Hays Cleveland
Div. of UniControl Inc.

SERIES A-10050-A0
OXYGEN ANALYZER ELECTRONICS
INSTRUCTION MANUAL

WARNING

Do not operate or service this equipment before reading the operator's manual! Failure to do so could result in serious injury.

Alterations to hardware, wiring, or software must be approved in writing by Hays Cleveland, Division of UniControl Inc.

Your feedback is important to us!
If you have comments about this document,
please send them to:
salescombustion@unicontrolinc.com.

REVISION CONTROL

This manual is UniControl Inc. Document Number IM A10050.00.

DOCUMENTATION NUMBER AND REVISION LOG	
MANUAL	**REVISION DATE**
IM A10050.00	None
HARDWARE	**REVISION NUMBER**
Microprocessor-based Electronics Unit	
Zirconium Oxide In Stack Probe Assembly	
SOFTWARE	**REVISION NUMBER**
Controller Software	2.18

CONVENTIONS

1. This manual pertains to the application of the A-10050 Oxygen Analyzer Electronics to boiler plants. Other applications are possible.
2. Terminology (as defined by ASME CSD-1-1998 “Controls and Safety Devices for Automatically Fired Boilers”) that is used in this manual includes the following:
   a. Control: a device designated to regulate the fuel, air, water, steam, or electrical supply to the controlled equipment. It may be automatic, semiautomatic, or manual.
   b. Control, operating: an automatic control, other than a safety control, to start input, or regulate input upon satisfaction of demand.
   c. Control, primary safety: a control directly responsive to flame properties, sensing the presence of flame and, in event of ignition failure or loss of flame, causing safety shutdown.
   d. Control, safety (also known as limit): a control responsive to changes in liquid level, pressure, or temperature, which is set beyond the operating range to prevent operation beyond designed limits.

ABBREVIATIONS USED IN THIS MANUAL

Term	Definition
AIT	Analyzer Indicating Transmitter (Analyzer Electronics)
O_2	Oxygen
ZrO_2	Zirconium Oxide; Zirconia

SYMBOLS USED IN THIS MANUAL

The following symbols (if used in this manual) alert the operator to the conditions defined below.

DANGER	Danger symbol indicates an immanently hazardous situation, which, if not avoided, will result in death or serious injury.
WARNING	Warning symbol indicates a potentially hazardous situation, which, if not avoided, could result in death or serious injury.
CAUTION	Caution symbol indicates a potentially hazardous situation, which, if not avoided, could result in minor or moderate injury.
CAUTION	Caution used without the safety alert symbol indicates a potentially hazardous situation, which, if not avoided, may result in property damage.

DANGER SAFETY WARNINGS

Failure to comply in full with the following safety requirements may result in equipment damage, personal injury or death.

1. Read the entire manual to become familiar with the use and operation of this device.
2. Only qualified personnel should attempt to install, wire, commission, startup, service or operate this device.
3. This device is not suitable for use in an explosive ambient atmosphere.
4. Before working on this device, be sure that you understand the processes affected by this device completely.
5. Before working on this device, be sure that any process affected by this device is secure and safe for servicing.
6. Take appropriate precautions to avoid electric shock when working with this device near water.
7. Exercise caution while wiring or working on this device. Multiple voltage sources may be present: take appropriate precautions to avoid electric shock.
8. RFI (radio frequency interference) can affect adversely the operation of this device and devices that are connected together as a system. Do not use radios near this equipment: examples include, but are not limited to; citizen band radios (CB), walkie-talkies, transceivers, and amateur radios (HAM).

WARNING WIRING TIPS

1. Remove all power from the unit before commencing any wiring operations. Wire with extreme caution!
2. All wiring must conform to the National Electrical Code and to local code regulations. Verify all electrical ratings on equipment.
3. Connecting high voltage to the low voltage circuits will damage the circuitry!
4. Mount the unit in such a manner that the wiring cable from the main electronics does not touch or approach any high magnetic sources such as motor starters, 3 ph. transformers, ignitors, etc. If mounted near a high magnetic source, electronic interference may cause the display to read incorrectly.

STORAGE, HANDLING & UNPACKING

When unpacking this equipment, consult the packing list to be sure all items are present. Immediately report any missing items to the sales office where you ordered the equipment. If any part of the equipment has been damaged in transit, notify the carrier: damage claims for items shipped FOB the factory are negotiated with the carrier. Retain carton and packing materials for the claim adjuster's inspection. Retain the shipping carton for future use in case the equipment needs factory repair or calibration. The following components may be shipped individually. Specific purchase orders may include some or all of these items.

- A-10050-A0 Microprocessor-based Oxygen Analyzer Electronics/Display Unit
- **One** of the following probe assemblies:
  - A-10018-A0 OXY-MIZER™ probe (cell, heater, RTD, lead bundle assembly, probe body and connector box).
  - A-10007-B0 OXYPROBE™ (cell, heater, RTD, lead bundle assembly, probe body and connector box).
  - A-08560-A0 MINI-O2™ (cell, heater, RTD, cable assembly, probe body and connector box).
- Interconnective Cable Assembly.
- Flow (calibration) panel, if ordered.
- Reference gas flow meter, if ordered.
- Instruction Manual IM A10050.00

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TABLES & ILLUSTRATIONS

1.0 INTRODUCTION

IN THIS SECTION

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1.1 OVERVIEW OF THE PRODUCT

Hays Cleveland is a pioneer in the application of zirconium oxide (ZrO_2) oxygen analyzers to flue gas analysis. The Model A-10050-A0 is Hays Cleveland's state of the art oxygen analyzer electronics, suitable for use with any Hays Cleveland oxygen analyzer probe.

Used in conjunction with a probe, the analyzer electronics displays and transmits the oxygen signal for recording and control functions. The electronics also includes basic functions to maintain the cell at its optimum temperature and monitor probe life. If a flue gas temperature input is provided, the A10050-A0 Electronics can compute combustion efficiency for the boiler, taking into account which one of numerous different fuels is being fired currently.

The following Hays Cleveland Oxygen Analyzer Probes are compatible with the A10050-A0 Electronics unit. Each of these units is shipped with its own instruction manual containing important information specific to that probe. In addition to this manual, which deals specifically with the A-10050-A0 oxygen analyzer electronics unit, please refer to the appropriate probe manual as necessary.

- Model A-08562-A0 MINI-O2™ Oxygen Analyzer Probe, used in gas, oil, and solid fuel firetube industrial boiler applications.
- Model A-10018-A0 OXY-MIZER™ Oxygen Analyzer Probe, the industrial standard for large fire tube boilers and water tube boilers burning any type of fuel.
- Model A-10007-B0 OXYPROBE™ Oxygen Analyzer Probe, used in severe duty applications such as power generation, incineration and rotary kilns.
- See Bulletin **BD06120 Thermocouple Meter** for information on the use of a flue gas temperature sensor/ transmitter as input for calculating combustion efficiency.

Features

- Automatic calibration sequence.
- Bright 2x20 vacuum fluorescent display.
- Front panel pushbuttons for parameter setup.
- Parameters stored in non-volatile memory.
- 4-20mA flue gas temperature input.
- Boiler efficiency calculation and display (when flue gas temperature input is used.)
- Two isolated 4-20mA outputs (Oxygen % and Efficiency).
- Modbus communications.
- Combustion air temperature (either preset from the front panel or measured via optional combustion air temperature sensor.)
- NEMA 4X fiberglass enclosure with window.

Heater control

- Selectable type K-thermocouple or RTD heater feedback.
- Selectable 750C/820C heater set point.
- Proportional/Integral heater control algorithm.
- Drives Hays Cleveland Series A-10007-B0, A-10018-A0, and A-08560-A0 probe heaters.

Form C relay outputs

- Alarm #1.
- Alarm #2.
- Calibration air.
- Calibration gas.
- Calibration in progress.
- Sensor Failure.

Inputs

- Start automatic calibration sequence.
- Fuel select (affects efficiency calculations).
- Alarm #1 external reset.
- Alarm #2 external reset.
- Boiler on.

Diagnostics

- Open thermocouple detection.
- Open or shorted RTD detection.
- Zirconium oxide sensing cell impedance monitoring.
- Open heater detection.

1.2 NOMENCLATURE

MODEL CODE:	A-10050-	A0-	_	_	_	_
			A	B	C	D

CODES	DESCRIPTION
A-10050	Base Model, Analyzer Electronics
- A0	Current Model Designation:
A: Electronics Mounting & Probe Configuration	
A01	Semi-flush panel mount, NEMA 4X: electronics configured for use with A-10007 or A-10018 probe.
A02	Semi-flush panel mount, NEMA 4X: electronics configured for use with A-08560 or A-08562 probe.
A03	Surface-mount, NEMA 4X: electronics configured for use with A-10007 or A-10018 probe.
A04	Surface-mount, NEMA 4X: electronics configured for use with A-08560 or A-08562 probe.
Z00	Factory Default Configuration (see Table 1-1).
Z01	Factory configuration for use with the type of probe or with options such as automatic calibration, flue gas temperature and combustion air temperature inputs for combustion efficiency computation.

1.2.1 DEFAULT FACTORY SETTINGS

TABLE 1-1: DEFAULT FACTORY SETTINGS		
MENU DISPLAY	**PARAMETER**	**VALUE**
Cal gas mix	Calibration gas mixture in cylinder, Model Code FZ2.	4.5% O_2
Smp Pressure	Partial pressure on sample side of probe.	407” WC
Ref Pressure	Partial pressure on reference side of probe	407” WC
Oxy Disp Mode	The display on the main menu will alternately display the % O_2 and the mV of the probe.	% and mV
FG & CA Temp Units	Units for all displays of flue gas or combustion air temperature, either F or C.	F
Flue Gas Disp Lo-Rng	Flue gas temperature low range.	32 F
Flue Gas Disp Hi Rng	Flue gas temperature high range.	999 F
Combustion temp source	Combustion air temperature source will be a transmitter. This value is fixed.	- 40 to 200 F
Combustion air preset	Combustion air temperature value preset for use when a transmitted input is not available.	75 F
AO1 type	Analog output 1 selected.	O_2%
AO1 Lo Range	Analog output 1, low range value, 4 mADC.	0%
AO1 Hi Range	Analog output 1, high range value, 20 mADC.	21%
AO1 fail	A01 fail mode for transmit of analog signal in this default case, % O_2.	Continue
AO2 type	Analog output 2 selected.	O_2%
AO2 Lo Range	Analog output 2, low range value, 4 mADC.	0%
AO2 Hi Range	Analog output 2, high range value, 20 mADC.	21%
AO2 fail	A02 fail mode for transmit of analog signal in this default case, % O_2.	Continue
Alarm # 1 type	Alarm selection of type.	Low O_2%
Alarm # 1 set point	Value of low alarm, default is O_2.	0.6%
Alarm # 2, type	Alarm selection of type.	High O_2%
Alarm # 2 Set point	Value of high alarm, default is O_2.	16.0%
Modbus Addr	Modbus address	1
Modbus Baud rate	Modbus baud rate.	19,200
ROC Limit	Rate of change limit.	1.0 mV
P.C. BOARD JUMPER	**FUNCTION**	**VALUE**
H4	Alarm # 1, reset mode.	Automatic
H5	Alarm # 2 reset mode.	Automatic
H6	Calibration method, manual/semi-automatic	-
H10	Boiler efficiency enable.	Yes

Table 1-1: Default settings, programmed before shipment from the factory.

1.3 SPECIFICATIONS

A10050-A0 OXYGEN ANALYZER ELECTRONICS TECHNICAL SPECIFICATIONS	
Electrical Power Requirement:	120 VAC, +/-10%, 50/60 Hz, 374 VA maximum.
Start Up:	170 VA, 30 minutes.
Operating:	40 to 100 VA, continuous.
Fuses:	
• Electronics:	1A.
• Temperature control:	4A.
Ambient Temperature:	32 to 131F (0 to 55C).
Relative Humidity:	0-90% non-condensing.
Enclosure:	NEMA 4X; fiberglass; surface-mounting, with semi-flush panel cutout. Mounting bezel available.
Shipping Weight:	<10 pounds (7 lbs. net).
Display:	Vacuum fluorescent (2 x 20 format).
Selectable displays (standard):	• % oxygen.
	• Sensor DC mV & status.
	• Operating temperature and status.
	• Alarm status.
	• Calibration status.
Additional displays with efficiency options:	• Flue gas temperature.
	• Combustion air temperature.
	• % combustion efficiency.
Temperature Control for Models A08561 & A08562 probes:	
	• Temperature Sensor: Type K (chromel/alumel) thermocouple.
	• Output to Heater: 120 VAC, ½ wave.
	• 750C nominal operating temperature
	• Open T/C shut off protection.
Temperature Control for Models A10007, A10018 & A10021 probes:	
	• Temperature Sensor: 100Ω platinum RTD.
	• Output to Heater: 55 VAC.
	• 820C nominal operating temperature.
	• Open & shorted RTD shut off protection.
Analog Inputs:	Two 4-20 mADC:
	• Flue Gas Temperature (into 100Ω internal).
	• Combustion Air Temperature (into 237Ω internal).
Analog Outputs:	Two 4-20 mADC into 750 ohms maximum. Ground isolated. User assigned and ranged. Assignable failure modes.
	• Excess Oxygen, 0 to 1 through 0 to 25%.
	• Analyzer sensor, 0 through 300 mV DC.
	• Combustion Efficiency, 0 to 100% through 50 to 100%.
	• Flue Gas Temperature, same scaling as input signal.

Discreet Inputs:	**All:** 120 Vac input.
Auto-Cal:	Initiate automatic calibration sequence from external switch.
Fuel 1 & Fuel 2:	Selections for combustion efficiency computations.
Alarm 1 & Alarm 2 Reset:	Remote reset of latching alarms.
Alarms & Relay Outputs:	• **All:** SPDT, NEMA Form C dry contacts. 10A ac, resistive.
• **Alarm 1 & Alarm 2:**	Assignable for high or low O_2, analyzer sensor dc mV, efficiency or flue gas temperature. Selectable for manual reset (latching) with local or remote reset, or auto reset (non-latching).
• **Sensor Failure:**	Heater, thermocouple, RTD or sensor impedance.
• **Calibration Air: & Calibration Test Gas:**	Used with solenoid operated calibration valves for automatic calibration.
• **Calibration in Progress:**	Alert controls or other devices when calibrating.
• **Communications:**	Modbus RTU slave. 9,600 or 19,200 baud rate, selectable.
The following auxiliaries are available for use with the electronics:	
• Semi-Automatic Calibration	uses a manual flow (calibration) panel and calibration gases consisting of dry instrument air and 4.5% nominal O_2 in N2 (cylinder).
• Automatic Calibration	uses a solenoid-operated flow (calibration) panel and calibration gases consisting of dry instrument air and 4.5% nominal O_2 in N_2 (cylinder). Automatic calibration can be initiated automatically via the real time clock, operator interface, and remote switch input.
• Flue Gas Temperature & Combustion Efficiency	use a transmitter or Hays Cleveland's Model D-06120 for computing combustion efficiency.
• Combustion Air Temperature Transmitter	provides automatic correction to the combustion efficiency computation.

2.0 INSTALLATION

IN THIS SECTION

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2.1 PRELIMINARY CONSIDERATIONS

The following paragraphs (2.1.1 - 2.1.9) provide information essential for understanding the main terminology of the A-10050 Oxygen Analyzer. Before proceeding to the wiring section (2.3), be sure that the requirements for the job are reviewed and understood. Please note that the A-10050 Oxygen Analyzer is primarily designed to operate with Hays Cleveland In Situ Zirconium Oxide (ZrO_2) Oxygen Analyzer probes; however, the unit ***may*** be compatible with probes made by other manufacturers. Contact Hays Cleveland for application assistance with third-party supplied probes.

2.1.1 CELL INPUT

The analyzer electronics unit provides a filtered input for the cell voltage generated by a zirconium oxide (ZrO_2) in situ probe. Firmware converts the cell voltage to a % O_2 reading for display and transmission (if required). Commonly, the transmitted signal serves as the trim signal in oxygen trim applications.

2.1.2 HEATER CONTROL

The zirconium oxide cell within the in-stack probe assembly provides an accurate reading of the oxygen present in flue gas only if it is operating at the appropriate temperature. To accomplish this, the analyzer electronics unit has circuitry that accepts and conditions feedback from a temperature sensor (either RTD or thermocouple), and generates a signal to drive a cell heater assembly in the probe. A sophisticated control algorithm ensures that the proper amount of power is delivered to the heater to maintain its operating temperature.

The heater drive circuitry also detects problems with the heater. For example, if the heater drive circuitry has been delivering full power (100%) for more than 60 minutes but the cell has not reached operating temperature, the heater is assumed to have failed.

2.1.3 ALARMS

The analyzer has two alarm relays, each of which can be dedicated independently to one of four variables: % Oxygen, cell millivolts, flue gas temperature, or % Efficiency. The alarm relays have Form C contacts (SPDT) brought out to a terminal block. Both alarms are fail-safe: whenever an alarm is active the corresponding alarm relay is de-energized, just as if power had been removed from the system. Consequently, actual loss of power to the analyzer drops out both alarm relays, thereby alerting the operator that a problem exists. Once tripped, the alarms can be reset individually either from the analyzer electronics front panel keypad or from dedicated external alarm reset pushbutton switches on a control panel. (External inputs are provided for the optional customer-supplied reset switches. See Section 2.3.4.) The alarms can also be configured to reset automatically as soon as the alarm condition has cleared. **The keypad reset and the external pushbutton switches can reset an active alarm only if its associated variable is within limits.**

2.1.4 COMBUSTION EFFICIENCY

As an option, the analyzer can calculate and display combustion efficiency. This calculation is based upon combustion air temperature, flue gas temperature, % O_2, and fuel constants specific to the current fuel.

2.1.4.1 Flue Temperature Input

The flue gas temperature input should be 4-20mA (required for combustion efficiency calculations). This input and the displayed range are fully scalable for degrees C and F.

2.1.4.2 Combustion Air Sensor

While combustion efficiency can be calculated automatically, for the most accurate calculation, the temperature of the combustion air should be measured. A sensor is available for this input to the A-10050 Analyzer Electronics . If there is no combustion air temperature sensor, combustion efficiency can still be calculated using a preset temperature value entered via the keypad in lieu of the measured value.

2.1.5 CALIBRATION MODES

Fully automatic, semi-automatic and manual calibration modes are selected via a jumper on the main printed circuit board. The unit ships factory-configured for the calibration mode selected by the customer during order entry.

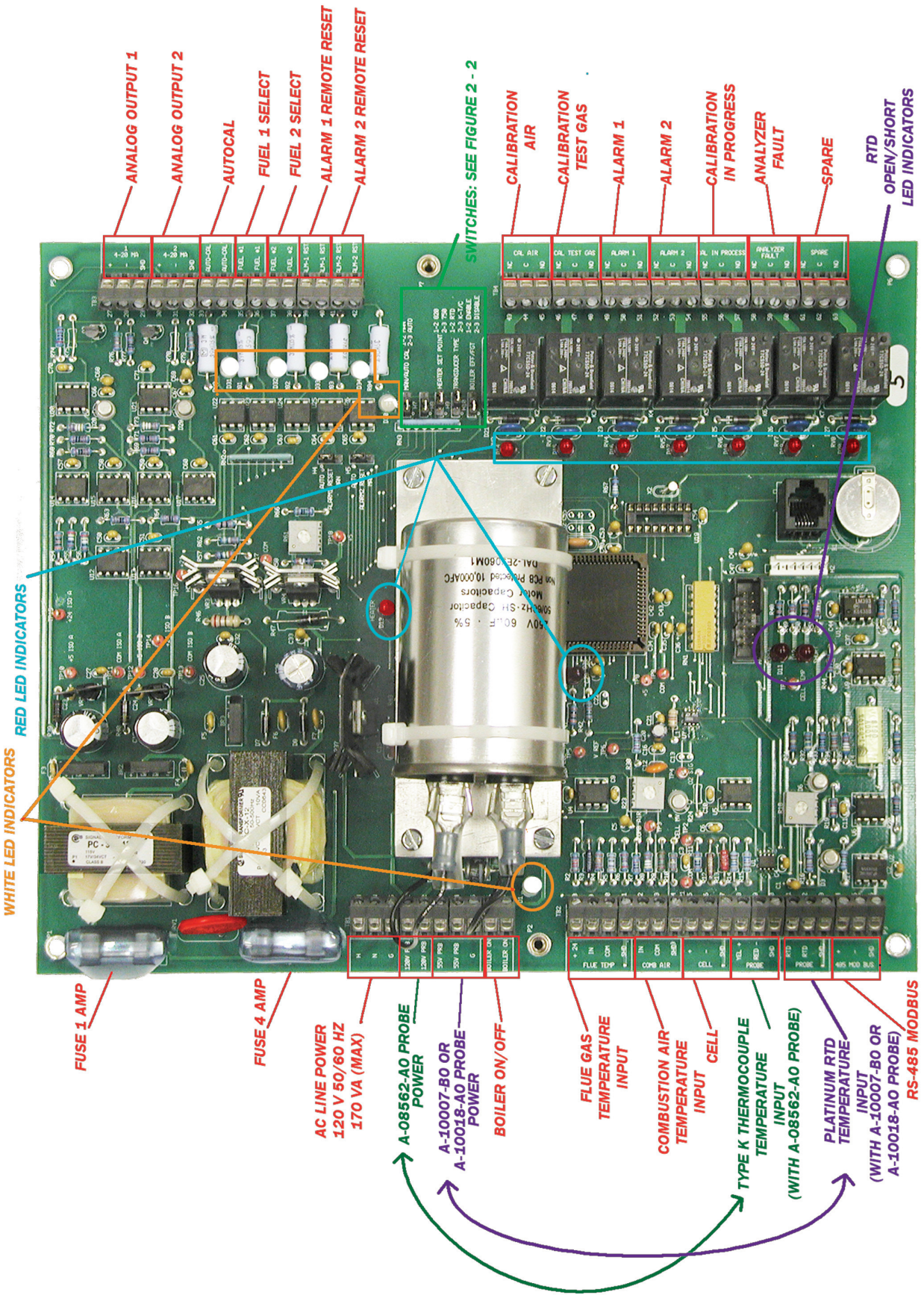


Figure 2-1: Main printed circuit board for the A-10050-A0 electronics with terminal connections called out.

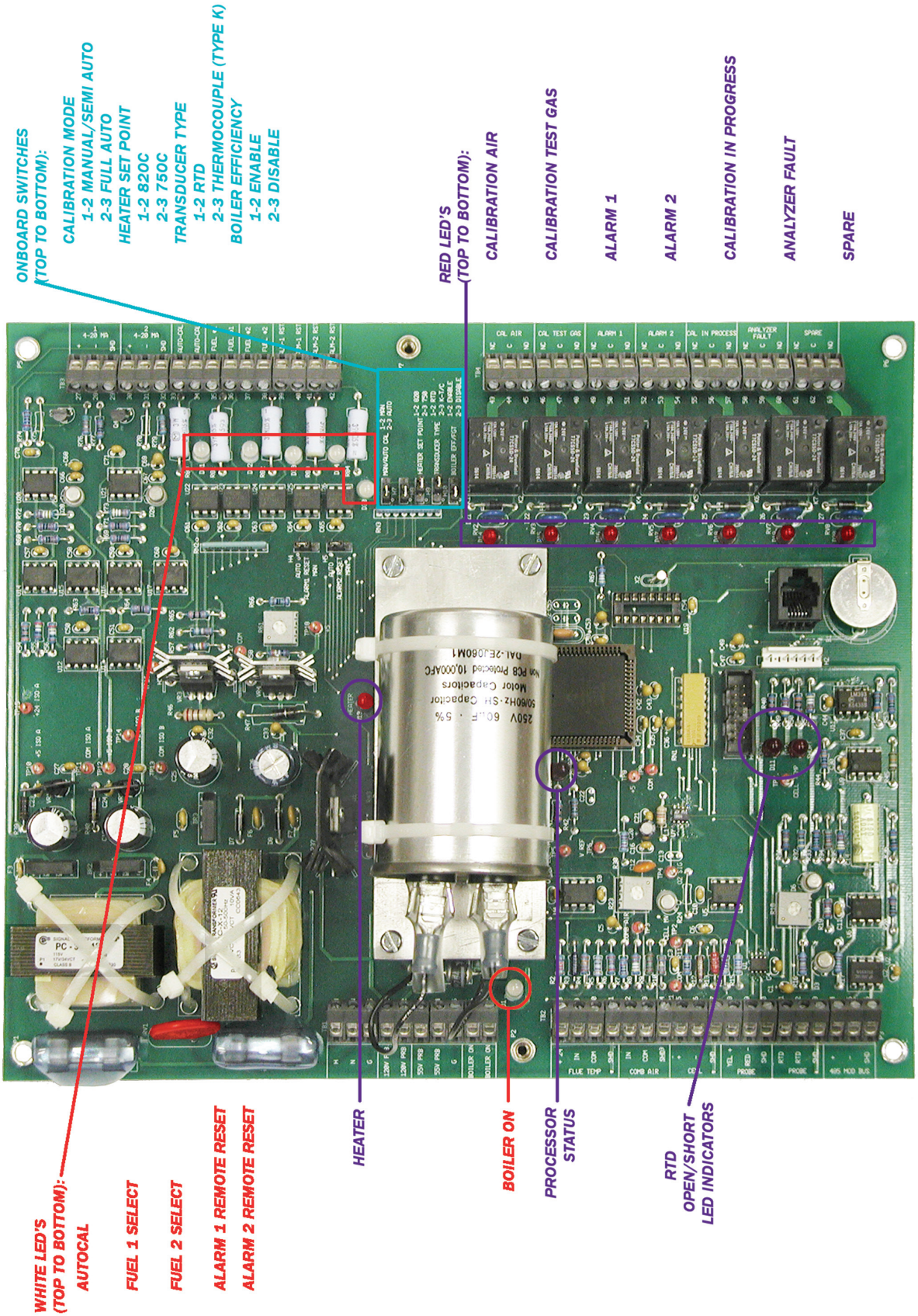


Figure 2-2: Main printed circuit board for the A-10050-A0 electronics with LED's and onboard switches called out.

2.1.5.1 Fully Automatic Mode

For fully automatic mode, the analyzer must be plumbed for test gas and have solenoid-operated valves to control test gas and 20.95% air. After the operator initiates the calibration, no further operator intervention is required.

2.1.5.2 Semi Automatic Mode

For semi-automatic mode the analyzer must be plumbed for test gas and have manually-operated valves to control test gas and 20.95% air. After initiating a semi-auto calibration, the operator must open and close the manual valves to complete the calibration.

2.1.5.3 Manual Mode

For manual mode the analyzer has no permanent plumbing for test gas or 20.95% air. There are no permanent valves for test gas and 20.95% air. When a calibration is necessary the operator must attach hoses, flow meters and any other required apparatus. This option is available with the A08652 Mini O_2 probe only.

2.1.6 CALIBRATION RELAYS

The analyzer has three relays dedicated to calibration functions: the calibration-in-progress relay, the calibration-air relay, and the calibration-test-gas relay.

2.1.6 1 Cal-in-Progress Relay

This relay is energized initially and throughout the cell calibration process. Typically, it is used to inhibit oxygen trim during a calibration sequence.

2.1.6 2 Cal-Air Relay (active in full auto calibration mode)

During fully automatic calibration, this relay typically opens a solenoid valve to apply **20.95% air** to the flue gas side of the cell.

2.1.6.3 Cal-Test-Gas Relay (active in full auto calibration mode)

During fully automatic calibration, this relay typically opens a solenoid valve to apply **test gas** to the flue gas side of the cell. The oxygen concentration of the test gas is set in the calibration setup menu under the menu item "cal gas mix". The default value is 4.5% oxygen.

2.1.7 OUTPUTS (4-20 mA)

The unit has two isolated 4-20mA outputs capable of driving 750 ohms or less. Each 4-20mA output is individually configured from the front keypad to transmit % O_2, cell mV, % efficiency or flue gas temperature. See the main menus for A01 and A02 setup in Sections 2.4.5 and 2.4.6.

Output behavior in the event of an analyzer fault is configured from the same front keyboard menus as follows:

- Go to a Low mA value (Low: near 0 mA).
- Go to a High mA value (High: near 24mA).
- Freeze (Freeze the output at the last value before the fault occurred).
- Continue (Continue even though the calculated value may be incorrect).

For most applications, 4-20mA outputs are appropriate. However, the analyzer transmit output hardware allows the mA output to be driven to zero (0-20mA outputs) for conversion to a zero-based voltage output with the addition of an external shunt resistor, as required in some applications. For example, if the output scaling is set for 0.0 to 20.0 mA the addition of a 500 Ohm shunt resistor results in a voltage output of 0 to 10Vdc.

2.1.8 ANALYZER FAULT RELAY

The analyzer fault relay provides a signal to other equipment that there is a problem with the analyzer. The analyzer fault relay is fail-safe: it is energized during normal operation and drops out if a problem is detected. Detectable problems include:

- Open analyzer probe sensor thermocouple.
- Open analyzer probe sensor RTD.
- Shorted analyzer probe sensor RTD.
- Analyzer probe sensor heater failure (low temperature: heater has been at 100% power for 60 minutes and the cell temperature is still too low).
- Analyzer probe sensor heater failure (high temperature: heater has been at 0% power for 60 minutes and the cell temperature is still too high).
- High analyzer oxygen sensing cell impedance.

2.1.9 MODBUS PORT

The RS-485 Modbus port provides for communication with a SCADA system or other Modbus master devices. The analyzer is configured as a Modbus RTU slave unit.

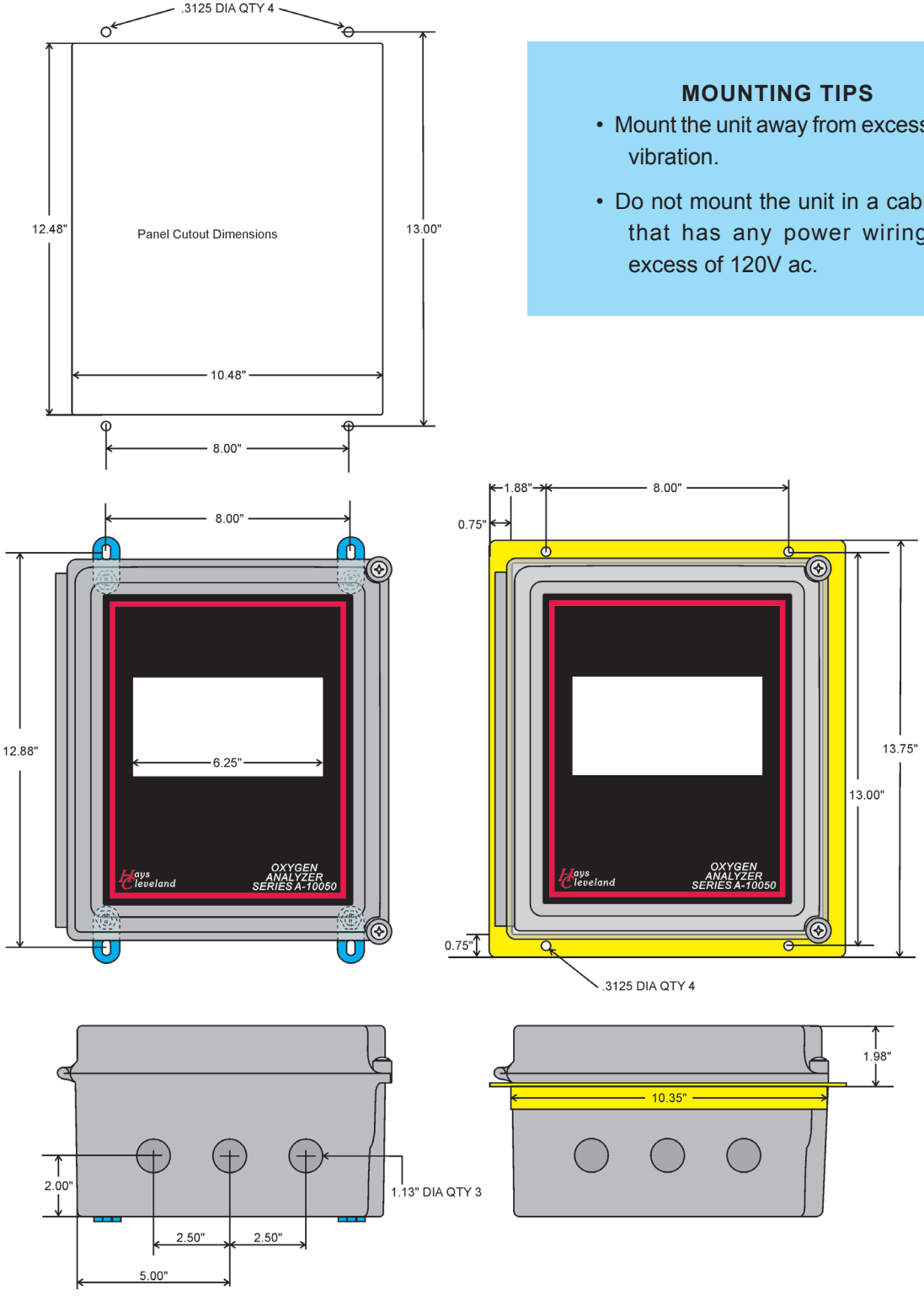
The communication parameters are:

- Baud rate 9,600 or 19,200 (menu selectable).
- Parity none (fixed).
- Data bits 8 (fixed).
- Stop bits 1 (fixed).

All available information is mapped in the 40000 block of Modbus registers. For details of the contents of the Modbus registers (see Section 2.6 MODBUS MEMORY MAP).

2.2 MOUNTING LOCATION

Panel- or surface-mounted analyzer electronics units are available (see Section 1.3 Nomenclature). Either style can be mounted in locations where the ambient temperature range is between 32 to 130F (0 to 55C). While an electronics unit can be up to 300 feet (90 meters) away from the probe, it is usually convenient to mount it with the flow (calibration) panel (which must be within 50 feet of the probe) if present.



MOUNTING TIPS

- Mount the unit away from excessive vibration.
- Do not mount the unit in a cabinet that has any power wiring in excess of 120V ac.

Figure 2-3 Housing: Cutout Dimension and Surface or Flush Mounting

2.3 WIRING

WARNING

WIRING TIPS

1. Wire with extreme caution! Failure to wire this unit properly may result in damage to this unit, other equipment, or nearby personnel. Read and understand the information in this manual before attempting to apply power to this device.
2. Follow all applicable codes when wiring this device. All wiring must conform to the National Electrical Code and to local code regulations. Verify all electrical ratings on equipment.
3. Connecting high voltage to the low voltage circuits will damage the circuitry!
4. Mount the display unit in such a manner that the wiring cable from the main electronics does not touch or approach any high magnetic source. If mounted near a high magnetic source, electronic interference may cause the display to read incorrectly.

2.3.1 WIRING – INPUT POWER

The 120Vac input power wiring consists of three wires applied to terminals “H”, “N” and “G”. Apply continuous power.

2.3.2 WIRING – PROBE

The probe wiring consists of three separate circuits for the ZrO_2 cell, heater, and temperature feedback, as described in the following paragraphs.

2.3.2.1 Wiring – Probe ZrO_2 Cell

The **ZrO_2 cell circuit** provides a voltage from the ZrO_2 cell (where the “cell voltage” is generated by the difference in O_2 from one side of the cell to the other) to the analyzer electronics for % O_2 indication. Three connections are required for the ZrO_2 cell: **plus (+)**, **minus (-)**, and **shield**. Use two-conductor shielded wire. See terminals 15, 16, and 17 on Figures 2-4, 2-5, or 2-6, depending on the probe being used.

2.3.2.2 Wiring – Probe Heater

The **heater circuit** provides a means to apply controlled power to the heater that maintains the cell at the proper operating temperature. The analyzer has terminals for two types of heater assemblies, depending on which type of probe is in use. A-10007-B0 OXYPROBE™ and A-10018-A0 OXY-MIZER™ have 55V heaters. A08562 Mini O_2™ probes and legacy A08560 probes have 110 V, ½ sine heaters. Connect the probe heater to the correctly labeled heater drive terminals, See terminals 1, 2, 3, 4, and 5 on Figures 2-4, 2-5, or 2-6, depending on the probe being used. **Connection to the wrong terminals can result in heater damage.** These connections do not need to be shielded.

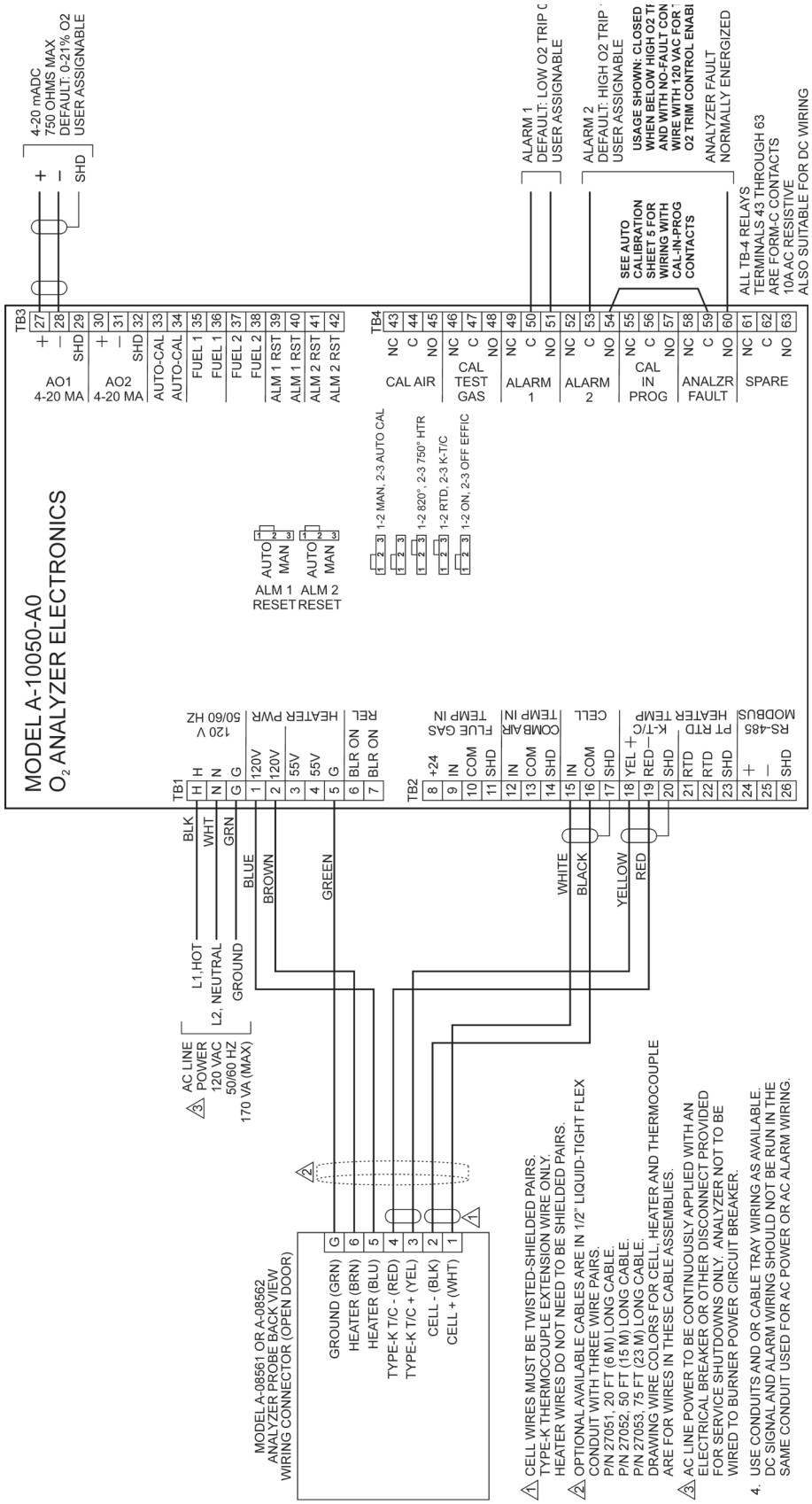


Figure 2-4 Field Wiring (Model A-08562-A0 MINI-O2™ Probe)

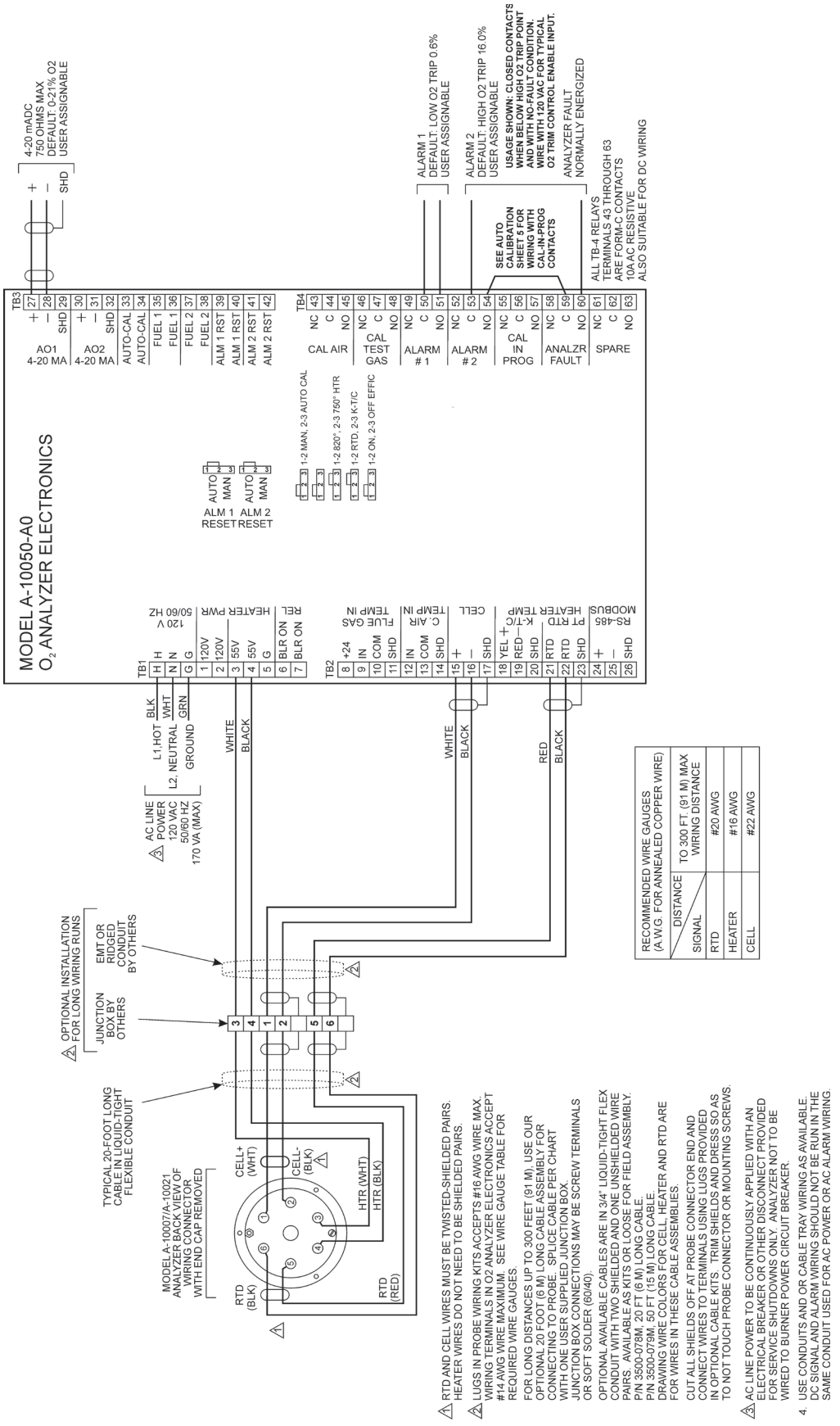


Figure 2-5 Field Wiring (Model A-10007-B0 OXYPROBE™ & A-10021 High Temperature Probe)

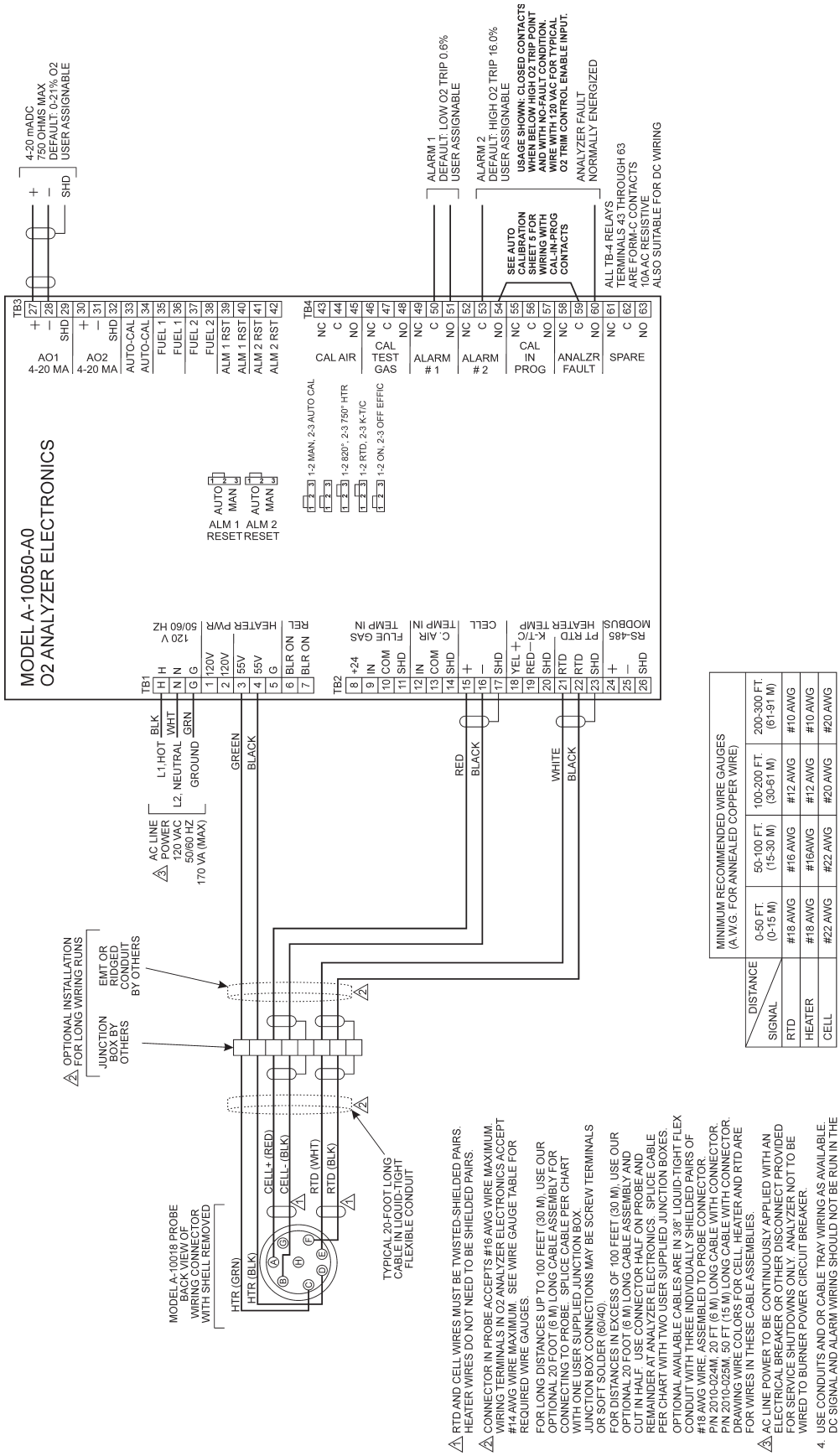


Figure 2-6 Field Wiring (Model A-10018-A0 OXY-MIZER™ Probe)

2.3.2.3 Wiring – Probe Temperature Feedback Device

The heater feedback circuit provides a signal to the analyzer electronics indicating the temperature of the probe heater assembly. Depending on the type of probe, the feedback transducer may either be an RTD or a K-type thermocouple.

- For probes with a 100Ω RTD (Series A-10007-B0 and A-10018-A0): connect the probe RTD to the analyzer terminals labeled “Heater – RTD”. The RTD is not polarized. See terminals 21, 22, and 23 on Figures 2-5 and 2-6.
- For probes with a thermocouple (Series A-08562-A0): use K-Thermocouple extension wire to connect the thermocouple to the terminals labeled “Heater Yel +” and “Heater Red –”. See terminals 18, 19, and 20 on Figure 2-4.

2.3.3 WIRING – ALARM RELAYS

The Alarm relay terminals are fail-safe: the relay coil is de-energized in the tripped condition. The "NO" and "NC" tags on the printed circuit board are from the perspective of the relay. Relay contacts are not powered and can be used in AC or DC wiring circuits. See terminals 49, 50, 51, 52, 53, and 54 on Figures 2-4, 2-5, 2-6, and 2-8.

- For a contact that is open when an alarm is inactive and closed when an alarm is active, wire to the “C” and “NC” terminals.
- For a contact that is closed when an alarm is inactive and open when an alarm is active, wire to the “C” and “NO” terminals.

2.3.4 WIRING – EXTERNAL ALARM RESETS

The “ALM-1 RST” and “ALM-2 RST” terminals are provided for optional customer-supplied alarm reset pushbutton switches. The reset inputs are 120Vac. Wire one reset terminal to Neutral and the other reset terminal to Hot through a pushbutton switch. See terminals 39, 40, 41, and 42 on Figures 2-4 through 2-8 for details. Note that jumpers on the circuit board are selected for latching or non-latching (auto) operation.

2.3.5 WIRING – BOILER ON INPUT

The 120Vac "Boiler On" input signals the analyzer electronics that the boiler is operating. Wire one “Boiler On” terminal to Neutral and the other to a switched hot connection that is active when the boiler is operating. This input is used to enable efficiency operations. See terminals 6 and 7 on Figures 2-4 through 2-8 for details.

2.3.6 WIRING – FLUE GAS TEMPERATURE INPUT

The 4-20mA flue gas temperature input can be powered from the analyzer electronics or externally. See terminals 8, 9, 10, and 11 on Figure 2-7 for details. An internal 100Ω load eliminates the need for an external shunt resistor.

2.3.7 WIRING – MODBUS

Connect the Modbus wiring to the analyzer terminals labeled “485 MOD BUS”. The Modbus is polarity sensitive: wire the “+” wire to the “+” terminal and the “-” wire to the “-” terminal. Special RS485 cable should be recommended by the communications equipment supplier that furnishes the modbus master device. See terminals 24, 25, and 26 on Figure 2-7 for details.

2.3.8 WIRING – FUEL SELECT INPUTS

The two 120Vac fuel select inputs determine the fuel to be used in the optional combustion efficiency calculations. Wire the analyzer so that 120Vac is present between the FUEL #1 input terminals when fuel #1 is in use, and between the FUEL #2 input terminals when fuel #2 is in use. For the combustion efficiency display to operate, only one fuel can be selected. See terminals 35, 36, 37, and 38 on Figure 2-7 for details.

2.3.9 WIRING – REMOTE CALIBRATION START INPUT

The “AUTO-CAL” terminals are provided for an optional dedicated remote calibration start pushbutton. The calibration start input is 120Vac. Wire one “AUTO-CAL” terminal to Neutral and the other “AUTO-CAL” terminal to hot through a pushbutton switch. See terminals 33 and 34 on Figure 2-8 for details. This input is for use with time

clocks or other initiating devices or controls.

2.3.10 WIRING – COMBUSTION AIR TEMPERATURE TRANSMITTER

The “COMB AIR” terminals are provided for the optional combustion air temperature input (4-20 mA input into 237Ω; 4mA = -40F or -40C; 29mA = +200F or +97C). Wire the combustion air temperature sensor terminals labeled “IN”, “COM” and “SHD” to the corresponding terminals on the analyzer electronics. See terminals 12, 13, and 14 on Figure 2-7 for details.

2.3.11 WIRING – ANALYZER FAULT RELAY

Wire the analyzer fault relay output into any external circuits that require notification when the analyzer is off-line. Wire to the “C” and “NO” contacts for a contact that is closed when the analyzer is operating normally, and opens when an analyzer fault occurs. Wire to the “C” and “NC” contacts for a contact that is open when the analyzer is operating normally, and closes when an analyzer fault occurs. Relay contacts are not powered and can be used in AC or DC wiring circuits. See terminals 58, 59, and 60 on Figure 2-8 for details.

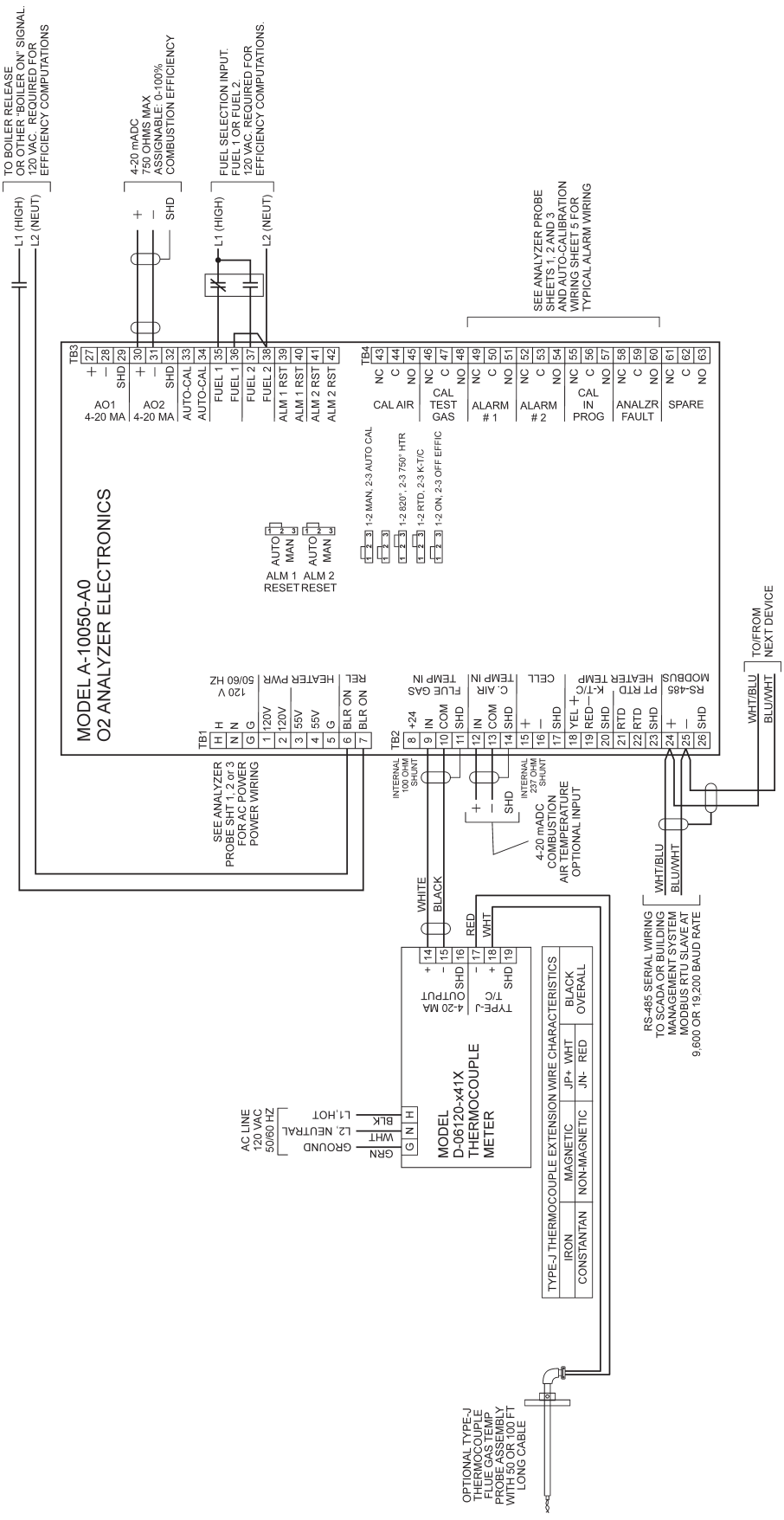


Figure 2-7 Field Wiring (Combustion Efficiency & Modbus)

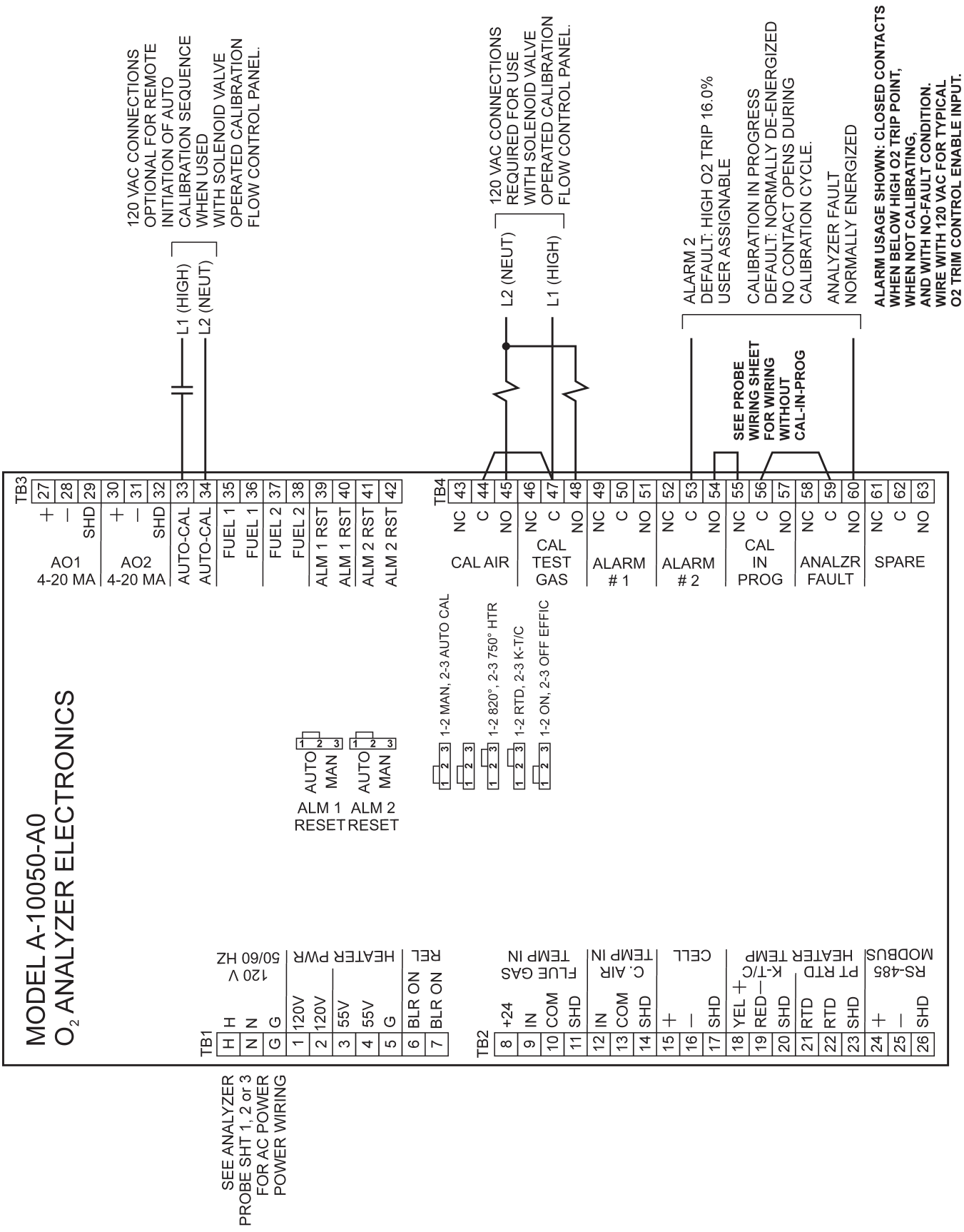


Figure 2-8 Field Wiring (Auto Calibration)

3.0 OPERATION & CONTROL LOGIC

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3.1 ZIRCONIUM OXIDE CELL DESIGN

Hays Cleveland Series A10050-A0 Oxygen Analyzers measure the free oxygen content of a gas stream and provide a linear output directly proportional to the measured oxygen. The analyzer compares a flue gas sample admitted at one side of the zirconium oxide cell in the in-stack probe to a reference gas of known composition present on the other side of the cell. Instrument air serves as the reference gas because of its convenience and reliable oxygen content.

The basic oxygen-sensing cell is a zirconium oxide tube with both surfaces partially platinum-coated so that an electrical connection can be made. The flue gas passes through a protective ceramic filter to the sample side of the zirconium oxide cell. The reference side of the zirconium oxide cell is exposed constantly to the reference gas. When the oxygen concentrations on the two sides of the cell are different, oxygen ions (charged particles) pass through the zirconium oxide cell wall, capturing electrons on one side and releasing them on the other side. See Figure 1-1. This generates an inverse logarithmic DC voltage signal proportional to the difference between the oxygen content of the process gas and of the reference gas. The voltage difference produced is expressed in the Nernst Equation as follows:

$$E = \frac{RT}{4F} \log_e \left(\frac{PO_{2r}}{PO_{2s}} \right) + C$$

Where:

E = Electromotive force in millivolts.

PO_{2r} = Oxygen partial pressure of reference gas.

PO_{2s} = Oxygen partial pressure of sample gas.

T = Absolute temperature of cell.

R = Gas constant.

F = Faraday's constant.

C = Cell offset.

The cell is sensitive to partial pressures of oxygen on either side of it. The partial pressure of oxygen in a gas mixture is that portion of the total pressure attributable to the oxygen alone.

The relationship to percent oxygen is:

$$\%O_2 + \frac{Pa}{100} - PO_2$$

Where:

Pa = absolute pressure of the mixture.

PO_2 = partial pressure of oxygen.

This equation shows that the partial pressure ratio, which influences cell output, is affected by absolute pressures as well as by oxygen content. If the pressure is equal on both sides of the cell, the output is a function of percent oxygen only. If the sample and reference pressures varied independently, the analyzer output would be incorrect. However, at standard atmospheric pressure conditions, a pressure difference of 4" H_2O (7.5mm Hg) across the cell yields an error of only 1% of the reading. The effects of constant pressure differential are eliminated when calibrating.

3.2 ZIRCONIUM OXIDE CELL OPERATION

The zirconium oxide sensing cell is surrounded by a heater assembly that maintains it at a constant temperature. Otherwise, temperature variations in the flue gas could affect the cell's output. A temperature detector positioned next to the cell monitors its temperature and provides feedback to the heater control circuitry. The electronics unit conditions the oxygen sensing cell output for indication and transmission to a remote controller, recorder or indicator. Alarm contacts are also provided.

Hays Cleveland Series A10050-A0 Oxygen Analyzers perform wet oxygen analysis; i.e., the analyzer retains the water vapor (H2O) content of the flue gas as a background gas. For this reason, it reads differently than oxygen analyzers that perform dry oxygen analysis (in which water vapor has been removed from the sample before measuring the oxygen content).

Figure 3-2 shows a set of curves relating oxygen to excess air on a wet basis. Each curve corresponds to a particular fuel. These curves are based on the chemical proportioning of air, fuel, and combustion products expected when fuel is completely burned. The presence of combustible gases (H2 and CO), along with oxygen in the flue stream causes Hays Cleveland Series A10050-A0 Oxygen Analyzers to measure predictably lower than dry analyzer oxygen levels. It does this by reporting net excess oxygen. Free oxygen within the cell chamber reacts catalytically with free combustible gases on the hot platinum surface of the zcell. Any oxygen remaining after this secondary combustion is measured by the cell and transmitted. The cell does not react to unburned solid combustibles (carbon or soot).

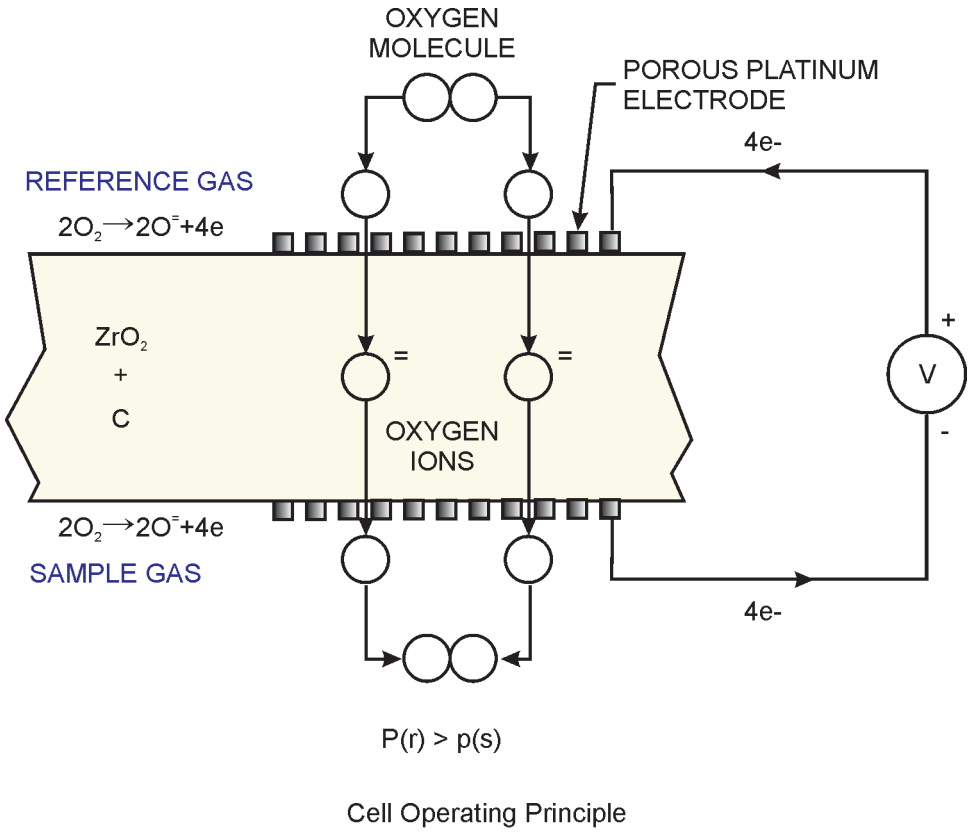

Figure 3-1: Cell operating principle.

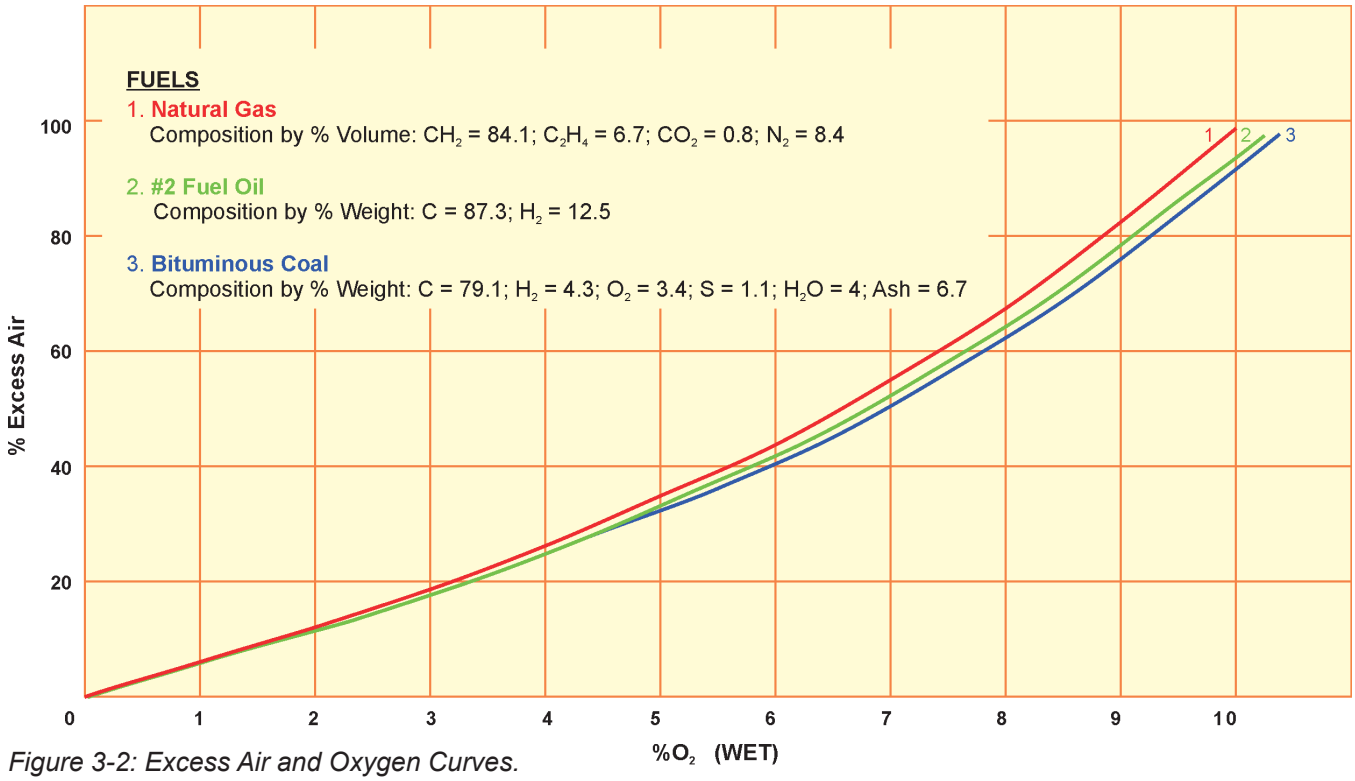

Figure 3-2: Excess Air and Oxygen Curves.

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4.0 OPERATOR INTERFACE

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4.1 OXYGEN ANALYZER DISPLAY

During normal operation mode, several types of information are displayed, as described in sections 2.8.1 through 2.8.8.

4.1.1 OXYGEN DISPLAY

Information regarding either the % O2 or the mV input from the cell appears to the left of the top line of the display. This area is highlighted in red in the example displays shown below.

The OXY DISP MODE menu determines which of these two variables is displayed at a given time. The OXY DISP MODE has four possible menu settings (%O2, MV, ALT, or AUTO). %O2 displays the oxygen percentage continuously. MV displays the cell millivolts all the time. ALT alternates between the two parameters every four seconds. AUTO displays the percentage oxygen unless that value drops below 0.1%, resulting in a display of MV. At that point, the cell millivolts is displayed instead until the oxygen value again exceeds 0.1%.

Below are examples of the possible displays.

%O2	Displays the percent O_2 continuously.
MV	Displays the cell mV corrected for cell offset continuously.
ALT	Display alternates between percent O_2 and mV every 4 seconds.
AUTO	Displays percent O_2 until percent O_2 drops below 0.1%; then automatically switches over to mV display.

Example of display showing %O2:

Example of display showing MV.

During an impedance check (which occurs every 10 minutes) Z CHK appears on the display for a few seconds while the impedance is being tested. An example is shown below.

4.1.2 MICROPROCESSOR STATUS

To the right of the %O2 or MV display, a "flipper" character indicates microprocessor status by rotating to indicate that the unit is operating normally. The flipper is highlighted red in the example display below.

4.1.3 ALARMS AREA

The alarm indicators for alarms 1 & 2 are located to the right of the status indicator. The indicators are off (blank) whenever the associated alarms are inactive. The indicators flash A1 or A2 respectively when an alarm is tripped. The alarm area is highlighted red in the example display below.

4.1.4 HEATER STATUS ICON

Furthest to the right is the heater status indicator, a single character icon indicating the status of power to the cell heater. The icon is blank when the heater is off: otherwise, it indicates whether the heater temperature is stable. The heater icon appears as a "+" sign that remains on continuously while the cell heats up from a cold start. As the cell approaches operating temperature, the icon begins to blink on and off (as power to the heater is modulated to control the temperature). The icon appears as either an empty or filled circle during operation, as shown on the table below.

+	Plus sign	Heater is on, but cell is not up to operating temperature
○	Empty circle	Heater is on and within +/- 8 degrees C of set point.
●	Filled circle	Heater is on, and within 8 degrees C and has been within 8 degrees C for 15 minutes or more.

The heater status icon area is highlighted red in the example display shown below.

4.1.5 COMBUSTION EFFICIENCY (IF ENABLED)

The left lower display line is the combustion efficiency area. If enabled, this area displays the calculated combustion efficiency. If there is a reason why the combustion efficiency can not be calculated (e.g., FGT over/under range, fuel-select issue, etc.) this area displays information pertaining to the reason efficiency can not be calculated. The combustion efficiency area is highlighted red in the example display shown below.

This area has several possible displays, as shown below:

--OFF--	Boiler is off (see Section 2.3.5).
EFF=FS?	Fuel select error: neither or both fuels selected.
EFF=FG↑	Flue gas temperature is overrange: unable to calculae efficiency.
EFF=FG↓	Flue gas temperature is underrange: unable to calculae efficiency
EFF=HT?	Heater temperature is not locked.
EF1=75%	Normal efficiency readout when fuel #1 is selected.
EF2=75%	Normal efficiency readout when fuel #2 is selected.

4.1.6 FLUE GAS TEMPERATURE/COMB AIR TEMPERATURE (IF ENABLED)

If combustion efficiency calculations are enabled, the flue gas temperature/combustion air temperature area alternates every 4 seconds between displaying the flue gas temperature and the combustion air temperature. In the example below, the area of the display highlighted in red indicates that the flue gas temperature is 550C.

In the next example, the area highlighted red indicates that the combustion air temperature is 27C.

4.1.7 CELL TEMPERATURE

Cell temperature as reported by the thermocouple or RTD appears to the right of the lower line of the display. The area highlighted red in the example below indicates that cell temperature is 750C.

4.1.8 ANALYZER FAULT MESSAGES

The analyzer has a dedicated fault relay that is normally energized. If an analyzer fault occurs, the fault relay de-energizes. The faults detected by the analyzer are shown in the table below. Any of these faults causes the analyzer fault relay to de-energize, and the corresponding message to flash on the bottom line of the display.

FAIL: T/C OPEN	Open Thermocouple
FAIL: RTD OPEN	Open RTD
FAIL: RTD SHORTED	Shorted RTD
FAIL: HEATER TEMP LO	Heater Failure (Lo Temperature)
FAIL: HEATER TEMP HI	Heater Failure (Hi Temperature)
FAIL: CELL IMPEDANCE	Probe Impedance

4.2 MENU NAVIGATION & DESCRIPTION

Most analyzer settings are adjusted via the front panel display and keypad. The menus are arranged in a logical hierarchy. Starting from the normal operating screen, press the ENT key to advance to the first top level menu. Continue to press ENT to scroll through the top level menus and return to the normal operating screen. Top level menus ending with MENU? contain a submenu. Any submenu can be entered by pressing the DEC key while the MENU? prompt is displayed. Press ENT while any submenu is displayed to advance to the next submenu. Continue to press ENT to return to the top level menu. Press the RESET key followed by the ENT key to return to the normal operating display immediately from any top level or submenu. After a period of inactivity, the display automatically returns to the normal operating screen from any menu or submenu. The top-level menus and submenus are discussed in detail in the following sections.

Top-Level Menus	Description
MODEL 10050 VX.YY	Displays model # and firmware revision
Ex: 12:00 THU APR 12 '07	Real Time Clock/Calendar
CAL SETUP MENU?	Calibration settings
OXY DISP MODE	Sets display mode – No sub menu
EFF SETUP MENU?	Efficiency settings – if enabled
A01 SETUP MENU?	Analog output #1 settings
A02 SETUP MENU?	Analog output #2 settings
ALARMS SETUP MENU?	Alarms setup
COMMS SETUP MENU?	Communications setup
VIEW DIAGNOSTICS?	Diagnostic Information

Figure 4-1: Top Level Menus

4.2.1 MODEL NUMBER & FIRMWARE REVISION DISPLAY

MODEL 10050 VX.YY

When ENT is pressed from the normal operating display, the model number & firmware revision top-level menu displays. Following the analyzer model number, the major revision number is shown as the VX portion of the display, and the minor revision number is shown as the YY portion of the display (see sample display above). There are no submenus for this menu. Pressing ENT from here displays the real time clock/calendar.

4.2.2 REAL TIME CLOCK/CALENDAR DISPLAY

Ex: 12:00 THU APR 12 '07

This display shows the current date and time from the clock/calendar. To advance immediately to the CAL SETUP MENU? prompt, press the ENT key. To set the clock/calendar, press and hold the INC key while pressing and releasing the DEC key. The hours will flash to indicate that this part of the display can now be set. Use the INC and DEC keys to change the hours setting. Hours are expressed in 24 hour format. When finished setting the hours, press the ENT key to advance to the minutes. Use the INC and DEC keys to change the minutes setting. In the same way, pressing ENT to advance to the next variable and then using INC and DEC to adjust it, set the day of the week, month, date, and year. Press ENT again to display the CAL SETUP MENU? prompt.

4.2.3 CALIBRATION SETTINGS

CAL SETUP MENU?

At the CAL SETUP MENU? prompt, press the DEC key to enter the calibration settings submenu. Press ENT to scroll through them and return to the CAL SETUP MENU?. Pressing ENT at the CAL SETUP MENU? prompt displays the next **top-level** menu, OXY DISP MODE.

4.2.3.1 Calibration Gas Value

CAL GAS MIX X.XX%

At this submenu, enter the oxygen concentration for the test gas to be used in calibrating the system. Use the INC and DEC keys to adjust the value to match the value of the certified gas. For example, if the certified test gas has a concentration of 0.992%, enter 0.99% in this menu. Press ENT when ready to advance to the next submenu.

4.2.3.2 Sample Side Pressure

SMP PRES XXX "WC ABS

At this submenu, set the partial pressure on the sample side of the probe. This value is expressed in absolute inches of water column. For most applications this value should remain at the default, 407"wc abs. For installations at high elevations, enter the local average barometric pressure. For pressurized boiler installations, enter the sum of the local barometric pressure and the pressure at the boiler outlet or other probe installation insertion point. Press ENT when ready to advance to the next submenu.

4.2.3.3 Reference Side Pressure

REF PRES XXX "WC ABS

At this submenu, set the partial pressure on the reference side of the probe. This value is expressed in absolute inches of water column. For most applications this value should remain at the default, 407"wc abs. Press ENT when ready to advance to the next submenu.

4.2.3.4 Auto Calibration Frequency Selection

CAL TIME SETUP MENU?

In the CAL TIME SETUP MENU?, parameters are set defining **both the frequeny and the specific times and dates** on which the analyzer executes a fully automatic calibration (i.e., requiring no operator intervention). This menu displays only when **full auto calibration** mode has been selected by placing the H6 jumper on 1-2.

CAL PERIOD:

At the CAL PERIOD menu, select the **period of time between** automatic calibration events. Use the INC and DEC keys to scroll through the available selections, shown on the table below.

Displayed Value	Period of time between automatic calibration events
DISABLED	Timed Calibration events are disabled
1 DAY	Calibrate once every day
1 WEEK	Calibrate once a week
2X MONTH	Calibrate twice a month
1 MONTH	Calibrate once a month
2 MONTHS	Calibrate once every two months
3 MONTHS	Calibrate once every 3 months
4 MONTHS	Calibrate once every 4 months
6 MONTHS	Calibrate once every 6 months
1 YEAR	Calibrate once a year

CAL HOUR:

At the CAL HOUR menu, select the hour of the day for initiation of an automatic calibration, in 24 hour format. When all other applicable parameters are met (Day, Date, Month, etc.) the analyzer will calibrate on the selected hour. Use the INC and DEC keys to move through the settings (0-23 hours). The CAL HOUR: menu displays

whenever any CAL PERIOD: is selected except DISABLED. Press the ENT to advance to the next item.

CAL DAY:

The CAL DAY menu selects the day of the week for automatic calibration. Use the INC and DEC keys to scroll through the days (MON, TUE, WED, THU, FRI, SAT, or SUN). This menu displays only if the selected CAL PERIOD is **one week**. Press the ENT to advance to the next item.

CAL DATE:

The CAL DATE menu selects the date for automatic calibration. Use the INC and DEC keys to modify the setting.This menu only displays if the selected CAL PERIOD is 2X MONTH, 1 MONTH, 2 MONTHS, 3 MONTHS, 4 MONTHS, 6 MONTHS or 1 YEAR. Press the ENT to advance to the next item.

For anyl applicable CAL PERIOD except 2X MONTH the CAL DATE can be set from **1 to 28**, corresponding to the calendar date directly.

When the 2x Month Cal Period is selected, the Cal Date can be set only from 1 to 14 because the unit calibrates twice a month,14 days apart. A CAL DATE of 1 indicates that calibration will occur on the 1st and also 14 days later on the 15th of each month. Likewise a Cal Date of 2 indicates that calibration will occur on the 2nd and also 14 days later on the 16th of each month. And a Cal Date of 14 indicates calibration on the 14th and the 28th of each month.

CAL MONTH:

The CAL MONTH: menu selects the month for automatic calibration when a CAL PERIOD of 1 YEAR is selected. Use the INC and DEC keys to modify the setting. Press the ENT key to advance to the next item.

CAL MONTHS:

The CAL MONTHS menu selects the months for automatic calibration when a CAL PERIOD of 2 Months, 3 Months, 4 Months, or 6 Months is selected. Use the INC and DEC keys to scroll though the available values, which will vary depending on the value of CAL PERIOD selected earlier, as shown in the table below. Press the ENT key to advance to the next item.

Cal Period	Setting	Months for Automatic Calibration
2 MONTHS	1 3 5 ...	Jan., Mar., May, Jul., Sep., Nov.
	2 4 6 ...	Feb., Apr., Jun., Aug., Oct. Dec.
3 MONTHS	1 4 7 10	Jan., Apr., Jul., Oct.
	2 5 8 11	Feb., May, Aug., Nov.
	3 6 9 12	Mar., Jun., Sep., Dec.
4 MONTHS	1 5 9	Jan., May, Sep.
	2 6 10	Feb., Jun., Oct.
	3 7 11	Mar., Jul., Nov.
	4 8 12	Apr., Aug., Dec.
6 MONTHS	1 7	Jan. & Jul.
	2 8	Feb. & Aug.
	3 9	Mar. & Sep.
	4 10	Apr. & Oct.
	5 11	May & Nov.
	6 12	Jun. & Dec.

CALIBRATE NOW?

At this submenu, confirm and initiate a calibration cycle as follows: while pressing and holding the INC key, press and release the DEC key. For additional information on the calibration cycle see **Section 5.1 Calibration**. (If ENT is pressed at the CALIBRATE NOW? prompt, the display returns to the CAL SETUP MENU? prompt.)

4.2.4 OXYGEN DISPLAY MODE

OXY DISP MODE

The OXY DISP MODE menu presents four options for the O_2 reading display: %O2, MV, ALT, or AUTO. These settings behave as shown on the table below. Use the INC and DEC keys to select from the choices, then press ENT to advance to the next top-level menu. There are no submenus associated with the OXY DISP MODE menu.

Oxygen Display Mode	Display Behavior
%O2	Continuously displays $\%O_2$.
MV	Continuously displays cell mV corrected for cell offset.
ALT	Alternately displays % O_2 and mV, switching every 4 seconds.
AUTO	Displays $\%O_2$ until $\%O_2$ drops below 0.1%; then switches to mV display automatically.

4.2.5 COMBUSTION EFFICIENCY SETUP MENU

EFF SETUP MENU?

The combustion efficiency setup menu is available only if combustion efficiency is enabled. When the EFF SETUP MENU? prompt is displayed, press the DEC key to enter the efficiency settings submenu. (If ENT is pressed at the EFF SETUP MENU? prompt, the display advances to the next top-level menu.)

The combustion efficiency setup menu includes the following submenu items, which are discussed in detail in the following paragraphs:

- Scaling the display for the flue gas input
- Calibrating the flue gas input
- Selecting the fuel
- Selecting the combustion temperature source & preset

FG & CA TEMP UNITS: X

This menu sets the temperature units for the Flue Gas and Combustion Air temperature values. Use the INC and DEC keys to toggle between degrees Centigrade (C) and degrees Fahrenheit (F). Press ENT when ready to move on to the next submenu item.

FG LO RNG DISP XXX

This menu item sets the low range for the flue gas temperature display; i.e., the flue gas temperature display will show under-range for values less than this preset value. Modify the value by pressing the INC and DEC keys. Press ENT when ready to move on to the next submenu item.

FG HI RNG DISP XXX

This menu item sets the high range for the Flue Gas temperature display; i.e., the flue gas temperature display will show over-range for values greater than this preset value. Modify the value by pressing the INC and DEC keys. Press ENT when ready to move on to the next submenu item.

CALIBRATE FG INPUT?

The Calibrate FG Input routine sets up the low and high range for the flue gas input circuit. To initiate a FG input calibration sequence, press and hold the INC key and then press and release the DEC key. The APPLY LO MA TO FG IN menu displays. (If the ENT key is pressed at the CALIBRATE FG INPUT? prompt the system skips the calibration and advances to the FUEL1 submenu.

APPLY LO MA TO FG IN

At the APPLY LO MA TO FG IN prompt, apply a mA signal to the flue gas input equivalent to the low mA level (typically 4mA). Press the ENT key to confirm that the currently applied signal level corresponds to the low range display value for the flue gas input. Press the ENT key again when ready to display the Apply FG Hi mA menu.

APPLY HI MA TO FG IN

At the APPLY HI MA TO FG IN prompt, apply a mA signal to the flue gas input equivalent to the high mA level (typically 20mA). Press the ENT key to confirm that the currently applied signal level corresponds to the high range display value for the flue gas input. Press the ENT key again when ready to display the FUEL1: menu.

FUEL1: AND FUEL2:

The type of fuel being fired affects the combustion efficiency calculation . At the FUEL1 prompt, use the INC and DEC keys to scroll through 6 choices for the fuel type:

- GAS
- #2 OIL
- #6 OIL
- SUB-BIT COAL
- SEMI-BIT COAL
- USER DEFINED

Each of the fuel presets (Gas, #2 Oil, #6 Oil, Sub-Bit coal, Semi-Bit coal) automatically assigns the appropriate values to the K1 & K2 constants in the firmware. However, the USER DEFINED option must be selected whenever the fuel in use is not one of these five presets (listed above as they appear on the display). The User Defined option requires the operator to input the appropriate K1 and K2 fuel constant values manually. Please call Hays Cleveland Customer Service at (216) 398-4414 for assistance in determining the correct K1 and K2 fuel constants. The FUEL1 CONST K1 X.XX and FUEL1 CONST K2 XX.X submenus appear only if USER DEFINED is the FUEL1 selection. The INC & DEC keys are used to adjust the values for K1 and K2. Press ENT to advance to the the FUEL2 submenu, and repeat these procedures. CAT SOURCE

At this submenu, select a combustion air temperature **source**, choosing between a **preset or measured combustion air temperature value**. Using the INC and DEC keys, toggle between PRESET and MEASURE. The analyzer is capable of measuring the combustion air temperature and using the measured temperature in the combustion efficiency calculations. For applications without a combustion air measurement, the PRESET temperature option is used for the efficiency calculations.

COMBUSTION AIR PRESET XX

At this prompt, which appears only if the combustion temperature source is set to PRESET, enter the combustion air temperature value to be used for the efficiency calculation. The temperature is displayed in the units that were selected in the FG & CA TEMP UNITS menu (see Section 4.2.5). Use the INC and DEC keys to change the value.

4.2.6 ANALOG OUTPUT #1 SETUP MENU

AO1 SETUP MENU?

At the AO1 SETUP MENU? prompt, press the DEC key to enter the settings submenu which includes the following submenu items related to setting up analog output #1:

4.2.6.1 Type of Analog Output to Transmit

AO1 TYPE

This item is used to set the variable that is retransmitted. Press the INC and DEC keys to select from the choices shown in the table below.

Displayed Variable	Analog output that is transmitted (A01)
% O2	% Oxygen.
MV	Cell millivolts.
EFF%	% Combustion efficiency.*
FGT	Flue Gas Temperature.*

***Note that the last two selections (EFF% and FGT) are available only if combustion efficiency is enabled.**

4.2.6.2 Set the High & Low Display Range for AO1.

AO1 LO RANGE: Set the low range for the variable that is retransmitted.

AO1 HI RANGE: Set the high range for the variable that is retransmitted.

4.2.6.3 Select Analog Output #1 Failure Mode.

AO1 FAIL

This item is used to set the behavior of analog output #1 when the analyzer detects a problem and enters **fail mode**. Press the INC and DEC keys to select from the choices shown in the table below.

Displayed Variable	Behavior of analog output #1 when the analyzer is in fail mode.
HIGH	Output goes to high mA level (>20mA).
LOW	Output goes to low mA level (approx 0mA).
CONTINUE	Continue calculating and updating output.
FREEZE	Stop calculating: freeze output at last level.

4.2.6.4 Calibrate Analog Output #1.

CALIBRATE AO1?

This routine sets the low and high output levels associated with the low and high range values for analog output #1. To initiate an analog output #1 calibration sequence, press and hold the INC key and then press and release the DEC key.

AO1 LO OUTPUT

At this prompt, set the output level for the low range of analog output #1. Place a milliamp meter in series with the current loop output of analog output #1. Then use the INC and DEC keys to adjust the output to the desired level – usually 4.0 mA.

AO1 HI OUTPUT

At this prompt, set the output level for the high range of analog output #1. Place a milliamp meter in series with the current loop output of analog output #1.Then use the INC and DEC keys to adjust the output to the desired level – usually 20.0 mA.

4.2.7 ANALOG OUTPUT #2 SETUP MENU

A02 SETUP MENU?

At the A02 SETUP MENU? prompt, press the DEC key to enter the settings submenu which includes the following submenu items related to setting up analog output #2:

4.2.7.1 Type of Analog Output to Transmit

A02 TYPE

This item is used to set the variable that is retransmitted. Press the INC and DEC keys to select from the choices shown in the table below.

Displayed Variable	Analog output that is transmitted (A02)
% O2	% Oxygen.
MV	Cell millivolts.
EFF%	% Combustion efficiency.*
FGT	Flue Gas Temperature.*

***Note that the last two selections (EFF% and FGT) are available only if combustion efficiency is enabled.**

4.2.7.2 Set the High & Low Display Range for A02.

A02 LO RANGE: Set the low range for the variable that is retransmitted.

A02 HI RANGE: Set the high range for the variable that is retransmitted.

4.2.7.3 Select Analog Output #1 Failure Mode.

A02 FAIL

This item is used to set the behavior of analog output #2 when the analyzer detects a problem and enters **fail mode**. Press the INC and DEC keys to select from the choices shown in the table below.

Displayed Variable	Behavior of analog output #2 when the analyzer is in fail mode.
High	Output goes to high mA level (>20mA).
Low	Output goes to low mA level (approx 0mA).
Continue	Continue calculating and updating output.
Freeze	Stop calculating: freeze output at last level.

4.2.7.4 Calibrate Analog Output #2.

CALIBRATE A02?

This routine sets the low and high output levels associated with the low and high range values for analog output #2. To initiate an analog output #1 calibration sequence, press and hold the INC key and then press and release the DEC key.

A02 LO OUTPUT

At this prompt, set the output level for the low range of analog output #2. Place a milliamp meter in series with the current loop output of analog output #2. Then use the INC and DEC keys to adjust the output to the desired level – usually 4.0 mA.

A02 HI OUTPUT

At this prompt, set the output level for the high range of analog output #2. Place a milliamp meter in series with the current loop output of analog output #2.Then use the INC and DEC keys to adjust the output to the desired level – usually 20.0 mA.

4.2.8 ALARMS SETUP MENU

ALARMS SETUP MENU?

At the ALARMS SETUP MENU? prompt, press the DEC key to enter the settings submenu which includes the following items related to setting up alarm #1 and alarm #2:

4.2.8.1 Alarm #1 Type

ALM #1 TYPE

To select an alarm type for alarm #1, press the INC and DEC keys to scroll through the choices shown in the table below. When the desired alarm type is displayed, press the ENT key to advance to the next menu item.

Displayed Variable	Alarm #1 activates when:
LO O2%	O_2% is less than set point.
HI O2%	O_2% is greater than set point.
LO MV	Cell mV is less than set point.
HI MV	Cell mV is greater than set point.
LO EFF	Combustion eff is less than set point.
HI EFF	Combustion eff is greater than set point.
LO FGT	FGT is less than set point.
HI FGT	FGT is greater than set point.

4.2.8.2 Alarm #1 Set Point

ALM #1 SETPT

Use the INC and DEC keys to set the activation point for alarm #1. The set point limits are determined by the type of alarm selected in the previous submenu, ALM #1 TYPE, as shown in the table below. Also, if FGT is the selected alarm #1 type, the temperature is displayed in the units that were selected in the FG & CA TEMP UNITS menu (see Section 4.2.5).

Alarm #1 Type	Set Point Limits
O2%	0.2% – 24.9%
mV	1mV – 300mV
Eff	1% - 99%
FGT	Depends on FG scaling

4.2.8.3 Alarm #2 Type

ALM #2 TYPE

To select an alarm type for alarm #2, press the INC and DEC keys to scroll through the choices shown in the table below. When the desired alarm type is displayed, press the ENT key to advance to the next menu item.

Displayed Variable	Alarm #2 activates when:
LO O2%	O_2% is less than set point.
HI O2%	O_2% is greater than set point.
LO MV	Cell mV is less than set point.
HI MV	Cell mV is greater than set point.
LO EFF	Combustion eff is less than set point.
HI EFF	Combustion eff is greater than set point.
LO FGT	FGT is less than set point.
HI FGT	FGT is greater than set point.

4.2.8.4 Alarm #2 Set Point

ALM #2 SETPT

Use the INC and DEC keys to set the activation point for alarm #2. The set point limits are determined by the type of alarm selected in the previous submenu, ALM #2 TYPE, as shown in the table below. Also, if FGT is the selected alarm #2 type, the temperature is displayed in the units that were selected in the FG & CA TEMP UNITS menu (see Section 4.2.5).

Alarm #2 Type	Set Point Limits
O2%	0.2% – 24.9%
mV	1mV – 300mV
Eff	1% - 99%
FGT	Depends on FG scaling

4.2.9 COMMUNICATIONS SETUP MENU

COMMS SETUP MENU?

At the COMMS SETUP MENU? prompt, press the DEC key to enter the settings submenu which includes the following items.

4.2.9.1 Modbus Address

MODBUS ADDR

Use the INC and DEC keys to adjust the value to the desired address for the analyzer on the Modbus. When the desired address is displayed, press the ENT key to advance to the next menu item.

4.2.9.2 Modbus Baud Rate

BAUD RATE

To set the baud rate for the Modbus, use the INC and DEC keys to toggle the baud rate between 9600 and 19200 baud. When the desired baud rate is displayed, press the ENT key to advance to the next menu item.

4.2.10 DIAGNOSTIC MENU

VIEW DIAGNOSTICS?

At the VIEW DIAGNOSTICS? prompt, press the DEC key to enter the settings submenu. If ENT is pressed while this prompt is displayed, the display will return to the normal operating screen. The diagnostic submenu includes the following items.

4.2.10.1 Cell Impedance

CELL IMPEDANCE

The impedance of the ZrO_2 cell is checked on-the-fly every 10 minutes. This menu item displays the cell impedance value in ohms. The impedance value is also available on Modbus. If cell impedance exceeds 175 Ohms for 4 successive readings a warning message flashes on the display, alerting the operator that the probe is deteriorating and probe maintenance will be required soon. If the warning is ignored, cell impedance will continue to rise as the cell continues to deteriorate. If the impedance exceeds 300 Ohms for 4 successive readings, the unit drops out the analyzer fault relay and the analyzer ceases to function until the probe impedance problem is addressed.

4.2.10.2 Heater Power

HEATER POWER

This menu item displays the percent power being delivered to the probe heater. When the heater power is 100% the heater is full on. Typical values for heater power are in the 50 – 70% range during normal operation.

4.2.10.3 I/O State

I/O STATE

This menu item displays the status of various inputs and outputs. This information is relevant only to Hays Cleveland support personnel during troubleshooting.

4.2.10.4 Internal Flags

INT FLAGS

This menu item displays the status of various internal firmware flags. This information is relevant only to Hays Cleveland support personnel during troubleshooting.

4.2.10.5 Cell A/D Counts

CELL A/D COUNTS

This menu item displays the raw codes being returned from the A/D converter. This information is relevant only to Hays Cleveland support personnel during troubleshooting.

4.2.10.6 Nernst Temperature

NERNST TEMP

This menu item displays the calculated value of the temperature at the point where the ion exchange is taking place in the probe assembly. The exchange of ions generates the cell voltage as a result of the difference in oxygen concentration. This value in most cases will be slightly lower than the cell “control temperature”.

4.2.10.7 Offset Counts

OFFSET COUNTS

This menu item displays information relevant only to Hays Cleveland support personnel during troubleshooting.

4.2.10.8 ROC Limit

ROC LIMIT

This is the rate-of-change limit used during calibration, expressed in mV per 10 second period. During calibration, the cell voltage is assumed to be changing if this rate of change is exceeded. The calibration routine will not advance to the next step until the cell voltage is changing less than this preset rate.

4.3 ALARM RESETS

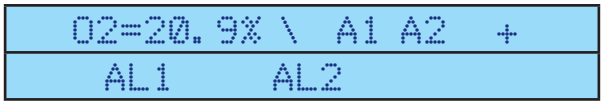
The two analyzer alarms can be reset from the front panel keypad provided that the associated alarm parameter is within its limits. Alarms can be reset also from dedicated external pushbuttons, if installed.

To reset an alarm using the keypad:

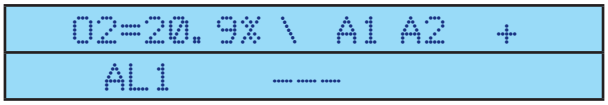
- Make sure the analyzer display is at the normal operating display (not in a submenu).
- Press the RESET key.
- The bottom line of the display changes to the alarm reset menu, showing which alarms are active. If Alarm 1 is currently active, AL1 will be shown above the INC key. If Alarm 2 is active, AL2 will be shown above the DEC key.
- At this point the INC key and DEC key become the alarm reset for the alarm displayed above the key.

When an alarm is successfully reset the display changes to ———.

In the example shown below, both Alarm 1 & Alarm 2 are active.



In the following example Alarm 1 is active and Alarm 2 is inactive.



When an alarm is inactive, ——— is displayed (there is nothing to reset).

If AL1 or AL2 is displayed, but the corresponding reset buttons seem to be inoperative, the associated alarm limit is currently exceeded and therefore the alarm cannot be reset.

To reset an alarm using the external reset pushbuttons (if installed), press the external reset pushbutton associated with the alarm.

5.0 START-UP PROCEDURES

IN THIS SECTION

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5.1 CALIBRATION

CAUTION

A calibration gas other than instrument air is required. The actual oxygen content of the calibration gas should be certified. The background gas should be inert (nitrogen or nitrogen and carbon dioxide). If the nominal oxygen control point is within the 3-8% range, select the value of the calibration gas near the control set point value. Otherwise, a good nominal value is 5% oxygen.

5.1.1 MANUAL AND SEMI-AUTOMATIC CALIBRATION

- Press the ENT key twice to display the CAL SETUP MENU? prompt.
- Press the DEC key to drop down into the cal setup submenus.
- Verify that the CAL GAS MIX value agrees with the cal gas concentration listed on the certification for the cylinder of calibration gas that will be used to calibrate the unit.
- Press the ENT key.
- Verify that the SMP PRES is 407”wc Abs.
- Press the ENT key.
- Verify that the REF PRES is 407”wc Abs.
- Press the ENT key.
- At the CALIBRATE O2? prompt initiate the calibration sequence by either of the following
  - Press and hold the INC key,then press the DEC key.
  - Press the external Start Calibration pushbutton, if installed.
- At the APPLY 20.95% CAL AIR prompt apply 20.95% air to the analyzer at the correct flow rate.
- Press the ENT key.
- The display will indicate the cell signal in mV.
- At the OVRD OFFSET? prompt, press the ENT key.
- At the APPLY CAL GAS X.XX% prompt, apply the certified calibration gas to the analyzer at the correct flow rate.
- Press the ENT key.
- The display will indicate the cell signal in mV.
- At the OVRD TEMP? display, press the ENT key.
- Observe the CALIBRATION COMPLETE message.
- The CALIBRATION COMPLETE message will clear in about 10 seconds.

5.1.2 FULLY AUTOMATIC CALIBRATION

- Press the ENT key twice to display the CAL SETUP MENU? prompt.
- Press the DEC key to drop down into the cal setup submenus.
- Verify that the CAL GAS MIX value agrees with the cal gas concentration listed on the certification for the cylinder of calibration gas that will be used to calibrate the unit.

- Press the ENT key.
- Verify that the SMP PRES is 407”wc Abs.
- Press the ENT key.
- Verify that the REF PRES is 407”wc Abs.
- Press the ENT key.
- At the CALIBRATE O2? prompt, initiate the calibration sequence by either of the following actions:
  - Press and hold the INC key, then press DEC key.
  - Press the external start calibration pushbutton, if installed.

The unit will energize the Cal Air relay to automatically apply 20.95% air to the cell at the proper flow rate.

- When the signal has stabilized (After about 2 – 3 minutes) the unit drops out the Cal Air relay and energizes the Cal Test Gas relay to apply the test gas to the cell at the proper flow rate.
- When the signal has stabilized (After about 2 – 3 minutes) observe the CALIBRATION COMPLETE message – the message clears after about 10 seconds.

The proper flow rates for the calibration air and the certified test gas must be set up during the installation and commissioning of the auto-cal hardware. Periodically verify that the flow is correct to ensure optimal system performance.

5.1.3 SINGLE POINT CALIBRATION (MANUAL MODE ONLY)

Single-point calibration refers to calibrating with air only (20.95% Oxygen). Calibration gas is not required for a single- point calibration sequence. This type of calibration is not as accurate as a calibration using both air and a certified test gas. A single-point calibration adjusts only for a milli-volt cell offset. The single-point calibration sequence is provided for situations where there is no certified calibration gas available.

- Press the ENT key twice to display the CAL SETUP MENU? prompt.
- Press DEC to drop down into the cal setup area.
- The CAL GAS MIX menu appears: disregard this display (since calibration gas will not be used).
- Press the ENT key.
- Verify that the SMP PRES is 407”wc Abs – Press the ENT key.
- Verify that the REF PRES is 407”wc Abs – Press the ENT key.
- At the CALIBRATE O2? prompt initiate the calibration sequence by either of the following actions:
  - Press and hold the INC key, then press DEC key.
  - Press the external start calibration pushbutton, if installed.
- At the APPLY 20.95% CAL AIR prompt apply 20.95% air to the cell.
- Press ENT.
- The display will indicate Cell Signal in mV.
- At the OVRD OFFSET? prompt press ENT.
- At the APPLY CAL GAS X.XX% prompt initiate a “single point” calibration by pressing and holding the INC key and then pressing DEC.
- The display will indicate SGL PT CAL COMPLETE. This message will clear in about 10 seconds.

6.0 MAINTENANCE

IN THIS SECTION

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6.1 ROUTINE MAINTENANCE

The rugged A-10050-A0 Microprocessor-based Oxygen Analyzer Electronics does not require routine maintenance. However, a recommended spare parts list is included in section 7 of this manual. For calibration (annually or as required by local regulations) please refer to section 5 of this manual. For routine maintenance of the oxygen analyzer probe, such as cell replacement please refer to the manual provided with the probe.

7.0 CUSTOMER SERVICE INFORMATION

IN THIS SECTION

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7.1 PARTS

7.1.1 SPARE PARTS

The following parts should be kept in inventory onsite:

Part Number	Description
31022-001	1-amp fuse.
31176	Main Printed Circuit (PC) Board Assembly, complete.
31458	Capacitor for main printed circuit (PC) board.
31040	Display Assembly, including alphanumeric display, pushbuttons, and ribbon cable to connect to main printed circuit (PC) board.
31468	4-amp fuse.

7.1.2 REPLACEABLE PARTS

The following parts should be considered replaceable under normal operating conditions:

Part Number	Description
31022-001	1-amp fuse.
31176	Main Printed Circuit (PC) Board Assembly, complete.
31458	Capacitor for main printed circuit (PC) board.
31040	Display Assembly, including alphanumeric display, pushbuttons, and ribbon cable to connect to main printed circuit (PC) board.
31468	4-amp fuse.

7.2 CUSTOMER SERVICE INFORMATION

7.2.1 CONTACTS

Hays Cleveland Sales Office
1903 South Congress Avenue
Boynton Beach FL 33426
Telephone: 561.734.9400
Fax: 561.734.8060
email: **salescombustion@unicontrolinc.com**

Hays Cleveland Customer Service Department
1111 Brookpark Road
Cleveland OH 44109
Telephone: 216.398.4414
Fax: 216.398.8556
email: **customerservice@unicontrolinc.com**

Visit us on the WEB! http://www.hayscleveland.com

7.2.2 REPAIRS

Damaged or defective units may be returned to the factory for repair. However, factory authorization must be obtained before shipping whether warranty or non-warranty service is required, and all units must be shipped prepaid.

A letter of transmittal that includes the following information should accompany the returned instrument:

1. Location, type of service, and length of time in service of the unit.
2. Description of the faulty operation of the device and the circumstances of the failure.
3. Name and telephone number of the person to contact if there are questions about the unit.
4. Indicate whether warranty or non-warranty service is requested.
5. Attach Purchase Order for all out-of-warranty repairs.
6. Complete shipping instructions for the return of the repaired instrument.
7. Original purchase order number and date of purchase.
8. Return Goods Authorization number provided by the factory when you called.
9. Clearly label the shipping container:

   RETURN FOR REPAIR
   Model _____
   RG # _____

10. Ship prepaid to:

    HAYS CLEVELAND
    1111 Brookpark Road
    Cleveland OH 44109-5869
    Telephone: 216-398-4414

Please follow this procedure. It expedites handling of the returned item, and avoids unnecessary additional charges for inspection and testing to determine the problem before repairing it.

7.3 STANDARD TERMS AND CONDITIONS OF SALE

AGREEMENT OF SALE: Acceptance by Seller of any order placed for the good described on the reverse side hereof shall be subject to Seller's Standard Terms and Conditions of Sale and is conditioned upon the Buyer's acceptance of these Standard Terms and Conditions.

TERMS OF CONTRACT: Any terms or conditions of the Buyer's order which are inconsistent with these Standard Terms and Conditions shall not be binding on the Seller and shall not be considered applicable to the sale or shipment of goods covered by this Acknowledgment or Sales Contract. Unless Buyer shall notify Seller in writing to the contrary within ten (10) days after the mailing of this Acknowledgment or Sales Contract by Seller, acceptance of these Standard Terms and Conditions by Buyer shall be indicated and, in the absence of such notification, the sale and shipment by Seller of the goods covered hereby shall be subject to these Standard Terms and Conditions.

PRICES: Prices are subject to change to the extent permissible under applicable federal law. Sales contracts which call for delivery in the future will be billed at prices in effect at the time of shipment. Shipping weights shown are approximate and subject to change without notice. Prices of products do not include supervision of erection or adjustment after installation by Buyer. MINIMUM BILLING ON ANY ORDER IS $150.00 U.S. FUNDS.

SHIPMENT AND PAYMENTS: All prices and shipments are F.O.B. the Seller's factory such that the risk of loss and risk of liability during shipment passes to the Buyer upon delivery of the equipment to the carrier. As discussed under the section, "Title and Ownership," the Seller shall retain title to the equipment. No freight is allowed on any shipments. Shipments and deliveries hereunder shall at all times be subject to the approval of Seller's Credit Department, and at any time Seller may require payment in advance or satisfactory security or guarantee that invoices will be promptly paid when due. If Buyer fails to comply with any terms of payment, Seller, in addition to its rights and remedies but not in limitation thereof, reserves the right to withhold further deliveries or terminate this Agreement, and any unpaid amount thereon shall become due immediately. Standard terms of payment are 1% 10 – Net 30 days unless otherwise negotiated prior to placement of order. Special terms of payment shall be as set forth on the quotation, or acknowledgment for order.

Pro rata payments shall become due as shipments are made. If shipments are delayed by the Buyer, payments shall become due on the date when the Seller is prepared to make shipment. If, in the judgment of the Seller, the financial condition of the Buyer at any time does not justify continuance of production or shipment on the terms of payment specified, the Seller may require full or partial payment in advance. Where the Buyer of the plant equipped is outside the territory of the United States of America, all remittances shall be made in U.S.A. funds. If the order is placed with complete specifications and instructions to fabricate, and then shipment is postponed by buyer, the order will be invoiced on date of shipment which was originally scheduled. If held for shipment, a charge may be made for storage in excess of four weeks after scheduled shipping date at the discretion of the Seller.

PARTIAL SHIPMENTS: The Seller reserves the right to ship and invoice units as manufacture of unit items is completed. Alternately, invoices may be rendered on net 30 day terms as unit items are completed, the equipment then being held for release by Buyer. It is sometimes necessary for certain instruments and/or controllers, etc., to be specially packed or for other reasons shipped separately, and therefore must be mounted in the panel at the job site. The Seller reserves the right to make exceptions to mounting such equipment in the panel before shipment, even though the Proposal is based on a completely assembled, piped and /or wired panel. The Seller will not accept any charges for labor and/or material required to unpack, mount in the panel, pipe and/or wire equipment shipped separately.

TITLE AND OWNERSHIP: The Seller shall retain title, and hold a lien against, the equipment furnished under the terms and conditions of this proposal until the full and final payment shall have been made to the Seller, by the Buyer. In the event of a default by the Buyer on any of the terms, payments or conditions which are on his part to be performed, then the Seller shall have the right, without notice, to repossess any or all of the above mentioned equipment wherever the same may be found, and in doing so, shall not be held as a trespasser.

DELAYS AND DEFAULTS: Where date of delivery is given, we will endeavor to make shipments as near the date as possible, but we cannot be held responsible for any loss or inconvenience caused by delay or failure to deliver. Delays or defaults in delivery by Seller of the goods covered by this Sales Contract shall be excused so far as the same is caused by fire, strikes, accident, governmental regulation, or any delays unavoidable or beyond reasonable control of Seller. In no event shall Seller be liable for any consequential, special, or contingent damages on account of any default or delay in delivery.

ACCELERATED OR DELAYED PAYMENTS: There will be no reduction in price for payments more favorable to UniControl Inc. than the standard terms. If payments are not made in conformance with the standard terms, the quoted price shall, without prejudice to the right of UniControl Inc. to immediate payment, be increased by an amount equal to the lesser of 1 ½ percent per month or fraction thereof on the unpaid balance or the highest legal rate.

NON-CANCELLATION: Orders are not subject to suspension, reduction, or cancellation, except on terms that will indemnify Seller against loss.

RENEGOTIATION: Unless advised by Buyer in writing, Seller understands that Buyer's order and this Sales Contract are not renegotiable under the Renegotiation Act of 1951.

SPECIFICATIONS: Seller relies on specifications and other data furnished by the Buyer, an architect, contractor, or consulting engineer in all phases of the work covered by this Sales Contract. Seller shall be responsible to check quantities only. Alterations to or changes in specifications, approval of samples, changes in delivery instructions and all other instructions must be submitted in writing to Seller.

In the event Seller performs design or engineering work at the request of Buyer, an architect, contractor, consulting engineer, or representative in any phase of the work covered by this Sales Contract, Seller shall not be responsible for any damages claimed by Buyer as a result of alleged errors or defects in such design or engineering work.

WARRANTY AND LIMITATION OF LIABILITY: The warranty applies to all components except those components which may be destroyed by negligence or abnormal use. Seller warrants that the goods supplied by it have been manufactured in accordance with its standard manufacturing practices and conform to the contract or catalog description for such goods. Seller further warrants that the goods supplied by it are fit for the ordinary purpose or purposes specified in its catalog for which such goods are used when installed in accordance with Seller's recommended installation procedures. Except as stated herein, Seller makes no express warranty with respect to goods supplied by it and Seller makes no warranty that the goods are fit for any particular purpose. When the use of materials not manufactured by Seller is suggested by Seller's recommended installation procedures or otherwise, Seller makes no express warranty with respect to such materials nor that such materials are merchantable or fit for any particular purpose. Seller will, at its sole option, credit, repair or replace, any goods supplied by it which its examination shall disclose to its satisfaction are defective in workmanship or material and are returned to it within one year from the date of shipment and any claim not made within this period shall conclusively be deemed waived by Buyer. Credit, repair, or replacement will be preconditioned upon examination of the goods by Seller, and, if requested by Seller, return of the goods to Seller at its direction and expense. In those instances in which a part or product is returned to the Seller, all transportation charges are to be paid by the Buyer. No goods are to be returned to Seller without its written consent. Seller shall not be liable for any expense incurred by Buyer in order to remedy any defect in its goods. Seller shall not be liable for any consequential, special, or contingent damage or expense, arising directly or indirectly from any defect in its goods or from the use of any defective goods. The remedies set forth herein shall constitute the exclusive remedies available to Buyer and are in lieu of all other remedies.

The responsibility for the performance and service of equipment included in this proposal which is not manufactured by the Seller and is not a part of equipment manufactured by the Seller will be the responsibility of the manufacturer of that equipment.

CLAIMS: Claims for shortage of goods or for mistakes or errors in billing must be presented within forty-five (45) days from the date of shipment of goods and must state the packing slip number and container number applicable to the claim. Any claim not so presented will be conclusively deemed waived.

TAXES: Any federal, state, local or other government tax or charge on the sale, shipment, or installation of the goods covered by this Sales Contract shall be added to the price and paid by Buyer or, in lieu thereof, the Buyer shall furnish Seller with tax-exemption certificates acceptable to the taxing authority. Buyer agrees to reimburse and save Seller harmless from all such state and local taxes, including interest and penalties thereon, which may at any time be payable to any governmental unit with respect to the sale of any goods covered by this Sales Contract.

CORRECTIONS: Typographical or clerical errors contained in this Sales Contract, including prices, are subject to correction by Seller.

FAIR LABOR STANDARDS: These goods were produced in compliance with all applicable requirements of sections 6, 7, and 12 of the Fair Labor Standards Act, as amended and of the regulations and orders of the United States Department of Labor issued under Section 14 thereof.

APPLICABLE LAW: All questions arising out of this Sales Contract, which shall be deemed an Ohio Contract, shall be governed by the laws of the State of Ohio.

EXCLUSIVE TERMS: All proposals are based on, and all products are sold on, the terms and conditions contained herein. No other representation by the Seller or its representatives is valid. This Sales Contract shall constitute the complete contract between the parties. No one has authority to depart from the terms and conditions set forth herein, nor to make any representations or arrangements other than those printed hereon unless the same are written on the face of this Sales Contract or are given in writing with it or in pursuance of it, and are fully approved in writing by an officer or authorized employee of the Seller. Others made thereon, or contracts resulting therefrom, are not binding until and unless as so accepted.

7.4 SERVICE

A Maintenance and Service Contract can ensure trouble-free, economical operation of Hays Cleveland equipment for many years. One-time on-site service by a factory-trained service engineer can also be provided as needed. Contact Hays Cleveland for information on these service options.

8.0 APPENDICES

IN THIS SECTION

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8.1 MODBUS MEMORY MAP

Much of the data provide by the analyzer is available on the Modbus port. The following information details how the Modbus registers are arranged.

MODBUS MEMORY MAP				
40001 – O_2 % * 10	This register contains the measured % O_2 times 10. For example, if the % O_2 reading is 20.9% this register will contain the integer 209. The value of this register ranges from 000 to 250.			
40002 – Cell mV	This register contains the cell millivolts reading corrected for cell offset. The value of this register ranges from 000 to 300.			
40003 – Cell Temperature	This register contains an integer indicating the cell temperature in degrees C as reported by either the RTD or thermocouple. The range is 000 to 999 if using a type K-thermocouple, and 600 to 999 if using a thermocouple.			
40004 - Cell impedance in Ohms	This register contains the cell impedance in ohms. The value will range from 000 to 999 Ohms.			
40005 - Heater drive power in percent (0 to 100)	This register contains a value indicating the percent power being delivered to the probe heater. The value ranges from 0 to 100%. When the heater power is 100% the heater is full on. Typical values for heater power are in the 50 – 70% range during normal operation.			
40006 - Flue Gas temp in degrees C	This register contains a signed integer indicating the value for the flue gas temperature in degrees C. The range of this register will depend on the scaling setup. Overrange is indicated by the highest positive signed integer that can be represented in 16 bits, +32767. Underrange is indicated by the lowest negative signed integer that can be represented in 16 bits, -32768.			
40007 – Combustion air temp in degrees C	This register contains the combustion air temperature. This value is either measured from the combustion air temperature input or preset from the keypad.			
40008 – Comb Efficiency (0 – 100%)	This register contains the computed % combustion efficiency. The value of this register will range from 0 to 94%. The actual theoretical limit on the maximum calculated efficiency will depend on the fuel selected.			
40009 Relays & Inputs	This is a bitmapped register containing various information regarding output relays and several analyzer inputs. See the bit definitions detailed below.			
	Bit	**Tag**	**0**	**1**
	0	Cal Air Relay	Denergized	Cal Air requested
	1	Cal Test Gas Relay	Denergized	Cal Test Gas requested
	2	Cal in Progress Relay	Denergized	Cal in progress
	3	Alarm 1 Relay	Alarm tripped	Alarm not tripped
	4	Alarm 2 Relay	Alarm tripped	Alarm not tripped
	5	Analyzer Fault Relay	Analyzer Fault	No Fault
	6	Spare Relay – Unused	Reserved	
	7	Unused	Reserved	

	8	Boiler On input status	Boiler Off	Boiler On
	9	External Start AutoCal input status	Inactive	Active (External Autocal button pressed)
	10	Fuel 1 Select input status	Inactive	Fuel #1 input active
	11	Fuel 2 Select input status	Inactive	Fuel #2 input active
	12	Alarm 1 reset input status	External Reset button pressed or Auto Reset mode selected	External Reset button not pressed
	13	Alarm 2 reset input status	External Reset button pressed or Auto Reset mode selected	External Reset button not pressed
	14	Combustion Efficiency Enable/Disable jumper	Combustion Efficiency enabled	Combustion Efficiency disabled
	15	Calibration Mode Select jumper	Manual or Semi Automatic calibration mode	Fully Automatic calibration mode
40010 Jumpers & Internal Flags	This is a bitmapped register containing various information regarding jumper settings and internal firmware flags. See the bit definitions detailed below.			
	Bit	**Tag**	**0**	**1**
	0	T/C Open	T/C Ok	T/C Open
	1	RTD Open	RTD Ok	RTD Open
	2	RTD Shorted	RTD Ok	RTD Shorted
	3	Heater Fail - Temperature Low	Heater Ok	Heater Fail - temp too Low
	4	Heater set point select jumper	750C	820C
	5	Transducer type select	type thermocouple	RTD
	6	Cell Impedance Fail	Inactive	Cell has failed impedance check
	7	Cell Impedance Warn	Inactive	Cell Impedance warning active
	8	Heater in range	Heater temperature not in operating range	Heater temperature is in operating range
	9	Heater Locked	Heater temperature is not yet locked in range	Heater temperature is locked in operating range
	10	Heater Fail Temp Hi	Heater Ok	Heater Fail - temp too High
	11	Cell impedance check active	Cell impedance check idle	Cell impedance check is in progress
	12	Unused	Reserved	
	13	Unused	Reserved	
	14	Unused	Reserved	
	15	Unused	Reserved	

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