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# Rosemount Analytical

**MODEL 7003M  
PERCENT OXYGEN  
ANALYZER**

**INSTRUCTION MANUAL**

748223-J

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## NOTICE

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The information contained in this document is subject to change without notice.

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**Rosemount Analytical Inc.**  
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# *NOTES*



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# PREFACE

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## SAFETY SUMMARY

To avoid explosion, loss of life, personal injury and damage to this equipment and on-site property, all personnel authorized to install, operate and service the Model 7003M Percent Oxygen Analyzer should be thoroughly familiar with and strictly follow the instructions in this manual. **Save these instructions.**

**DANGER** is used to indicate the presence of a hazard which **will** cause **severe** personal injury, death, or substantial property damage if the warning is ignored

**WARNING** is used to indicate the presence of a hazard which **can** cause **severe** personal injury, death, or substantial property damage if the warning is ignored.

**CAUTION** is used to indicate the presence of a hazard which **will** or **can** cause **minor** personal injury or property damage if the warning is ignored.

**NOTE** is used to indicate installation, operation, or maintenance information which is important but not hazard-related.



### **WARNING: ELECTRICAL SHOCK HAZARD**

***Do not operate without doors and covers secure. Servicing requires access to live parts which can cause death or serious injury. Refer servicing to qualified personnel.***

***For safety and proper performance this instrument must be connected to a properly grounded three-wire source of power.***

***Relay contacts wired to separate power sources must be disconnected before servicing.***

***This instrument was shipped from the factory set up to operate on either 115 VAC 50/60 Hz, or 230 VAC 50/60 Hz, as specified by sales order. Verification that this voltage is proper for the installation is the responsibility of the purchaser. See Section 2.4.2.***



**WARNING: OXYGEN LEVEL WILL NOT BE MONITORED**

*The instrument will not return automatically to the RUN mode from HOLD or DIAGNOSTICS modes. Operator must manually return instrument to RUN mode to continue monitoring oxygen.*



**WARNING: ERRONEOUS OXYGEN READINGS**

*If the pressure compensation function is not applied correctly, erroneous readings can be displayed. The display using span gas during calibration should be the same as the reading using the same gas in RUN mode if the pressure values are correctly entered.*



**WARNING: PARTS INTEGRITY**

*Tampering or unauthorized substitution of components may adversely affect safety of this product. Use only factory documented components for repair*



**WARNING: HIGH PRESSURE GAS CYLINDERS**

*If gas cylinders are used for supplying drying or carrier gases, refer to "General Precautions for Handling and Storing High Pressure Gas Cylinders" in the rear of this manual.*



**WARNING: SENSOR NOT INTRINSICALLY SAFE**

*The oxygen sensors used with this analyzer are not intrinsically safe. Use of the sensors in or near flammable liquids, gases or vapors or in Class I, Division 1, Hazardous Locations should be carefully evaluated by qualified personnel at the site and is entirely the responsibility of the user.*

*The sensor is approved as non-incendive for use in Class I, Division 2 locations.*

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## **SPECIFICATIONS - PERFORMANCE**

**ACCURACY**

±0.25% oxygen

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**OPERATING RANGE**

0 to 25% oxygen (endpoints set by user)

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**LINEARITY**

±0.25% oxygen  
(with constant sample temperature after sensor zero offset correction)

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**ZERO STABILITY**

±0.25% oxygen/week at 25°C

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**SPAN STABILITY**

±0.25% oxygen/24 hours at 25°C

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**NOISE**

±0.25% oxygen

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**RESPONSE TIME**

90% of reading in 20 seconds at 25°C

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**TEMPERATURE EFFECTS**

32 to 110°F (0 to 44°C): ±6% reading  
60 to 90°F (15 to 32°C): ±3% reading  
other 30°F (16°C) ranges: +4% reading

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## **SPECIFICATIONS - PHYSICAL**

**MOUNTING**

Standard: Panel Mount  
Optional: Wall Mount, Pipe Mount

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**DIMENSIONS**

5.7 x 5.7 x 7.6 inches (14 x 14 x 19 cm) HxWxD

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**WEIGHT**

Approximately 3.0 pounds (1.36 kg)

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**ENCLOSURE**

ABS Plastic, Black, NEMA Type 4X, IP65

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**AMBIENT HUMIDITY**

95% relative humidity, non-condensing (maximum)

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**AMBIENT TEMPERATURE**

14 to 122°F (-10 to 50°C)

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## ***SPECIFICATIONS - PHYSICAL (CONTINUED)***

### ***SENSOR CABLE***

2 twisted pairs, specified length up to 1000 feet (305 m) maximum

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### ***POWER CABLE***

3 conductor, Type SJT, 18 AWG minimum

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### ***CONNECTION CONDUIT***

Power: 1/2 inch  
Sensor: 3/4 inch

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## ***SPECIFICATIONS - ELECTRICAL***

### ***POWER REQUIREMENTS***

115/230 VAC  $\pm 10\%$ , 50/60 Hz  $\pm 3$  Hz

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### ***DISPLAY***

3-1/2 digit liquid crystal (LCD)

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### ***SIGNAL OUTPUT***

Isolated 4 to 20 or 0 to 20 mA (selectable)  
600 ohms maximum load

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### ***ALARM RELAY CONTACTS***

Two Form C Relays  
SPDT, resistive load, independently adjustable  
Deadband adjustable over full range

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### ***ALARM RELAY CONTACTS RATINGS***

General Purpose (Ordinary) Locations:  
115 VAC, 3.0 A (resistive), 230 VAC, 1.5 A resistive  
Class I, Division 2 Locations:  
CSA: 120 VAC, 3.0 A (non-inductive)  
240 VAC, 1.5 A (non-inductive).  
FM: 28 VDC (resistive) (Ci = 0, Li = 0)  
Groups A&B: 150 mA  
Group C: 400 mA  
Group D: 540 mA

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### ***RECORDER OUTPUT***

Isolated 4 to 20 mA

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## **SPECIFICATIONS - SENSORS**

### **TYPES**

Rechargeable and Disposable

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### **PROCESS CONNECTIONS**

Refer to flow chamber (if supplied)

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### **SAMPLE PRESSURE**

0 to 50 psig (0 to 345 kPa)

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### **SAMPLE TEMPERATURE**

32 to 110°F (0 to 44°C)

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### **AMBIENT TEMPERATURE**

32 to 110°F (0 to 44°C)

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### **AMBIENT HUMIDITY**

95% relative humidity, non-condensing (maximum)

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**ALSO REFER TO INSTRUCTIONS SUPPLIED WITH SENSOR.**

## ***CUSTOMER SERVICE, TECHNICAL ASSISTANCE AND FIELD SERVICE***

For order administration, replacement Parts, application assistance, on-site or factory repair, service or maintenance contract information, contact:

**Rosemount Analytical Inc.  
Process Analytical Division  
Customer Service Center  
1-800-433-6076**

## ***RETURNING PARTS TO THE FACTORY***

Before returning parts, contact the Customer Service Center and request a Returned Materials Authorization (RMA) number. Please have the following information when you call: *Model Number, Serial Number, and Purchase Order Number or Sales Order Number.*

Prior authorization by the factory must be obtained before returned materials will be accepted. Unauthorized returns will be returned to the sender, freight collect.

When returning any product or component that has been exposed to a toxic, corrosive or other hazardous material or used in such a hazardous environment, the user must attach an appropriate Material Safety Data Sheet (M.S.D.S.) or a written certification that the material has been decontaminated, disinfected and/or detoxified.

Return to:

**Rosemount Analytical Inc.  
4125 East La Palma Avenue  
Anaheim, California 92807-1802  
USA**

## ***TRAINING***

A comprehensive Factory Training Program of operator and service classes is available. For a copy of the *Current Operator and Service Training Schedule* contact the Technical Services Department at:

**Rosemount Analytical Inc.  
Phone: 1-714-986-7600  
FAX: 1-714-577-8006**

## ***DOCUMENTATION***

The following Model 7003M Percent Oxygen Analyzer instruction materials are available. Contact Customer Service or the local representative to order.

748223 Instruction Manual (this document)

## COMPLIANCES

The Model 7003M Percent Oxygen Analyzer and Models 4000 and 5000 series sensors are suitable for use in Class I, Groups A, B, C, and D, Division 2 locations per North American electrical codes. Factory Mutual Research (FM) approved under J.I. 1T5AO.AX. Canadian Standards Association (CSA) certified under file LR 93812.



# ***NOTES***



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# 1 INTRODUCTION

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## 1.1 OVERVIEW

The Model 7003M Percent Oxygen Analyzer continuously monitors the concentration of oxygen in a gaseous sample. It consists of a sensor and the analyzer. The sensor is housed in a chamber assembly and is connected to the analyzer by a shielded multi-conductor cable.

The Model 7003M Percent Oxygen Analyzer provides direct digital readout, isolated current output, automatic temperature compensation circuitry, and dual relay contact closures for alarms or ON/OFF control devices as standard features. The alarm ranges can be selected independently from the output range, eliminating the need to readjust alarm setpoints if the range is changed.

The analyzer has six modes of operation:

MODE	FUNCTION
RUN (see Section 3.4)	Normal monitoring
SETUP (see Section 3.5)	Changing parameters
ALARM/CONTROL (see Section 3.6)	Set alarms or ON/OFF controllers
CALIBRATION (see Section 4.2)	Gas calibration/pressure inputs
HOLD (see Section 4.3)	Retain last output value
DIAGNOSTICS (see Section 4.4)	Electronics checks

The Model 7003M Percent Oxygen Analyzer is housed in a NEMA 4X (CSA enclosure 4), corrosion resistant housing suitable for panel, pipe or wall mounting.

The analyzer has a microprocessor controlled keyboard for operation. Signals from the remote oxygen and temperature sensors are processed to compute real time oxygen concentration corrected for temperature, constant pressure differences and residual sensor current. The oxygen concentration is compared with user-set alarm parameters, and also generates an isolated 4 to 20 or 0 to 20mA signal. Data is stored in a memory circuit that retains the data in case power is removed.

The analyzer is shipped from the factory configured for operation on either 115 VAC or 230 VAC, 50/60 Hz as specified by the customer when ordered.

## 1.2 PRINCIPLE OF MEASUREMENT

Measurement is based on the electro-chemical reaction between oxygen and the sensor cathode which produces a low level electrical current. The sensor signal is proportional to the partial pressure of oxygen present at the membrane. This signal and a thermistor signal are received by the analyzer and processed by the electronics to output a calibrated oxygen signal that is compensated for temperature.

## 1.3 SENSORS

Rosemount Analytical offers rechargeable and disposable oxygen sensors which can be used with the Model 7003M. These sensors are supplied in kits: Submersion, in-line flow, fast response, and a cell separation kit. Sensors are available constructed of polypropylene or Ryton. See Section 7.3 Replacement Parts - Sensors, for additional information.

## 1.4 CONDITIONS AFFECTING MEASUREMENT

Oxygen measurement is affected by the following:

- Composition of the sampled gas
- Sample and calibration gas pressures
- Environment of sensor, cable and analyzer

Each must be considered when calibrating and operating the analyzer to obtain accurate measurements.

### 1.4.1 GAS COMPOSITION

Any substance in the sample that significantly interferes or "poisons" the sensor oxygen reading should be removed by a chemical and/or mechanical sample handling system (see Section 5.2). If ambient air is not used as the span gas, the composition of calibration gases should also be representative of the sample.

The sample and calibration gases must meet certain specifications (see Specifications in Preface) to ensure accurate measurement. Physical parameters that affect measurement include:

- Pressure
- Humidity
- Temperature
- Gas composition

Also refer to Section 5.2 for additional information about how gas conditions affect the oxygen measurement.

## 1.4.2 SAMPLE AND CAL GAS PRESSURES

The sample and calibration gases may be at different pressures as long as the pressure of each remains constant. Any variation in the pressure of either gas will result in an incorrect output reading of the same proportion.

Two methods of sample calibration are recommended:

1. Calibrate at the sample pressure, or
2. Calibrated at a different pressure, and enter the two pressure in the analyzer (Section 4.2.3)

Refer to Section 5.2 for a more detailed discussion of the relationship between gas pressures and apparent oxygen concentration.

## 1.4.3 ENVIRONMENTAL FACTORS

If radio frequency interference (RFI) normally occurs in the operating environment, the sensor cable should be electrically shielded during installation.

## 1.5 FEATURES

### SUPPRESSED RANGES

When setting the Model 7003M to a suppressed output range (15 to 25%, etc.), note that the absolute accuracy, drift, and noise of the oxygen measurement will remain the same for all ranges (see Specifications in Preface).

### ALARM MODE

ALARM Mode is not self-resetting. Operator must press ACK to bring relays back to their no-alarm state. Used when immediate operator action is required.

#### **Note:**

#### ***Operator Can Bypass Alarm Relays***

***When relays are set to ALARM Mode (Section 3.6.1) and an alarm condition has occurred, pressing the ACK key will turn off the relay switch, whether the oxygen level is out of range or not. If you do not want an operator to be able to bypass the relay switches in this way, set the instrument to ON/OFF -CONTROL Mode.***

### ON/OFF-CONTROLLER MODE

ON/OFF-CONTROLLER Mode is self-resetting. Pressing ACK has no effect on relay coils. Used when automated action is required.

# ***NOTES***

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# 2 INSTALLATION

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## 2.1 UNPACKING

Carefully examine the shipping carton and contents for signs of damage. Immediately notify the shipping carrier if the carton or contents is damaged. Retain the carton and packing material until all components associated with the Model 7003M Percent Oxygen Analyzer are operational.

### 2.1.1 STORAGE

The sensors and analyzer unit may be shipped together or separately. The sensors are shipped assembly and charged, ready for use.

If rechargeable sensors are stored longer than six months, they may need to be recharged or rejuvenated if performance is marginal. Disposable sensors are not rechargeable.

Refer to documentation supplied with sensors for more information.

## 2.2 ANALYZER INSTALLATION

The Model 7003M Percent Oxygen Analyzer is designed to meet NEMA Type 4X (CSA enclosure 4) requirements, provided that the cutouts in the bottom of the enclosure are fitted with approved conduit fittings or are properly sealed by the user with Hoffman plugs (PN A-S050) or equivalent.

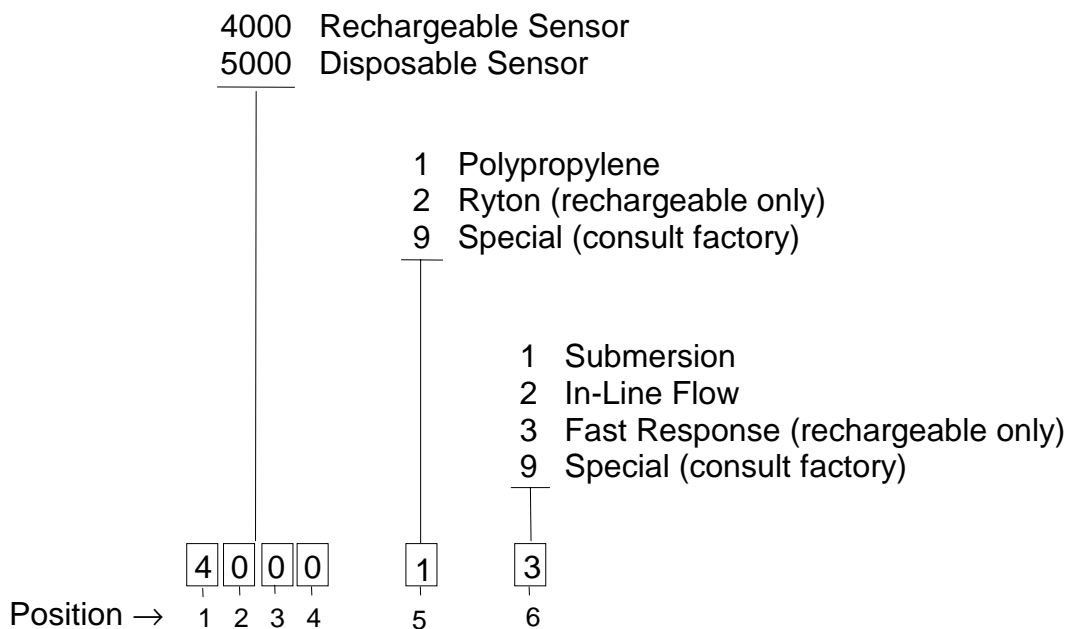
The Model 7003M is supplied with the Panel Mounting Kit PN 652527 as standard. Optional Wall Mount Kit PN 652539 and Pipe Mount Kit PN 652529 are available. Refer to the Outline and Mounting drawings provided in the rear of this manual.

## 2.3 SENSOR INSTALLATION

**Note:**

***Refer to Figure 2-1 Sensor Ordering Matrix, and verify that the sensor to be used corresponds with the application. If an incorrect sensor is used, calibration may be impossible or incorrect. If a different type of sensor is to be used, the rocker switch (SW1) on the Signal Board may have to be changed (see Section 2.3.1).***

Install the sensor in an area where temperature is relatively constant, taking care to avoid changes in exposure to sunlight or due to sudden drafts. A room-temperature environment is preferable. The flow chamber/sensor kit contains detailed mounting and sample flow information. Add distilled or deionized water to the sensor to the maximum level indication on the sensor reservoir. Let sensor stand for approximately 15 minutes and check for leaks around the base of the reservoir, and at the seams and corners. If a leak is found, contact the factory before proceeding. Drain the sensor.



Positions 1 through 4 = Sensor Type  
Position 5 = Material of Construction (Sensor and Flow Assembly)  
Position 6 = Flow Assembly Configuration

Example 400013 is a Rechargeable sensor, constructed of polypropylene, mounted in a Fast-Response Flow Chamber Assembly.

**FIGURE 2-1. SENSOR ORDERING MATRIX**

**2.3.1 ANALYZER/SENSOR JUMPER CONFIGURATION**

The Model 7003M is configured to match the type of sensor ordered with the analyzer. If the Signal Board or Sensor is repaired or replaced, verify rocker switch SW1 on the Signal Board is properly set.

Rechargeable Sensor: Close positions 1, 4, and 5

Disposable Sensor: Close positions 2, 4, and 6

## 2.4 ELECTRICAL CONNECTIONS

Observe all precautions stated in this manual and in the drawings provided at the back of this manual before installation.

All electrical connections to the analyzer are made on the Power Supply Board connection panel (see Figure 2-2 and drawing 652683), which is accessed by removing the rear cover.



### **WARNING: ELECTRICAL SHOCK HAZARD**

***Do not operate without rear cover secured. Servicing requires access to live parts which can cause death or serious injury. Refer servicing to qualified personnel.***

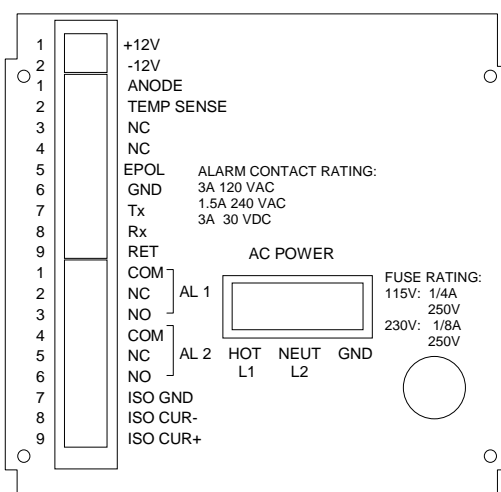
***For safety and proper performance this instrument must be connected to a properly grounded three-wire source of power.***

***Electrical installation must be made in accordance with the National Electrical Code (ANSI/NFPA-70) and/or any applicable national or local codes.***



### **WARNING: ENCLOSURE INTEGRITY**

***Unused cable conduit entries must be securely sealed by non-flammable closures to provide enclosure integrity in compliance with personnel safety and environmental protection requirements. For watertight installation conforming to the requirements of NEMA Type 4X, use Hoffman plugs (PN A-S050) or equivalent to seal any unused openings.***



**FIGURE 2-2. MODEL 7003M REAR PANEL CONNECTIONS**

Provide three separate 1/2 inch conduits as follows:

- Power cable
- Sensor cable
- Alarm cables

### 2.4.1 SENSOR CABLE

The sensor cable used with the Model 7003M may be of any length up to a maximum of 1000 feet (305 m). (See Table 2-1.)

The signal cable should be routed through a conduit (customer-supplied) in permanent installations or in cases where the sensor is located more than a few feet from the control unit. (See Table 2-2.)

**Note:**

*In humid environments, temperature changes can cause moisture to condense in the conduit, resulting in signal noise and corrosion. To minimize the effect of condensation, put desiccant (available locally) inside the conduit before sealing it.*

CABLE PART NUMBER	LENGTH
191748	10 Feet (3.1 m)
193265-SPECL	Any specified length up to 1000 Feet (305 m)

**TABLE 2-1. SENSOR CABLES**

<p><b>IF CONDUIT USED:</b></p> <p>1/2 inch NPT female connection on bottom of control unit. (Conduit customer-supplied.)</p> <p><b>IF NO CONDUIT USED:</b></p> <p>Use cable connector assembly (PN 856831) to provide watertight seal. Assembly includes: Aluminum inner sealing grommet for connector compression nut.</p>
-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

**TABLE 2-2. ANALYZER CABLE CONNECTIONS**

#### CONNECT SENSOR CABLE

1. Ensure that power is disconnected and remove rear cover.
2. Install the conduit or cable clamp in the left opening in the bottom rear of the case.



3. Install the sensor cable in the instrument through the cable clamp and tighten the nut on the plug to create a seal around the cable.
4. Refer to Figure 2-2. Using a flat-blade screwdriver, connect the wires of the sensor cable to the TB2-1, TB2-2, TB2-5 and TB2-6 on the rear panel of the analyzer.
5. Replace the rear cover if no other connections are to be made. Do not overtighten the cover retaining screws to avoid stripping the threads in the plastic case.

## 2.4.2 POWER CONNECTIONS

Electrical power is supplied to the analyzer via a customer-supplied three conductor cable, type SJT, minimum 18 AWG. Refer to the installation drawing in the rear of this manual.

### JUMPERS AND FUSES

To verify the jumper location for the specified power (115 or 230 VAC) or if the analyzer is to be connected to a different power source, refer to Figure 2-3 and set jumpers and fuse as follows:



**WARNING: ELECTRICAL SHOCK HAZARD**

*Disconnect power to analyzer before continuing.*

1. Remove the rear cover from the analyzer.
2. Remove Power Supply Board.
3. Verify and/or set Jumpers E1, E2, E3, and E4 per Figure 2-3.
4. Verify that fuse (F1) is correct for power.
5. Re-install Power Supply Board.
6. Replace the rear cover if no other connections are to be made. Do not overtighten the cover retaining screws to avoid stripping the threads in the plastic case.

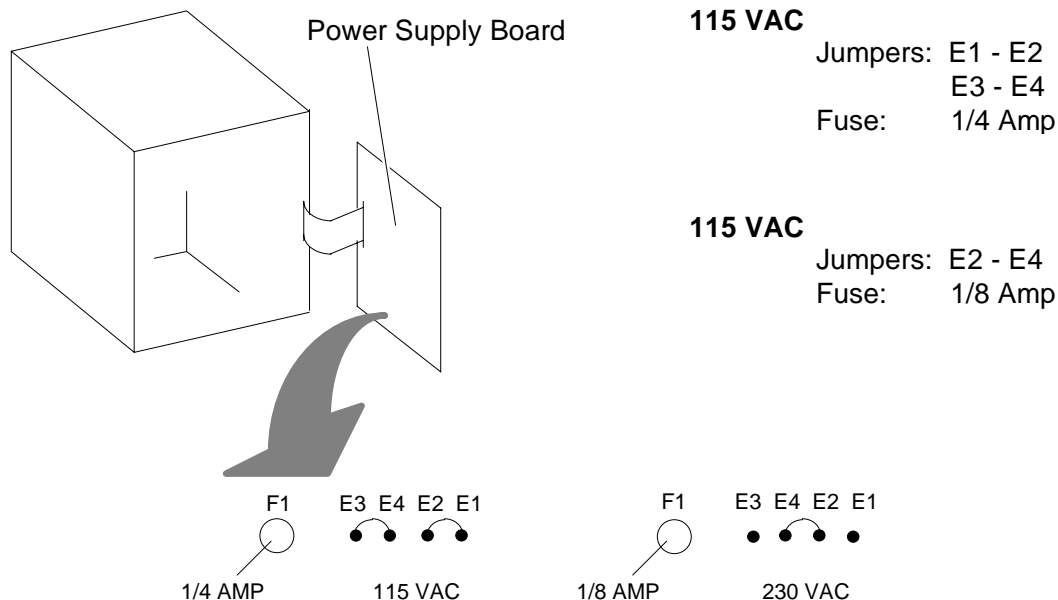
### CONDUIT CONNECTIONS

Route the power cable through conduit and into the central opening in the bottom of the case. The inlet hole is sized for standard 1/2 inch conduit fittings



**WARNING: ENCLOSURE NOT GROUNDED**

*The non-metallic enclosure does not provide grounding between conduit connections. Use grounding-type bushing and jumper wires.*



**FIGURE 2-3. POWER JUMPERS AND FUSES**

### CONNECT POWER CABLE

Connect power wiring to the compression type connectors on the rear panel (Figure 2-2) as follows:

1. Loosen the connector screw.
2. Strip insulation back approximately 1/4 inch (6.35 mm), twist stranded wires together. DO NOT tin braid wire or the connection can work loose.
3. Insert wire into connector about 1/4 inch (6.25 mm), ensuring that wires do not touch any other wire or connector.
4. Tighten screw.

### 2.4.3 CURRENT OUTPUT CONNECTIONS



#### **CAUTION: TOTAL OUTPUT RESISTANCE**

**Total resistance of all output devices and associated interconnection cable must not exceed 600 ohms.**

Refer to Figure 2-4. Isolated current output (0 to 20 or 4 to 20 mA) is standard on the Model 7003M. To convert from current output to voltage output, see Section 2.4.4.

1. Disconnect power to the analyzer. Remove rear cover.
2. Connect the shielded recorder cable leads to the rear panel of the analyzer (Figure 2-2):

TB3-8 negative (-)

TB3-9 positive (+)

**Note:**

***TB3-7 has no connection.***

3. Connect the other end of the output cable to terminals of the output device. Ensure that polarity is correct. Connect the shield to a suitable ground point.

**Note:**

***Current output terminals are not grounded. Ground the current loop at some point within the circuit to minimize noise or other undesirable interactions.***

4. Replace the rear cover. Do not overtighten cover retaining screws, to avoid stripping the threads in the plastic case.
5. To connect recorder(s), see Figure 2-4.

#### 2.4.4 VOLTAGE OUTPUT CONNECTIONS



#### **CAUTION: TOTAL OUTPUT RESISTANCE**

***Total resistance of all output devices and associated interconnection cable must not exceed 600 ohms.***

Refer to Figure 2-4. To convert the voltage output to current output see Section 2.4.3.

To monitor the signal output with a voltage recorder or other voltage device, the standard current output must be converted into a voltage by connecting a resistor in parallel with the output device as follows:

1. Determine the resistor value (R) required:

$$R_1 \text{ ohms} = (\text{fullscale voltage, volts}) / (0.02 \text{ amps})$$

2. Disconnect power; remove the rear cover.

3. Connect resistor (1/4 watt or greater) of value R between TB3-8 and TB3-9 (Figure 2-4).
4. Connect leads of a shielded recorder cable to the rear panel of the analyzer (Figure 2-2):

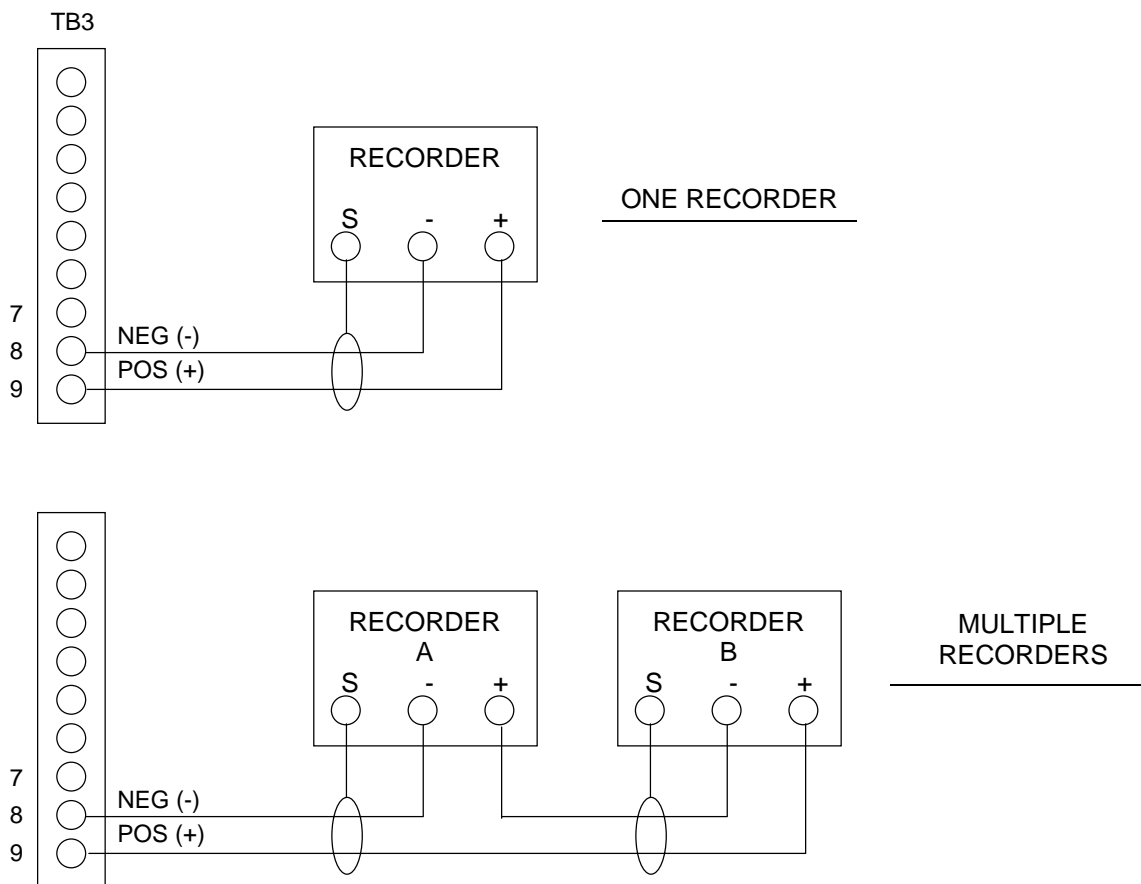
TB3-8 negative (-)

TB3-9 positive (+)

**Note:**

**TB3-7 has no connection.**

5. Connect other end of output cable to terminals of output device. Ensure that polarity is correct.
6. Replace the rear cover. Do not overtighten cover retaining screws, to avoid stripping the threads in the plastic case.
7. For the low end point to be 0 volts, set the current output range to 0 to 20mA when setting up the instrument (Section 3.5.2).



**FIGURE 2-4. CURRENT OUTPUT CONNECTIONS**

## 2.4.5 RELAY CONTACTS FOR ALARMS OR ON/OFF-CONTROLS

### **Note:**

**Whenever "Alarm" is used, it refers to either alarm or ON/OFF Control, depending on how the relays are connected and configured by the customer.**

### **RATINGS**

Two sets of alarm relay contacts are provided for actuation of customer-supplied alarm and/or ON/OFF-Control functions. (see analyzer specifications in Preface).

### **POWER FAILURE**

Removal of AC power from the analyzer, as in a power failure, removes power from both relay coils. The Model 7003M should operate on a different AC power source than the Alarm relay contacts.

### **RADIO FREQUENCY INTERFERENCE (RFI)**

If alarm contacts are connected to any device that causes radio frequency interference (RFI), an arc suppressor (PN 858728) should be used to minimize RFI.

### **CONNECTING DEVICES TO RELAY CONTACTS**



### **WARNING: RELAY CONTACTS**

**Relay contacts wired to separate power source must be disconnected before servicing.**

Connect alarm or ON/OFF-Control devices to the relay contacts as follows:

1. Disconnect power; remove rear cover of analyzer.
2. Connect leads from the external alarm or ON/OFF Control system (see Figure 2-2).

TB3-1	Alarm 1	Com
TB3-2	Alarm 1	NC
TB3-3	Alarm 1	NO
TB3-4	Alarm 2	Com
TB3-5	Alarm 2	NC
TB3-6	Alarm 2	NO

3. Connect other end of output cable to terminals of alarm device.
4. Replace the rear cover. Do not overtighten cover retaining screws, to avoid stripping the threads in the plastic case.

**Note:**

***For installation in a Class I, Division 2 location, refer to the Specifications in the Preface section, and the approval label on the analyzer for Factory Mutual limitations on contact ratings.***

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# 3 OPERATION

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## 3.1 OVERVIEW

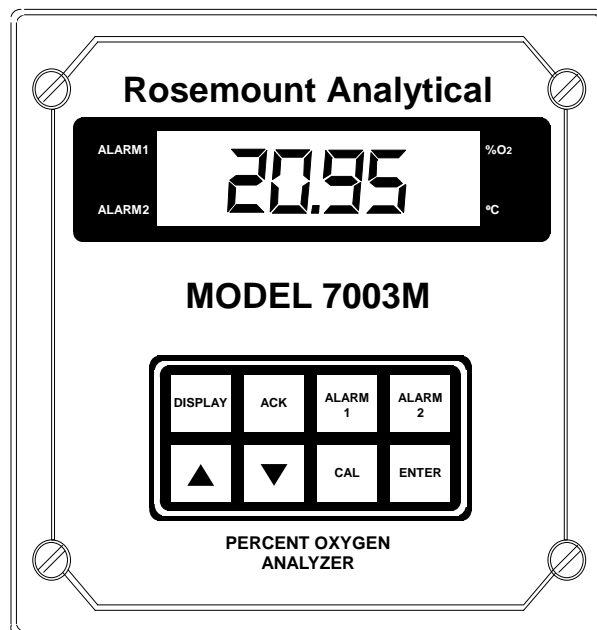
It is recommended that the operator read the entire manual through before first operating the instrument.

The operator can generally operate the Model 7003M using the flow chart in Figure 3-2 after the display symbols and modes of operation are understood.

## 3.2 KEYPAD OPERATION

During each particular keystroke sequence, the analyzer will recognize only certain keys. If an unrecognized key is pressed, the instrument will either not respond or will display "SrY" ("Sorry") and return to RUN Mode.

Generally, to escape from any routine, press ENTER repeatedly until the instrument returns to the RUN Mode and the oxygen concentration is displayed.



**FIGURE 3-1. MODEL 7003M FRONT PANEL CONTROLS AND INDICATORS**

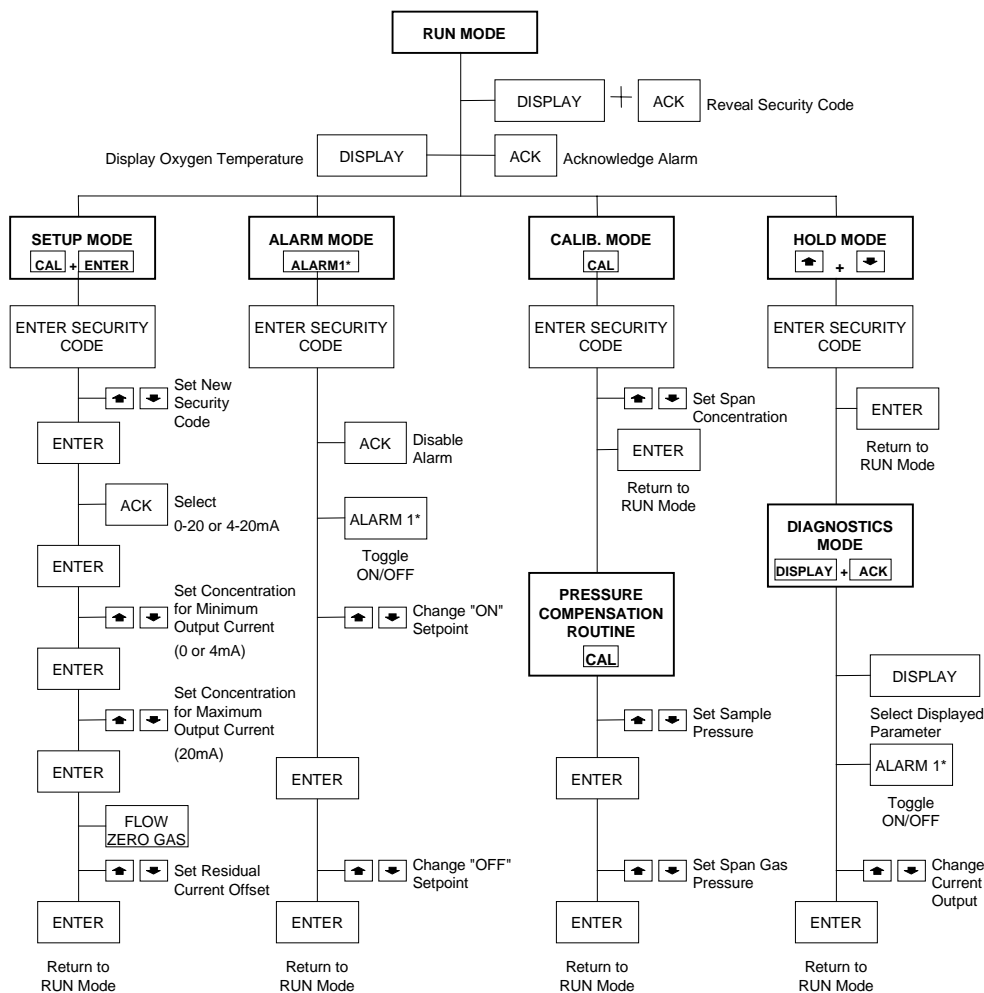
### 3.2.1 CHANGING PARAMETERS WITH THE KEYPAD

All operation parameters are set with the keypad. When the instrument is waiting for operator input, the display will flash a digit. At this point, if the number itself can be changed, the operator can generally increase the number (UP arrow) or decrease it (DOWN arrow) at this time. An exception is when the operator is restricted to pre-selected choices (e.g., output current ranges, see Section 3.5.2).

When changing a value, an arrow key can be pressed for a moment, and the display will change by one digit. If it is held down, the display will change, slowly at first, then rapidly.

If the display has a digit flashing and will not change, check the range of that parameter. For example, an alarm setpoint cannot be set higher than 25%.

When the number desired is displayed, press ENTER. The Model 7003M will accept that number and continue with the next step of that routine.



\*Press ALARM 2 to set Alarm 2.

**FIGURE 3-2. MODEL 7003M OPERATION FLOW DIAGRAM**



### 3.2.2 SINGLE AND DOUBLE KEYSTROKE

Most procedures involve a sequence of single keystrokes by which the operator presses one key at a time. Some of the more frequently used single-key commands are:

KEY	FUNCTION	HOW TO USE IT
ACK	Acknowledges an alarm condition	Press once to silence alarms
DISPLAY	Switch between %O2 and °C	Press to display °C; press again to display O2. Output signals are not affected.
ARROW keys	Increase/Decrease displayed value	Press once to change value by one digit. Hold key down to change value quicker.
CAL	Access CALIBRATION mode	Press to calibrate. (If security is enabled, prompts for ID code first)
ENTER	End command sequence	Press to enter value or to end a command sequence
ALARM1	Access ALARM 1 mode	Press to check, set or disable Alarm 1 or ON/OFF-Control relays
ALARM2	Access ALARM 2 mode	Press to check, set or disable Alarm 2 or ON/OFF-Control relays
CAL + ENTER	Access SETUP mode	From RUN mode, press CAL and ENTER keys simultaneously.
UP ARROW + DOWN ARROW	Access HOLD mode.	From RUN mode, press UP ARROW and DOWN ARROW keys simultaneously.
DISPLAY + ACK	Access DIAGNOSTICS mode	From HOLD mode, press DISPLAY and ACK keys simultaneously.
DISPLAY + ACK	Access security ID code	From RUN mode, press DISPLAY and ACK keys simultaneously.

**TABLE 3-1. KEY FUNCTIONS**

INDICATOR	CARET/STATUS	DESCRIPTION
%O2	Caret ON	Oxygen percentage displayed
°C	Caret ON	Sensor temperature displayed, °C
ALARM1,2	Caret OFF	Normal condition
ALARM1,2	Caret blinking	Alarm condition
-	Caret ON	Displays current output in mA (DIAGNOSTICS mode only)

**TABLE 3-2. DISPLAY INDICATORS**

### 3.2.3 DISPLAY PROMPTS

The Model 7003M prompts the operator for inputs and also indicates the function in progress. For example, when entering the calibration mode, the prompt "CAL" is displayed for one second after the CAL key is pressed. Display acronyms are listed in Tables 3-3 through 3-9.

CODE	DEFINITION
id	enter security code prompt
no	invalid security code entered - access denied
YES	access granted or security code entered is correct

**TABLE 3-3. SECURITY ACCESS PROMPTS AND RESPONSES**

CODE	DEFINITION
A-1	setpoints for Alarm 1 - ALARM function
A-2	setpoints for Alarm 2 - ALARM function
C-1	setpoints for Alarm 1 - ON/OFF - Controller function
C-2	setpoints for Alarm 2 - ON/OFF - Controller function
On	value in which to initiate an Alarm Action (On-setpoint)
OFF	value in which to terminate an Alarm Action (Off-setpoint)
dis	Alarm is now disabled

**TABLE 3-4. ALARM SETTINGS PROMPTS AND RESPONSES**

CODE	DEFINITION
CAL	initiate a span calibration
PPr	enter process pressure value
CPr	enter calibration pressure value
GAS	Initiate a zero offset calibration (gas)

**TABLE 3-5. CALIBRATION PROMPTS AND RESPONSES**

CODE	DEFINITION
Set	enter system setup mode
4-0	define the current output as 4-20 or 0-20 mA
CLo	% concentration that 0/4 mA represents (calibration low)
CHi	% concentration that 20 mA represents (calibration high)

**TABLE 3-6. SYSTEM SETUP PROMPTS AND RESPONSES**

CODE	DEFINITION
A-1	toggle ON/OFF check of relay coil for Alarm 1
A-2	toggle ON/OFF check of relay coil for Alarm 2
D-2	performing non-intrusive test Internal RAM (16#00#..16#FF#)
D-3	performing non-intrusive test on Internal RAM (16#4000#..16#5FFF)
D-4	performing non-intrusive test on EEPROM (16#B600#..16#B7FF#)
D-5	performing non-intrusive test on PROM (16#C000#..16#FFFF#)
F-2	failed D-2 test
F-3	failed D-3 test
F-4	failed D-4 test
F-5	failed D-5 test
hld	entering system Hold
OFF	alarm relay is de-energized (normally-closed)
On	alarm relay is energized (normally-open)
tSt	entering on-line test diagnostics mode

**TABLE 3-7. SYSTEM HOLD AND DIAGNOSTICS CODES**

CODE	DEFINITION
caret lit	displayed
O <sub>2</sub>	sensor membrane voltage from ADC
Temp	sensor thermistor voltage from DC
minus sign	milliamps sent to current output

**TABLE 3-8. DATA DISPLAYED IN DIAGNOSTICS MODE**

CODE	DEFINITION
Sry	invalid keypad function (Sorry)
run	current function completed - entering RUN Mode

**TABLE 3-9. MISCELLANEOUS PROMPTS AND RESPONSES**

### 3.2.4 ERROR MESSAGES

If an error condition occurs, E-# (non-fatal error) or F-# (fatal error) will flash on the display. Tables 3-10 through 3-13 list error codes and corrective actions. Pressing "ACK" or "ENTER" will acknowledge any alarm and the error message will disappear.

CODE	DEFINITION
F-1	Invalid PROM (16#C000#..16#FFFF#) checksum detected
F-2	Internal RAM (16#00#..16#FF#) failed testing
F-3	External RAM (16#4000#..16#5FFF) failed testing
F-4	EEPROM (16#B600#.. 16#B7FF#) bulk erase failure
F-5	Signal Board not connected
F-6 thru F-9	EEPROM write failure

**TABLE 3-10. POWER ON, RESET DIAGNOSTICS ERRORS (FATAL ERRORS)**

CODE	DEFINITION
E-1	5 volts power supply above 5.5 V
E-2	5 volts power supply below 4.5 V
E-3	12 volts power supply above 13.2 V
E-4	12 volts power supply below 10.8 V
E-5	sensor output too low for calibration
E-6	sensor missing
E-8	sample temperature is below 1°C
E-9	sample temperature is above 44°C

**TABLE 3-11. RUN MODE ERRORS (NON-FATAL ERRORS)**

CODE	DEFINITION
HI	sample temperature is above 50°C
LO	sample temperature is below 0°C
Ahi	excessive sensor signal

**TABLE 3-12. SIGNAL BOARD ERRORS**

CODE	DEFINITION
COP	Computer Operating Properly error (error detected)
iot	Invalid Op code Trap (internal computer command is invalid)
E-0	power interruption occurred

**TABLE 3-13. MICROPROCESSOR ERRORS THAT RESET THE SYSTEM**

### 3.2.5 AUTOMATIC RETURN TO RUN MODE

If no keys are pressed for five minutes, the instrument will automatically return to the RUN Mode, except when in Zero Offset, HOLD, or DIAGNOSTICS Modes.



#### **CAUTION: OXYGEN WILL NOT BE MONITORED**

*The instrument will remain in HOLD or DIAGNOSTICS Modes until the operator returns it to the RUN Mode or other operation.*

### 3.2.6 PREVENTING UNAUTHORIZED ACCESS

The Model 7003M is equipped with a security feature to prevent unauthorized tampering with the instrument settings. The instrument is shipped from the factory with the security feature disabled. It can be enabled or disabled at any time.

Security access is not required to:

- Display sensor data
- Acknowledge alarms
- Reveal security code

Security access is required to:

- Calibrate with span gas
- Access options and diagnostics
- Change operation parameters
- Enable or disable alarms and ON/OFF-Control
- Disable or change the security code

After the security code is entered, the operator can change any instrument setting and can go back and forth to the RUN Mode without having to enter the code again.

If security is enabled, and the instrument is left in the RUN Mode for five minutes, security will automatically be re-activated. Within this five minute period, anyone can access the functions without re-entering the security code.

### 3.2.7 SENSOR EQUILIBRIUM

When a new sensor is installed, power up the instrument and let the sensor stabilize for about 5 hours before calibrating it.

If the oxygen sensor is calibrated at a relatively high oxygen concentration, such as with ambient air (typically 20.95%) and then is exposed to a low oxygen level, a longer equilibrium time period may be required for the sensor to equilibrate. This time period depends on the monitoring concentration level and how long the sensor was operated at the higher level.

### 3.3 START-UP

Before proceeding, the operator should be familiar with the keypad and indicators (Section 3.2).

Operational checks and adjustments are not normally required, provided that the sensor, inter-connection cable and analyzer have been properly installed. The analyzer continually performs self-checking routines during operation.

Calibration with ambient air is recommended after start-up and at regular intervals (see Section 4.2.2)

The following sections provide instructions for initial start-up and subsequent standardization of the analyzer.

#### 3.3.1 INITIAL POWER-UP

1. Ensure that the proper sensor and sensor cable are connected to the analyzer.
2. Apply power to the analyzer.

The following internal tests are performed:

RAM Read/write test

ROM "Checksum" test

EEPROM Read/write test

3. If an error code flashes, refer to the error code lists in Tables 3-10 through 3-13. Press ACK to continue with the startup procedure.

After internal tests are passed, the software version is displayed for a few seconds, and the analyzer goes directly into RUN mode. "RUN" is briefly displayed, then current oxygen level.

Error codes E-0 (power failure) and E-5 (not calibrated) typically occur upon power-up.

4. Monitor the oxygen output or display until the level stabilizes (typically 5 hours). The alarms and current output levels can be set immediately if desired.
5. Once the sensor has stabilized, the analyzer is operational and is ready for subsequent operations. Refer to Table 3-14 for the default settings present upon power-up.

Alarm 1	Mode:	Alarm
	State:	Disabled
	Setpoints:	On: 0.0 Off: 0.1%
Alarm 2	Mode:	Alarm
	State:	Disabled
	Setpoints:	On: 0.0 Off: 0.1%
Range	0% of scale:	0% Oxygen
	100% of scale:	25% Oxygen
Current Output Range		4-20 mA
Security		Disabled
Pressure	Calibration:	76.0 cm Hg
	Process:	76.0 cm Hg
Residual Zero Offset		0
Calibration Status		Not Calibrated

**TABLE 3-14. DEFAULT SETTINGS AT POWER-UP**

### 3.3.2 SYSTEM RESTART

The Model 7003M will attempt to restart itself in the event of a power interruption, power surge or other outside interference to microprocessor operation (Section 3.3.3).

The analyzer can also be manually restarted if the RAM or EEPROM becomes corrupted (3.3.4).

### 3.3.3 AUTOMATIC RESTART - DUE TO POWER FAILURE

If a power failure or other event occurs that affects operation of the microprocessor the system will attempt to re-start itself. If it is successful, the instrument will continue to operate normally, except that the appropriate error code will be displayed until the ACK button is pressed. See Section 5.3.3 for circuit description.

### 3.3.4 MANUAL RESTART

1. Turn power to analyzer OFF.
2. Wait 30 seconds, and turn the power to the analyzer ON.
3. While the software revision is being displayed and the self-tests are being performed, press DISPLAY and ACK simultaneously.

"dYn" is displayed.

4. Press ENTER to clear the RAM and EEPROM.  
The display will go blank, then continue with the SETUP routine.

Continue with Section 3.5.1, step 2.

### 3.4 RUN MODE

Refer to Figure 3-2 and Table 3-15. The RUN mode is the normal mode of operation, from which the operator can:

- Display oxygen concentration and sensor temperature
- Acknowledge alarms
- Display security code
- Access other modes

KEY	DISPLAY	WHAT HAPPENS
DISPLAY	Number change	Toggles between O <sub>2</sub> reading and temperature
ACK	Clears message	Acknowledges Alarms
ALARM 1	"A-1" then ON	To Alarm 1 SETUP mode
ALARM 2	"A-2" then ON	To Alarm 2 SETUP mode
UP ARROW	"SrY" "run"	Stays in RUN mode
DOWN ARROW	"SrY" "run"	Stays in RUN mode
CAL	"CAL" then ON	To CALIBRATION mode
ENTER	"SrY" "run"	Stays in RUN mode
CAL + ENTER	"SET" then ON	Moves to SETUP mode
UP + DOWN	"hLd" then ON	Moves to HOLD mode
DISPLAY + ACK	"123"	Shows the security code

**TABLE 3-15. RUN MODE KEY FUNCTIONS**

#### 3.4.1 DISPLAY OXYGEN CONCENTRATION/SENSOR TEMPERATURE

Press DISPLAY once to display sensor temperature. Press DISPLAY again to display oxygen concentration.

#### 3.4.2 ACKNOWLEDGE ALARMS

If an alarm setpoint has been reached, "A-1" or "A-2" will flash with a concentration value. Acknowledging the alarm will stop the flashing display and turn off the relay switch.

**To Acknowledge Alarm** - Press ACK key. If relays are configured as ON/OFF controllers, pressing the ACK key has no effect.

#### 3.4.3 ACCESS OTHER MODES

The following lists which key(s) to press to access various modes:

- SETUP = CAL+ENTER
- ALARM = ALARM1 (or ALARM2)
- CALIBRATION = CAL
- HOLD = UP and DOWN ARROWS
- DIAGNOSTICS = DISPLAY+ACK (from HOLD)



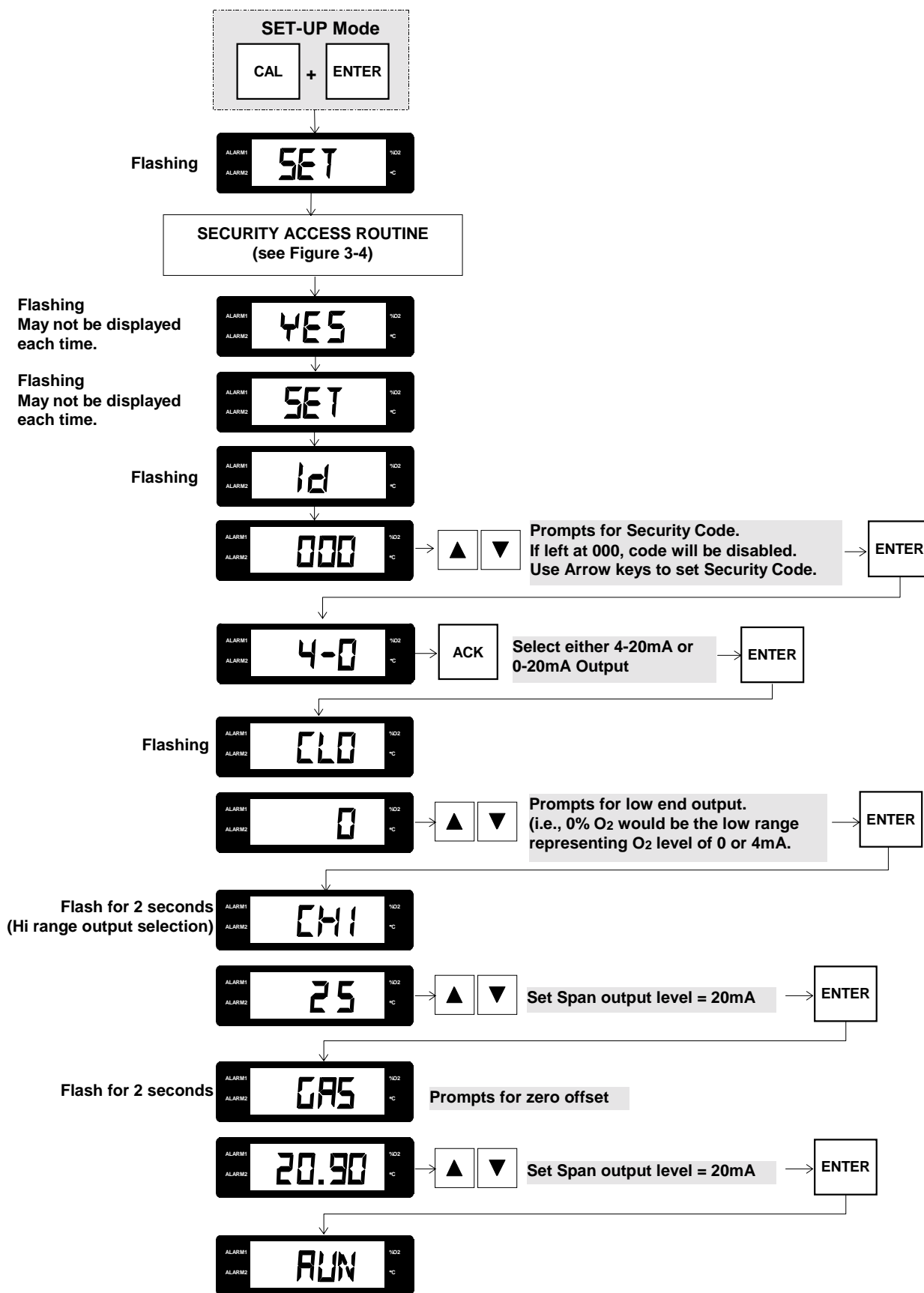
### 3.5 SETUP MODE

Refer to Figure 3-3 and Table 3-16. From the SET-UP mode the operator can:

- Change security code
- Set output current range (0-20mA or 4-20mA)
- Set output concentration range endpoints
- Adjust zero offset

KEY	DISPLAY	WHAT HAPPENS
DISPLAY	Nothing	Nothing
ACK	"<4>-0" / "4-<0>"	Selects 4-20 or 0-20 mA operation
ALARM 1	Nothing	Nothing
ALARM 2	Nothing	Nothing
UP ARROW	10.8 →10.9	Changes the number displayed
DOWN ARROW	10.9 →10.8	Changes the number displayed
CAL	Nothing	Nothing
ENTER	various to "run"	Moves to the next step or goes to RUN mode

**TABLE 3-16. SETUP MODE KEY FUNCTIONS**



**FIGURE 3-3. SETUP MODE FLOWCHART**

### 3.5.1 SECURITY CODE

Refer to Figure 3-4.

#### REVEAL CURRENT SECURITY CODE

From RUN mode, hold down DISPLAY and ACK keys simultaneously.

#### CHANGE CURRENT SECURITY CODE

1. From RUN mode, press CAL and Enter simultaneously.
2. SET, id are briefly displayed. Then "000" is displayed with the right digit flashing.

#### Note

***If RUN and CAL are not press exactly at the same time, "SRY", or "RUN" will appear, and the analyzer will return to RUN mode.***

3. If the security code has been disabled, skip to step 4. Use the ARROW keys to enter the current security code, then press ENTER.
4. If the correct code is entered, YES, SET, id will be displayed briefly, the code will flash. If the incorrect code is entered the analyzer will return to RUN mode.
5. Use the ARROW keys to set the new security code (or "000" to disable), press enter.
6. Continue with the next set-up routine, or hold down ENTER until "run" appears (the instrument is back in RUN mode).

### 3.5.2 CURRENT OUTPUT RANGE - 0-20mA OR 4-20mA

Following the last procedure, "4-0" is displayed with either digit flashing. "4" indicated 4-20mA (default), and "0" indicates 0-20mA.

1. Press ACK until the desired range is flashing, press ENTER.
2. Continue with the next SET-UP routine, or hold ENTER key to return instrument to RUN mode.

### 3.5.3 RANGE ENDPOINT ADJUSTMENTS

The oxygen values corresponding to minimum and maximum output current must be set. Default is 0% for 0 or 4mA and 25% for 20mA. Endpoints must be within the range of the instrument and must be at least 1% oxygen apart.

#### SET OXYGEN LOW CONCENTRATION ENDPOINT

Following the last procedure, "CLo" is displayed briefly, followed by the oxygen concentration last stored to correspond to minimum output current.

#### Note

***If "CLo" is set to a value greater than "CHi", "CHi" will be automatically reset to a value 1% greater than "CLo".***

Use the ARROW keys to set the low oxygen concentration (0 to 24%), press ENTER.

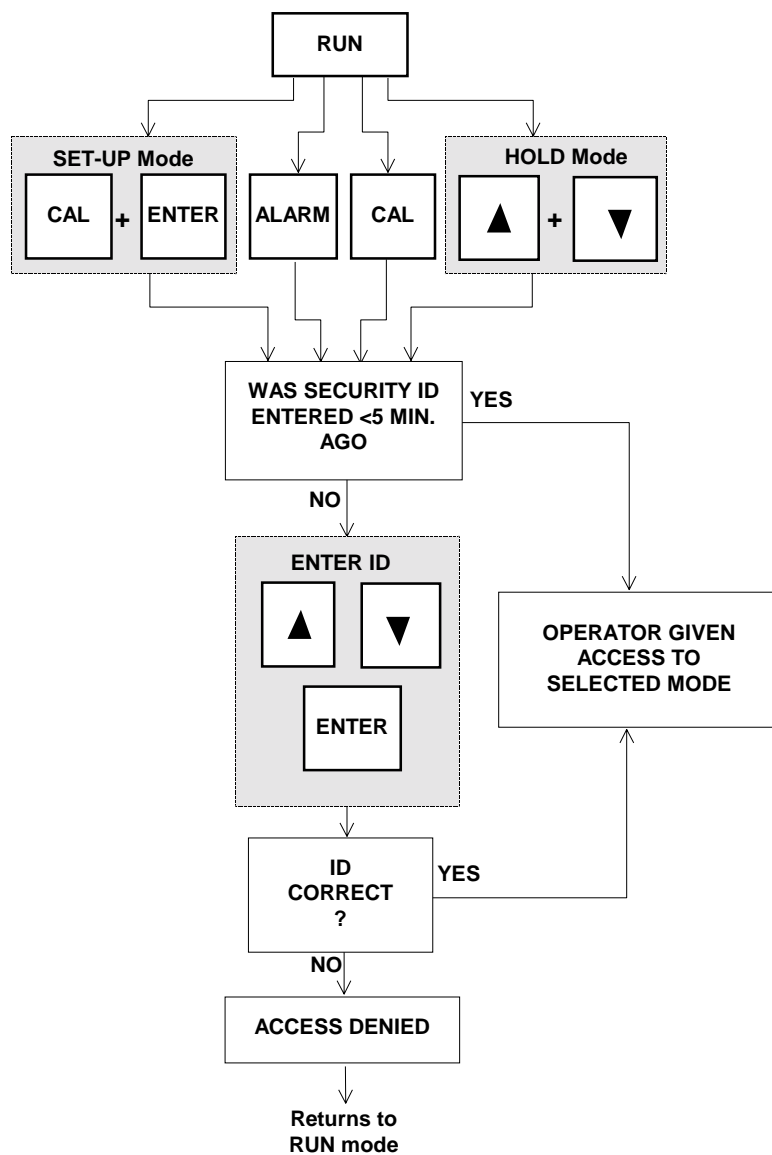
"CHi" is displayed briefly, followed by the latest oxygen concentration stored corresponding to maximum output current.

### SET OXYGEN HIGH CONCENTRATION ENDPOINT

"CHi" cannot be set to a value equal to or less than "CLo".

Use the ARROW keys to set the high oxygen concentration (1 to 25%), press ENTER.

Continue with next SET-UP routine or hold ENTER to return to RUN mode.



**FIGURE 3-4. SECURITY ACCESS ROUTINE FLOWCHART**

### 3.5.4 ZERO OFFSET ADJUSTMENT

Following the last procedure, the current zero offset value will be flashing.

#### **Note**

***When flowing zero gas over the sensor, ensure that there are no leaks and the gas actually has zero oxygen concentration. Otherwise, significant errors will result. Zero offset adjustment is generally not required. Errors are more often due to incorrect zero gas oxygen concentration than residual current of the oxygen sensor.***

The zero offset adjustment allows the operator to compensate for any residual sensor current. Adjustment range is 0-5% equivalent oxygen.

$$\text{Sensor Current} = \text{Current from Oxygen} + \text{Residual Current}$$

#### **Note**

***Adjusting the zero offset affects the output of the Model 7003M. Therefore, if the zero offset is changed, the system must be re-calibrated with span gas.***

### ZERO OFFSET IS NOT TO BE CHANGED

Press ENTER to return analyzer to RUN mode, and skip the remainder of this procedure.

### ZERO OFFSET IS TO BE REMOVED

1. Press the UP ARROW until the maximum value is displayed.
2. Press ENTER and re-calibrate with span gas per Section 4.2.2.

### ZERO OFFSET TO BE ADJUSTED

1. Expose the sensor to 100% oxygen-free nitrogen or other inert gas and allow the sensor signal to stabilize (2-5 hours depending on sample conditions).
2. Use the DOWN ARROW to bring the displayed value to zero (for maximum offset).
3. Press ENTER to return to RUN mode.
4. Re-calibrate with span gas per Section 4.2.2.

### 3.6 ALARM MODE VS. ON/OFF-CONTROL MODE

Refer to Figure 3-5 and Table 3-17. From the ALARM or ON/OFF-Control Mode, the operator can:

- Set alarm ON and OFF setpoints.
- Select alarm or ON/OFF-Control function for relays
- Disable alarm(s)

KEY	DISPLAY	WHAT HAPPENS
DISPLAY	Nothing	Nothing
ACK	"dIS"	Disables alarms
ALARM 1	"C-1" / "A-1"	Toggles between alarm and controller mode
ALARM 2	"C-2" / "A-2"	Toggles between alarm and controller mode
UP ARROW	10.8 →10.9	Changes alarm setpoint
DOWN ARROW	10.9 →10.8	Changes alarm setpoint
CAL	Nothing	Nothing
ENTER	"OFF" / "run"	Moves to the "OFF" setpoint step or goes back to RUN mode

**TABLE 3-17. ALARM MODE KEY FUNCTIONS**

#### 3.6.1 RELAY CONFIGURED AS ALARM

Relays are configured as alarms (ALARM Mode) when immediate operator action is required.

When alarms are selected, "A-1" and "A-2" are displayed in the ALARM mode set-up procedure.

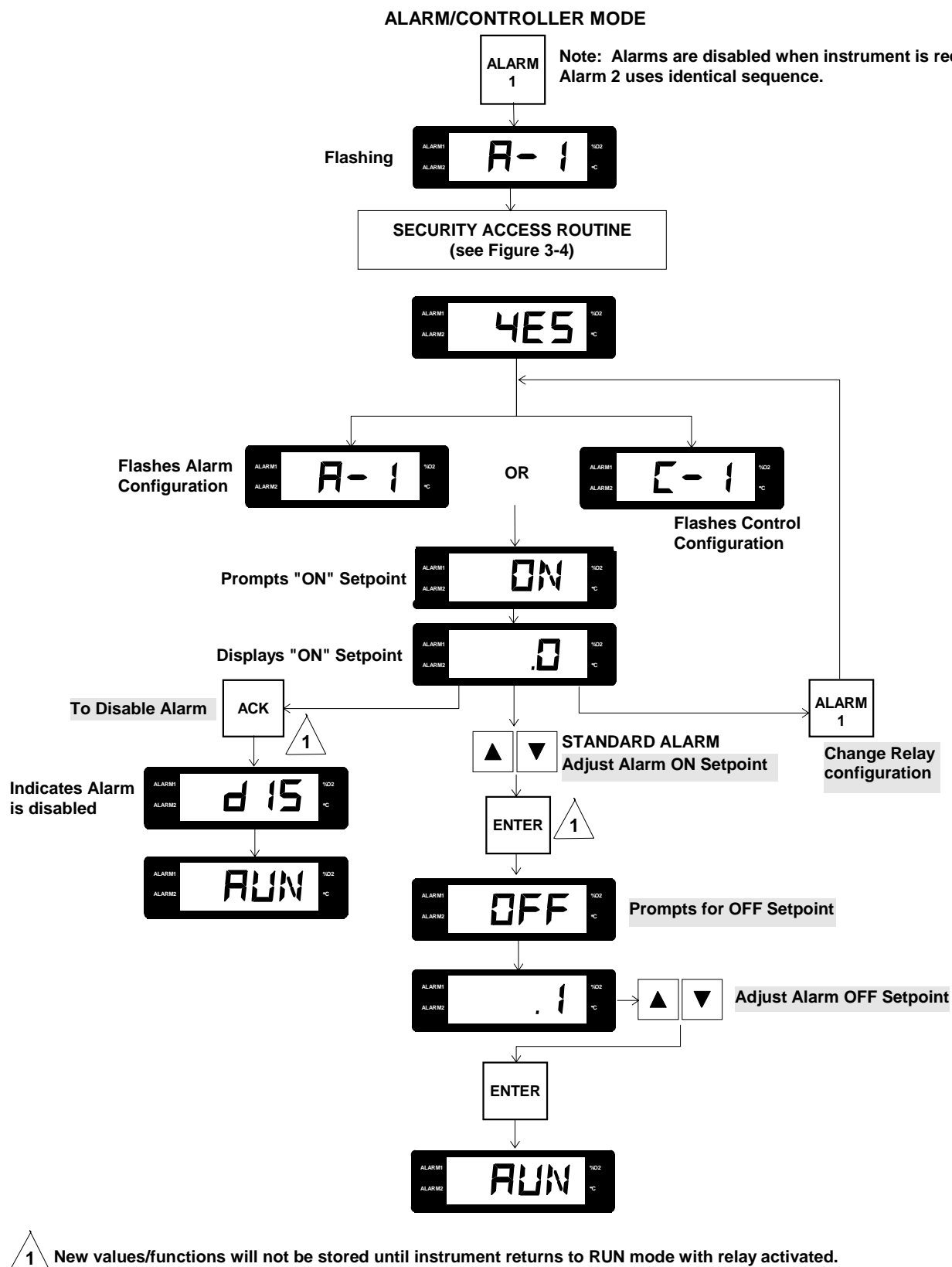
When an alarm condition occurs, the caret blinks, the relay activates, and the display flashes. Press the ACK key to acknowledge the alarm, de-energize the relay coil and stop the alarm actions.

#### 3.6.2 RELAY CONFIGURED AS ON/OFF-CONTROLLER

Relays are configured as ON/OFF-Controllers (ON/OFF-Controller mode) when a non-critical, non-hazardous automated action is desired, or when it is important that the relay output not be bypassed by the operator.

When ON/OFF-Controllers are selected, "C-1" and/or "C-2" is displayed in the ALARM mode set-up procedure.

When an ON/OFF-Controller alarm condition occurs, Alarm 1 or 2 caret blinks and the relay coil is energized. However, the display does not flash, and the ACK key is inactive. Alarm conditions are automatically reset when the sensor indicates that an alarm condition no longer exists.



**FIGURE 3-5. ALARM MODE FLOWCHART**

### 3.6.3 RELAY CONTACTS

The relay contacts are:

RELAY POS	TERMINAL LOCATIONS	
	ALARM1	ALARM2
NO (Normally open)	TB3-3	Tb3-6
NC (Normally closed)	TB3-2	TB3-5
COM (Common)	TB3-1	TB3-4

Relay positions are with power removed.

**TABLE 3-18. ALARM RELAY CONTACT POSITIONS/TERMINAL LOCATIONS**

### 3.6.4 FAIL SAFE OPERATION

The relays are setup to operated in "Fail Safe" configuration. In this configuration the relay coils are powered when the unit is NOT in an alarm condition. When an alarm condition occurs, power is removed from the relay coils.

If a power failure occurs, power will be removed from the relays and an alarm condition will be indicated to the device connected to the relays.

### 3.6.5 RELAY RESET UPON FATAL ERROR

If a fatal error is detected, the unit will attempt to reset itself which will make both relays go into alarm mode. If the microprocessor is able to continue its operation, the relays will then be reset to their normal operating position.

### 3.6.6 PRESSURE EFFECTS ON ALARMS

If the sample pressure changes, the partial pressure of oxygen, and thus the reading, will change and the alarm relays will not actuate at the same oxygen levels as they were set when the interment was last calibrated. See Section 5.4.2 for a more detailed description of pressure effects.

### 3.6.7 SETTING ALARM AND ON/OFF-CONTROLLER RELAYS

Wherever "Alarm" is referred to in this section, the term "ON/OFF-Controller" can be substituted, unless specifically called out. Also, any reference to A1 or Alarm 1 also applies to Alarm 2, and to ON/OFF-Controllers 1 and 2.

### 3.6.8 SETTING ALARM SETPOINTS

This procedure can be used to:

- Verify alarm relay setpoints
- Change setpoints
- Enable alarms
- Disable alarms



Perform the following procedure for each Alarm setpoint, as required. Figure 3-6 illustrates how relays are energized and de-energized in High and Low Alarm configurations.

### 3.6.9 SETTING ALARM ON AND OFF LEVELS

Refer to flowchart Figure 3-5.

From RUN mode, press ALARM 1.

A-1, YES, A-1 (or C-1), ON flash briefly; the alarm ON setpoint is displayed with the right digit blinking.

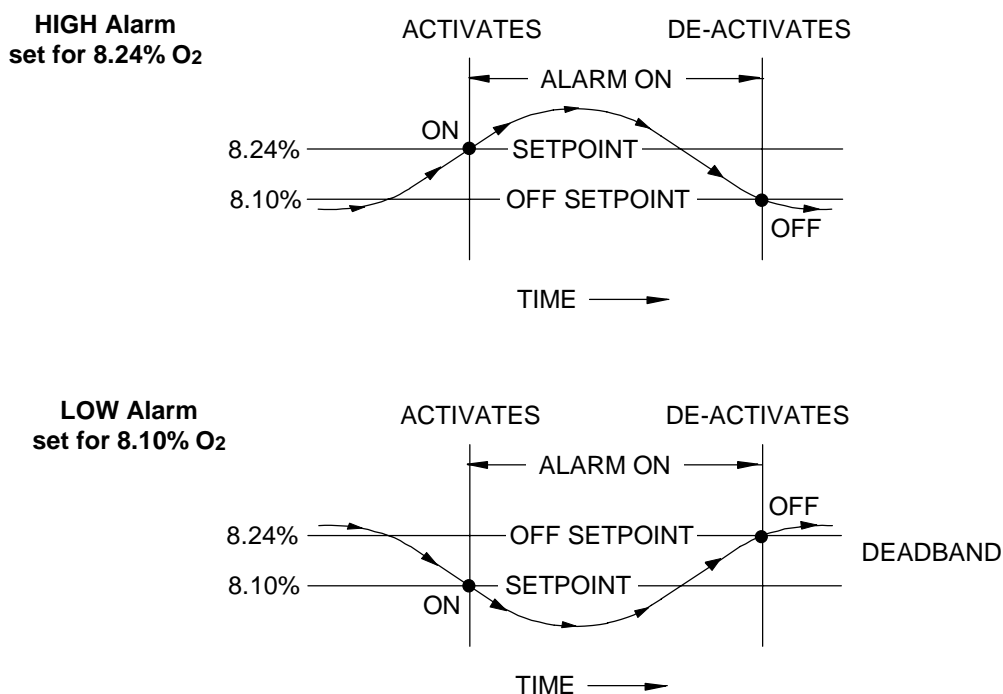
A-1 indicates relay 1 acts as an ALARM; C-1 indicates relay one acts as an ON/OFF-Control.

**To change the relay action from ALARM to ON/OFF Control function** (or vice versa) press ALARM 1. C-1 or A-1 will flash indicating a new mode.

**To disable ALARM 1** - Press ACK. "DIS" will flash briefly and return to RUN mode.

**To set the ON setpoint for ALARM 1** - Use the ARROW keys, press ENTER. OFF is flashed briefly, then the alarm OFF setpoint is displayed with the right digit flashing.

**To set the OFF setpoint for ALARM 1** - Use the ARROW keys, press ENTER. The instrument displays "run" and returns to RUN mode



**FIGURE 3-6. ACTION OF ALARM RELAY ON AND OFF SETPOINTS**

## ***NOTES***

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# 4 CALIBRATION AND ADJUSTMENTS

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## 4.1 FREQUENCY OF CALIBRATION

When a new sensor is installed, adjust the zero offset current (4.2.1) and calibrate the instrument with span gas (4.2.2). Span the instrument weekly at first and note the stability. Use this information to determine the regular calibration frequency required by this particular application.

## 4.2 CALIBRATION MODE

Refer to Figure 4-1 and Table 4-1. From the CALIBRATION Mode, the operator can:

- Calibrate with span gas
- Enter sample and span gas pressures

KEY	DISPLAY	WHAT HAPPENS
DISPLAY	Nothing	Nothing
ACK	Nothing	Nothing
ALARM 1	Nothing	Nothing
ALARM 2	Nothing	Nothing
UP ARROW	10.8 →10.9	Changes calibration factor
DOWN ARROW	10.9 →10.8	Changes calibration factor
CAL	"PPr"	Moves to pressure compensation mode
ENTER	"run"	Drops back to RUN mode

**TABLE 4-1. CALIBRATION MODE KEY FUNCTIONS**

### 4.2.1 ZERO CALIBRATION

Each oxygen sensor produces a constant residual electrical current in the absence of oxygen due to characteristics of the sensor. Typically this current is less than 0.1% apparent oxygen. It is different for each sensor, but will remain constant for the life of that sensor. The instrument can be zeroed by adjusting the residual current per Section 3.5.4. After this procedure is performed once, the zero should not need adjusting again during the life of the sensor.

**4.2.2 SPAN CALIBRATION**

1. Expose the sensor to ambient air<sup>1</sup> and let the oxygen reading and sensor temperature stabilize.
2. Press CAL to enter the CALIBRATION mode. Enter the security code if required.
3. CAL flashes and oxygen concentration is displayed with the right digit flashing. Output is held at last reading until returned to RUN mode.
4. Use the ARROW keys to set the instrument to the concentration of the calibration gas. See Tables 4-2 and 4-3 if using ambient air as span gas.
5. Press ENTER to return to the RUN mode.
6. If the ratio between the concentration value entered and the sensor voltage is excessive, an error message will be flashed.
7. If the sample gas and the calibration gas are each at constant pressure, continue with Section 4.2.3 and enter the pressure of each.

Oxygen	20.946%	±0.002
Nitrogen	78.084%	±0.004
Argon	0.934%	±0.004
CO <sub>2</sub>	0.033%	±0.001
Water Vapor	0.000%	
Other Gases	Balance	

760 mm Hg; 0% Relative Humidity<sup>2</sup>

**TABLE 4-2. COMPOSITION OF DRY ATMOSPHERIC AIR**

GAS	PERCENT COMPOSITION ( .002%) A@			
	15°C	20°C	25°C	30°C
Oxygen	20.641%	20.510%	20.338%	20.115%
Water Vapor	1.683	2.307	3.126	4.187
Other Gases	Balance	Balance	Balance	Balance

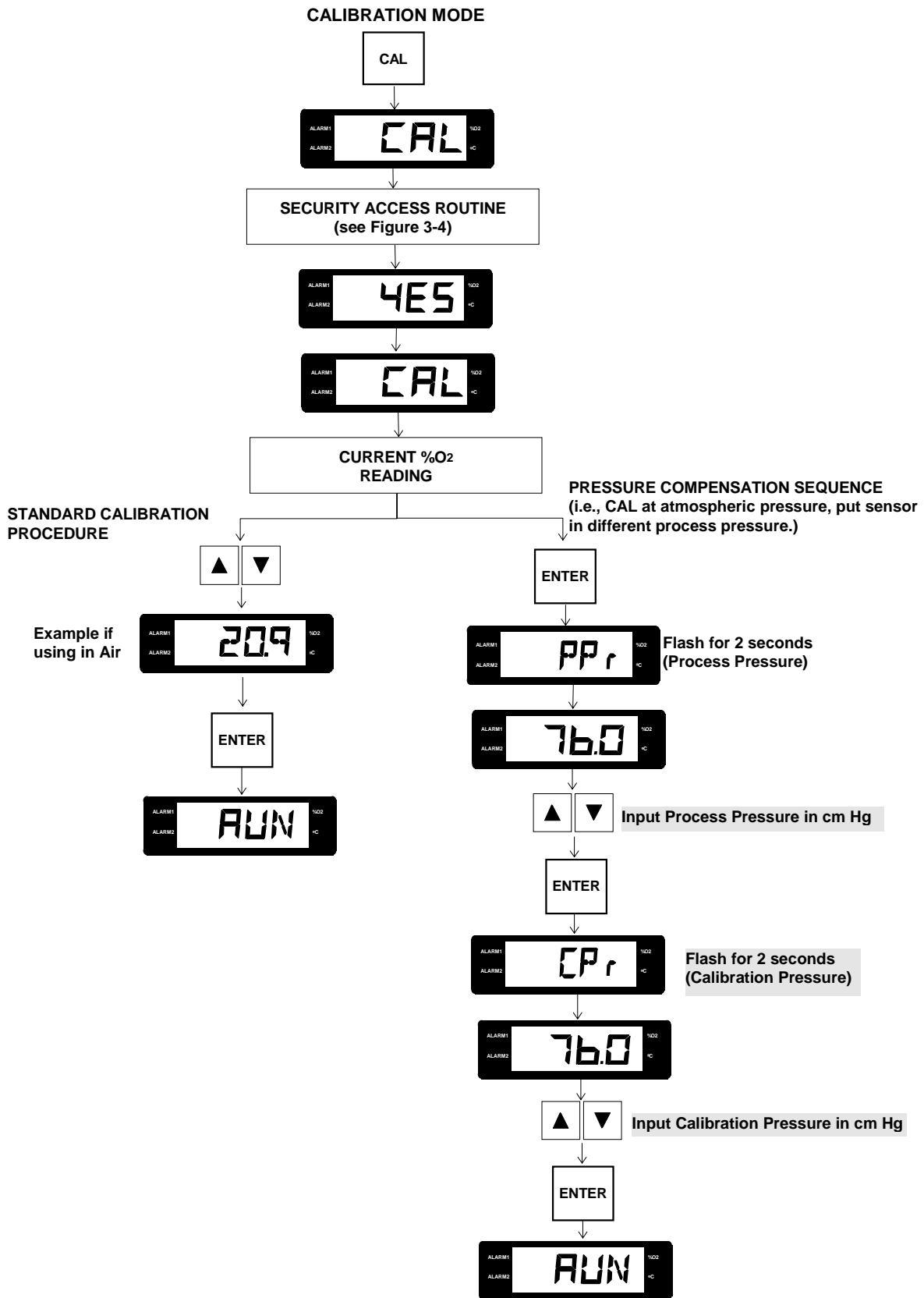
760 mm Hg; 100% Relative Humidity<sup>3</sup>

**TABLE 4-3. COMPOSITION OF HUMID ATMOSPHERIC AIR**

<sup>1</sup> We recommend using ambient air in calibration, regardless of the range. Only when monitoring at 0 to 1% range, can the accuracy of the instrument be slightly improved by using a gas of lower concentration (e.g., 1%) for calibration. If bottled air is used, verify the oxygen concentration against National Bureau of Standards certified calibration gas. The true oxygen concentration in cylinders is often different from the concentration indicated on the cylinder label.

<sup>2</sup> CRC Handbook of Chemistry and Physics, R. Weast, ed., Chemical Rubber Co., Boca Raton, FL: CRC Press, 1987, p. F-148.

<sup>3</sup> Computed from data in CRC Handbook of Chemistry and Physics, p. D-190.



**FIGURE 4-1. CALIBRATION MODE AND PRESSURE COMPENSATION FLOWCHART**

BAROMETRIC PRESSURE cm Hg (in. Hg)	APPARENT O <sub>2</sub> PARTIAL PRESSURE cm Hg (Dry Air)	O <sub>2</sub> CONCENTRATION WITH NO PRESSURE CORRECTION <sup>4</sup>
73 (28.7)	15.3	20.24%
74 (29.1)	15.5	20.52
75 (29.5)	15.7	20.80
76 (29.9)	15.8	20.95
77 (30.3)	16.1	21.36
78 (30.7)	16.3	21.63

**TABLE 4-4. BAROMETRIC PRESSURE EFFECT ON APPARENT OXYGEN CONCENTRATION**

KEY	DISPLAY	WHAT HAPPENS
DISPLAY	Nothing	Nothing
ACK	Nothing	Nothing
ALARM 1	Nothing	Nothing
ALARM 2	Nothing	Nothing
UP ARROW	10.8 →10.9	Changes pressure value
DOWN ARROW	10.9 →10.8	Changes pressure value
CAL	Nothing	Nothing
ENTER	"CPr" / "run"	Moves to calibration pressure input or goes back to RUN mode

**TABLE 4-5. PRESSURE COMPENSATION MODE KEY FUNCTIONS**

### 4.2.3 PRESSURE COMPENSATION - CORRECTION FOR CONSTANT PRESSURE DIFFERENCES

Refer to Figure 4-1 and Table 4-5. If the sample and calibration gases are each at constant pressure, the following procedure should be used to correct for the pressure difference between them. However, the instrument does not monitor pressure and will not correct the output if either sample or calibration gas pressure changes. (See Section 5.2).

1. From RUN mode, press CAL.  
CAL, YES, CAL flash briefly, then the oxygen concentration is displayed with the right digit flashing.
2. Press CAL again.  
PPr flashes, then previous sample pressure setting is displayed with right digit flashing (76.0 cm Hg is default).
3. Use ARROW keys to enter sample pressure.

<sup>4</sup> Computed using 20.946% oxygen at 760 m.

4. Press ENTER to accept the value.  
CPr flashes, then previous span gas pressure setting is displayed with right digit flashing (76.0 cm Hg is default).
5. Use the ARROW keys to enter pressure of the calibration gas to be used. If the sample and calibration gas will always be at the same pressure, set PPr and CPr at the same value.
6. Press ENTER to accept the value. Instrument returns to RUN mode.

### 4.3 HOLD MODE

Refer to Figure 4-2 and Table 4-6. In the HOLD mode:

- All instrument functions are locked
- All existing values are retained
- The instrument stops responding to sensor signals
- The last measured value is displayed
- The last output value remains at the isolated current output connections
- Alarms and ON/OFF-Controllers are held in their last state
- No keys are recognized except entry to the diagnostic routing.

KEY	DISPLAY	WHAT HAPPENS
DISPLAY	Nothing	Nothing
ACK	Nothing	Nothing
ALARM 1	Nothing	Nothing
ALARM 2	Nothing	Nothing
UP ARROW	Nothing	Nothing
DOWN ARROW	Nothing	Nothing
CAL	Nothing	Nothing
ENTER	"run"	Drops back to RUN mode
DISPLAY + ACK	"d-4" "tSt"	Moves to DIAGNOSTIC mode

**TABLE 4-6. HOLD MODE KEY FUNCTIONS**

If the sensor cable must be disconnected, the instrument can be put in the HOLD mode, in which all existing signal levels and output current levels are maintained. This may be useful to prevent disturbing an ON/OFF-control loop connected to the relay contacts.

1. Press the UP ARROW and DOWN ARROW at the same time to put the instrument on HOLD.
2. If the security is activated, enter the security identification (id) code and press ENTER to continue.

Hld, YES, flash briefly, then Hld flashes alternately with the last oxygen reading. The output signal will remain unchanged until the instrument returns to the RUN mode.

3. Press ENTER to return to the RUN mode, or continue with Section 4.4, Diagnostics Mode.

CARET LIT	VALUE DISPLAYED	TYPICAL VALUE <sup>5</sup>	ADJUSTABLE
%	Raw Sensor Voltage	<sup>6</sup>	Yes
°C	Thermistor Voltage	2.43	No
- <sup>7</sup>	Current Output	17.43	Yes

Use ARROW keys to make adjustments.

**TABLE 4-7. CARET READINGS**

<sup>5</sup> These typical values were obtained under the following conditions:

O2 Concentration: 20.95%  
 Sensor Temperature: 26.07°C  
 Current Output Range: 4-20mA  
 Range Endpoint, Low: 0%  
 Range Endpoint, High: 25%  
 Zero Offset Signal: None  
 Pressure Compensation: None

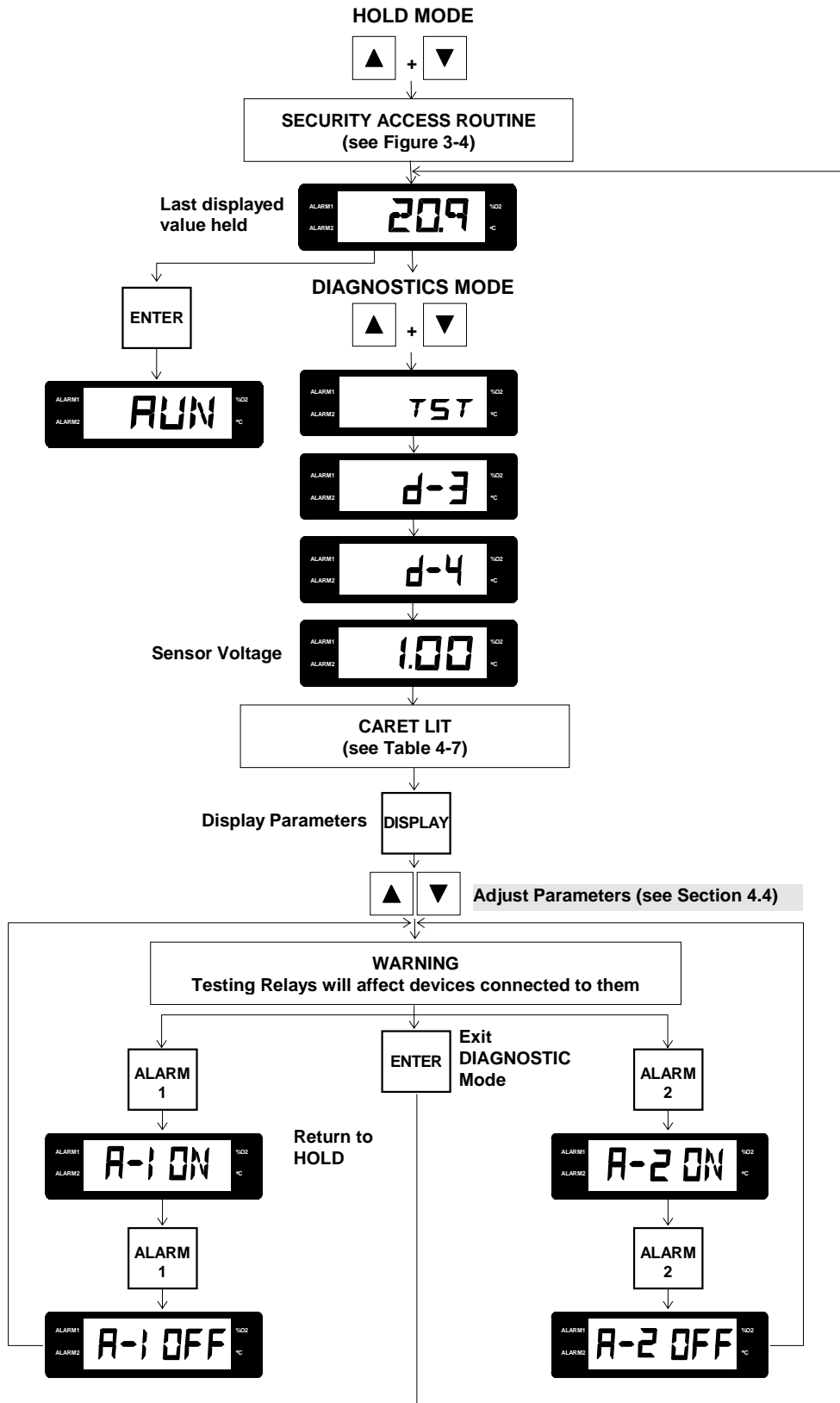
<sup>6</sup> Typical voltages for new sensors at 25°C:

TYPE OF SENSOR	MINIMUM	NOMINAL	MAXIMUM
Disposable	1.05V	1.39V	1.69V
Rechargeable	0.97V	1.29V	1.76V

Near the end of the life of the sensor, the sensor voltage is typically 0.53V (disposable) or 0.48V (rechargeable). At temperatures (T) other than 25°C, multiply the voltages above by (1.025)<sup>exp(T-25)</sup>.

<sup>7</sup> "-" is a minus sign displayed on the left of the display between AL 1 and AL 2.





**FIGURE 4-2. HOLD AND DIAGNOSTICS MODES FLOWCHART**

## 4.4 DIAGNOSTICS MODE

Refer to Figure 4-2 and Tables 4-7, 4-8. The DIAGNOSTICS mode is used to:

- Check sensor circuit voltages
- Check relays
- Adjust the output current

### ENTER DIAGNOSTICS MODE

If the instrument is already in HOLD mode, skip step 1 and proceed to step 2.

1. From the RUN mode, press the UP ARROW and DOWN ARROW at the same time to enter the HOLD mode.
2. If the security is activated, enter the security identification (id) code and press ENTER to continue.

Hld, YES, flash briefly, then Hld flashes alternately with the last oxygen reading. The output signal will remain unchanged until the instrument returns to the RUN mode.

#### 4.4.1 RAW SENSOR VOLTAGE

1. Press DISPLAY and ACK at the same time to enter DIAGNOSTICS mode.  
  
Tst, d-3, d-4 flash briefly, then the %O<sub>2</sub> caret lights and the raw sensor voltage is displayed.
2. Press ENTER at any time to return to HOLD mode. Press ENTER again to return to RUN mode.

KEY	DISPLAY	WHAT HAPPENS
DISPLAY	"2.13"	Scrolls among the DIAGNOSTIC displays
ACK	Nothing	Nothing
ALARM 1	"A-1" "On"/ "OFF"	Toggles the Alarm 1 relay ON/OFF
ALARM 2	"A-2" "On" / "OFF"	Toggles the Alarm 2 relay ON/OFF
UP ARROW	"2.13" → "2.14"	Increases current output or span setting
DOWN ARROW	"2.14" → "2.13"	Decreases current output or span setting
CAL	Nothing	Nothing
ENTER	"hLd"	Drops back to HOLD mode

**TABLE 4-8. DIAGNOSTICS MODE KEY FUNCTIONS**

#### 4.4.2 TEST CURRENT OUTPUT

The current output can be tested (increased or decreased using the ARROW keys) and the actual output will change. When the instrument returns to the RUN mode, the output will return to the previous value.

1. Press DISPLAY until the minus sign (-) is displayed on left.
2. Use the ARROW keys to increase or decrease the current output.

#### 4.4.3 LINEARIZING CURRENT OUTPUT

For some samples, current output does not track the oxygen reading displayed. The operator can linearize output and store the compensating second-order polynomials in EEPROM. This data will remain and function there as long as the EEPROM is not erased. However, if a "cold boot" is performed, the operator must repeat this linearization routine.

To determine if current output linearization is necessary, do the following:

1. Connect a separate current meter to the output terminals (any device that will display an accurate current measurement such as a computer input will suffice).

##### **Note**

***Do not simply connect a current measurement meter in parallel with the usual load because this will lead to incorrect readings.***

1. Place the instrument in DIAGNOSTIC mode by pressing the UP and DOWN ARROWS, followed by the DISPLAY and ACK keys. The display will show consecutively:

tSt, d-3, d-4, and oxygen input voltage

2. Press the DISPLAY key until the minus sign and a number are displayed. This reading is the current output (in milliamps) as determined by the Model 7003M.
3. Use the UP and DOWN ARROW keys to increase the display reading, and occasionally, compare the current displayed on both meters (the instrument display and the separate meter).

If the two readings are too disparate (different applications require lesser or greater tolerance), do the following 3-point calibration to linearize the current output:

4. Use the UP and DOWN ARROW keys to set the current output to a value halfway up its range. The operator may prefer to set it at a critical measurement point.
5. Press the CAL key. The instrument will flash CCA, illuminate the three right-hand carets, and continue displaying the current output.
6. Use the UP and DOWN ARROW keys to adjust the actual current output (as noted on the separate meter) to the correct amount. Note that the instrument display does not change.
7. Press ENTER, the instrument displays **diA**, returns to the DIAGNOSTIC mode, and continues to display the current output.
8. Use the UP and DOWN ARROW keys to adjust the current output to a lower value, representing the low range (the operator may prefer to use 4 mA to represent 0% oxygen).
9. Press CAL (the instrument displays CCL for lower current output setting), and repeat steps 3 and 4 of this procedure.
10. Use the UP and DOWN ARROW keys to adjust the current output to a value higher than the initial calibration value (step 1 of this procedure), representing the higher range (the operator may prefer to set it at 16.72mA to represent 20.9% oxygen).
11. Press CAL (the instrument displays CCH for high current output setting), and repeat steps 3 and 4 of this procedure.

To return to the RUN mode, press ENTER twice.

At any time during this procedure, the operator may press the ACK key to reset all calibration coefficients to default values. Pressing DISPLAY at any time during this procedure will cause the instrument to display for a moment the relevant calibration efficient.

The operator may escape the current CALIBRATION and DIAGNOSTIC mode altogether by pressing ENTER twice. Note, all coefficients will return to the default values, and the current calibration procedure must be started over to linearize current output.

**Note**

***The low calibration point must be between the initial calibration point (step 1 of previous procedure) and zero, and the high calibration point must be between the initial calibration point and 20mA.***

***If the third point calibrated (step 8, previous procedure) is actually another low range (between the initial calibration point and CCL) it will override the original CCL but won't affect the initial calibration.***

**Note**

***The current output linearizing procedure uses second order polynomials to adjust the output linearity. The correction effect is maximized at the calibration point, and is smoothly diminished towards the endpoints.***

**4.4.4 TEST ALARM RELAYS**

1. Disconnect any alarm or ON/OFF-Control devices that are connected to the analyzer, before testing.

**Note**

***When alarms are tested manually, any alarm or ON/OFF-Control devices connected to the relays will respond as they would in an alarm condition. The alarm devices may have to be disconnected from the relays for this test.***

2. Toggle the relays ON and OFF using the ALARM 1 and ALARM 2 keys.  
A-1 ON or A-2 OFF is displayed. The alarm contacts can be heard opening and closing.
3. Connect any alarm or ON/OFF-Control devices that were disconnected in step 6.
4. Press ENTER to exit the DIAGNOSTICS mode.  
"Hld" flashes alternately with the last oxygen reading and the analyzer returns to HOLD mode.
5. Press ENTER again to return to RUN mode.

## 4.5 ADJUSTMENTS AND SETTINGS

All operator settings and adjustments are made using the front keypad except if the power jumpers are to be changed. Refer to the following sections:

2.4.2 Power Connections

3.5.4 Zero Offset Adjustment

4.4.1 Raw Sensor Voltage

4.4.3 Current Output Adjustment

## 5.1 PRINCIPLES OF OPERATION

The Model 7003M Percent Oxygen Analyzer consists of an amperometric sensor and analyzer interconnected by a multi-conductor shielded cable. The sensor responds to the partial pressure of oxygen and produces a current signal. The analyzer amplifies and processes the signal, providing readout in percent oxygen and current output.

### 5.1.1 ELECTROCHEMICAL THEORY

With the sensor placed in the sample gas, a voltage is applied across the cathode and anode. Sample gas diffuses through the membrane and is reduced at the cathode resulting in a current proportional to the partial pressure of oxygen in the sample.

When no oxygen is present, a small residual sensor current, which can be offset during instrument setup.

## 5.2 EFFECTS OF SAMPLE CONDITIONS

### 5.2.1 BAROMETRIC PRESSURE

If ambient air is used to calibrate the sensor, a change in barometric pressure can be a significant factor. At 76 cm Hg, the partial pressure of oxygen is 15.9 cm Hg (20.9% of 76 cm Hg). As atmospheric pressure deviates from 76 cm Hg, the partial pressure of oxygen will vary proportionally. The highest partial pressure that can be read by the Model 7003M is 19 cm Hg (25% oxygen at 76 cm Hg).

### 5.2.2 HUMIDITY

If calibrating with humid ambient air, the effect of the partial pressure due to water vapor content should be taken into consideration. High humidity has the effect of reducing the partial pressure of oxygen without affecting the total barometric pressure.

This relationship can be expressed as :

$$P_{\text{atm}} = P_{\text{O}_2} + P_{\text{H}_2\text{O}} + P_{\text{other}},$$

where:

$P_{\text{atm}}$  = total barometric pressure,

$P_{\text{O}_2}$  = partial pressure of oxygen,

$P_{\text{H}_2\text{O}}$  = partial pressure of water vapor,

$P_{\text{other}}$  = partial pressure of all gases other than oxygen and water vapor

### 5.2.3 SAMPLE TEMPERATURE

The rate of oxygen diffusion through the sensor membrane varies with temperature, with a coefficient of about +3% °C (5% °F), causing a corresponding change in sensor current. The instrument continuously monitors temperature with a thermistor in the sensor body, and compensates the output for both sample temperature and membrane permeability.

Because of a slight time lag in the response of the temperature sensor, a rapid temperature change will cause a temporary change in apparent oxygen level, such as might be encountered if the sensor is suddenly exposed to direct sunlight from a shadow.

Extended use of the sensor at low temperatures will shorten the life of the sensor. As the sensor reaches the end of its useful life, distinct step changes in the oxygen reading will be evident as the oxygen level changes.

### 5.2.4 INTERFERING GASES

Gases that are reduced or oxidized in the range of 0.5 to 0.8VDC contribute to sensor current and can cause a readout error. Only a few gases have this characteristic. Common gases that should be avoided include SO<sub>2</sub>, Cl<sub>2</sub>, and oxides of nitrogen (NO<sub>x</sub>). Low-level concentrations of hydrogen sulfide tend to contaminate the sensor, but may not seriously affect oxygen measurement.

If you suspect that any stream components are affecting the operation of the sensor, contact Rosemount Analytical Technical Services.



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If contaminated, the rechargeable sensor must be rejuvenated and the disposable sensor must be replaced. Refer to the instructions supplied with the sensor.

## 5.3 CIRCUIT DESCRIPTIONS

### 5.3.1 SIGNAL BOARD

The Signal Board is configured to match the type of sensor ordered with the analyzer. If the type of sensor is changed, or the Signal Board is repaired or replaced, verify the rocker switch position (SW1):

Rechargeable Sensor: Close positions 1,4, and 5

Disposable Sensor: Close positions 2,4, and 6

### 5.3.2 POWER SUPPLY BOARD

The Power Supply Board provides:

- ±12V (non-isolated) for analog signaling function

- +5V (non-isolated) for microprocessor and associated logic

- +24V (non-isolated) for the isolated current function

- +5V (isolated) for other functions for that circuit

There are isolated and non-isolated grounds on the Power Supply Board. TTTP1 is the non-isolated ground and should be used with TP6 and TP7.

### 5.3.3 MICROPROCESSOR BOARD

The Microprocessor Board is the functional center of the instrument. With the exception of the program chip, no user serviceable functions are on this assembly. If the Microprocessor Board is to be repaired or replaced, note the positions of the configuration jumpers for setting jumpers on replacement board.

An instrument timer circuit monitors instrument power for a power failure, power surge or other outside condition interfering with the microprocessor operation. When conditions return to normal, the circuit will attempt a system restart. If the microprocessor is still capable of operating, both alarm relays will be put into alarm condition, the screen will clear, and the output current will drop to 0 mA. Then the instrument will go through a normal power-up routine and will eventually return to routine operation with alarms and output restored to their normal conditions. The appropriate error code (E-0, etc.) will be displayed until the ACK button is pressed.

### 5.3.4 ALARM CIRCUITS

Each alarm activation setpoint is designed to be at a different level from the deactivation setpoint:

- To prevent relay contacts from chattering if the oxygen level stays around the setpoint.
- To indicate to the microprocessor whether alarm is HIGH or LOW.
- To allow for a time lag between the time the alarm is activated and the time it is deactivated for ON/OFF-Control purposes.

# 6

## ROUTINE SERVICING AND TROUBLESHOOTING



### **WARNING: ELECTRICAL SHOCK HAZARD**

*Servicing requires access to live parts which can cause death or serious injury. Refer servicing to qualified personnel.*

*Relay contacts wired to separate power sources must be disconnected before servicing.*

### 6.1 ROUTINE SERVICING

Most service and maintenance involves cleaning and recharging the sensor. Refer to the instructions supplied with the sensor for recharging and maintenance procedures.

Service is rarely required on the Model 7003M Percent Oxygen Analyzer. Repair is limited to replacement of PCB boards, EPROM and fuses. See Section 7 Replacement Parts.

### 6.2 TROUBLESHOOTING

Troubleshooting should be referred to qualified service technicians. Refer to Section 3.8 Circuit Descriptions as an aide in isolating a problem.

#### 6.2.1 SYMPTOMS

##### **CALIBRATION ERROR CODE DISPLAYED**

<b>Possible cause</b>	Exhausted Sensor
<b>Check/Test</b>	Install know good sensor and isolate
<b>Corrective Action</b>	Recharge or replace sensor

##### **CANNOT ADJUST SIGNAL TO CALIBRATION VALUE**

<b>Possible cause</b>	Sensor voltage error
<b>Check/Test</b>	Install know good sensor and verify voltage
<b>Corrective Action</b>	Recharge or replace sensor

**READINGS NOT CONSISTENT WITH CALIBRATION CURVE**

<b>Possible cause</b>	Incorrect sensor used for application
<b>Check/Test</b>	Verify sensor corresponds with application
<b>Corrective Action</b>	Install new sensor and calibrate with span gas
<b>Possible cause</b>	Sensor temperature incorrect
<b>Check/Test</b>	Sensor temperature should be 0 to 50°C
<b>Corrective Action</b>	Install new sensor and calibrate with span gas
<b>Possible cause</b>	Incorrect span gas concentration
<b>Check/Test</b>	Verify span gas concentration
<b>Corrective Action</b>	Install new sensor and calibrate with span gas

**ERROR CODE E-0 DISPLAYED**

<b>Possible cause</b>	Power interruption, power surge or other outside interference has occurred
<b>Corrective Action</b>	Press ACK. If this symptom occurs frequently, surge-protection is recommended.

**WILL NOT READ LOW LEVELS OF OXYGEN**

<b>Possible cause</b>	Ambient air leaking into system
<b>Check/Test</b>	Increase sample flow rate, block off flow of gas in and out of flow chamber, and not analyzer response
<b>Corrective Action</b>	If signal increases with test, isolate and seal leak. If signal does not increase, replace or recharge sensor.

**SUDDEN CHANGE IN OUTPUT FOR NO APPARENT REASON**

<b>Possible cause</b>	Sensor subjected to sudden change in conditions, as when a shadow moves and exposes the sensor to an increase in temperature
<b>Corrective Action</b>	Locate sensor in an area shaded from sunlight and away from cold or warm drafts.

**RESOLUTION DEGRADING WITH TIME**

<b>Possible cause</b>	Sensor exposed to low temperatures.
<b>Check/Test</b>	Per Section 4.4.2, check current output of sensor. If the sensor is degrading, the signal will change in steps as the oxygen level changes instead of changing continuously.
<b>Corrective Action</b>	Relocate sensor or replace more frequently.

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# 7 REPLACEMENT PARTS

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## 7.1 CIRCUIT BOARD REPLACEMENT POLICY

In most situations involving a malfunction of a circuit board, it is more practical to replace the board than to attempt isolation and replacement of an individual component. As standard policy, rebuilt boards are available on an exchange basis.

Because of the exchange policy covering circuit boards, the following sections on replacement parts do not include individual, circuit board mounted components. If circumstances necessitate replacement of an individual component, which can be identified by inspection or from the schematic diagrams, obtain the replacement component from a local source of supply.

## 7.2 REPLACEMENT PARTS - MODEL 7003M



### **WARNING: PARTS INTEGRITY**

***Tampering or unauthorized substitution of components may adversely affect safety of this product. Use only factory documented components for repair***

PART NUMBER	DESCRIPTION
652630	Signal Board
652640	Power Supply Board
654605	Display/Keypad Board
655195	EPROM
655197	Microprocessor Board
777156	Fuse, 1/4 A, 120V (package of 5)
777360	Fuse, 1/8 A, 240 V (package of 5)
858728	Arc Suppressor

When replacing Microprocessor Board PN 652650, replace with Microprocessor Board PN 655197 AND EPROM 655195.

## 7.3 REPLACEMENT PARTS - SENSORS

### 7.3.1 RECHARGEABLE SENSORS

#### SENSOR:

MATERIAL	PART NUMBER
Polypropylene	623371
Polypropylene	623370 (use with Fast Response Kit)
Ryton	190408
Ryton	190409 (use with Fast Response Kit)

#### SENSOR KITS (SENSOR NOT INCLUDED):

DESCRIPTION	PART NUMBER	USE WITH SENSOR
Submersion, Polypropylene	639904	623371
In-Line Flow, Polypropylene	639905	623371
Fast Response, Polypropylene	639906	623370
Submersion, Ryton	646628	190408
In-Line Flow, Ryton	646629	190408
Fast Response, Ryton	646630	190409

#### SENSOR KITS (SENSOR INCLUDED):

DESCRIPTION	PART NUMBER
Submersion, Polypropylene	400011
In-Line Flow, Polypropylene	400012
Fast Response, Polypropylene	400013
Submersion, Ryton	400021
In-Line Flow, Ryton	400022
Fast Response, Ryton	400023

#### RECHARGE KIT

Recharge Kit (10 recharges) 191755

### 7.3.2 DISPOSABLE SENSORS

#### SENSOR:

MATERIAL	PART NUMBER
Polypropylene	623742

#### SENSOR KITS (SENSOR *NOT* INCLUDED):

DESCRIPTION	PART NUMBER	USE WITH SENSOR
Submersion, Polypropylene	623715	623742
In-Line Flow, Polypropylene	623716	623742

#### SENSOR KITS (SENSOR INCLUDED):

DESCRIPTION	PART NUMBER
Submersion, Polypropylene	500011
In-Line Flow, Polypropylene	500012

## ***NOTES***