensor/Boiler Load Sensor Type** set to **None** requires the **Options/Load/Load Sensor/Internal Stat Operation** to be set to **Internal Stat Always Closed**. Note that some method of controlling the Stat is required.
OTC Setpoints Too High For Optioned Load Sensor
• If **Options/Load/Setpoint/Outside Temperature Compensation** is **Enabled**, the **Setpoint At Minimum Temperature** and **Setpoint At Maximum Temperature** must be set within the possible range of the optioned load detector. • Check load detector range in **Options/Load/Load Sensor/Boiler Load Sensor Type**. • Set **Options/Load/Setpoint/Setpoint At Minimum Temperature** and **Setpoint At Maximum Temperature** appropriately.
Two Fuel Channels Cannot Be Enabled
• Only One channel may be configured as fuel. • Check all three **Options/MM/Servo/Servo Enable** settings and the **Options/MM/VSD/VSD 1 Enable** setting.
User Setpoint Limits Invalid
• **Options/Load/Setpoint/Setpoint Minimum** cannot be set higher than the **Setpoint Maximum**.
External Setpoint Limits Invalid
• **Options/Load/Setpoint/External Setpoint Minimum** cannot be set higher than the **External Setpoint Maximum**.
OTC Configuration Invalid
• **Options/Load/Setpoint/Setpoint At Minimum Temperature** cannot be set the same as **Setpoint At Maximum Temperature**. • **Options/Load/Setpoint/Minimum Outside Temperature** cannot be set the same as **Maximum Outside Temperature.**
UV/Ionization Changeover Not Allowed With No-Pilot
• If **Options/Burner/Pilot/Pilot Mode** is set to **No Pilot**, then **Options/Burner/Flame Scanners/Flame Sensor Selection** cannot be set to **UV/Ionization Switchover**.
Single Valve Pilot Configured With No Pilot
• If **Options/Burner/Pilot/Pilot Mode** is set to **No Pilot**, then **Options/Burner/Pilot/Single Valve Pilot** must be set to **Single Valve Pilot Disabled**.
Single Valve Pilot Configured With Oil Fuel
• If **Options/MM/Fuel/Fuel Type** is set to **Oil** for either fuel, then **Options/Burner/Pilot/Single Valve Pilot** must be set to **Single Valve Pilot Disabled** for that fuel.
Single Valve Pilot Configured With Dual Fuel Output Mode
• If **Options/MM/Terminals/Fuel Valve Output Configuration** is set to **Two Sets of Outputs (No Changeover Relays)** or **Two Sets Of Outputs, Change On The Fly (COF)**, then **Options/Burner/Pilot/Single Valve Pilot** must be set to **Single Valve Pilot Disabled**.
Second Safety Time Invalid For Fuel Type
• If **Options/MM/Fuel/Fuel Type** is set to **Gas**, **Bio-Gas** or **Hydrogen**, the maximum allowed **Options/Burner/Timings/Second Safety Time** is 10 seconds.
NFPA Post Purge Less Than 15 Seconds
• If **Options/Burner/Purge/Post Purge Type** is set to **NFPA Post Purge**, then **Options/Burner/Purge/Post Purge Time** must be set to a minimum of 15 seconds.

Setting Conflict Message
Valve Proving Digital Input Is Not Configured
• Setting **Options/Burner/Sensors/Fuel Pressure Sensor Mode** to **Valve Proving With Digital Input** requires configuration of one of the Burner Control Inputs. • In **Options/MM/Terminals** set one of **T80 Function**, **T81 Function** or **T82 Function** to **Valve Proving**.
Valve Proving Not Allowed For Fuel Type
• Valve proving and gas pressure limits can only be used for gaseous fuels. • Check **Options/MM/Fuel/Fuel Type** and **Options/Burner/Sensors/Fuel Pressure Sensor Mode**.
Internal High Limit Stat Configured Without Internal Stat
• If **Options/Load/Setpoint/Internal High Limit Setpoint** is set greater than zero (i.e. it is enabled), then **Options/Load/Load Sensor/Internal STAT Operation** must be configured to **Burner Operates Below Setpoint** or **Burner Operates Above Setpoint**.
Modulation Exerciser Enabled With Sequencing
• **Options/Firing/Modulation/Modulation Exerciser Period** should only be used for test purposes. It must be set to disabled if **Options/Load/Sequencing/Sequencing** is **Enabled.**
Stat Exerciser Enabled With Sequencing
• **Options/Firing/Modulation/STAT Exerciser Period** should only be used for test purposes. It must be set to disabled if **Options/Load/Sequencing/Sequencing** is **Enabled.**
Purge Pressure Proving Timeout Longer Than Pre-Purge Time
• **Options/Burner/Purge/Purge Pressure Proving Timeout** must be set to 0 (**Disabled**) or set longer than the **Options/Burner/Purge/Pre-Purge Time**.
Purge Pressure Proving Timeout Longer Than Post-Purge Time
• **Options/Burner/Purge/Purge Pressure Proving Timeout** must be set to 0 (**Disabled**) or set longer than the **Options/Burner/Purge/Post-Purge Time** if a **Post-Purge** is set.

19.5 Forced Commission

The MM will be forced into 'Not Ready To Run' mode if there is a setting conflict and/or one or more of the following conditions occurs:

Forced Commission Message
Optioned channels do not match commission.
• The defined **servomotor**, **VSD** and/or **PWM** channels selected does not match the last commission settings or this fuel is yet to be commissioned. • Check channel settings in **Options/MM** and re-commission if necessary.
Golden Start optioned but not commissioned.
• **Options/Firing/Start-Up/Golden Start** is **Enabled** but has not yet been commissioned. Check **Golden Start** and carry out a **Golden Start** commission if required.
FGR optioned but not commissioned.
• **Options/Firing/FGR/Flue Gas Recirculation Timer** has been set but has not yet been commissioned. Check **Flue Gas Recirculation Timer** in carry out an **FGR** commission if required.
EGA fuel/air-rich trim ranges changed.
• EGA trim range does not match last commission settings. Check **Commissioned Fuel-Rich Trim** and **Commissioned Air-Rich Trim** and recommission trim points in **Commission/Single Point Change/Trim Change** if necessary.
Commissioned VPS pressure missing
• **Options/Burner/Sensors/Fuel Pressure Sensor Mode** has been set to **Valve Proving With Pressure Sensor** but is not yet commissioned. Select **Commission/Commission/Pressure** to perform a gas pressure commission or **Commission/Commission/Full Commission** for a full re-commission.
Pressure commission data missing
• **Options/Burner/Sensors/Fuel Pressure Sensor Mode** has been set to **Valve Proving And Pressure Limits** or **Options/Burner/Sensors/Air pressure Sensor Type** has been set to **Air Pressure Sensor** but they are not yet commissioned. Select **Commission/Commission/Pressure** to perform a gas pressure commission or **Commission/Commission/Full Commission** for a full re-commission.

Forced Commission Message
Commissioned VPS Pressure too low.
• The gas pressure stored during valve proving is less than the **Options/Burner/Valve Proving/Maximum Pressure Change Allowed During VPS**. Check value or re-do the Pressure Commission.
Running Fuel Pressure Limit Too Low
• **Options/Burner/Valve Proving/Gas Running Pressure Offset Below Commissioned Curve** is greater than the commissioned gas pressure. Check value or re-do the Pressure Commission.
Air Pressure Error Window Too Large
• **Options/Burner/Sensors/Air Pressure Error Window** is larger than one or more of the commissioned points.
VSD 1 Feedback Insufficient Variation
• VSD feedback variation across the Fuel-Air curve is within the **Options/MM/VSD/VSD 1 Feedback Fault Tolerance,** meaning that a constant value can pass for any point on the curve. Change the Tolerance or redo the commission with a greater variation of the VSD.

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