CONTENTS

Section 4 page:

1. VFD (VSD) and PWM fan speed control

1.1 Introduction.

The NX6300 must be ordered with one of two alternative fan speed control systems as follows:

- 0 – 10V dc speed output
- PWM speed output

The 0 -10V system is the option to choose when using the controller with a conventional VFD with pulse or current speed feedback.

The PWM versions is used with burners that have an air blower with integrated PWM speed control electronics. These blowers are frequently used on pre-mix burners and the manufacturers include EBM Papst and Ametek.

1.2 How does the speed controller work?

During the start-up of the burner and before the boiler can be purged, the NX6300 controller drives all metering valve actuators to their minimum positions and sets the speed output to zero. The controller then monitors the feedback signal from the VFD drive or pulse feedback unit and compares it to the values stored in memory at commission time. If the values do not match those stored in memory, a positioning fault is given, and the controller performs a non-volatile lockout.

If the test is successful, the controller moves all selected drives to their pre-purge positions. If the drives cannot achieve their pre-purge positions, as set during commissioning, a positioning fault is given, and the controller performs a non-volatile lockout.

If the burner start-up is successful, the controller will control the speed of the fan during modulation. A closed loop control method is used, where adjustments to the speed reference signal are based on the value of the feedback signal.

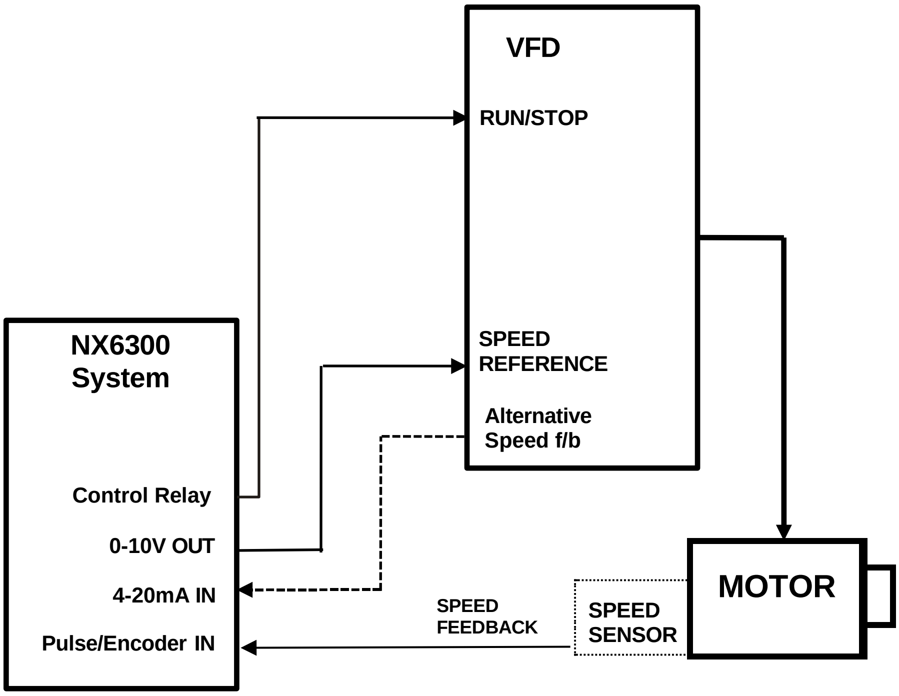
If the feedback signal from the drive is lost during a run condition (e.g., the loop current drops below 3.5 mA or encoder feedback fails) the NX6300 series controller will perform a non-volatile lockout.

1.3 System Configuration

The NX6300 series controllers can control one VFD drive unit to regulate the combustion air fan speed. The controller outputs a 0-10V signal as a speed reference to the VFD which it uses to set the motor supply frequency (speed).

Many national burner codes do not allow the speed feedback as a 4-20 mA signal from the VFD. This is because it is not a true indication of the fan motor speed. The preferred feedback method is an encoder pulse signal, albeit you may still choose to configure the feedback as a 4-20mA signal. The value of the feedback signal is used to calculate the speed output requirement, in a similar way to the feedback from the metering valve actuators.

In addition to the 0-10V signal, the VFD drive unit also requires a start signal, which can configure as a function of a volt-free relay contact on an HMI. Make sure its function is set correctly using the relevant option parameter.



1.4 Setting up the VFD for use with the NX6300

The NX6300 series will work with most VFD drive units, provided they meet the following criteria:

- 0 - 10 V speed reference input.
- Remote run/stop command.
- The VFD must be powerful enough to accelerate / decelerate the motor as required. A good industrial VFD drive unit will have a significant overload capability, meaning that it can supply well above the rated motor load for some time. This should be 150% (or more) for 1 minute.

CAUTION

- An HVAC VFD typically will have no (or very limited) overload capability and may not be able to accelerate / decelerate the motor and fan quickly without current limiting. This can cause drive position faults when driving to purge.

Analog inputs and outputs

Configure the Analog inputs and outputs (i.e., the 0 -10 V reference and 4-20mA feedback signals) on the VFD in the following way:

- 0 -10 V signal (this may be an option parameter and/or a board jumper)
- Speed reference input
- Minimum frequency 0 Hz for 0V
- Maximum reference frequency as required (nominally 50 Hz or 60 Hz) for 10V input signal.
- No filtering (time constant = 0.0) and no rate limiting

Additional settings when using 4-20mA speed feedback from the VFD:

- Alternative 4-20mA speed feedback output
- Maximum feedback frequency (same as reference) for 20 mA signal

Run/Stop Digital input

Configure the VFD in the following way:

- RUN/STOP from external input (NOT VFD keyboard)
- RUN/STOP active high (i.e., energize to start)

Control characteristics

Configure the control characteristics of the VFD in the following way:

- Acceleration and deceleration time approximately 25 - 40 seconds, must be the same, values entered into (Appendix > Option Parameters > Option 09.3).
- Straight line (linear) acceleration between reference points
- Motor to coast to a stop when RUN signal is removed.
- No critical frequencies.
- DC braking may be needed if motor deceleration is not linear.

Motor characteristics

Enter the following motor characteristics into the VFD's option parameter list:

- Motor nominal voltage, power, current and frequency (see motor plate and/or supplier data).
- Motor current and temperature limits.
- U/F ratio. Use the option for fans and pumps.
- Motor slip ratio

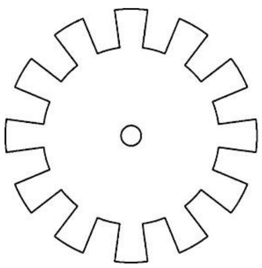
1.5 Encoder Wheel design

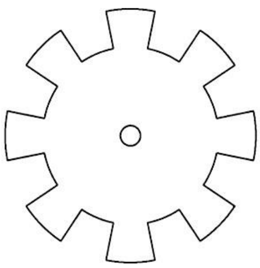
Encoder feedback is in the form of a series of electronic pulses, which represent the speed of the motor shaft. A toothed encoder wheel is fixed to the motor shaft. The electronic pulses are generated when the teeth of the wheel pass close to a proximity detector. The number of teeth on the encoder wheel determines the resolution of speed measurement.

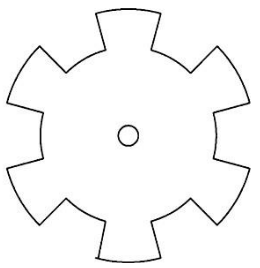
The manufacturer of this equipment recommends the following relationship between the maximum motor speed and the number of teeth on the encoder wheel:

Motor speed rating for 50/60 Hz	Number of encoder teeth
1000 – 2499 rpm	12
1000 – 3750 rpm	8
3000 – 5000 rpm	6

The encoder wheel must be manufactured to close tolerances to ensure an even ON and OFF pulse width when rotating. Here are drawings of example encoder wheels:


12 teeth


8 teeth


6 teeth

Proximity Detection Devices

The NX6300 is designed to operate with detectors that meet a minimum requirement specification as follows:

- 24V dc supply
- 3-wire connection
- PNP, open collector output

The following proximity detection devices have been tested and are recommended as compatible with the NX6300 when using encoder discs of the types shown above:

- Pepperl+Fuchs NBB4-12GM30-E2
- Omron E2E-X5MB1 L2
- Carlo Gavazzi ICB12L50F04

1.6 PWM Fan speed control

The PWM type blowers operate in a very similar way to the conventional VFD system.
The speed output from the NX6300 is a series of 10V pulses of varying length (depending upon the target speed).
Feedback of the fan speed is in the form of pulses from an integrated encoder system in the blower electronics.
The electric interface between the NX6300 and the blower is a very simple 4 wire system.

1.7 Setting up the NX6300 series for use with an VFD Drive

In order to use an VFD drive unit with the NX6300 series, the following steps must be taken:

1. Enter Commission mode.
2. Push the MODE key to select Option Set mode.
3. Set option 3.x to select the feedback mode.
4. Set options 9.x to suit the VFD and load characteristics.
5. Set option 17.x to a value 26 for Run/Stop from a HMI relay.
6. Push the MODE key to select Commission Ratio mode.
7. Look at the display for the VFD output. The display should show 0 for a feedback signal of zero speed and 999 for full speed. If the display is flashing ‘High’, then the feedback signal is not connected, or the encoder sensor is faulty. In all these cases, check the wiring and/or the option parameters on the VFD. The encoder feedback value displayed will depend on the frequency measured by the input - See 8 below.
8. Monitor the reference signal from the NX6300 daughter board. Select the VFD drive unit and use the UP key to increase the output gradually up and the DOWN key to decrease the output.
9. Drive the VFD drive unit to its maximum value (normally 50 Hz or 60 Hz, depending on motor rating / local mains frequency). Using Engineer's Key number 69 you can determine the measured pulse frequency in Hertz. Add about 2% to 5% to this value (to ensure it is the maximum you would ever expect to get) and program the increased value into option parameter 9.5. The displayed value for this drive should now be 950 to 990 (i.e., 95% to 99%). For reliability, make sure the feedback cannot exceed 99.9% (999). This is why a small percentage is added to the 100% scale value entered in the option parameter. See the description for option parameter 9.5 for a way to check this value using a calculation.
10. For the rest of the commissioning procedure, treat the VFD drive unit in the same way as a motor. The VFD drive unit has a closed position (000), a maximum position (999), a pre-purge position, an ignition position and up to 20 profile positions.

2. The Oxygen Trim option

2.1 Introduction

Oxygen trim is the process of adjusting the Fuel Air ratio to improve the operating characteristic of the burner.

2.2 Oxygen Probe description

The oxygen trim / monitoring function requires the optional NXO2TRIM Oxygen Probe Interface unit with an NX6083 oxygen probe. This probe offers fast, accurate response and good reliability when mounted and maintained in accordance with the guidelines in this section.

The NXO2TRIM interface controls the oxygen probe and processes the signals from the probe into CAN messages, which are then transmitted to the NX6300. The interface also manages the condition of the NX6083 oxygen probe to optimize the operation life. Part of the management function is to set the probe Off into a 'sleep' mode when the burner has been Off for 4 minutes, and then restarting the probe as soon as the burner starts. When the probe is in sleep mode the oxygen measurement system is suspended.

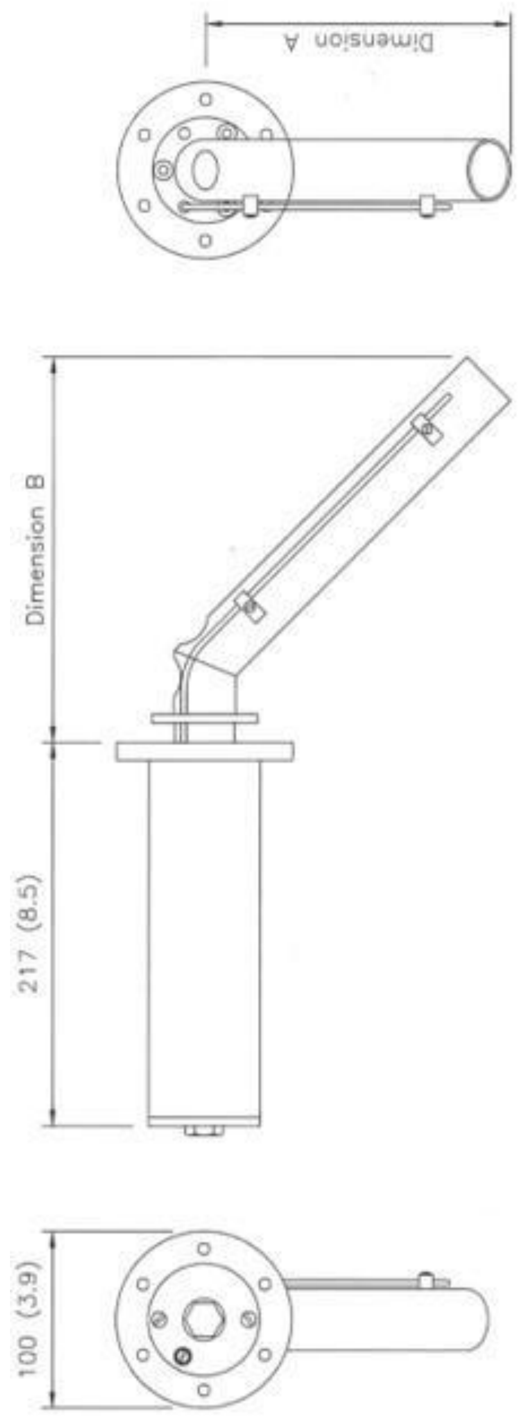
The probe is available in three different sizes, shown by the drawing on the following page.

NX6083-1 is suitable for flue/chimneys with diameter 0.3m to 0.86m.(1ft to 3 ft)
NX6083-2 is suitable for flue/chimneys with diameter 0.5m to 1.6m. (1.5ft to 5.25 ft)
NX6083-3 is suitable for flue/chimneys with diameter 1.0m to 3.75m. (3.25 ft to 12.25 ft)

The probe end cap is removed to expose the electrical connections and carries the 20 mm flexible conduit fitting, to enable the interconnection wiring to be easily detached without re-wiring.

There is a calibration port located in the back of the probe, which is sealed with a screw.
You must keep this port sealed during normal operation, for safe and accurate performance.

Oxygen Probe drawing:

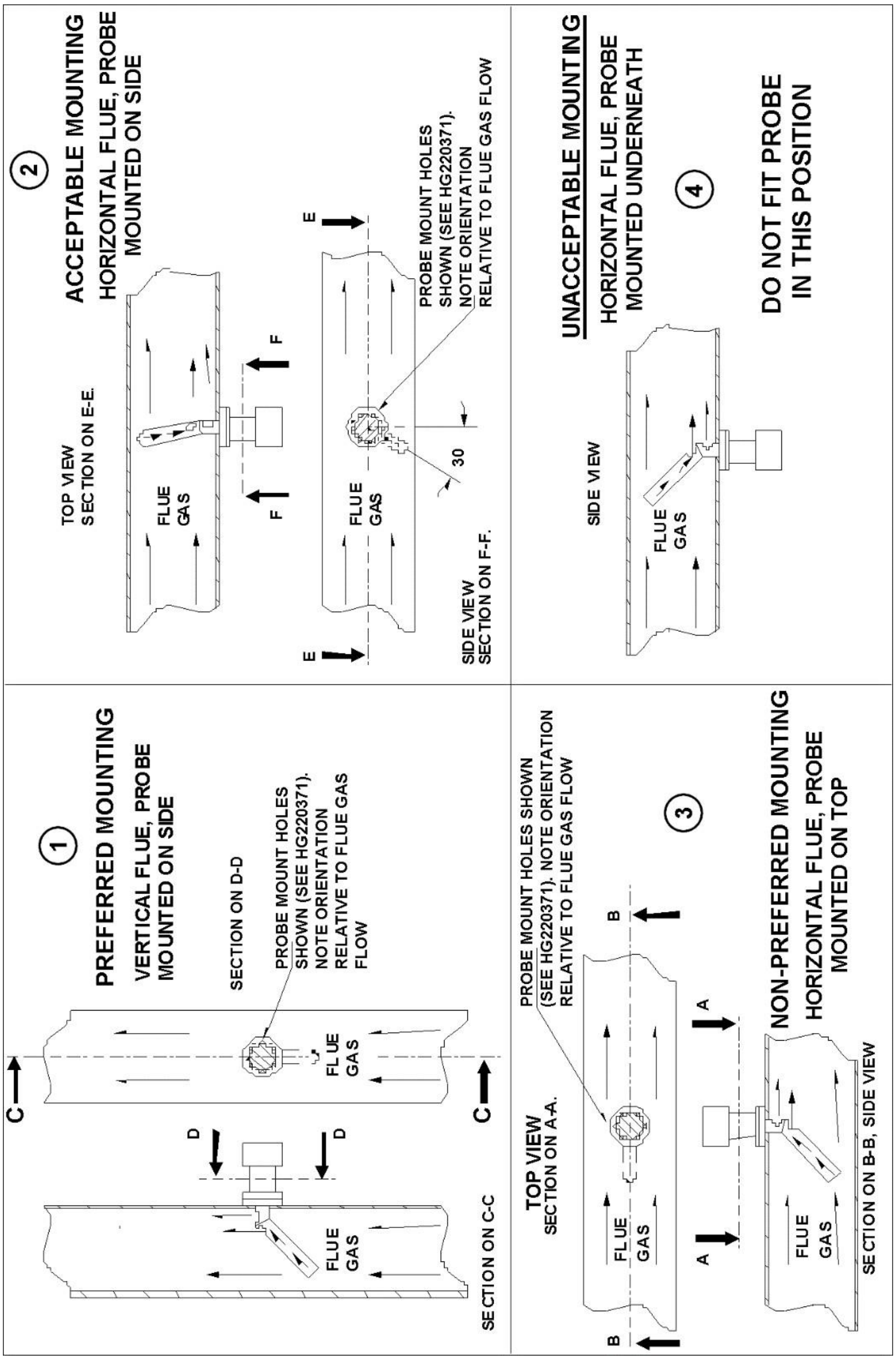


Model No.	Dimension A	Dimension B	Weight
6083/1	173mm (6.8")	215mm (8.5")	2.4kg (5.3lb)
6083/2	362mm (14.3")	406mm (16.0")	2.9kg (6.4lb)
6083/3	716mm (28.2")	757mm (31.4")	3.6kg (7.9lb)

2.3 Installing the Oxygen Probe

2.3.1 Mounting the Oxygen Probe

Mount the probe so that the flue gases pass into the gas tube at its open end and out of the tube at the flange end. Preferred mounting (1) is with the flange vertical, and the gas tube angled downwards, to make sure that particulates do not build up within the sample tube. Mounting the probe with the flange horizontal (2) is acceptable. Inverted probe mounting is **not** acceptable.



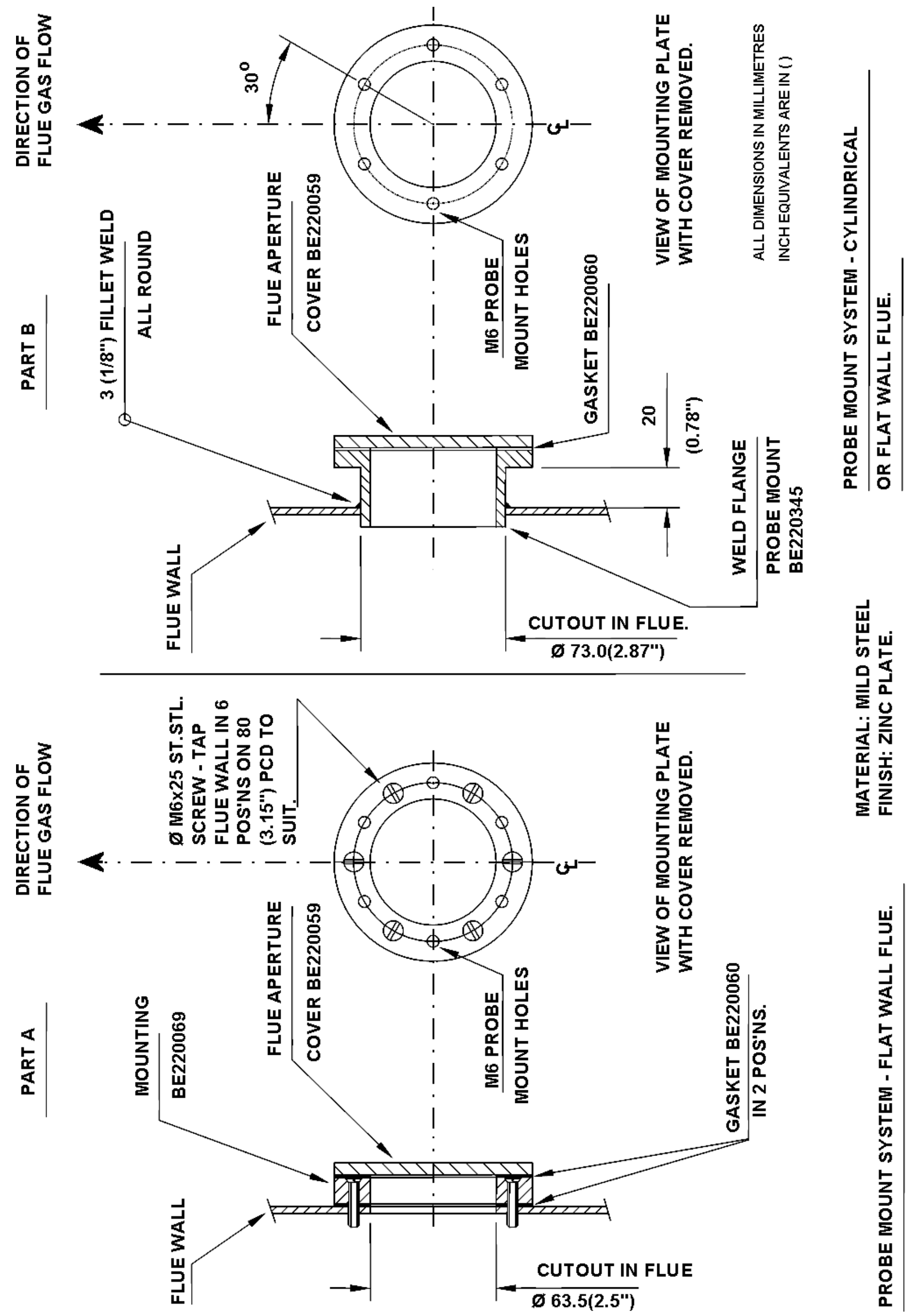
Flanges

There are two types of flanges available (see the drawing below). With either flange, the vertical center line of the flange shown on the drawing must correspond to the gas flow direction.

The flange kit includes 6 stainless steel M6 x 20 mm socket cap screws for attaching the probe.

The probe flange temperature must be maintained at the temperature of the flue wall by repacking or adding lagging that may have been removed to mount the probe. Sulfate condensation will occur if the flue wall of an oil-fired boiler falls below approximately 130 °C (266 °F). The sulfate problem does not occur in gas-fired installations, but vapor may cause problems due to condensation if the temperature of the flue gas falls below 100 °C. (212°F)

The maximum flue gas temperature rating is 540ºC (1,004 °F).



2.3.2 Wiring

The NXO2TRIM Oxygen Probe Interface unit is designed to interface directly to the NX6083 oxygen probe, which allows the NX6300 series controller to monitor the flue gas oxygen and temperature levels. The Oxygen Trim system relies on the oxygen measurement sent from the NXO2TRIM to the NX6300.

The cabling between the oxygen probe interface and the probe consists of the following:-

Cable function	Specification
Cell heater and O_2 measurement.	**Max Voltage in use 14V d.c.** • 6-core cable with each core 16/0.2mm (20 AWG) and with overall braided screen. Cable covered in PVC sheath. • Resistance per core 40 milliohms/meter. • Maximum length between the probe and controller is 10m (33ft).
Flue gas temperature measurement.	**Max Voltage in use 5V d.c.** • Type 'K' compensating cable. • 2-core PVC insulated cable with 7/0.2mm (24 AWG) conductors, covered in overall PVC sheath.

The Oxygen Probe connection detail is shown in Section 2.

2.4 Calibrating and servicing the Oxygen Probe

2.4.1 Probe Calibration

WARNING

- Before proceeding with probe calibration, make sure you have a compatible air supply.
- Disable the oxygen trim function using option parameter 30.5. Depending on the system configuration there may be 2 oxygen probes connected to the system, in which case make sure the calibration gas is being supplied to the correct probe.
- If the probe calibration is to be checked while the burner is firing, make sure that oxygen limits have not been set (option 38.0), which may cause a burner lock-out to occur while the calibration is being performed.

You must execute the probe calibration in the correct sequence, or the calibration will be invalid. The calibration sequence is as follows: -

1. Enter the Option Set mode using the Commission passcode (see “Commissioning” in section 3.

2. Select option parameter 30.6 for the first oxygen probe, or 42.6 for the second oxygen probe. The display will show the status of calibration.

3. If the display shows 0, then the system is not in Calibrate mode.

4. Use the LEFT/RIGHT scroll keys and then the UP/DOWN keys to change option value to display 1, and then press Enter. The oxygen trim function will be disabled, and the system will be in Calibrate-Air mode.

5. Apply the calibration air supply to the oxygen probe calibration port at a rate of 350cc/min.

6. When the calibration air has been connected, scroll to view the probe offset, Option 30.1 (42.1). Wait for this value to settle (expect a value between 450 and 500).

7. When the value displayed for option 30.1 (42.1) has settled to a value within range, scroll back to Option 30.6 (42.6), change the display to zero and then press Enter.

8. Next, scroll to Option 30.2 and program a value which is 8 less than the value set for option 30.1.

9. The new calibration value will now be used for the oxygen probe.

2.4.2 Testing the Oxygen Probe Filter

CAUTION

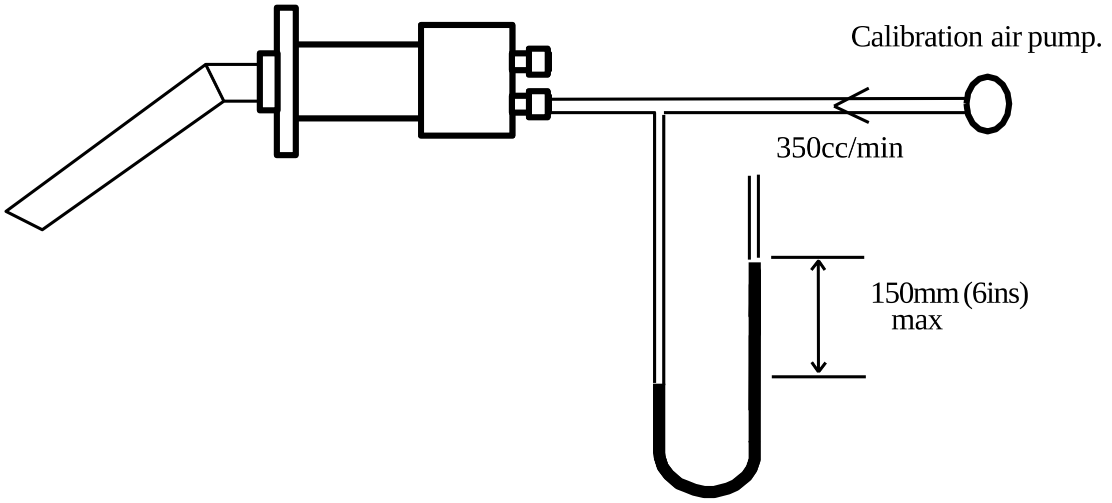
The filter can be tested without removing the probe from the flue.

- If the burner is firing before proceeding, disable the **oxygen trim** function using option parameter 30.5, and make sure that **oxygen limits** have **not** been set (option 38.0) which may cause a burner lock-out to occur while the calibration is being performed.

The filter can be tested without removing the probe from the flue. Before proceeding, use option parameter 30.5 to make sure the oxygen trim function is disabled.

To carry out the check, pass air at 350cc/min (22cu. ins/min) into the calibration gas connection on the rear of the probe adjacent to the flexible conduit fitting, and check the pressure drop.

The pressure drop can be found by connecting a manometer or similar in the flow line to the calibration gas connection, as shown below.



If the pressure is 150 mm (6 ins) water gauge or more, replace the filter.

2.4.3 Removing the oxygen probe from the flue

WARNING

- **Before attempting to** remove the probe, switch OFF the system and the boiler. It is essential to switch the burner OFF because dangerous levels of carbon monoxide may be present in the flue.
- Since the body of the probe will be hot, use heat resistant gloves to hold the probe.
- If you need to operate the boiler while the probe is removed, you **must** fit the blanking plate (supplied with the equipment) to the probe flange.

The NX6083 Oxygen Probe is fixed in the flue by six, 6 mm stainless steel socket head cap screws.

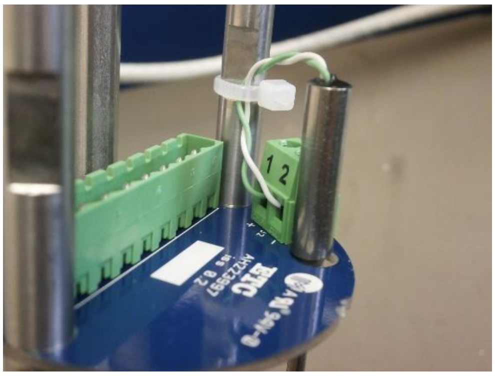
- Loosen the 2 screws securing the probe end cap and remove the cap to expose the green 8-way terminal block.
- Remove the terminal block from the printed circuit board, allowing the cables to slide out of the probe body, complete with its plug.
- Remove the six retaining screws. Taking care not to damage the sealing gasket, you can now extract the probe from the flue.
- The only customer-replaceable items are the flue thermocouple and the oxygen filter.
- **Refitting** is the reverse of the removal procedure. Make sure that the screws are tightened sequentially and evenly.

2.4.4 Replacing the Filter

- Remove the oxygen probe from the flue, as detailed in section 2.4.3, and unscrew the insulating mounting blocks for the flue thermocouple, from the sample tube.
- Before removing the three fixing screws and spring washers which retain the sample tube, make sure you hold the body horizontal, or the sample tube downwards, to prevent soot or other deposits from falling into the probe body.
- When the screws and washers have been removed, pull the sample tube away from the body to allow the captive filter assembly to be removed.
- You can now insert the new filter assembly (part number 19-117) into the sample tube, with the beveled side to the probe body.
- Refit the sample tube, ensuring that the filter locates into the probe body. Tighten the retaining washers and screws evenly, to seal the filter assembly to the flange.

2.4.5 Replacing the Probe-mounted Flue Thermocouple

- Remove the oxygen probe from the flue, as detailed in section 2.4.3.
- Disconnect the internal connections to the thermocouple.
- Unscrew the 2 thermocouple-mounting blocks from the probe sample tube, to allow the thermocouple to be straightened.
- Remove the hexagonal nut securing the thermocouple into the probe flange and withdraw the thermocouple through the probe body.
- Refitting is the reverse of the removal procedure but ensure that new packing material is applied to seal the new thermocouple to the flange.
- The electrical connection and polarity of the thermocouple are shown in the picture below:



2.5 Oxygen Trim operation

With the oxygen trim system correctly commissioned and enabled, a multiple adaptive trim algorithm will compensate for changes in fuel and environmental conditions that affect combustion.

Using air or fuel flow information entered during the commissioning process, the trim drive motor(s) will be moved by an amount that will give the desired change in air or fuel flow, which then gives the desired flue oxygen reading. The trim system will continually monitor the flue oxygen level and attempt to maintain this as close to the programmed oxygen set point for the current point in the firing range.

The system will remember the amount of trim to apply for each firing position and the trim will be applied at each point immediately without having to wait for the oxygen value to change. The adaptive trim is reset on either a fuel profile (curve set) change or on a system power down.

Trim is not applied if the controller is in Commission mode.

2.6 Commissioning Oxygen Trim

WARNING

- **Before** commissioning the oxygen, trim system ensure that the combustion profiles (curve sets) have a minimum of 10 setpoints – P3 to P12. Ideally, the profile should have 15 points.
- If the trim commissioning process is manual, ensure that *all* combustion air drives are increased, and decreased, when characterizing the burner flow. This is important even if the trim drive set in 2.x will be only one device (for example VSD).

For the oxygen trim system to function correctly, the following information must be entered:

1. Option parameters
2. Flow values and O_2 set points.

A commissioning engineer can enter these values manually, or the system can automatically calculate the values and enter them itself ("Automatic Trim commissioning").

If the Automatic Trim commissioning is performed, the engineer **MUST** check that the values entered are valid and safe after completion. Also, check the oxygen probe calibration before and after the procedure, since the results are highly dependent on measurements taken using the probe.

2.6.1 Entering the Option Parameters

With the burner OFF, go into Commission mode (see section 3).

To get the trim operational, you need to set up the following option parameters:

1. Trim gain – to improve stability of the trim algorithm control (options 33.X, 34.X).
2. Trim limits – to impose limits on the amount of trim applied (options 32.X).
3. Trim enable – to turn trim ON (option 30.5).

Before you enter the oxygen set points for each profile, consider these points relating to the oxygen trim option:

- Make sure no trim is applied which would require a drive to move above its High Fire position or below its Low Fire position, unless a limited modulation range has been selected.
- The flow for each profile position must be entered to ensure correct operation. The flow can either be measured for each profile position or calculated as a percentage of the flow at High Fire.

2.6.2 Using the text display in Adjust Ratio mode to enter Oxygen Set Points and Flow Values manually

CAUTION

- When using the Adjust Ratio mode, the controller cannot check drive positions at all times. It is therefore the responsibility of the engineer to check that motors and valves are responding correctly.

To adjust an oxygen set point or enter an air flow value in the firing range, use the following procedure. (The manual calculation of the values to be entered here is covered in the following section 2.6.3.)

1. Go into Adjust Ratio mode. (With the burner ON, go into COM mode.)

2. Enable oxygen trim by setting option parameter 30.5 to 1.

3. Use the ▲ ▼scroll keys to select the desired set point (A4 for example). The system will modulate to the selected set point, and the number shown on the display will flash to indicate that the drives are modulating.

4. Wait for the number in the display to be illuminated steadily. This means that the drives have arrived at the selected set point.

5. The display will show an 'o2' value within the table for the profile set point. Press the **ADJ** key to move the highlight to the positions table then use ◄ ► keys to move the selection to the O2 field.

6. Use the ▲ ▼ keys to adjust the oxygen set point as necessary. If the new oxygen set point value is correct, then press the **ENTER** key. The value will be stored in memory.

7. If the new oxygen set point value is not wanted, or an adjustment is not required, press the **NEXT** key to return to the value stored in memory.

8. Use the ◄ ► scroll keys to select the ‘FLOW’ field on the display. The display shows the air flow value, represented as a percentage of the air flow when the drives are at the **High Fire** position.

9. Use the ▲ ▼ keys to adjust the Flow value as necessary. If the new Flow value is correct, then press the **ENTER** key. The value will be stored in memory.

10. If the new flow value is not wanted, or an adjustment is not required, press the **NEXT** key to return to the value stored in memory.

11. If you need to adjust another set point in the firing range, then press the **Axx** key and then repeat the procedure above from step 3.

2.6.3 Calculating and entering the Flow Values manually

If the flow values are to be calculated manually, then complete the procedure below, filling out the table in section 0

2.6.4 Flow Calculation table

Profile position	Excess Air		Ex. Air + 100 y = x + 100 c = a + 100 d = b + 100		Ratio	Airflow	Fuel flow
High Fire = A	x		y				
1 = A	a_1 b_1		c_1 d_1		$e_1 = c_1/d_1$	$f_1 = e_1$ (99.9)	$g_1 = f_1 (y/c_1)$
2 = A	a_2 b_2		c_2 d_2		$e_2 = c_2/d_2$	$f_2 = e_2 (f_1)$	$g_2 = f_2 (y/c_2)$
3 = A	a_3 b_3		c_3 d_3		$e_3 = c_3/d_3$	$f_3 = e_3 (f_2)$	$g_3 = f_3 (y/c_3)$
4 = A	a_4 b_4		c_4 d_4		$e_4 = c_4/d_4$	$f_4 = e_4 (f_3)$	$g_4 = f_4 (y/c_4)$
5 = A	a_5 b_5		c_5 d_5		$e_5 = c_5/d_5$	$f_5 = e_5 (f_4)$	$g_5 = f_5 (y/c_5)$
6 = A	a_6 b_6		c_6 d_6		$e_6 = c_6/d_6$	$f_6 = e_6 (f_5)$	$g_6 = f_6 (y/c_6)$
7 = A	a_7 b_7		c_7 d_7		$e_7 = c_7/d_7$	$f_7 = e_7 (f_6)$	$g_7 = f_7 (y/c_7)$
8 = A	a_8 b_8		c_8 d_8		$e_8 = c_8/d_8$	$f_8 = e_8 (f_7)$	$g_8 = f_8 (y/c_8)$
9 = A	a_9 b_9		c_9 d_9		$e_9 = c_9/d_9$	$f_9 = e_9 (f_8)$	$g_9 = f_9 (y/c_9)$
10 = A	a_{10} b_{10}		c_{10} d_{10}		$e_{10} = c_{10}/d_{10}$	$f_{10} = e_{10} (f_9)$	$g_{10} = f_{10} (y/c_{10})$
11 = A	a_{11} b_{11}		c_{11} d_{11}		$e_{11} = c_{11}/d_{11}$	$f_{11} = e_{11} (f_{10})$	$g_{11} = f_{11} (y/c_{11})$
12 = A	a_{12} b_{12}		c_{12} d_{12}		$e_{12} = c_{12}/d_{12}$	$f_{12} = e_{12} (f_{11})$	$g_{12} = f_{12} (y/c_{12})$
13 = A	a_{13} b_{13}		c_{13} d_{13}		$e_{13} = c_{13}/d_{13}$	$f_{13} = e_{13} (f_{12})$	$g_{13} = f_{13} (y/c_{13})$
14 = A	a_{14} b_{14}		c_{14} d_{14}		$e_{14} = c_{14}/d_{14}$	$f_{14} = e_{14} (f_{13})$	$g_{14} = f_{14} (y/c_{14})$

Profile position	Excess Air		Ex. Air + 100 y = x + 100 c = a + 100 d = b + 100		Ratio	Airflow	Fuel flow
15 = A	a_{15} b_{15}		c_{15} d_{15}		$e_{15} = c_{15}/d_{15}$	$f_{15} = e_{15} (f_{14})_{15}$	$g_{15} = f_{15} (y/c_{15})$
16 = A	a_{16} b_{16}		c_{16} d_{16}		$e_{16} = c_{16}/d_{16}$	$f_{16} = e_{16} (f_{15})$	$g_{16} = f_{16} (y/c_{16})$
17 = A	a_{17} b_{17}		c_{17} d_{17}		$e_{17} = c_{17}/d_{17}$	$f_{17} = e_{17} (f_{16})$	$g_{17} = f_{17} (y/c_{17})$

.
Go into Adjust Ratio mode with oxygen trim **disabled** as outlined above.

1. Select the High Fire position. The display will then show A(n), where n is the number of the High Fire profile point.
2. Wait until the oxygen reading has stabilized.
3. Record the **excess air** value at location x in the table. This value can be found using the e parameter EK48 (provided the hydrocarbon ratio has been entered into the appropriate option parameters (35.1 – 35.4) for the fuel being fired).
4. Select the profile position immediately below High Fire. The display will then show A(n-1).
5. Wait until the oxygen reading has stabilized and record the **excess air** value at location a_1 in the table.
6. Move the drive(s) that are to be trimmed {e.g., secondary air damper and variable speed or fuel drives} to their respective positions for the next profile position above the existing position. **Do not press Enter.**
7. Wait until the oxygen reading has stabilized, then record the **excess air** value at location b_1 in the table, relating to the current profile position.
8. Repeat the above for all other profile positions including Low Fire (profile position A3), recording each time the values at locations **a** and **b** in the table. When extra air is added at P3, measure the time taken before the flue oxygen reading starts to increase, and enter the value into Option 37.
9. After completing the table for all Excess Air, values **a** and **b**, complete the Excess Air + 100 column, by adding 100: (i.e., y = x + 100, c = a + 100 and d = b + 100).
10. Complete the Ratio column by dividing c by d (i.e., e = c/d).
11. Complete the Airflow column by multiplying e by the previous value of f (i.e., $f_x = e_x f_{x-1}$).
12. If the system will be applying trim to the fuel, the fuel flow column must be completed. This is achieved by multiplying the airflow at each point by the ratio of excess air + 100 at High Fire divided by the excess air + 100 at the actual point (i.e., $g_x = f_x(y/c_x)$).

Here is an example of the table completed for A10 (High Fire) to A8. In practice, the table must be filled out down to A3 (Low Fire).

Profile position	Excess Air		Ex. Air + 100 y = x + 100 c = a + 100 d = b + 100		Ratio	Airflow	Fuel flow
High Fire = A**10**	x	**10**	y	**110**	------------	**99.9%**	**99.9%**
1 = A**9**	a_1	**8**	c_1	**108**	$e_1 = c_1/d_1$	$f_1 = e_1$ (99.9)	$g_1 = f_1 (y/c_1)$
	b_1	**33**	d_1	**133**	**0.812**	**81.1%**	**82.6%**
2 = A**8**	a_2	**9**	c_2	**109**	$e_2 = c_2/d_2$	$f_2 = e_2 (f_1)$	$g_2 = f_2 (y/c_2)$
	b_2	**20**	d_2	**120**	**0.908**	**73.7%**	**74.4%**

2.6.5 Flow Calculation table

Profile position	Excess Air		Ex. Air + 100 y = x + 100 c = a + 100 d = b + 100		Ratio	Airflow	Fuel flow
High Fire = A	x		y				
1 = A	a_1 b_1		c_1 d_1		$e_1 = c_1/d_1$	$f_1 = e_1$ (99.9)	$g_1 = f_1 (y/c_1)$
2 = A	a_2 b_2		c_2 d_2		$e_2 = c_2/d_2$	$f_2 = e_2 (f_1)$	$g_2 = f_2 (y/c_2)$
3 = A	a_3 b_3		c_3 d_3		$e_3 = c_3/d_3$	$f_3 = e_3 (f_2)$	$g_3 = f_3 (y/c_3)$
4 = A	a_4 b_4		c_4 d_4		$e_4 = c_4/d_4$	$f_4 = e_4 (f_3)$	$g_4 = f_4 (y/c_4)$
5 = A	a_5 b_5		c_5 d_5		$e_5 = c_5/d_5$	$f_5 = e_5 (f_4)$	$g_5 = f_5 (y/c_5)$
6 = A	a_6 b_6		c_6 d_6		$e_6 = c_6/d_6$	$f_6 = e_6 (f_5)$	$g_6 = f_6 (y/c_6)$
7 = A	a_7 b_7		c_7 d_7		$e_7 = c_7/d_7$	$f_7 = e_7 (f_6)$	$g_7 = f_7 (y/c_7)$
8 = A	a_8 b_8		c_8 d_8		$e_8 = c_8/d_8$	$f_8 = e_8 (f_7)$	$g_8 = f_8 (y/c_8)$
9 = A	a_9 b_9		c_9 d_9		$e_9 = c_9/d_9$	$f_9 = e_9 (f_8)$	$g_9 = f_9 (y/c_9)$
10 = A	a_{10} b_{10}		c_{10} d_{10}		$e_{10} = c_{10}/d_{10}$	$f_{10} = e_{10} (f_9)$	$g_{10} = f_{10} (y/c_{10})$
11 = A	a_{11} b_{11}		c_{11} d_{11}		$e_{11} = c_{11}/d_{11}$	$f_{11} = e_{11} (f_{10})$	$g_{11} = f_{11} (y/c_{11})$
12 = A	a_{12} b_{12}		c_{12} d_{12}		$e_{12} = c_{12}/d_{12}$	$f_{12} = e_{12} (f_{11})$	$g_{12} = f_{12} (y/c_{12})$
13 = A	a_{13} b_{13}		c_{13} d_{13}		$e_{13} = c_{13}/d_{13}$	$f_{13} = e_{13} (f_{12})$	$g_{13} = f_{13} (y/c_{13})$
14 = A	a_{14} b_{14}		c_{14} d_{14}		$e_{14} = c_{14}/d_{14}$	$f_{14} = e_{14} (f_{13})$	$g_{14} = f_{14} (y/c_{14})$

Profile position	Excess Air		Ex. Air + 100 y = x + 100 c = a + 100 d = b + 100		Ratio	Airflow	Fuel flow
15 = A	a_{15} b_{15}		c_{15} d_{15}		$e_{15} = c_{15}/d_{15}$	$f_{15} = e_{15} (f_{14})_{15}$	$g_{15} = f_{15} (y/c_{15})$
16 = A	a_{16} b_{16}		c_{16} d_{16}		$e_{16} = c_{16}/d_{16}$	$f_{16} = e_{16} (f_{15})$	$g_{16} = f_{16} (y/c_{16})$
17 = A	a_{17} b_{17}		c_{17} d_{17}		$e_{17} = c_{17}/d_{17}$	$f_{17} = e_{17} (f_{16})$	$g_{17} = f_{17} (y/c_{17})$

2.6.6 Automatic Trim commissioning

The controller can automate the above procedures, automatically calculating and entering flow values, oxygen trim set points, and boiler transport delay. The automatic commissioning procedure will only work if the following conditions are met:

- Option parameter 30.9 (Automatic Trim commissioning) is set to 1.
- An oxygen probe is fitted and fully operational.
- The controller is in Adjust Ratio mode with the burner firing.
- A hydrocarbon ratio has been entered for the current fuel profile.

The Automatic Trim commissioning procedure usually takes between 10 and 30 minutes (depending on number of set points), and is performed by the controller as follows:

1. Beginning with High Fire, the controller moves the drives to each point in the firing range. The 'PROFILE SET' display parameter toggles between '**A n**' and 'O2', where **n** is the current set point. When the measured oxygen reading settles, the controller stores the measured oxygen reading as the new oxygen set point.

2. The controller moves the air drives up to one point above the current set point, leaving the fuel drive in the same position. The 'PROFILE SET' display parameter toggles between '**A n**' and '**Flo**', where **n** is the current set point.

3. When the new oxygen reading settles, the controller calculates and stores the new flow value. If the oxygen reading exceeds 15.0% during this stage, the controller shuts the burner down and shows fault code F77 (see "List of Fault Code Numbers" in section 5, "Fault Finding").

4. When the controller has completed the transition to Low Fire, the measured boiler transport delay (at Low Fire) is stored in Option 30.7. Also, Option parameter 30.5 (oxygen trim enable) is set to zero.

IMPORTANT: BEFORE ENABLING TRIM, USE ADJUST RATIO MODE TO MANUALLY CHECK THE CALCULATED FLOW VALUES, OXYGEN SET POINTS AND TRANSPORT DELAY. The ratio of the flow numbers, being High Fire flow rate (99.9) to the Low Fire flow rate, should be like the expected turn-down ratio that you programmed into the controller. Refer to your prepared profile commissioning data for comparison.

To perform Automatic Trim commissioning, follow the procedure below:

1. Calibrate the oxygen probe (see 2.4 in this section, "Probe Calibration").

2. Go into Adjust Ratio mode (see section 3, Commissioning).

3. Enable Automatic Trim commissioning by setting option parameter 30.9 to 1.

4. Wait for the procedure to finish.

5. Re-calibrate the oxygen probe.

6. Check that the O_2, flow and transport delay values are in the following ranges:

   - For O_2, we would expect it to be in the range 8% - 2%, normally reducing as the profile set point increases.
   - For Flow, we would expect the values to increase as the profile set point increases, ending with High Fire set point as a value of 99.9(%).
   - Typically, the transport delay will be 15 to 40s depending upon the size of the boiler.

3. The CO Trim option

3.1 Introduction

The NX6300 system can be configured to modify the Oxygen trim algorithm based upon a Carbon Monoxide measurement made in the flue gases. For CO trim to be active the oxygen trim system must be commissioned and set ON.

The CO trim system will modify the O2 set points for the oxygen trim algorithm within limits set by option parameters. In addition, a high CO alarm may be configured to ensure that the burner operation is stopped in the event of the measurement of continuous high levels of CO.

3.2 CO Trim wiring

The CO measurement must be provided as a 4-20mA signal from an external CO measuring device.
The CO signal must be connected into the NXO2TRIM Oxygen Probe controller as follows:
PG6: CO signal +
PG5: CO signal –

If the application utilizes a third party combined CO/O2 probe, then the 4-20mA for the oxygen signal must be connected as follows:
PG7: Oxygen signal +
PG9: Oxygen signal –

3.3 CO Trim option parameters

The option parameters associated with CO trim system are the same parameters assigned for a second oxygen probe, 42.0 to 42.6 but with alternative descriptions. Setting option 42.0 to the same value as set in option 30.0 identifies to the controller that the options are for CO trim.

The options are as follows:

Option	Description
42.0	Probe interface serial number.
42.1	CO sensor signal span value.
42.2	CO trim gain.
42.3	CO set point.
42.4	Maximum oxygen reduction.
42.5	Maximum oxygen increase.
42.6	High CO limit alarm.

Full option descriptions can be found in the Appendix section of this manual.

3.4 CO Trim EK's

In a similar way to the option parameters, the EK's associated to the second oxygen probe change their meaning when CO trim is enabled as follows.

EK	Description
75	CO level (ppm)
76	Oxygen set point after CO trim.
78	CO trim modifier
79	Oxygen set point before CO trim.

Section 4 Update History

New version	Date		Changes in brief
V1pt4	10.27.23	RAL	Update North America Version

——— End of Section 4 ——