CM-420 Combustion Monitor
Installation and Operation

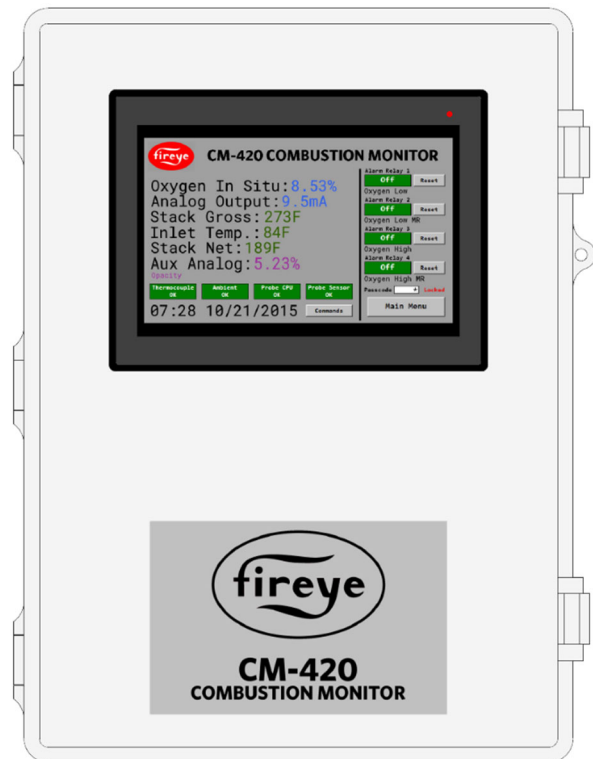**508A Enclosed Industrial Control Panel**

DESCRIPTION

The CM-420 Combustion Monitor is designed to connect to the Fireye NXCESO2 or FXCESO2 (with FXO2TRIM-1 interface) in situ oxygen probes. These probes utilize industrial sensors with integrated heater and pump controls. This allows these Fireye oxygen probes to be used in applications without Fireye efficiency controls.

The CM-420 provides power and communication to the oxygen probe through a four-wire cable connection. While the oxygen probe is designed to mount in the stack, the CM-420 is designed for remote mounting, typically on the side of the boiler or appliance. The CM-420 has UL508A listing for enclosed industrial control panels. The enclosure is IP65 (NEMA 4X) rated.

The CM-420 provides a 4-20mA output to represent the current O_2 reading from the oxygen probe. Two 4-20mA analog inputs are provided to allow connection to an inlet temperature sensor as well as an auxiliary sensor that can be configured to measure any other site need. Four programmable relay outputs are provided for alarm status that are configured by default to indicate O_2 low, low-low (manual reset), high and high-high (manual reset) conditions. There is also a dry contact input provided to initiate calibration for the oxygen probe when needed.

The CM-420 is configured using the 7" touchscreen. Communication is available to a PLC/SCADA/BMS using Modbus TCP/IP and/or Modbus RTU via RS-232, RS-422 or RS-485. All operating information including O_2 percent, stack temperature, inlet temperature and auxiliary input are provided, as well as the ability to initiate commands to the oxygen probe or directly control the relay outputs via Modbus. All communication parameters are configurable.

See Fireye bulletin *NXCESO2-1001* or *FXCESO2-1001* for additional information on mounting and wiring of the oxygen probe. This bulletin only covers installation and operation of the CM-420 Combustion Monitor.

> ⚠ **WARNING: Do not connect or disconnect oxygen probe while energized as this can present an explosion hazard.**

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TECHNICAL DATA

Screen type:	TFT, 4-wire analog resistive
Resolution:	800 x 480
Diagonal screen area:	177.8mm (7 in.)
Backlight:	LED rated at 20,000 hours at 25°C
Interface method to oxygen probe:	Modbus RTU via RS-485
Nominal voltage:	100VAC-240VAC (45Hz-65Hz)
Nominal power consumption:	124.3VA
Internal power supply maximum output:	60W (24VDC)
Relay output ratings:	230VAC/2A, pilot duty only
Analog input resolution:	16-bit
Analog output resolution:	12-bit
Operating temperature range:	0°C to 60°C (32°F to 140°F)
Operating humidity:	10% to 95%, non-condensing
Storage temperature range:	-20°C to 85°C (-4°F to 185°F)
Shock during operation:	25g acceleration for 11ms
Degree of protection:	IP65 (NEMA 4X), indoor use only (not UV stabilized)
Unit dimensions:	270mm x 370mm (10.64 in. x 14.59 in.)
Unit dimensions depth:	151mm (5.92 in.)
Weight:	4.76kg (10.5 lb.)

ORDERING INFORMATION

Combustion Monitor		Bulletin
NXCM-420	Combustion monitor for use with Fireye oxygen probe.	CM420-1001
NXCESO2 Oxygen Probe		**Bulletin**
NXCESO2-8	Standard O2 probe assembly, 216 mm (8.5 inch) insertion depth.	NXCESO2-1001
NXCESO2-16	Standard O2 probe assembly, 407 mm (16 inch) insertion depth.	
NXCESO2-8-KIT	Kit, NXCESO2-8 with FXIATS-140 and 35-381-2.	
NXCESO2-16-KIT	Kit, NXCESO2-16 with FXIATS-140 and 35-381-2.	
FXCESO2-8	High temperature O2 probe assembly, 215 mm (8 inch) insertion depth. Requires FXO2TRIM-1 control board.	FXCESO2-1001
FXCESO2-16	High temperature O2 probe assembly, 406 mm (16 inch) insertion depth. Requires FXO2TRIM-1 interface module.	
FXCESO2-30	High temperature O2 probe assembly, 757 mm (30 inch) insertion depth. Requires FXO2TRIM-1 interface module.	
FXO2TRIM-1	O2 probe interface module for FXCESO2 probes.	
35-381-2	O2 probe mounting flange.	133-750
Inlet Temperature Sensor		**Bulletin**
FXIATS-140	Ambient air temperature sensor, -40°C to 60°C (-40°F to 140°F), 4-20mA.	FXIATS-1
Connectors and Cable		**Bulletin**
129-192	Quick disconnect connector for field wiring, female (cable 59-565 recommended).	133-747
129-194	Quick disconnect connector with wire leads, male.	n/a
59-565-6	Quick disconnect cord set, 6 feet, PVC jacket, temperature rating -40°C to 105°C, meets NEMA 1,3,4,6P and IEC67.	133-748
59-565-40	Quick disconnect cord set, 6 feet, PVC jacket, temperature rating -40°C to 105°C, meets NEMA 1,3,4,6P and IEC67.	
59-565	Cable to connect CM-420 to NXCESO2 or FXO2TRIM-1, separate power and communication, sold by the foot.	n/a

SAFETY ADVICE

The CM-420 Combustion Monitor only provides readings from the connected Fireye oxygen probe. The CM-420 does not provide any control of the process. Use proper caution when applying any values read from the CM-420 to a combustion process including any necessary redundancy checks.

The programmable relay outputs are not safety rated and are designed to be used for status reporting only. Check the technical specifications for the rating of these relays.

MOUNTING

The CM-420 enclosure is designed for mounting indoors as the ABS poly blend of the enclosure is not UV stabilized. The enclosure has four mounting bosses that are designed for connecting to the provided mounting clips using M5 x 0.8mm bolts. These mounting clips can be mounted in any orientation that works best.

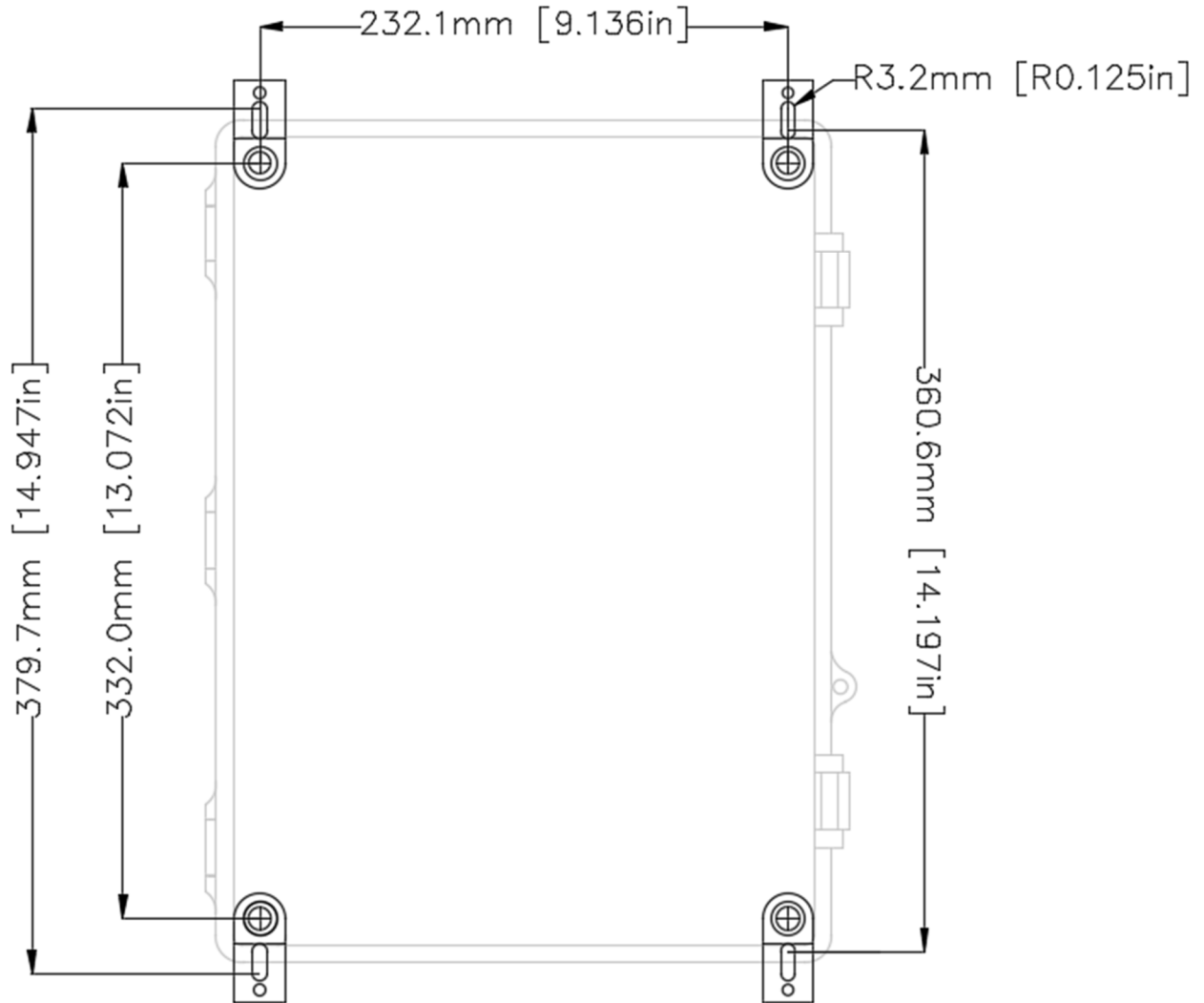*Mounting clip boss*   *Mounting clip fastened to boss*

Dimensional Diagram

The following diagram shows the footprint with the mounting clips attached and oriented in an up/down arrangement.

WIRING

All conduit entry points should be drilled from the bottom of the enclosure. Ensure that no internal components can be damaged in the process. Also make sure that any fittings used will comply with the desired IP or NEMA rating as the IP65 (NEMA 4X) ratings only apply before any penetrations are made. The rating after penetrations depends on the rating of the connectors.

Be sure to connect the ground connection first to eliminate any ESD (electrostatic discharge) potential.

> ⚠️ **WARNING: Do not penetrate the top of the CM-420 enclosure when wiring. Doing so may result in debris entering the internal devices.**

Five wires must be connected to power and communicate with the NXCESO2. A cord set (59-565) with all the necessary wiring is available.

Quick disconnecting cord sets are also available. Quick disconnect fittings are also available for field construction and installation. The 129-194 quick disconnect adapter can be fitted to the bottom of the CM-420 on the left side for direct connection to terminals P1, P2, P3 and P4. Another 129-194 can then be fitted to the NXCESO2. This allows use of a quick disconnect cord (such as the 59-565-40) directly from the CM-420 to the NXCESO2.

Eight wires must be connected between the FXCESO2 probe and the FXO2TRIM-1 interface. A cable set (59-612-33) with a six-conductor cable and two-conductor thermocouple wire is available. Five wires must be connected to power and communicate with the FXO2TRIM-1. A cord set (59-565) with all the necessary wiring is available. The 129-194 quick disconnect adapter can be fitted to the bottom of the CM-420 on the left side for direct connection to terminals P1, P2, P3 and P4. Another 129-194 can then be fitted to the FXO2TRIM-1. This allows use of a quick disconnect cord (such as the 59-565-40) directly from the CM-420 to the FXO2TRIM-1.

Terminals

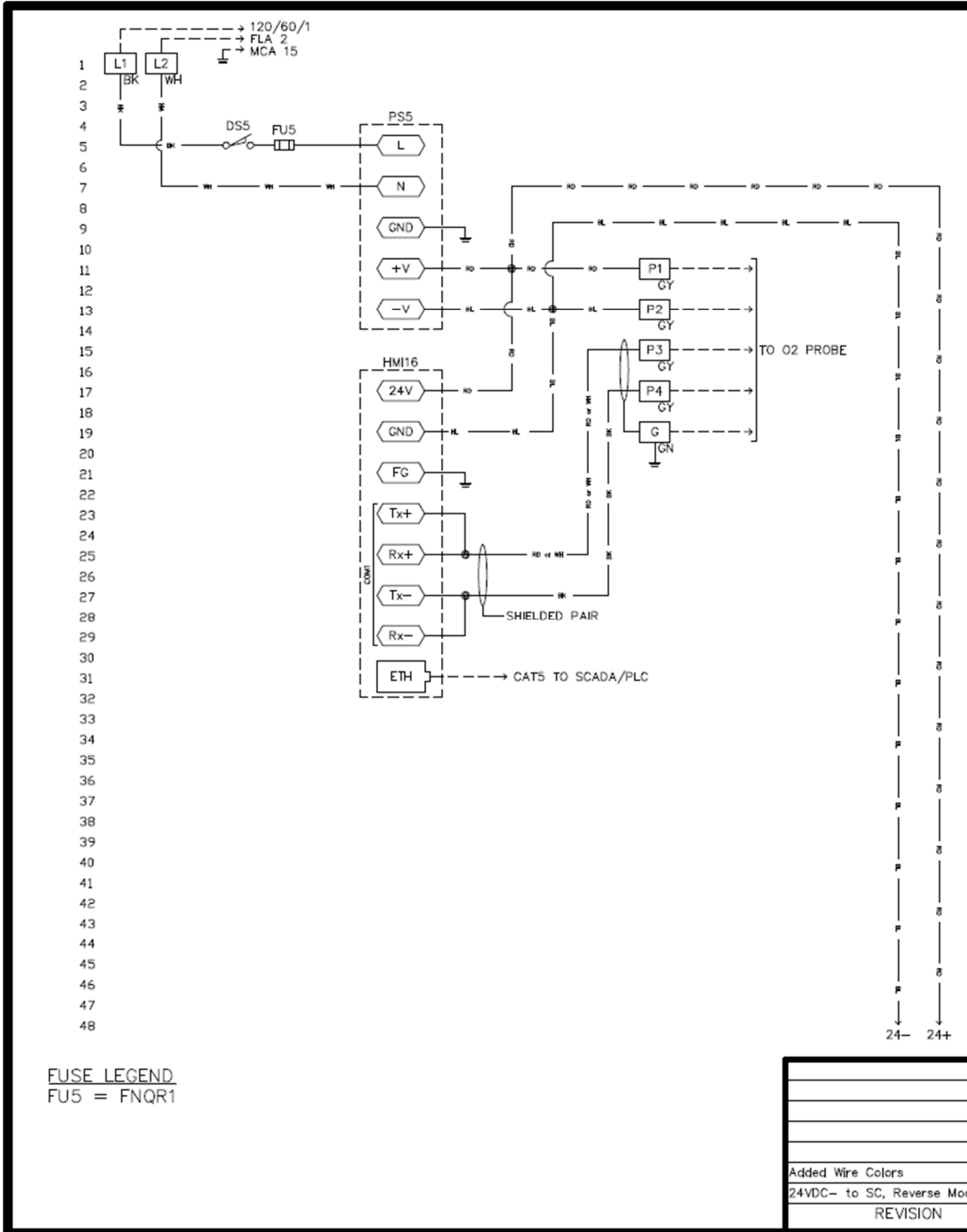| Terminal	Type	Description	Notes
P1	Power	24VDC+ to NXCESO2 probe or FXO2TRIM-1 interface	Via 59-565 cable RED wire
P2	Common	24VDC- to NXCESO2 probe or FXO2TRIM-1 interface	Via 59-565 cable BLACK wire
P3	Modbus	Modbus A to NXCESO2 probe or FXO2TRIM-1 interface	Via 59-565 cable ORANGE wire
P4	Modbus	Modbus B to NXCESO2 probe or FXO2TRIM-1 interface	Via 59-565 cable BROWN wire
G	Ground	Grounding to NXCESO2 probe or FXO2TRIM-1 interface	Via 59-565 cable bare wire
SP	Power	24VDC+ to sensors	Use for loop powered sensors
S1	Analog In	4-20mA signal from inlet sensor	Not isolated
S2	Analog In	4-20mA signal from auxiliary sensor	Not isolated
SC	Common	24VDC- from sensor	Use for self-powered sensors
G	Ground	Grounding for analog shielded cables	
PV	Analog Out	4-20mA signal representing oxygen percentage	Not isolated
PC	Common	Common signal for analog out	Connected to 24VDC-
DC	Power	Common for digital input	Connected to 24VDC+
D1	Digital In	Digital input to initiate calibration	Connect D1 to DC with button or relay (dry contact)
R1	Relay out	Programmable relay output alarm 1 Default = Oxygen < 2.0% (LOW)	230V/2A, pilot duty only
R2	Relay out	Programmable relay output alarm 2 Default = Oxygen < 1.0%, manual reset (LOW-LOW)	
R3	Relay out	Programmable relay output alarm 3 Default = Oxygen > 12.0% (HIGH)	
R4	Relay out	Programmable relay output alarm 4 Default = Oxygen > 13.0%, manual reset (HIGH-HIGH)	
RC	Common	Common for all relay outputs	
L1	Power In	Line voltage input 120VAC (50Hz/60Hz) Line voltage input 230VAC (50Hz/60Hz)	Input range 100VAC-240VAC nominal, 45Hz-65Hz
L2	Power In	Neutral input 120VAC (50Hz/60Hz) Line voltage input 230VAC (50Hz/60Hz)	
G	Ground	To earth ground	

Fuses

There is one internal fuse that protects the 24VDC power supply. The fuse is marked FU5 and is a Bussmann FNQ-R-1 or equivalent.
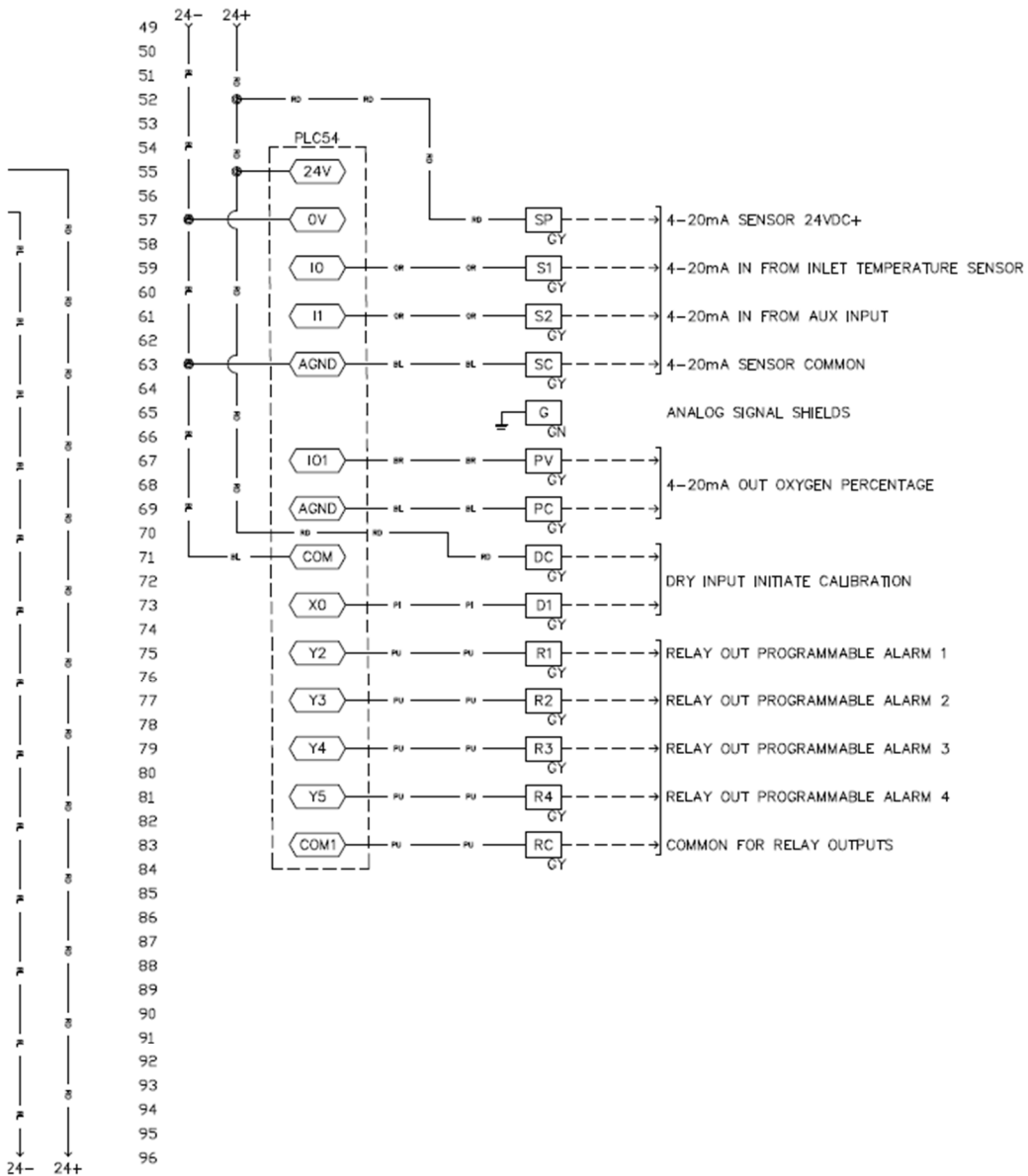
Wiring Diagram

The following is the as-built wiring diagram for the CM-420 (split to two pages):

PLC54

24V		
0V	SP	4-20mA SENSOR 24VDC+
IO	S1	4-20mA IN FROM INLET TEMPERATURE SENSOR
I1	S2	4-20mA IN FROM AUX INPUT
AGND	SC	4-20mA SENSOR COMMON
	G	ANALOG SIGNAL SHIELDS
IO1	PV	4-20mA OUT OXYGEN PERCENTAGE
AGND	PC	
COM	DC	DRY INPUT INITIATE CALIBRATION
X0	D1	
Y2	R1	RELAY OUT PROGRAMMABLE ALARM 1
Y3	R2	RELAY OUT PROGRAMMABLE ALARM 2
Y4	R3	RELAY OUT PROGRAMMABLE ALARM 3
Y5	R4	RELAY OUT PROGRAMMABLE ALARM 4
COM1	RC	COMMON FOR RELAY OUTPUTS

24- 24+

DRAWN BY	CZ	APPROVED BY	RL
DATE DRAWN		11/5/2020	
DRAWING NUMBER		CM-420	
TITLE		CM-420 PANEL UL508A	

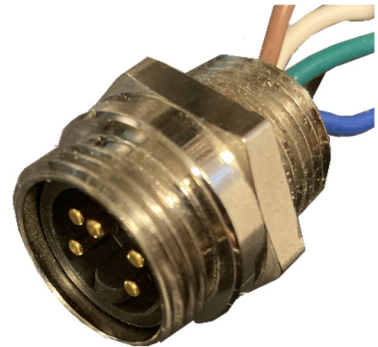|			
ors	CAZ	12/31/2020	
Reverse Modbus	CAZ	12/18/2020	
EVISION	BY	DATE	

fireye

Quick Disconnect Adapter

A quick disconnect adapter (Fireye part 129-194) can be fitted to the bottom of the CM-420 enclosure. Place the fitting on the left side, below terminals P1, P2, P3 and P4.

A trade size ½" hole (22mm or 0.875 in.) is required to mount the adapter. Using a regular ½" NPT conduit locknut is sufficient for IP10 (NEMA 1) rating use. If the IP65 (NEMA 4X) rating should be maintained, first fit a ½" NPT watertight conduit hub through the panel, then thread the quick disconnect adapter into that. The watertight conduit hub has a sealing gasket to maintain the NEMA rating.
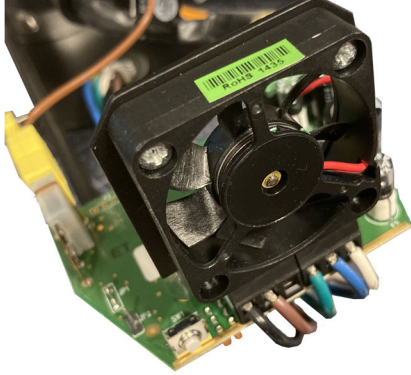
Use the following color scheme for wiring the adapter:

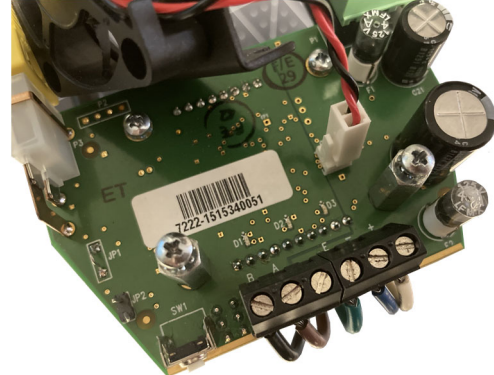| Color	Terminal	Description
White	P1	24VDC+
Blue	P2	24VDC-
Brown	P3	Modbus A
Black	P4	Modbus B
Green/yellow	G	Earth ground

Wiring to NXCESO2

If desired, fit a quick disconnect adapter (Fireye part 129-194) to the NXCESO2. Access to the terminals is possible after loosening the screws and removing the cooling fan.

Loosen screws and remove cooling fan to access terminals

Connect wiring to terminals (quick disconnect wiring is shown here)

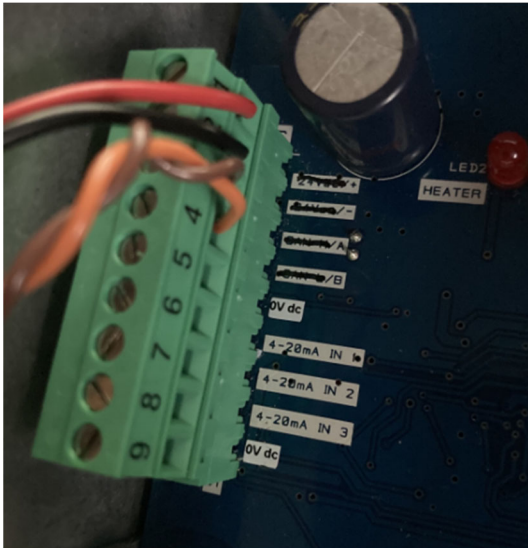Use the following color scheme for wiring the quick disconnect adapter:

Color	Terminal	Description
White	+	24VDC+
Blue	-	24VDC-
Green/yellow	E	Earth ground
Brown	A	Modbus A
Black	B	Modbus B

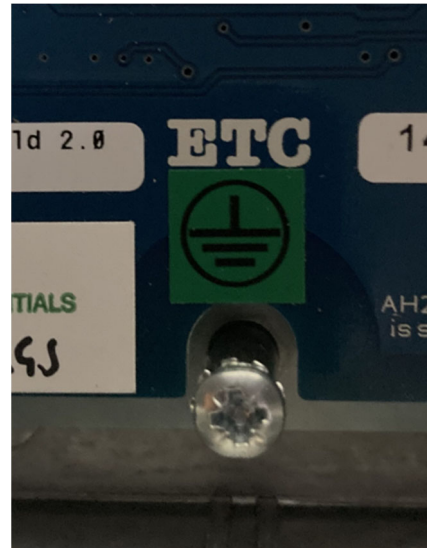For direct wiring, wire to the following chart (color coding for Fireye cable 59-565 is shown):

CM-420 Terminal	NXCESO2 Terminal	59-565 Color
P1	+	Red
P2	-	Black
G	E	Bare
P3	A	Orange
P4	B	Brown

Wiring to FXCESO2 with FXO2TRIM-1

Wire the FXCESO2 oxygen probe to the FXO2TRIM-1 interface using the 59-612-33 cable. Wire the FXO2TRIM-1 using 59-565 cable.

Remove cover from FXO2TRIM-1 to access terminals

Grounding connection for FXO2TRIM-1

Use the following color scheme for wiring the quick disconnect adapter:

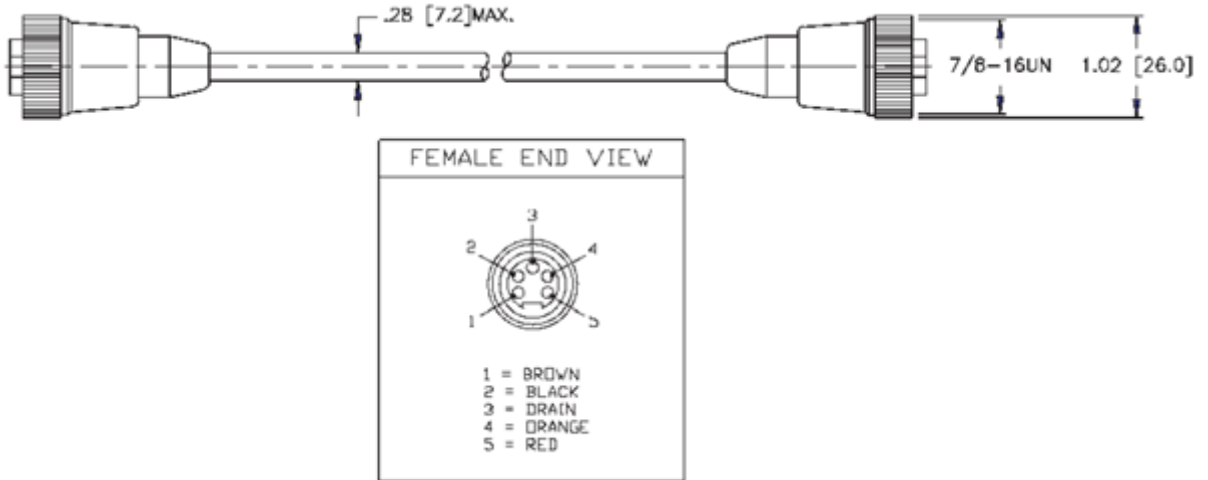| Color	Terminal	Description
White	+	24VDC+
Blue	-	24VDC-
Green/yellow	Grounding screw	Earth ground
Brown	B	Modbus A
Black	A	Modbus B

For direct wiring, wire to the following chart (color coding for Fireye cable 59-565 is shown):

CM-420 Terminal	FXO2TRIM-1 Terminal	59-565 Color
P1	+	Red
P2	-	Black
G	Grounding screw	Bare
P3	B	Orange
P4	A	Brown

Quick Disconnect Cord Sets
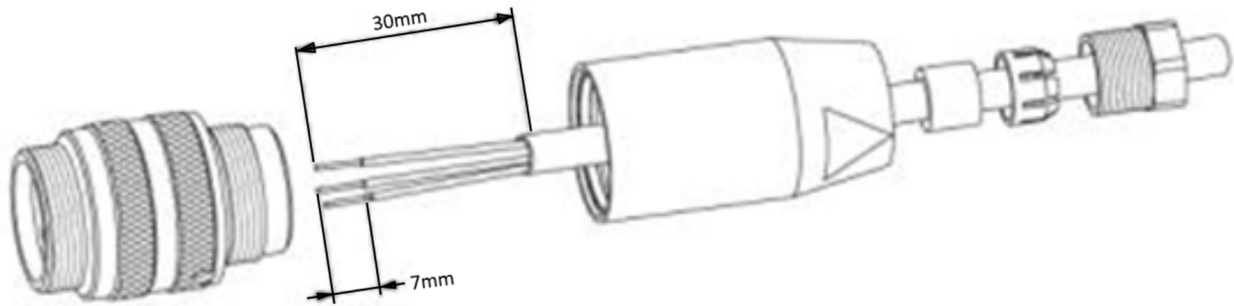
Pre-made cord sets having female connectors on both ends are available in 1.83m (6 ft.) and 12.19m (40 ft.) lengths.

FEMALE END VIEW

1 = BROWN
2 = BLACK
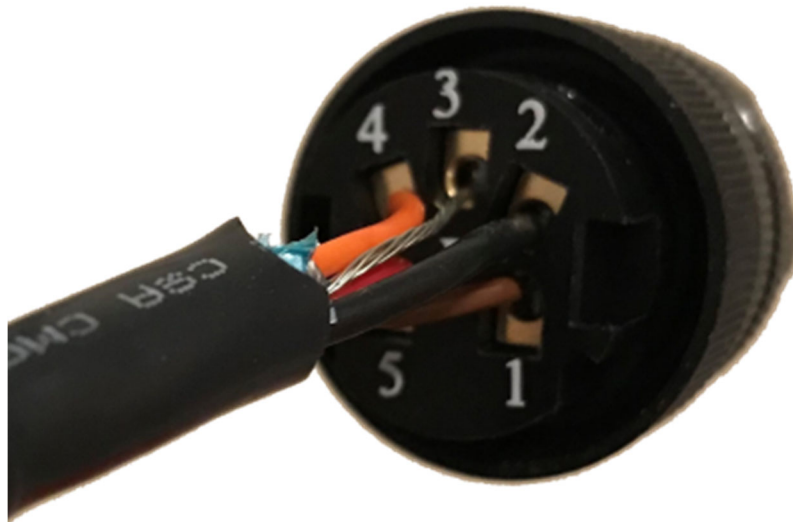3 = DRAIN
4 = ORANGE
5 = RED

Quick Disconnect Field Wiring

Quick disconnect connectors are available in kit form for field wiring (Fireye part number 129-192). Two are needed per cord, one for each end. The recommended cable is Fireye part number 59-565 (sold by the foot).

As shown above the cable strip length is specified at 30 mm (1.2 in) and each wire strip length is 7 mm (0.275 in).

To use cable 59-565, strip one end as specified. Strip each wire and wire to connector as shown in the image and table below:

Terminal	Description	Color (59-565 cable)
1	Modbus B	Brown
2	24VDC-	Black
3	Earth ground	Bare
4	Modbus A	Orange
5	24VDC+	Red

INTERFACE

The touchscreen is used for configuration and monitoring of data.

Navigation

The first screen that appears after power-up is the STATUS screen.

This screen displays the operating information for the connected oxygen probe, as well as providing access to the main menu for navigation to other screens.

Only data that is configured will appear on the STATUS screen. For example, if an inlet temperature sensor is not fitted, the area where the inlet temperature and the net stack temperature are shown will be blank (net stack temperature is calculated by subtracting the inlet temperature from the gross stack temperature, which is the temperature read by the thermocouple in the oxygen probe).

The status of the stack thermocouple, ambient temperature sensor, probe CPU and probe O_2 sensor are all indicated on the STATUS screen. If the status is "OK", the boxes (status lamps) will be green. If there is a fault, the status lamp will be red. For the probe sensor, the status lamp can also be blue when it is calibrating, or orange when the probe is in standby or when it is warming up. These are the four internal "modules" of the oxygen probe. If a fault is indicated, navigating to the INFORMATION screen will provide additional data.

The area on the right side of the screen shows the settings and current status for the programmable alarm relays. If the reset type is set to manual reset, a RESET pushbutton will appear beside the status lamp when the alarm is active, to allow a reset.

Probe Commands

Commands can be sent to the probe by pressing the COMMANDS pushbutton.

A pop-up window will appear allowing commands to be sent.

CALIBRATE: Send a calibration signal to the probe. As the warning indicates, this should only be performed in a free-air condition to ensure 20.9% oxygen concentration. Prior to calibration, the combustion air fan is typically allowed to purge for at least five minutes to ensure this condition is met.

Main Menu

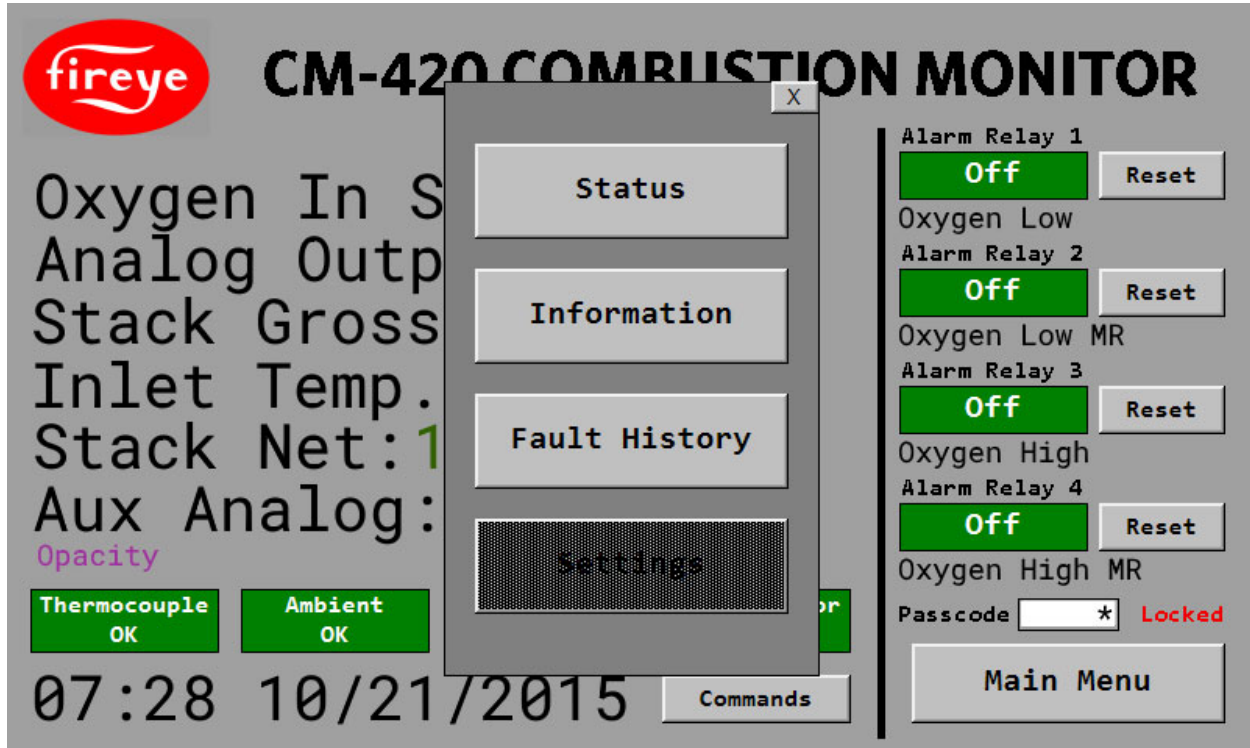The main menu will be displayed if MAIN MENU is pressed.

STATUS: This is the overview screen shown at power-up.

INFORMATION: This screen shows additional prove information such as detailed status and ambient temperature.

FAULT HISTORY: Shows the codes for the last ten faults in the oxygen probe memory. This button will only be available when the connected probe type is NXCESO2.

SETTINGS: The accesses all the CM-420 configuration area. A passcode is required to enter these screens. If the passcode area above the MAIN MENU button shows "Locked" in red, SETTINGS will appear hashed out. If the passcode is successfully entered, "Unlocked" will appear in green and the SETTINGS button will be accessible.

The passcode is fixed to **903**. Touch the entry area (indicated by one or more asterisks) to enter the passcode.

Information

The information screen will be displayed if INFORMATION is pressed from the main menu.

The status information, COMMANDS button, MAIN MENU button and alarm relay information shown on the STATUS screen are also shown on the INFORMATION screen.

The static probe information related to firmware is shown, as well as the software revision of the CM-420. The probe ambient temperature is also displayed. More detailed status information is also shown for the stack thermocouple, ambient temperature, probe CPU and probe sensor. The text will be in green when the status is no fault and will be in red if the status is a fault. As with the status lamp, the probe sensor status will be in blue when calibrating and in orange when in standby or warming up.

See the Modbus Mapping section for a complete list of all the possible status messages.

Fault History

The fault history screen will be displayed if FAULT HISTORY is pressed from the main menu. Note that only the NXCESO2 probe has a fault history. This page is not accessible when the connected probe is the FXCESO2 with FXO2TRIM-1 interface.

The status information, COMMANDS button, MAIN MENU button and alarm relay information shown on the STATUS screen are also shown on the INFORMATION screen.

For each fault, the relevant module (stack thermocouple, ambient temperature, probe CPU or probe sensor) will be displayed. Faults can also display as "Internal" or "Modbus" as well. Following the module, the type and sub-type of fault will be shown, as well as the contents of the data register which varies depending upon the module, type and sub-type combination. As such, the data is shown both unsigned (positive number only) and signed (positive or negative number).

For more detail on the faults, reference Fireye bulletin *NXCESO2-1001*.

SETTINGS

The settings screens share a common set of menu buttons located on the right-hand side of the page. The first settings screen show will be the general settings screen.

General

This screen shows general screen-related settings.

TEMPERATURE DISPLAY UNITS: Selects whether to show temperatures on the STATUS and INFORMATION screens in Imperial units (degrees Fahrenheit) or in Metric units (degrees Celsius).

DATA DISPLAY FORMAT: Choose whether to show the date as DD/MM/YYYY or MM/DD/YYYY.

SCREEN BEEP ON TOUCH: Enables or disables the audible beep when the screen is touched.

SCREEN SAVER FUNCTION: Enables or disables the screen saver function.

SCREEN SAVER: If screen saver is enabled, sets the minutes before screen is blanked.

TIME/DATE SETTINGS: Adjust an element of the real-time clock +/- 1 unit.

Probe

This screen shows probe-related settings. Changing values here changes the corresponding values in the probe memory.

Probe Type Fitted	NXCESO2	
Start-up Delay (minutes)	5	

Probe Type Fitted: NXCESO2

Start-up Delay (minutes): 5

Not Running Threshold (%): 18

Auto Calibration (hours): 24

Stack Temp. Max Limit: 1562 F 850 C Write New

Ambient Upper Limit: 221 F 105 C Write New

Ambient Lower Limit: -13 F -25 C Write New

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General | Probe | Analog Inputs | Analog Output | Alarm Relays | Network | Main Menu

PROBE TYPE FITTED: Selects whether the connected probe type is the NXCESO2 or the FXCESO2 with the FXO2TRIM-1 interface. This selection will enable/disable buttons and features that are not applicable to the connected probe.

START-UP DELAY: Sets the delay in minutes after powering up before any high O_2 level alarms can be generated. This gives the heater enough time to warm the oxygen probe if the connected appliance is idle.

NOT RUNNING THRESHOLD: Sets the threshold in O_2 percent where the appliance is assumed to be idle. Any reading above this threshold will not trigger a high O_2 level alarm. Automatic calibration can only occur when in this state for greater than five minutes.

AUTO CALIBRATION: Sets the delay in hours before the command to initiate automatic calibration. Once this command is issued, the probe must be in the not running state for greater than five minutes before the calibration command is sent. Setting this option to 0 will disable automatic calibration. Note that calibration is a logical process that sets the idle state reading (20.9%) and should only be done in a free air condition (no combustion gas present).

STACK TEMP. MAX LIMIT: Enter a value in either °F or °C and the corresponding value will change as well. Touch WRITE NEW to send the value to the oxygen probe. The allowed range to set is from 38°C to 1024°C (100°F to 1875°F), while the default setting is 482°C (900°F). A stack thermocouple reading above this value will cause the oxygen probe to issue a status fault for the stack thermocouple module. This setting will only be enabled when the connected probe type is NXCESO2. Note that the preferred method of monitoring the stack temperature is to use a programmable relay output, set to monitor a high stack temperature.

AMBIENT UPPER LIMIT: Set using the same method shown above. The allowed range to set is from 65°C to 125°C (149°F to 257°F), while the default setting is 85°C (185°F). An ambient temperature reading above this value will cause the oxygen probe to issue a status fault for the ambient temperature module. This setting will only be enabled when the connected probe type is NXCESO2.

AMBIENT LOWER LIMIT: Set using the same method shown above. The allowed range to set is from -15°C to -55°C (5°F to -67°F), while the default setting is -25°C (-13°F). An ambient temperature reading above this value will cause the oxygen probe to issue a status fault for the ambient temperature module. This setting will only be enabled when the connected probe type is NXCESO2.

Analog Inputs

This screen allows configuration of the two analog inputs.

Use Inlet Sensor	Yes			General
Inlet Sensor Scale Low	-40 F	-40 C		Probe
Inlet Sensor Scale High	140 F	60 C		Analog Inputs
Use Aux 4-20mA Input	Yes			Analog Output
Aux 4-20mA Input Name	Aux Input			Alarm Relays
Aux 4-20mA Input Scale Low	40			Network
Aux 4-20mA Input Scale High	200			
Suffix mA	Decimal Accuracy	1		Main Menu

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USE INLET SENSOR: Enables or disables use of an inlet temperature sensor. While not required the inlet temperature sensor allows calculation of a net stack temperature. This can make monitoring the stack temperature more accurate. It can also be useful for the PLC/SCADA/BMS to calculate efficiency.

INLET SENSOR SCALE (LOW/HIGH): Displays only when using the inlet sensor. Enter a value in either °F or °C and the corresponding value will change as well. This sets the range of the sensor used. The default settings match those of Fireye part FXIATS-140 but any 4-20mA sensor can be used.

USE AUX 4-20mA INPUT: Enables or disables use of an auxiliary sensor. This can be any type of 4-20mA signal.

AUX 4-20mA INPUT NAME: Displays only when using the auxiliary input. Up to 20 string characters can be entered for the name (will be shown on the STATUS screen). Note that the auxiliary input display on the STATUS screen can only show a total of 10 characters. This includes the value, decimal point and suffix. If the range is too large the suffix may truncate.

INLET SENSOR SCALE (LOW/HIGH): Displays only when using the auxiliary input. The values entered can be from -2147483648 to 2147483647, allowing use of a wide variety of sensors. If the low scale is higher than the high scale, the output will scale in reverse (4mA is maximum, 20mA is minimum).

SUFFIX: Displays only when using the auxiliary input. Up to 4 string characters can be entered for the suffix/units of the auxiliary input (will be shown on the STATUS screen).

DECIMAL ACCURACY: Displays only when using the auxiliary input. Choose from 0 to 2 decimals.

Analog Output

This screen allows configuration of the analog output.

```
Oxygen Reading at 4mA Output          0 %        General

Oxygen Reading at 20mA Output        25 %         Probe

                                              Analog Inputs

                                              Analog Output

                                              Alarm Relays

                                                Network


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OXYGEN READING AT 4mA OUTPUT: Sets the O_2 value that will be represented by 4mA. Any value below this amount will also read as 4mA. The default is 0%.

OXYGEN READING AT 20mA OUTPUT: Sets the O_2 value that will be represented by 20mA. Any value above this amount will also read as 20mA. The default is 25%. Note that the maximum O_2 value read by the oxygen probe should be around 20.9%.

NOTE: If the value entered for 4mA is higher that the value entered for 20mA, the output will scale in reverse. In this case, any value above the 4mA setting will read as 4mA, and any value below the 20mA setting will read as 20mA.

Alarm Relays

Each programmable alarm relay has a separate configuration screen. The options for each are the same. Use the << and >> buttons to scroll between the different configuration screens.

The default settings for the programmable alarms are:

- **ALARM 1:** Oxygen Low Limit, Automatic Reset, Setpoint 2.0%, No Delay (Oxygen Low)
- **ALARM 2:** Oxygen Low Limit, Manual Reset, Setpoint 1.0%, No Delay (Oxygen Low-Low)
- **ALARM 3:** Oxygen High Limit, Automatic Reset, Setpoint 12.0%, No Delay (Oxygen High)
- **ALARM 4:** Oxygen High Limit, Manual Reset, Setpoint 13.0%, No Delay (Oxygen High-High)

Alarm 1 Function	Probe Error	General
Alarm 1 Output Polarity	Closed = Alarm (N.O.)	Probe
Alarm 1 Reset Type	Automatic Reset	Analog Inputs
		Analog Output
		Alarm Relays
Alarm 1 Delay Function	No Delay	Network
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ALARM x FUNCTION: Sets the function for the programmable alarm relay. Choices are:

- **PROBE ERROR:** The condition will be true if any of the four modules (stack thermocouple, ambient temperature, probe CPU or probe sensor) indicate a fault condition.
- **CALIBRATING:** The condition will be true if the oxygen probe is calibrating.
- **OXYGEN LOW LIMIT:** Compares the O_2 reading to the setpoint to set the condition. Condition is true when the reading is below the setpoint.
- **OXYGEN HIGH LIMIT:** Compares the O_2 reading to the setpoint to set the condition. Condition is true when the reading is above the setpoint for longer than the filter delay time of five minutes. Note that the reading must be at or below the NOT RUNNING THRESHOLD for an alarm to be true. The boiler or appliance is offline when the reading is above NOT RUNNING THRESHOLD.

- **STACK LOW LIMIT:** Compares the net stack reading to the setpoint to set the condition. Condition is true when the reading is below the setpoint and the O2 reading is below the NOT RUNNING THRESHOLD, for the longer than the filter delay time of five minutes. If the inlet sensor is not optioned (i.e. net stack temperature can't be calculated), then the gross stack temperature is used.
- **STACK HIGH LIMIT:** Compares the net stack reading to the setpoint to set the condition. Condition is true when the reading is above the setpoint. If the inlet sensor is not optioned (i.e. net stack temperature can't be calculated), then the gross stack temperature is used.
- **AUX LOW LIMIT:** Compares the auxiliary input reading to the setpoint to set the condition. Condition is true when the reading is below the setpoint.
- **AUX HIGH LIMIT:** Compares the auxiliary input reading to the setpoint to set the condition. Condition is true when the reading is above the setpoint.
- **MODBUS CONTROL:** The condition is directly set by writing via Modbus (allows PLC/SCADA/BMS direct control of the output).
- **COMM. LOSS:** The condition is true when communication between the NXCESO2 or FXO2TRIM-1 and CM-420 is lost.

ALARM x OUTPUT POLARITY: Choose whether the relay should be closed when the condition is true (CLOSED = ALARM) or when the condition is false (OPEN = ALARM).

> ⚠ **WARNING: Do not use the relay outputs for safety related connections. For example, do not set up a programmable relay output to monitor high stack temperature with the output set to be open with alarm if this is expected to be a primary safety device. This can be done if it is not required or is an optional safety device.**

ALARM x RESET TYPE: Choose whether the condition will latch. Choosing AUTOMATIC will result in the condition automatically changing states (alarm clears). Choosing MANUAL will result in the condition remaining true indefinitely unless reset using the RESET button for the respective alarm relay.

ALARM x DELAY FUNCTION: Choose whether there should be a delay before the alarm condition is true or a delay before the alarm condition is released. Choices are:

- **NO DELAY:** Condition is immediate.
- **DELAY ON MAKE:** Condition is not true until the delay setpoint has elapsed. The condition must remain true during the entire timing period. This can be used to filter out nuisance setpoint crossings to ensure that the condition is true.
- **DELAY ON BREAK:** Output remains on after the condition is no longer true until the delay setpoint has elapsed.

ALARM x DELAY SETPOINT: Displays only when using a delay. Sets how long the timer delays on make or on break in seconds. Can be set up to 9999 seconds.

Additional settings will be shown when the alarm type is set to monitor O_2, stack or auxiliary input low or high limits (screen shown for O_2 limit).

Alarm 1 Function	Oxygen Low Limit		General
Alarm 1 Output Polarity	Closed = Alarm (N.O.)		Probe
Alarm 1 Reset Type	Automatic Reset		Analog Inputs
Alarm 1 Setpoint Oxygen	?	2.0 %	Analog Output
			Alarm Relays
Alarm 1 Delay Function	No Delay		Network
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ALARM x SETPOINT OXYGEN: Choose the setpoint for the low or high O_2 limit. A help button is provided that explains the high limit alarm is only valid to the NOT RUNNING THRESHOLD option (the boiler or appliance is considered offline if the O_2 reading is above the NOT RUNNING THRESHOLD option).

ALARM x SETPOINT STACK TEMP.: Choose the setpoint for the low or high stack temperature limit. Enter a value in either °F or °C and the corresponding value will change as well.

ALARM x SETPOINT AUX INPUT: Choose the setpoint for the low or high auxiliary input limit. The value can be either negative or positive and is entered without decimal accuracy. This means that if the auxiliary input is using two decimals to represent a value from -50.00 to 200.00 and the setpoint desired is 75.25, the setpoint can only be entered as either 75 or 76.

Network

The setting for the Modbus connections can be set from this screen. Modbus TCP/IP is available from the Ethernet port on the rear of the touchscreen interface. Modbus RTU is available from the COM2 port on the rear of the touchscreen interface. See the MODBUS CONNECTION section for further connection information.

IP Address	192	168	0	11		General
Subnet Mask	255	255	255	0		Probe
Default Gateway	0	0	0	0		Analog Inputs
Modbus RTU Node Address				1		Analog Output
Modbus RTU Baud Rate			38400			Alarm Relays
Modbus RTU Data Bits			8			Network
Modbus RTU Parity			None			
Modbus RTU Stop Bits			1			Main Menu

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All settings will be applied immediately to non-volatile memory – no reboot is required.

IP ADDRESS: Sets the IP address. There is a separate entry for each byte. Each byte can be set from 0 to 255. The default is 192.168.0.11.

SUBNET MASK: Sets the subnet mask. There is a separate entry for each byte. Each byte can be set from 0 to 255. The default is 255.255.255.0.

DEFAULT GATEWAY: Sets the IP address. There is a separate entry for each byte. Each byte can be set from 0 to 255. The default is 0.0.0.0.

MODBUS RTU NODE ADDRESS: Sets the node address. This can be set from 1 to 255 (default is 1).

MODBUS RTU BAUD RATE: Sets the baud rate. Choices are 4800, 9600, 19200, 38400, 57600, 115200 or 187500 (default is 38400).

MODBUS RTU DATA BITS: Sets the data bits. Choices are 7 or 8 (default is 8).

MODBUS PARITY: Sets the parity. Choices are none, even, odd (default is none).

MODBUS RTU STOP BITS: Sets the stop bits. Choices are 1 or 2 (default is 1).

MODBUS

Modbus is available in either a TCP/IP connection or an RTU connection. The mapping is the same for each – see the MODBUS MAPPING section for a complete list.

All Modbus data is contained in holding registers (4x type). Use function code 3 to read the holding registers. Bit data is contained in complete words, coil and input registers are not used. Any writes to data can use either function code 6 or function code 16. The valid register area is from 40001 to 40140. Any reads/writes must begin and end in this range. There is no limit from the server side as to how many registers can be read consecutively.

Modbus Connection

The Modbus TCP/IP connection uses standard Cat5 cabling and Ethernet topology. If the connection is made directly to another device, automatic switching will take place, so a crossover cable is not required. Make sure that the IP address is not duplicated, or a pop-up window will appear to allow the IP address to be changed. Note that this pop-up is automatic and will allow DHCP to be selected. Do not select DHCP as doing so may make it difficult to locate the device on the network.

The Modbus RTU connection is made to the DB9 female connector on COM2. This connector supports RS232, RS422 or RS485. A custom cable can be made or a connector such as the DGB9MT1 from L-Com can be used to convert to terminals (image shown below).
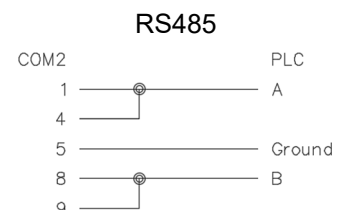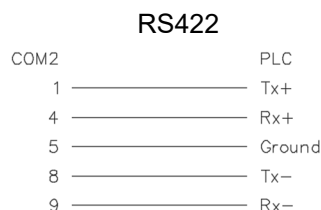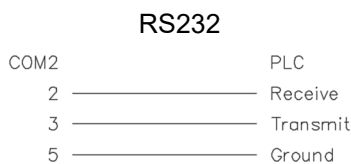
DB connectors have standard pin numbers from 1 to 9. These are shown in the table below with the corresponding functions:

DB9 Pin	Function
1	RS422/RS485 Tx+
2	RS232 Transmit
3	RS232 Receive
4	RS422/RS485 Rx+
5	Ground
6	No connection
7	No connection
8	RS422/RS485 Tx-
9	RS422/RS485 Tx-

L-Com DGB9MT1

Connection diagrams:

Modbus Mapping

Read access is shown with **R** and write access is shown with **W**.

Data types:

- **UINT** (unsigned integers, occupies a single register)
- **REAL** (floating point IEEE 754, occupies two consecutive registers)
- **STRING** (single register of two ASCII characters)
- **HEX** (single register to be read in hexadecimal)

Where bit data is packed into UINT registers, bit positions are indicated.

Address	Bit	Access	Type	Description	Notes
40001	---	R	UINT	O_2 percent	Data is x100 65535 = invalid
40002	---	R	UINT	Analog output 4-20mA	Data is x10 65535 = invalid
40003	---	R	REAL	Stack temperature, gross (°C)	-1 = invalid
40005	---	R	REAL	Stack temperature, gross (°F)	-1 = invalid
40007	---	R	REAL	Inlet temperature (°C)	-1 = invalid
40009	---	R	REAL	Inlet temperature (°F)	-1 = invalid
40011	---	R	REAL	Stack temperature, net (°C)	-1 = invalid
40013	---	R	REAL	Stack temperature, net (°F)	-1 = invalid
40015	---	R	REAL	Probe ambient temperature (°C)	-1 = invalid
40017	---	R	REAL	Probe ambient temperature (°F)	-1 = invalid
40019	---	R	REAL	Auxiliary input	-1 = invalid
40021	---	RW	UINT	Command bits	See note 7
---	0	RW	Bit	Calibrate command	
---	4	RW	Bit	Alarm relay 1 manual command	
---	5	RW	Bit	Alarm relay 2 manual command	
---	6	RW	Bit	Alarm relay 3 manual command	
---	7	RW	Bit	Alarm relay 4 manual command	
40022	---	R	UINT	Status bits	
---	0	R	Bit	Stack thermocouple OK	
---	1	R	Bit	Stack thermocouple error	
---	2	R	Bit	Probe CPU OK	
---	3	R	Bit	Probe CPU error	
---	4	R	Bit	Ambient temperature OK	
---	5	R	Bit	Ambient temperature error	
---	6	R	Bit	Probe sensor OK	
---	7	R	Bit	Probe sensor error	
---	8	R	Bit	Probe sensor calibrating	
---	9	R	Bit	Probe sensor in standby	

Address	Bit	Access	Type	Description	Notes
---	10	R	Bit	Display units	0 = imperial 1 = metric
---	11	R	Bit	Communication to NXCESO2 or FXO2TRIM-1 active	0 = comm. loss 1 = active
40023	---	R	UINT	Alarm relay 1 status bits	
---	0	R	Bit	Alarm condition	0 = condition false 1 = condition true
---	1	R	Bit	Alarm relay status	0 = relay open 1 = relay closed
40024	---	R	UINT	Alarm relay 2 status bits	
---	0	R	Bit	Alarm condition	0 = condition false 1 = condition true
---	1	R	Bit	Alarm relay status	0 = relay open 1 = relay closed
40025	---	R	UINT	Alarm relay 3 status bits	
---	0	R	Bit	Alarm condition	0 = condition false 1 = condition true
---	1	R	Bit	Alarm relay status	0 = relay open 1 = relay closed
40026	---	R	UINT	Alarm relay 4 status bits	
---	0	R	Bit	Alarm condition	0 = condition false 1 = condition true
---	1	R	Bit	Alarm relay status	0 = relay open 1 = relay closed
40027	---	R	UINT	Stack thermocouple message	See note 2
40028	---	R	UINT	Probe CPU message	See note 3
40029	---	R	UINT	Ambient temperature message	See note 4
40030	---	R	UINT	Probe sensor message	See note 5
40031	---	R	STRING	Oxygen probe firmware revision	
40032	---	R	HEX	Oxygen probe firmware CRC	
40033	---	R	STRING	CM-420 software revision	
Fault history registers (see note 1, NXCESO2 only)					
40xx1	---	R	UINT	Fault module	See note 6
40xx2	---	R	UINT	Fault type	
40xx3	---	R	UINT	Fault sub-type	See Fireye bulletin *NXCESO2-1001*
40xx4	---	R	UINT	Fault data register	

Note 1: There are ten faults in the fault history. Each is organized with the same structure, using the following addresses:

- **Latest fault:** 40041-40044
- **History 1 fault:** 40051-40054
- **History 2 fault:** 40061-40064
- **History 3 fault:** 40071-40074
- **History 4 fault:** 40081-40084
- **History 5 fault:** 40091-40094
- **History 6 fault:** 40101-40104
- **History 7 fault:** 40111-40114
- **History 8 fault:** 40121-40124
- **History 9 fault:** 40131-40134

Note 2: Stack thermocouple messages. See Fireye bulletin *NXCESO2-1001* for additional information.

- **0:** Stack Probe OK
- **1:** Stack Probe Disconnected Fault
- **2:** Stack Over Temperature Fault
- **3:** Stack Read Fault

Note 3: Probe CPU messages. See Fireye bulletin *NXCESO2-1001* for additional information.

- **0:** CPU OK
- **1:** CPU CRC Fault
- **2:** CPU RAM Fault
- **3:** CPU Instruction Fault

Note 4: Ambient temperature messages. See Fireye bulletin *NXCESO2-1001* for additional information.

- **0:** Ambient Temperature OK
- **1:** Ambient Temperature Cannot Be Read Fault
- **2:** Ambient Over Temperature Fault
- **3:** Ambient Under Temperature Fault

Note 5: Probe sensor messages. See Fireye bulletin *NXCESO2-1001* for additional information.

- **0:** Sensor OK
- **1:** Sensor 24V Low Fault
- **2:** Sensor 24V High Fault
- **3:** Sensor 12V Open Fault
- **4:** Sensor 12V Low Fault
- **5:** Sensor 12V High Fault
- **6:** Sensor Unexpected Calibration Fault
- **7:** Sensor Stuck Fault
- **8:** Sensor Calibration Needed
- **9:** Sensor Heater Short Fault
- **10:** Sensor Heater Open Fault
- **11:** Sensor Pump Short Fault
- **12:** Sensor Pump Open Fault
- **13:** Sensor Nernst Cell Short Fault
- **14:** Sensor Nernst Cell Open Fault
- **15:** Sensor Conversion Timeout Fault
- **16:** Sensor Low Voltage Fault
- **17:** Sensor Too Cold Fault
- **18:** Sensor Too Hot Fault
- **19:** Sensor Air Calibrating
- **20:** Sensor Heater Calibrating
- **21:** Sensor Comm. Busy
- **22:** Sensor Comm. Fault
- **32:** Sensor Warming Up
- **33:** Sensor In standby

Note 6: Fault history module enumerations. See Fireye bulletin *NXCESO2-1001* for additional information.

- **1:** CPU
- **2:** Stack thermocouple
- **3:** Ambient temperature
- **4:** Probe sensor
- **5:** Internal
- **6:** Modbus

Note 7: When writing commands, the bit must also be turned back off or the command will continue to execute (i.e. the CM-420 will continuously send a calibrate command to the NXCESO2 or FXO2TRIM-1). The best strategy is to issue the command and monitor the status bits and messages to determine when to turn the command off.

CERTIFICATIONS

UL508A Enclosed Industrial Control Panel (United States/Canada)

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