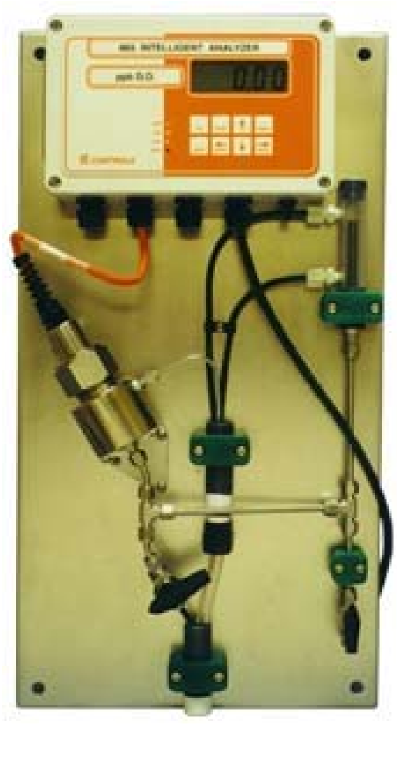
USER MANUAL

MODEL 865-25

ppb DISSOLVED OXYGEN ANALYZER

um-865-25-203



IC CONTROLS

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um-865-25-203

865 MENUS

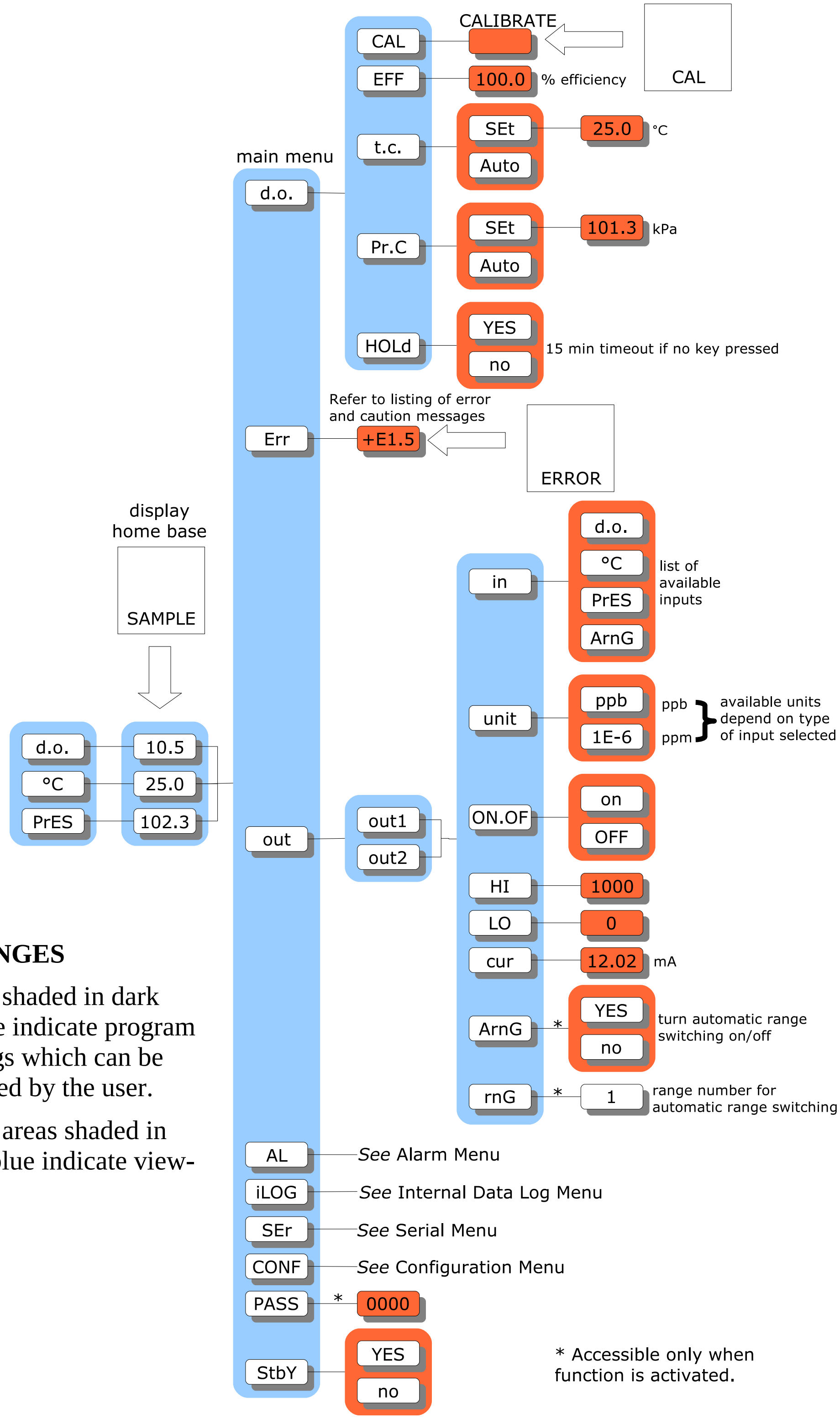

Illustration 1: Menu overview

CHANGES

Areas shaded in dark orange indicate program settings which can be changed by the user.

Menu areas shaded in light blue indicate view-only.

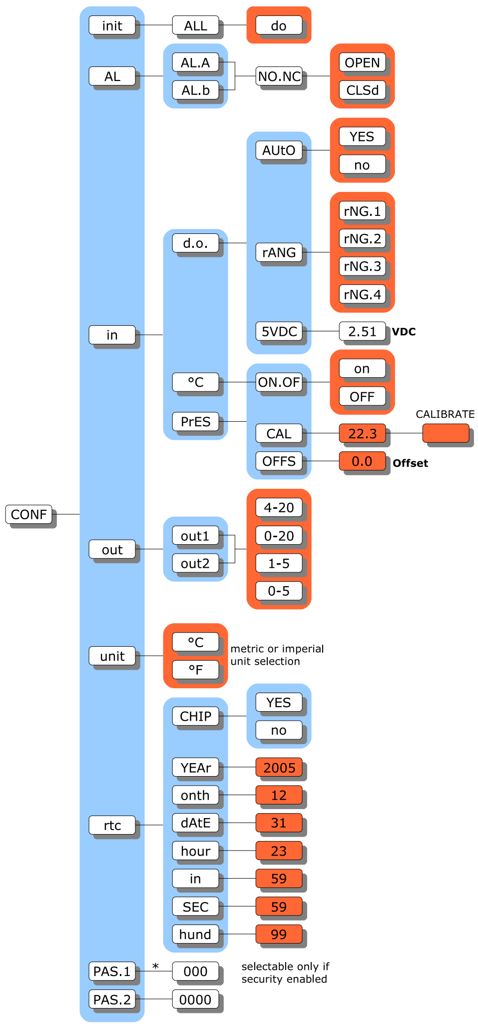

Illustration 2: Configuration menu

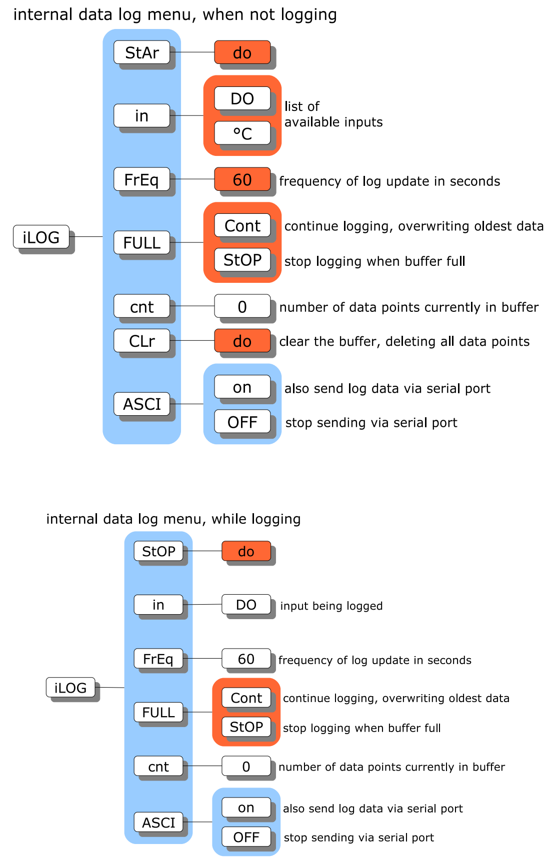

Illustration 3: Internal data log menu

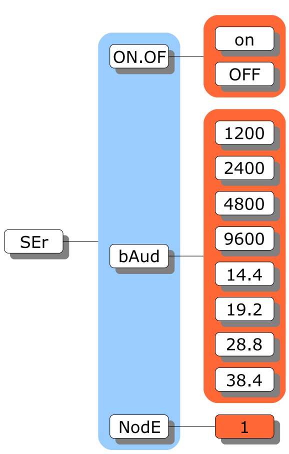

Illustration 5: Serial communication menu

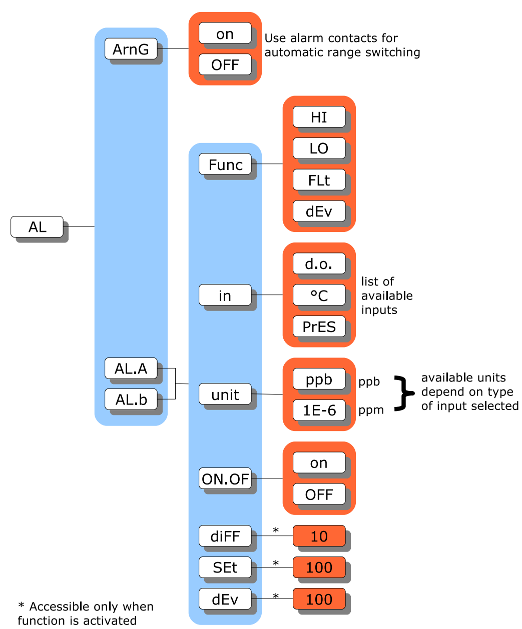

Illustration 4: Alarm menu

INTRODUCTION

The model 865 is IC Controls' industrial quality remote operational low-level dissolved oxygen analyzer, designed to give maximum flexibility, reliability, and ease-of-use. The model 865 is factory calibrated with automatic ranging to measure dissolved oxygen from 0 ppb (parts per billion) to 20 ppm (parts per million). Calibration should not be required. It has two isolated 4 mA to 20 mA outputs, two 10 A SPDT relays, dual programmable alarms plus a serial communication port. The analyzer is programmed to auto-calibrate, holds output during calibration, notifies user of diagnosed sensor or analyzer faults, plus stores in memory the last 12 calibration records, 1 000 minute measurement trend, alarms, power outages, and diagnostic messages, all date and time stamped.

The model 865 is one of a series of 115/230 VAC process analyzers supplied in a corrosion resistant IP65 (NEMA 4X) water- and dust-tight case. These analyzers are also available for pH, ORP, conductivity and chlorine, plus as two-wire versions with an optional explosion-proof rating. In the case of dissolved oxygen, the sensor is an electrochemical cell similar to a battery that produces a current when oxygen is present, therefore, no applied voltage is required. The analyzer conditions and digitizes the signal for maximum accuracy, and then sends it out as a digital output and/or on 4 mA to 20 mA outputs.

Features

The 865 D.O. analyzer features:

1. Intuitive user friendly program; easy-to-use.
2. Auto-calibration using saturated air technique.
3. Self and sensor diagnostics.
4. Output hold during calibration.
5. Stores 12 calibration records.
6. Stores alarms, caution and error messages.
7. Stores running 1 000 minute dissolved oxygen trend.
8. Two programmable 4 mA to 20 mA outputs.
9. Two programmable alarms.
10. Serial digital output and for remote operation.
11. Three level security to protect settings.
12. Durable housing; IP65, NEMA 4X.

Specifications

Analyzer: 865

Physical Data	
PROPERTY	***CHARACTERISTIC***
Display	Four and one half LCD digits, 2.0 cm (0.8 in) displays for dissolved oxygen, atmospheric pressure, temperature, efficiency, error codes, prompts and diagnostic information
Display Ranges	Dissolved Oxygen: 0.00 mg/L to 10.00 mg/L *or* 0.01 µg/L to 9,999 µg/L Temperature: -5.0 °C to 105 °C (23.0 °F to 221 °F) Barometric Pressure: 72 kPa to 130 kPa
Keypad	8 pushbutton entry keys
LED's	2 alarms (A and B), 1 auto, 1 error
Case Dimensions	16.0 cm (H) × 26.0 cm (W) × 9.0 cm (D) (6.3 in (H) × 10.2 in (W) × 3.5 in (D))
Panel Dimensions	36 cm (W) × 66 cm (H) / 14 in (W) × 26 in (H)
Weight	11.4 kg (25.0 lb)
Shipping Weight	13.6 kg (30.0 lb)
Shipping Dimensions	71 cm × 41 cm × 20 cm (28 in × 16 in × 8 in)

Environmental Data	
PROPERTY	***CHARACTERISTIC***
Temperature	Operational: 5.0 °C to 45 °C (41.0 °F to 113 °F) Storage: -10.0 °C to 55 °C (14.0 °F to 131 °F) Relative Humidity: 95 % maximum; non-condensing
Environment Ratings	Housing: IP65 (Nema 4X) Pollution Degree: 2 Installation Category: II
Electrical Ratings	115/230 VAC, 0.25 A, 50/60 Hz
Electrical Requirements	115/230 VAC ± 10 %, 50 W
Certifications	CSA C22.2 1010.1-92 (equivalent to IEC 1010.1) LR 109591-3 UL Std No 3111-1; CE EN50081, EN55011; EN61000

es-865-1.3

Specifications

Analyzer: 865

Operational Data	
PROPERTY	***CHARACTERISTIC***
Accuracy	Dissolved Oxygen: ±2 % reading *or* 0.1 µg/L, whichever is greater Temperature: ±0.1 °C
Precision	Dissolved Oxygen: ± 2 % reading *or* 2 digits Temperature: ± 0.1 °C
Response Time	90% within 30 s (default), function of flow and temperature
Temperature Compensation	Auto: -5.0 °C to 105 °C (23.0 °F to 221 °F) Manual: -5.0 °C to 105 °C (23.0 °F to 221 °F)
Sample Conditions	Flow: 50 mL/min to 200 mL/min Temperature: 2 °C to 45 °C (35.0 °F to 113 °F) with standard D.O. sensor, P/N A2103012. Option -82, PEEK D.O. sensor, P/N A2103042, allows for temperatures up to 65 °C (149 °F). Pressure: < 400 kPa (60 psi, 4 bar) Drain: Atmospheric
Sample Inlet	¼ in NPT tube fitting
Sample Outlet	¾ in MNPT fitting
Security	3 access-level security; partial and/or all settings may be protected via 3 and/or 4 digit security code.
Alarms	Two independent, assignable, programmable, configurable, failsafe NO/NC or auto-range BCD alarm relays; SPDT, Form C, rated 10 A 115 V/5 A 230 V, 5 position BCD contact closure.
Outputs	Two continuous, assignable, programmable 4 mA to 20 mA, or 0 mA to 20 mA outputs; isolated, max. load 600 Ω; Convertible from 1 VDC to 5 VDC or 0 VDC to 5 VDC.
Communication	Via RS232 bidirectional serial data port; require IC Net™ 2000 software.

es-865-1.3

Specifications

Sensor: A2103012

Measurement Range	0.01 µg/L to 9,999 µg/L
Minimum Temperature	2 °C (35 °F)
Maximum Temperature	45 °C (113 °F)
Maximum Pressure	400 kPa (60 psi)
Principle of Operation	Galvanic
Electrode Materials	
Cathode	Silver
Anode	Lead
Wetted Materials	Stainless Steel, PTFE, Viton, Delrin
Temperature Sensor	1000 Ω PT RTD
Optimal Flow Velocity	0.83 cm^3/s to 3.3 cm^3/s (50 mL/min to 200 mL/min)
Electrode Dimensions	
Diameter	3.2 cm (1.3 in)
Length	10.1 cm (4.0 in)
Process Connections	Flow cell; insertion via 1.25 in Swage-Lok nut
Sensor Cable	double shielded; 1 m length
Weight	0.5 kg (1.0 lb)
Shipping Weight	1.4 kg (3.0 lb)
Shipping Dimensions	46 cm × 30 cm × 23 cm (18 in × 12 in × 9 in)

es-A2103012-1.1

Specifications

Sensor: A2103001

Measurement Range	0.01 µg/L to 9,999 µg/L
Minimum Temperature	2 °C (35 °F)
Maximum Temperature	45 °C (113 °F)
Maximum Pressure	400 kPa (60 psi)
Principle of Operation	Galvanic
Electrode Materials	
Cathode	Silver
Anode	Lead
Wetted Materials	Stainless Steel, PTFE, Viton, Delrin
Temperature Sensor	1000 Ω PT RTD
Optimal Flow Velocity	0.83 cm^3/s to 3.3 cm^3/s (50 mL/min to 200 mL/min)
Electrode Dimensions	
Diameter	3.2 cm (1.3 in)
Length	10.1 cm (4.0 in)
Process Connections	Flow cell; insertion via 1.25 in Swage-Lok nut
Sensor Cable	double shielded; 3 m length
Weight	0.5 kg (1.0 lb)
Shipping Weight	1.4 kg (3.0 lb)
Shipping Dimensions	46 cm × 30 cm × 23 cm (18 in × 12 in × 9 in)

es-A2103001-1.1

Specifications

Sensor: A2103042

Measurement Range	0.01 µg/L to 9,999 µg/L
Minimum Temperature	2 °C (35 °F)
Maximum Temperature	65 °C (113 °F)
Maximum Pressure	400 kPa (60 psi)
Principle of Operation	Galvanic
Electrode Materials	
Cathode	Silver
Anode	Lead
Wetted Materials	Stainless Steel, PTFE, Viton, PEEK
Temperature Sensor	1000 Ω PT RTD
Optimal Flow Velocity	0.83 cm^3/s to 3.3 cm^3/s (50 mL/min to 200 mL/min)
Electrode Dimensions	
Diameter	3.2 cm (1.3 in)
Length	10.1 cm (4.0 in)
Process Connections	Flow cell; insertion via 1.25 in Swage-Lok nut
Sensor Cable	double shielded; 1 m length
Weight	0.5 kg (1.0 lb)
Shipping Weight	1.4 kg (3.0 lb)
Shipping Dimensions	46 cm × 30 cm × 23 cm (18 in × 12 in × 9 in)

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Specifications

Sensor: A2103041

Measurement Range	0.01 µg/L to 9,999 µg/L
Minimum Temperature	2 °C (35 °F)
Maximum Temperature	65 °C (113 °F)
Maximum Pressure	400 kPa (60 psi)
Principle of Operation	Galvanic
Electrode Materials	
Cathode	Silver
Anode	Lead
Wetted Materials	Stainless Steel, PTFE, Viton, PEEK
Temperature Sensor	1000 Ω PT RTD
Optimal Flow Velocity	0.83 cm^3/s to 3.3 cm^3/s (50 mL/min to 200 mL/min)
Electrode Dimensions	
Diameter	3.2 cm (1.3 in)
Length	10.1 cm (4.0 in)
Process Connections	Flow cell; insertion via 1.25 in Swage-Lok nut
Sensor Cable	double shielded; 3 m length
Weight	0.5 kg (1.0 lb)
Shipping Weight	1.4 kg (3.0 lb)
Shipping Dimensions	46 cm × 30 cm × 23 cm (18 in × 12 in × 9 in)

es-A2103041-1.1

865-25 D. O. MEASUREMENT

Introduction

Dissolved oxygen is a measure of the amount of oxygen, usually thought of as a gas, that is dissolved in a liquid such as water. Oxygen is essential to life, even for fish and other aquatic forms, plus is the most common element found taking part in corrosion reactions. It is this corrosion reaction that provides the need for the 865-25 dissolved oxygen measuring system, which is designed to measure trace parts per billion (ppb) levels.

Mechanically hard and porous metal oxide deposits have little strength and form rapidly in the presence of water and oxygen. Rapid corrosion will occur inside an industrial utility boiler system unless dissolved oxygen can be virtually eliminated. Corrosion results in expensive repairs or equipment failures and subsequent replacement.

The model 865-25 is designed to continuously monitor the oxygen in steam and water circuits. The operating range of 0 ppb to 10,000 ppb allows monitoring of leaks from condensers, valves and fittings, plus very low level precision to clearly show the performance of oxygen removal equipment and chemical scavengers. Design considerations include an easy-to-use, simple and accurate calibration approach, ISO 9000 compatible internal memory documentation of both calibrations and recent measurement trends plus serial communication capability with DCS systems and evolving technology.

Galvanic Measuring Cell

The 865-25 dissolved oxygen measuring sensor, P/N A2103012, is an electrochemical cell similar to a battery that produces a current when oxygen is present. By using carefully selected electrodes, in contact with an appropriate electrolyte, a chemical reaction occurs that uses electrons gained from oxygen molecules to produce a galvanic current directly proportional to the concentration of oxygen present. Illustration 6 shows how such an electrode system works in a simple laboratory test.

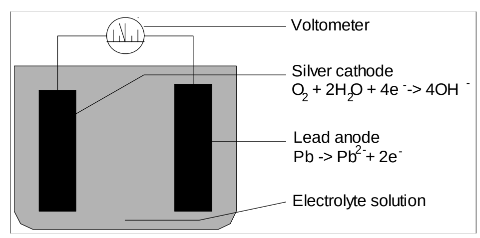


Illustration 6: Basic galvanic cell

Illustration 7 shows how these scientific principles can be implemented into a working dissolved oxygen sensor. Also, unlike an electrolytic cell in which a flow of current produces the chemical reaction, there is no zero-current as galvanic current is naturally zero when zero oxygen is present.

The A2103012 sensor uses a galvanic cell separated from the sample by an oxygen permeable PTFE (teflon) membrane. The cell has a silver cathode in close contact with the PTFE membrane where oxygen (O_2) gains electrons (is reduced) to become hydroxyl ions (OH^-), and a lead (Pb) anode that produces a fixed potential regardless of oxygen concentration, to complete the circuit.

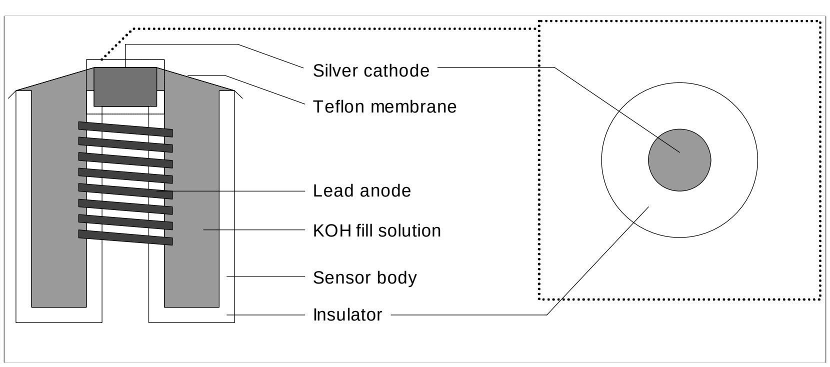


Illustration 7: Galvanic dissolved oxygen sensor

The chemical reactions within the cell are:

At the cathode: $O_2 + 2H_2O + 4e^{-1} = 4OH^{-1}$

At the anode: $2Pb = 2Pb^{+2} + 4e^{-1}$

Overall: $O_2 + 2H_2O + 2Pb = 2Pb_2OH$

Principles of Calibration

At any given temperature and barometric pressure, the partial pressure of oxygen in water-saturated air is exactly the same as it is in air-saturated water. Thus a sensor can be calibrated in water-saturated air, using the 20.9% oxygen available in air as the full-scale standard, and it will correctly read dissolved oxygen in water samples. Both temperature and barometric pressure affect the partial pressure of oxygen in air saturated with water vapor . The 865 has microprocessor memory programmed with all the values, as well as automatic temperature and barometric pressure sensors, so it can automatically obtain the correct data, look up the dissolved oxygen table, compute the correct gain, and calibrate the analyzer. The operator need only remove the cell and suspend it over a beaker of water. This calibration technique will give a 100% saturation reading for the temperature and pressure which the 865 will display as ppb dissolved oxygen.

To calibrate the sensor, simply suspend the probe above water and let the analyzer auto-calibrate. Refer to the *Calibration* section for complete procedure.

Sample Requirements

Sample inlet connection:
¼ inch NPT tube fitting. Suggested sample delivery tubing is 316SS with quality tube fittings to eliminate diffusion of oxygen through the sample system tube walls and leaks at fittings.

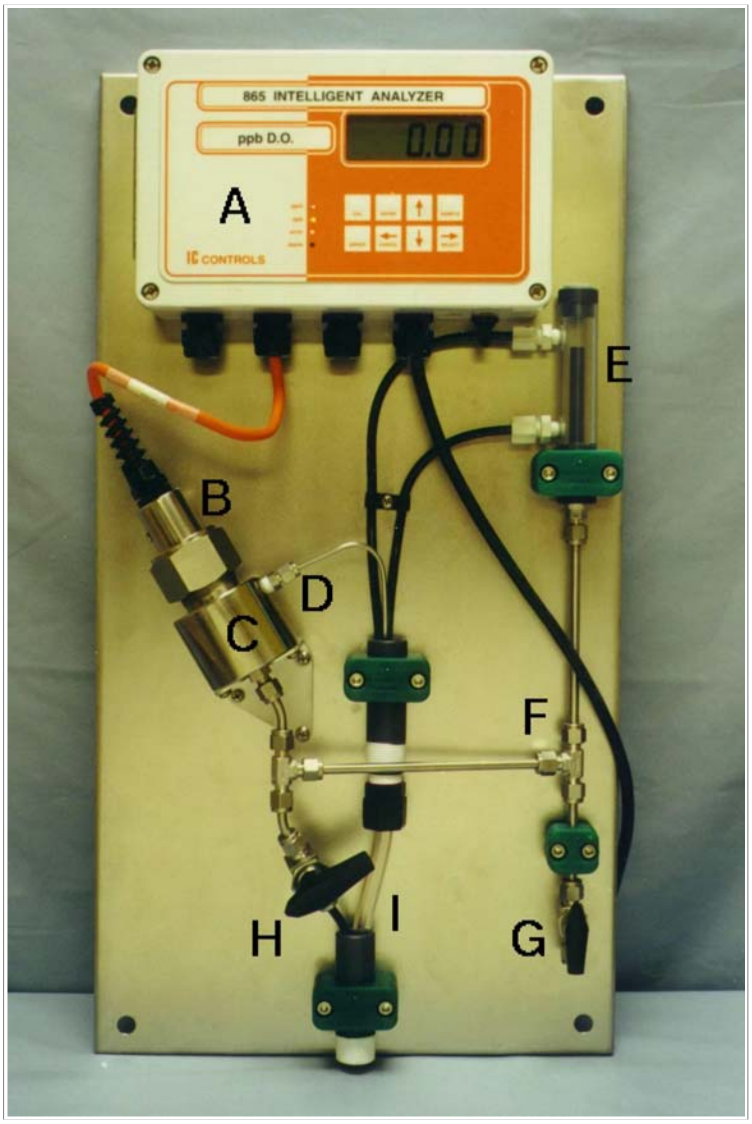
Sample outlet connection:
¾ inch MNPT fitting.

Flow rate:
100 mL/min to 200 mL/min is recommended, with a minimum flow rate of 50 mL/min. Lower sample flow rates will result in slower response to ppb dissolved oxygen changes.

Temperature:
2 °C to 45°C (35 °F to 113 °F) with standard D.O. sensor, P/N A2103012.
2 °C to 65°C (35 °F to 149 °F) with PEEK D.O. sensor, P/N A2103042.

Pressure - less than 400 kPa (60 psi, 4 bar).

865-25 Component Identification



A) Analyzer, model 865
B) Dissolved oxygen sensor, P/N A2103012
C) Flow cell chamber
D) Flow cell outlet
E) Atmospheric pressure relief & grab sample chamber
F) Magnetite grit bypass
G) Inlet valve
H) Calibration & grit removal valve
I) Drain outlet

Illustration 8: 865-25 component location

Description of Model 865 Analyzer

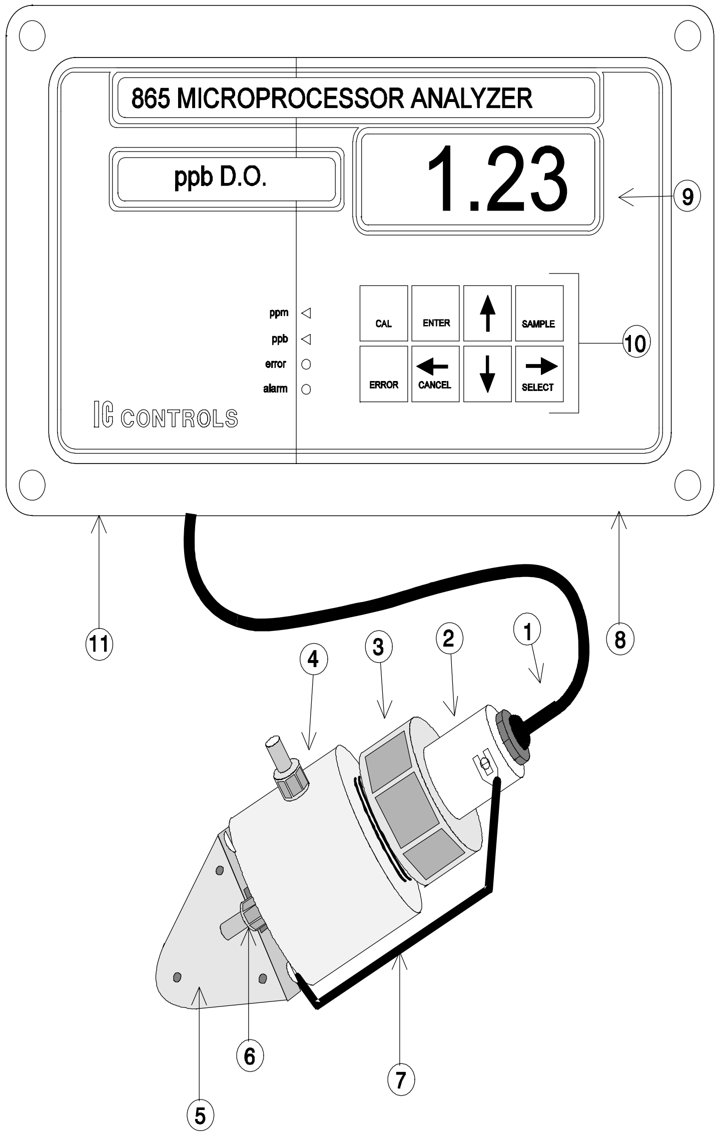


Illustration 9: Model 865 analyzer component location

1) **D.O. sensor and lead** - senses ppb oxygen in sample stream and produces a current dependent on sample concentrations. Equipped with 1 m (3 feet) cable.
2) **Stainless steel sensor housing** - provides total shielding for stable low-level ppb signals; included with each electrode.
3) **Hand seal gland nut -** provides easy removal of sensor and pressure seal.
4) **Stainless steel flow cell -** contains dissolved oxygen sensor and close contact sample flow paths.
5) **Angle mounting bracket -** securely mounts flow cell at 30 degrees from vertical to allow air bubbles to bypass the sensor tip.
6) **O-Ring seal -** inlet fitting, special ¼ inch tube fitting to provide oxygen-tight inlet seal.
7) **Ground/shield wire -** ensures no electrical potential from static which would affect low ppb-level readings.
8) **865 Dissolved Oxygen Analyzer electronics** - handles all signal manipulation and results.
9) **LED display -** provides digital readout of measurement.
10) **Keypad -** analyzer operation keys
11) **Communications port**

INSTALLATION

Report any obvious damage of shipping container to carrier and hold for inspection. The carrier, not IC Controls, is responsible for any damage incurred during shipping.

Mounting the 865-25

The model 865-25 comes as a complete sample conditioning system. The analyzer is mounted on a stainless steel panel with a flow cell containing the dissolved oxygen sensor. The sample conditioning panel includes on-line calibration, magnetite grit bypass and siphon-drain system. The only installation requirement of the user is to mount the panel and supply plumbing to the inlet and from the outlet.

The panel mounts on a wall via four ⅜ inch bolts at 12¼ inch x 24¼ inch centers; refer to drawing D4060084 for mounting dimensions. Sample inlet is a ¼ inch NPT tube fitting and sample outlet is a CPVC, ¾ inch MNPT fitting. It is suggested that the sample be delivered in a ¼ inch stainless steel line.

Analyzer Wiring

Nominal input power for the model 865 microprocessor analyzer is selectable for 115/230 VAC ±10%, single phase 50/60 Hz. Default power is set to 115 VAC. Refer to drawing D5920101 for component locations. Power connections are made at TB400. Three-wire grounded power must be used, with the third wire connected to a good earth ground. If this ground connection is not made, published instrument specifications may not be achieved.

CAUTION: *Line voltage selector switch must be set prior to applying power for either 115 VAC or 230 VAC.*

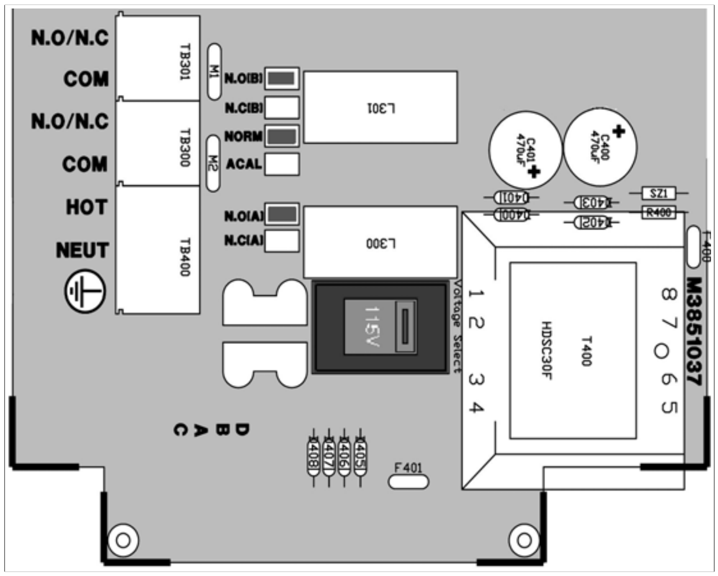


Illustration 10: Power wiring

There are four ½ inch conduit entrances located on the bottom of the instrument enclosure.

Recommended use:	line power	- right-hand entrance
	alarm/output wiring	- second from right entrance
	D.O. sensor wiring	- third from right entrance
	serial communication	- left-hand entrance

All conduit connections should be sealed with a gasket to maintain environmental integrity within the instrument enclosure. Power supply wiring terminals are designed for 14 AWG conductors. Supply should be protected by an external 15 A branch circuit. CSA certified ½ inch liquid tight fittings should be used to maintain the IP65 rating.

CAUTION: *Bonding between conduit connections is not automatic and must be provided as part of the installation.*

CAUTION: *Signal wiring connected in this box must be rated at least 300 V.*

Sensor Wiring

The basic wiring scheme for all IC Controls D.O. sensors is shown in illustration 11. This wiring scheme is intended for cable lengths less than 3 meters (10 feet) where electrical interference is expected not to be severe. The D.O. sensor at 1 ppb D.O. produces less than 1 µA. It is recommended that the sensor be located as near as possible to the dissolved oxygen analyzer to minimize any effects of ambient electrical noise interference. All long, low-level D.O. sensor signals should be run through a dedicated conduit. Take care to route D.O. signal wiring away from AC power lines to minimize unwanted electrical interference.

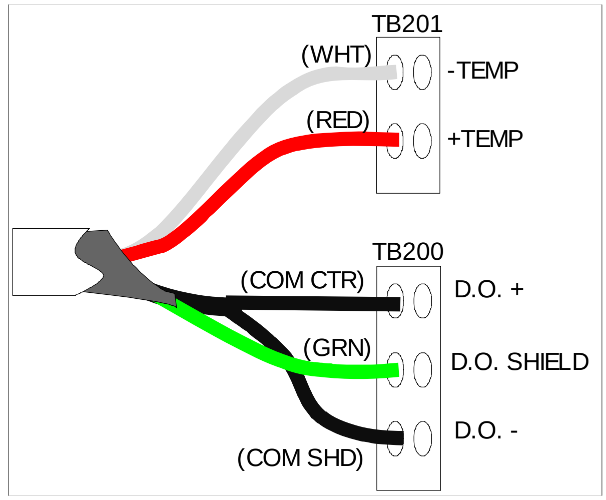


Illustration 11: Sensor wiring

When installing any instrument cable in conduit, use caution to avoid scraping or cutting the cable insulation—resulting exposure of the cable's internal shield wire will greatly increase the chances of system malfunction at any given time. Avoid excessive twisting or coiling of all instrument cable to minimize possibilities for broken wire. Make sure all connections are clean and tight.

Equipment Symbols

 Caution (refer to accompanying documents)

 Protective conductor terminal

Assembly of the Dissolved Oxygen Sensor

This procedure should be done over a sink. ***Wear thin plastic or rubber gloves and protective eye wear as the electrolyte is a caustic solution.*** Wash hands thoroughly with lots of water if the electrolyte comes in contact with the skin. Rinse until the slippery feel of the caustic disappears.

NOTE 1: *The D.O. sensor should be assembled and charged while connected to the analyzer with the power on. The analyzer presents a current route for the electrons released from oxygen in the air. If the sensor cannot be connected to the analyzer during assembly/charging, short the D.O. + lead and D.O. - lead (refer to illustration 11) to provide an alternate current path. Failure to provide a current path will result in secondary undesirable reactions with byproducts that slow the sensor response when placed in service.*

NOTE 2: *Ensure all air bubbles are removed during assembly. Air has 20.9 % oxygen or in parts per billion, 209,000,000 ppb. Water is saturated with dissolved oxygen at 8,240 ppb (refer to Appendix B; 25 °C and 101.3 kPa) so an air bubble can saturate about 25,000 times as much water, or at 1 ppb can add an extra ppb to 25,000,000 times as much sample.*

1) Remove the protective cap exposing the lead coils and silver tip. Inspect the sensor to ensure the coils are clean and the silver electrode is bright. If the coils are tarnished, wipe in the direction of coils with a low-lint paper towel.
   NOTE: *Ensure brown sealing O-ring is seated in sensor groove.*

2) Hold the retainer tip at about 60 degrees and add two drops of electrolyte. Then install the membrane module in the cap with the membrane facing down so that it covers the center hole in the cap as per illustration 12. Push the membrane module firmly in to force the electrolyte drops around the cap bottom displacing any air.

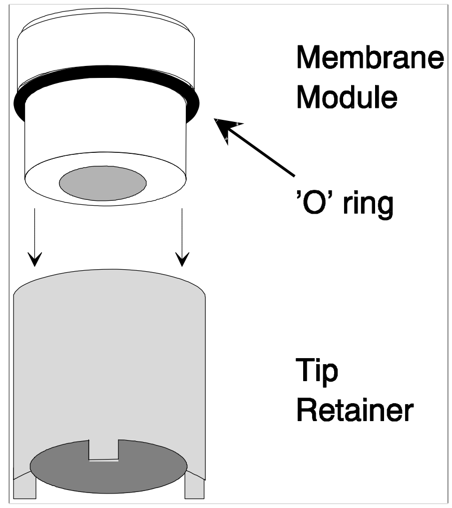


Illustration 12: Membrane module assembly

3) Holding the retainer tip (with membrane module installed) in an upright position, fill with electrolyte until the center cavity is full. Tilt at about 60 degrees and add an extra ⅛ inch of electrolyte, observing that the crack around the membrane module fills with electrolyte and air is displaced.

4) Hold the assembled retainer tip and slowly lower the electrode coils (see illustration 13) down into the cap until the threads touch. Raise and repeat ensuing all air is displaced around the coils.

5) Rotate the sensor body until you can see the flat area through the threads. Slowly rotate the cap on, allowing the excess electrolyte and bubbles to overflow up the flat. Lightly tap the cap to dislodge air bubbles. Continue to slowly rotate the cap until a firm stop is reached.
CAUTION: *Do not force the cap beyond the stop; the parts are plastic and can break.*

6) Dry the D.O. sensor and blot the tip. Examine the tip - the membrane should be smooth with no wrinkles or cuts and the surface contours of the silver electrode should be clear. There should be no lines from trapped air bubbles between the membrane and the silver electrode. If there are no visible problems, the D.O. sensor is ready to be put into service. A sensor with no air inside will come down in a few minutes. A sensor with trapped air inside will come down to 1 ppb in several hours or days. *If there are wrinkles, lines from large air bubbles or tiny air bubbles present, disassemble and re-charge the sensor.*

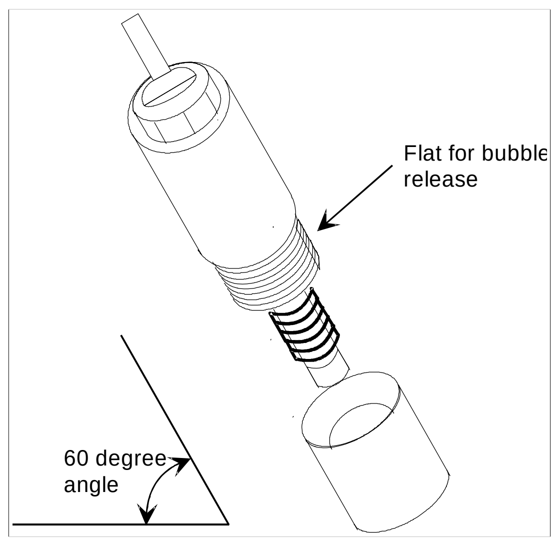


Illustration 13: Sensor assembly

Inserting the Sensor into the Flow cell

1) Inspect the inside of the flow cell for any foreign matter; wipe out if necessary. It should appear clean, shiny, and bright.
2) Insert the assembled sensor through the nut and sealing O- ring. Rock the sensor back and forth to pass the O-ring.
3) Press slowly all the way down until the sensor firmly reaches the stop.
4) By hand, tighten the nut firmly to get a good seal. This should be sufficient for 5 psi to 10 psi pressure. **Give the nut an extra quarter turn beyond finger tight to keep out tramp oxygen.**
   NOTE: *The flow cell is not intended for use at high pressure. The teflon seal ring is not designed to hold against pressure.*

Removal of the Sensor from Flow cell

1) Stop the sample flow to the dissolved oxygen sensor and vent the sample line to atmosphere.
2) Unscrew the nut and gently rock the dissolved oxygen sensor back and forth to ease the O-ring seals back up the compression throat.
   CAUTION: *Removal of the dissolved oxygen sensor from a sealed flow cell will vacuum stretch the thin dissolved oxygen sensing membrane. Stretching the membrane will cause slow response and higher readings at low ppb levels. Parting the membrane will cause dissolved oxygen sensor failure.*
3) When the dissolved oxygen sensor has been fully removed, wipe the sensor clean and then proceed to the calibration procedure or maintenance section, as necessary.

ANALYZER OPERATION

Description of Basic Unit Controls

LCD display - Displays four-and-one-half digit and plus/minus sign used to display dissolved oxygen concentration, temperature, pressure, error messages, as well as the entire menu used to control the analyzer.

ppm LED - Indicates that the sample is being displayed on the LCD with units in parts per million (ppm) dissolved oxygen.

ppb LED - Indicates that the sample is being displayed on the LCD with units in parts per billion (ppb) dissolved oxygen.

error LED - When the error LED is lit, it indicates that an error or alarm condition has been detected. Use the ERROR key to list errors.

alarm LED - When lit, indicates that the analyzer detects an alarm or out-of-limits condition.

Up and Down arrow keys - Moves up and down in the menu. In edit mode, adjusts blinking digit or selects an item from the list. Refer to the *Edit Mode* section.

Cancel/left arrow key - Moves left in the menu. In edit mode, moves left one digit or cancels edit. Refer to the *Edit Mode* section.

Select/right arrow key - Moves right in the menu. In edit mode, moves right one digit. Refer to the *Edit Mode* section.

Enter key - Enters edit mode when displaying a parameter that can be edited. In edit mode, accepts the displayed setting. Refer to the *Edit Mode* section.

Sample key - From anywhere in the menu, press the SAMPLE key to return to displaying the dissolved oxygen measurement.

Cal key - From anywhere in the menu, starts the 865 analyzer into calibration mode.

Error key - If error LED is lit, then pressing the ERROR key causes the LCD to display an error code. If no error condition has been encountered, the LCD will show [NONE].

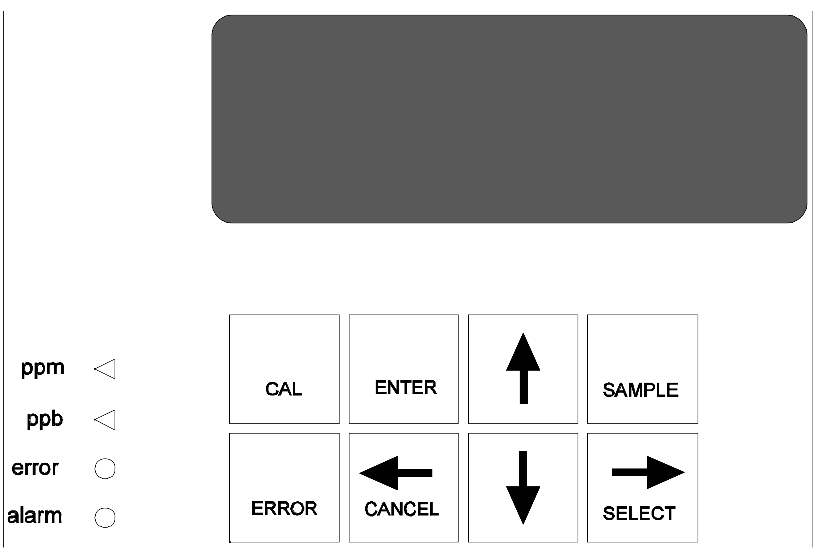


Illustration 14: Front panel keypad of analyzer

Start-up Procedure

1. Install the model 865-25 according to the instructions in *Installation* section.
   Verify power supply has been wired for proper voltage and instrument is suitably grounded.
2. Turn on flow at sample inlet.
3. Power up the 865 analyzer. The startup procedure will begin by alternately flashing [tESt] and [----] while performing the memory tests.
4. The analyzer will display in sequence the analyzer model number, in this case [865], and the program version number, e.g. [2.01].
5. The display test lights each of the implemented display segments in turn. At the same time, each of the LEDs will be lighted in turn.
6. If the analyzer passes all the tests, then the hardware is functioning properly and the analyzer will proceed to display dissolved oxygen.
7. If the analyzer displays +Err, this indicates that the dissolved oxygen input is off-scale. The error LED will be lighted as long as either the dissolved oxygen or the temperature input is off-scale. An off-scale error can indicate that a sensor is not in solution, is off-scale, or is not connected properly. If the error LED remains lighted, then press the *ERROR* key or select [Err] from the main menu, to see what errors have been detected by the analyzer.
8. After completing the above steps, the monitor is now in normal operational mode. Analyzer settings and parameters can be viewed and/or changed at any time using the keypad.

Initial Instrument Set-up

Refer to *Appendix D* for a list of factory default settings used by the analyzer. Before putting the analyzer into operation, verify the analyzer settings to ensure that they agree with the intended set-up.

1) **To change the alarms:** set alarm function (high, low, deviation, fault alarm), input source (D.O., temperature, or pressure), differential, set-point, and on/off switch. Set the normally open/normally closed configuration of the alarm contacts in [CONF] [AL]. The program setting must reflect the actual NO/NC wiring. Refer to *Alarm Functions* section for complete details.
2) **To change the 4 mA to 20 mA outputs:** set input source (D.O., temperature, pressure), zero, span, and on, or if not used, off switch. Each output can be calibrated for 4 mA to 20 mA, 0 mA to 20 mA (or 1 VDC to 5 VDC or 0 VDC to 5 VDC using a 250 ohm 1% resistor across the terminals). Refer to *Outputs* section for complete details.
3) Set preferences for metric or imperial units in [CONF] [unit].
4) If desired, install password security. Refer to *Appendix A* for complete details.

Start-up Settings

The 865 dissolved oxygen analyzer uses a sensor with a galvanic cell which has an electrochemical zero current output at 0 ppb dissolved oxygen. Full-scale calibration is easily done using atmospheric air as the oxygen standard. The 865 needs only to have the operator remove the cell, expose it to air, plus enter the calibrate command. All stabilization, temperature and pressure compensation, plus calibration adjustments are automatic.

Temperature plays a major role in dissolved oxygen readings. The 865 has stored temperature vs. dissolved oxygen tables in it's memory. A temperature detector is in close contact with the dissolved oxygen sensing tip in the sample. The temperature sensor can be field calibrated but comes from the factory pre-calibrated.

Pressure also plays a significant role during calibration. The 865 has stored pressure vs. dissolved oxygen tables stored in it's memory. A pressure sensor is supplied for automatic pressure compensation.

Refer to *Appendix C* for a table of saturated D.O. values at various temperatures and pressures.

Changing Settings

Analyzer settings and parameters can be viewed and/or changed at any time. Refer to the menus on pages 3 and 4; the areas shaded in dark orange indicate program settings which can be changed by the user. Menu areas shaded in light blue are view-only menus.

Shutdown and Start-Up Procedure

Sample interruption less than 72 hours: If the analyzer will not have flow for less than 72 hours, but will have low ppb sample in the flow cell, leave the instrument on and either neglect its output or put the analyzer in standby mode.

Sample interruption greater than 72 hours: If no sample flow is expected for longer than 72 hours, perform the following shutdown procedure. This procedure will prevent possible build-up of oxidation products in the sensor.

SHUTDOWN PROCEDURE

1) Leave power on.
2) Turn off sample flow prior to the flow cell inlet.
3) Close the drain from flow cell to prevent oxygen from entering flow cell.
4) Keep flow cell full of ppb dissolved oxygen water. Since the sensor consumes small quantities of dissolved oxygen, it will store for months in a sealed flow cell if the power is on, or, if the cell leads are shorted; D.O. + and D.O. -.
5) If it is necessary to turn the analyzer power off; first remove and disassemble the sensor over a drain while it is still wired to the analyzer (refer to step 6 to step 9). Use the analyzer display reading to indicate the sensor is clean when it drops to low ppb levels.
6) Remove white sensor cap and membrane module.
7) Rinse electrodes with pure water and wipe dry to remove any trace of internal fill solution. Using a clean low lint paper towel, tighten the lead coils and wipe to a bright condition.
8) Rinse membrane module, blot dry, and store in original plastic case in which it was shipped.
9) Place the white sensor cap onto the sensor and store the sensor in it's box.
10) Turn off power. A disassembled sensor stored in a clean dry container can keep for years.

START-UP, IF STORED IN A SEALED FLOW CELL

1) Open the drain valve.
2) Open the sample inlet valve.
3) The system is ready to measure ppb dissolved oxygen.

START-UP, IF STORED DISASSEMBLED AND DRY

Refer to *Assembly of the Dissolved Oxygen Sensor* in the *Installation* section.

Standby Mode

Standby mode can be selected from the main menu. In standby mode the alarms will not function and the 4 mA to 20 mA outputs will go to 4.00 mA. When *SAMPLE* is pressed, the inputs will show [StbY] instead of the normal input measurement.

The analyzer will not resume normal operation until it is taken out of standby mode. While in standby mode, the entire menu and all settings are accessible to the operator, as before. None of the settings will take effect until the analyzer is returned to normal operation.

The standby feature is protected by security level 2.

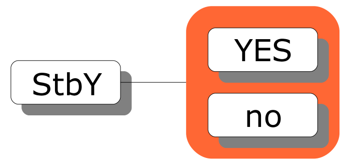


Illustration 15: Standby menu

EASY MENU

The layout of the program is shown in the *865 Menus* starting on page 3.

Remembers Where You Were

The analyzer remembers where *SAMPLE* is. The sample display is home base for the program. The program also remembers which menu selections were used last and loops around the columns. The menu can be accessed using the arrow keys to find any parameter then press *SAMPLE* to return to the displayed reading. Then using the *Right* arrow key return to exactly where you were.

Home Base: Press Sample

From anywhere in the menu, the *SAMPLE* key can be used to return to displaying dissolved oxygen. The program will safely abort whatever it was doing at the time and return to displaying the dissolved oxygen reading.

The dissolved oxygen display is the default sample display for the analyzer. The analyzer's inputs, dissolved oxygen, temperature, and pressure, are arranged underneath each other at the left-hand side of the menu. Use the *Up* or *Down* arrow key to display each of the readings in turn.

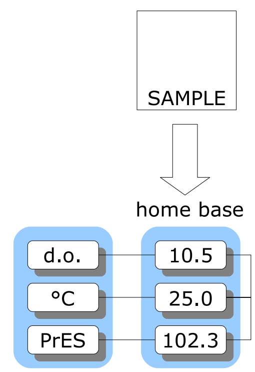


Illustration 16: Home base

Display Features

1. The analyzer has a built-in timer which returns the program to displaying dissolved oxygen if no key is pressed for 15 minutes. This time-out has the same effect as pressing the *SAMPLE* key. If security has been enabled, then the time-out will change the access level back to 0 or 1 automatically which gives the user read-only access. The user will have to enter an appropriate password to go to a higher access level. If output hold for D.O. is in effect, the same timer will release output hold.
2. When the sample value is displayed, pressing the *Left* arrow key will show which of dissolved oxygen, temperature, or pressure is displayed. Pressing *Right* arrow key displays the sample reading again.
3. The temperature and pressure input can effectively disappear from the menu if they are turned off in the configuration menu. To change the configuration, refer to *Input On/Off Switch* section in the *Edit Mode* section.
4. The main sample, ie. the input that is displayed first when the *SAMPLE* key is pressed, can be changed. By default the main input is [d.o.]. Change the default in [CONF] [in] [dFLt].

Arrow Keys

The four arrow keys on the keypad are used to move around in the menu.

Example*:*
Press *SAMPLE* to make sure that display is at home base. Press the *Right* arrow key. One of the prompts in the column starting with [d.o.] (refer to illustration 1) will be displayed. Use the *Up* or *Down* arrow keys to display the prompt above or below. If the prompt at the top or the bottom is displayed, the program will loop around. Press the *Up* or *Down* key until [AL] is displayed. Press the *Left* key to return to the sample display. Press the *Right* key again and [AL] will be displayed.

EDIT MODE

Edit mode is used to change a numeric value or to select between different options. Values and settings which can be edited are identified by the darker shading in the menu. Any frame which has a white background cannot be modified.

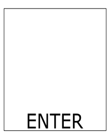
Editing by Selecting a Setting

Editing a value is like picking an option from a list; only one item on the list can be seen at a time. To change the setting, press *ENTER* to go into edit mode; the display will start blinking. Use the *Up* or *Down* arrow key to switch between the possible options and then press *ENTER* again to accept the new setting and leave edit mode.

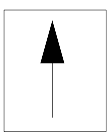
Example*:* Turn alarm A off.

From the menu, select [Al] [Al.A] [ON.OF]. The analyzer will now display either [on] or [OFF], which are the two choices. To change the setting, press *ENTER* to go into edit mode; the display will start blinking. Use the *Up* or *Down* arrow key to switch between the possible options. When [on] is displayed, press *ENTER* again to accept the new setting and leave edit mode.

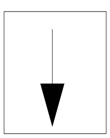
Summary of Key Functions in Edit Mode



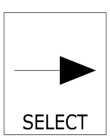
Enters edit mode. The entire display or a single digit will blink to indicate that the analyzer is in edit mode. Press the *ENTER* key again to leave edit mode and accept the new value.



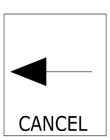
Adjusts blinking digit upward or selects the previous item from the list. If a 9 is displayed then the digit will loop around to show 0.



Adjusts blinking digit downward or selects the next item from the list. If a 0 is displayed then the digit will loop around to show 9.



Numeric values only: move to the right one digit. If blinking is already at last digit, the display will loop to the +/- sign on the left.



Numeric values: move left one digit. If blinking is at the +/- sign then blinking goes to last character.
Settings: restore the initial value if it was changed. Otherwise leaves edit mode without doing anything.

Illustration 17: Edit keys

Input On/Off Switch

The temperature input has been provided with an on/off switch. The most common use of this feature is to “turn off” the temperature input if no temperature compensator or temperature sensor has been installed. Turning off the temperature input will make the temperature [°C] or [°F] display at the left side of the menu disappear, as if it did not exist.

Refer to illustration 2 for the configuration menu; select [CONF] [in] [°C] [ON.OF] and edit as required.

Metric or Imperial Units

By default, the analyzer will use metric units. This means that temperature will be displayed using degrees Celsius and that the prompt for the temperature input will be [°C]. Using metric units, the pressure is displayed as kPa. The analyzer can be made to use imperial units. Using imperial units, temperature will be displayed using degrees Fahrenheit and the prompt for the first temperature input will be [°F] instead of [°C]. Pressure will be displayed as psi throughout the program.

For practical reasons, the temperature input is always identified as [°C] throughout this instruction manual and in the menus.

To select imperial units for the analyzer, select [unit] from the configuration menu, [CONF], then go into edit mode and change the [°C] prompt to [°F]. Since this is a global setting, both the units used for temperature and for pressure will change.

Real-Time Clock

The 865 analyzer has an internal date/time clock which allows the analyzer to maintain the date and time even when the analyzer is powered off. The date and time are needed to accurately date/time stamp the internal data log plus system and calibration event tags.

To set the real-time clock, select [CONF] [rtc] from the menu. Set the year, month, day, hour, minute, and second. The [hund] frame displays hundreds of a second but cannot be edited.

The [rtc] [CHIP] frame will show [YES] when a real-time clock chip is present, and shows [NO] when no real-time clock capability has been installed in the hardware. This frame cannot be edited.

CALIBRATION

When executing the calibration procedure, the analyzer will adjust the efficiency constant for the dissolved oxygen cell. Calibration is performed in air over water, at 100% humidity for optimal accuracy. A zero oxygen measurement can also be checked using zero dissolved oxygen standard, P/N A1100193.

There are two methods available for performing a calibration, in-line calibration or off-line calibration.

NOTE*:* *Before starting a calibration, the analyzer needs to use automatic range switching or manual range, [rNG.4], must be selected. Calibrating using manual range [rNG.1], [rNG.2] or [rNG.3], will generate error 1.3.*

In-line Calibration

In-line calibration is recommended as it is easy and results in lower sensor maintenance due to less sensor handling. In-line calibration requires a sample siphon drain system to allow air to reach the dissolved oxygen sensor (see illustration 18) and a D.O. flow cell arrangement that leaves some water in the flow cell for humidity but no water drops on the sensor. The model 865-25 is supplied on a panel with such a sample system as standard.

1) Open the calibration valve.
2) Observe the dissolved oxygen reading; it should start to rapidly climb towards 8,000 ppb.
3) Press the *CAL* key. The analyzer will show the dissolved oxygen reading. The display will be blinking to indicate that the analyzer is calibrating and testing for stability.
   NOTE*:* *The calibration is automatic from here on. As soon as the sensor reading has stabilized sufficiently the display will stop flashing and the new sensor efficiency constant will be calculated.*
4) When the reading stops blinking, the calibration has been completed. The reading will be displayed using the new calibration value. *Appendix B* lists the saturated D.O. values used.
5) Close the calibration valve completely to restore sample flow to the sensor, and press the *SAMPLE* key to return to normal operation. If this key is not pressed, the analyzer will return to the sample display after the 15 minute time-out.
6) Output hold will be in effect until it is turned off or until no key has been pressed for 15 minutes.
7) After a successful calibration, select [d.o.] [EFF] from the menu to inspect the new calibration value. This value is used internally to determine the analyzer gain.

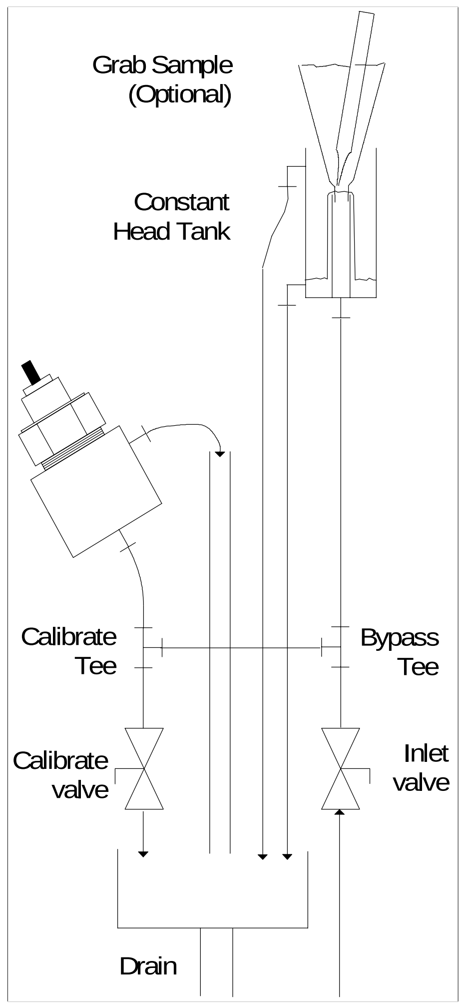


Illustration 18: In-line calibration setup

In-line Zero Test

An in-line zero dissolved oxygen check can be performed by closing the inlet valve and allowing the sample to drain completely; then closing the calibration valve securely. Pour the zero D.O. standard, P/N A1100193, into the constant head tank standpipe until it overflows from the flow cell to drain.

In-line Grab Sample

An in-line grab sample dissolved oxygen check can be performed by inserting a grab sample funnel into the constant head tank standpipe and allowing it to overflow. When the sample has overflowed for a couple of minutes - to rinse down to ppb levels - insert your vial and break the tip. Keep the tip submerged for a minute to let the color develop, then move quickly following test instructions to get your reading before air introduces an error.

Off-line Calibration

1) Turn off sample flow.
2) Remove the sensor from flow cell. Refer to *Removal of the Sensor from Flow Cell* in the *Installation* section for proper procedure.
3) Dry the tip carefully by blotting with a tissue; ensure there are no water drops on the membrane. Suspend the sensor above water as per illustration 19.
4) Press the *CAL* key. The analyzer will show the dissolved oxygen reading. The display will be blinking to indicate that the analyzer is calibrating and testing for stability.
   NOTE: *The calibration is automatic from here on. As soon as the sensor reading has stabilized sufficiently the display will stop flashing and the new sensor efficiency constant will be calculated.*
5) When the reading stops blinking, the calibration has been completed. The reading will be displayed using the new calibration value.
6) Press the *SAMPLE* key to return to normal operation. If this key is not pressed, the analyzer will return to the sample display after the 15 minute time-out.
7) Output hold will be in effect until it is turned off or until no key has been pressed for 15 minutes.
8) After a successful calibration, select [d.o.] [EFF] from the menu to observe the new calibration value. This value is used internally to determine the analyzer gain.

To manually override the automatic operation of the analyzer, the *ENTER* key may be pressed before the electrode has stabilized, forcing the analyzer to calibrate using the current dissolved oxygen reading. Calibration may be re-done or started over at any time. Press *CANCEL* to display the [CAL] frame, then press *SELECT* to restart the calibration.

The calibration setting will be based on the temperature used for temperature compensation and the pressure used for pressure compensation. The proper ppb dissolved oxygen reading is obtained from an internal table. Refer to *Appendix C* for a table of values used by the 865 analyzer.

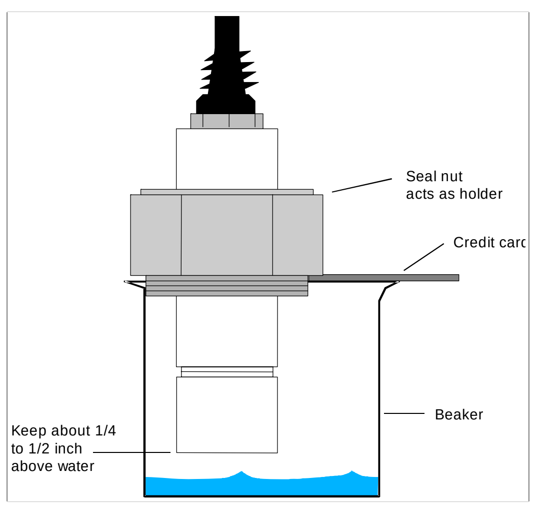


Illustration 19: Off-line sensor calibration

Off-line Zero Test

The best way to zero check at the point of use in the plant, is to use zero dissolved oxygen standard, P/N A1100193. Alternatively, a slower approximate zero can be obtained using a solution of sodium sulfite in water.

Submerge the dissolved oxygen sensor in a deep beaker so that it is 2 inches to 3 inches below the surface of the zero standard. Provide gentle mixing to ensure the oxygen present is consumed. Then cover the beaker with Parafilm to preserve product integrity. Let stand for five minutes - the sensor should rapidly fall to low ppb levels, thus confirming operation of the sensor.

Discard used zero standard after use as exposure to air will exhaust it. Reseal the storage bottle tightly for the same reason.

Preparation of Sodium Sulfite Solution:

To 1 liter of distilled water add 20 grams of Na_2SO_3 and mix thoroughly. Ensure that the solution is used within 8 hours because the oxygen scavenger will be used up quickly with exposure to air.

Use of sodium sulfite to get a zero is similar to use described above for zero standard but it may take longer to get to low ppb levels and/or zero may never be reached.

Calibration Errors

If the analyzer detects a problem during calibration, an error message will appear. If an error has been detected then the calibration was not successful and the previous calibration is retained. Press any key to acknowledge the error message. Take corrective action and redo the calibration. Consult the *Troubleshooting* section for further details.

Press any key to resume normal operation after an error message has appeared.

Output Hold

The 865 analyzer allows the user to hold the output for dissolved oxygen. Output hold affects both outputs and alarms if and when these monitor the dissolved oxygen input.

Enable output hold by changing the [d.o.] [HOLd] setting to [YES]. Output hold has the following effect:

- 4 mA to 20 mA output signals transmitting D.O. are frozen at their current levels.
- Alarms monitoring D.O. will maintain existing on/off condition.

The output hold remains in effect until the operator changes the [d.o.] [HOLd] setting to [no], or until no key has been pressed for 15 minutes. The 15-minute timeout ensures that output hold for dissolved oxygen will not remain in effect for longer than 15 minutes if the analyzer is left unattended. If it is desired to freeze the outputs for longer outages, use standby mode in the main menu.

Temperature Compensation

Almost all industrial applications encounter fluctuating temperature and need rapidly responding automatic compensation. IC Controls dissolved oxygen sensors typically have a temperature compensator (TC) built into the D.O. sensor. The TC is wired to the analyzer allowing the 865 to provide digital temperature compensation.

If no automatic temperature compensator is available or needed, manual temperature compensation can be used. If the temperature of the sample is constant, set the manual TC temperature to the process temperature. If the process temperature varies or is unknown, a default temperature of 25 °C or 77 °F is normally used.

Selecting Manual Temperature Compensation

To see the current temperature compensation method used by the 865 analyzer during calibration, select [d.o.] [tc] from the menu; refer to illustration 20. Either [Auto] (for automatic temperature compensation), or [SEt] (for manual temperature compensation set-point) will be displayed, depending on the current setting. To change the setting from [Auto] to [SEt], press *ENTER* to edit the current setting. The display will start blinking, indicating that a selection needs to be made. Use the *Up* or *Down* arrow key to display [SEt]. Press *ENTER* to select manual temperature compensation.

With [SEt] still displayed, press *SELECT* to display and/or adjust the temperature setting to be used with manual temperature compensation. If the current value needs to be changed, press *ENTER* to edit the current setting; the display will start blinking. Use the *Up* or *Down* arrow key to display the desired temperature for manual temperature compensation. Press *ENTER* to accept the displayed value.

Barometric Pressure Compensation

The 865 uses a pressure sensor inside the analyzer case to measure the atmospheric pressure. If the atmospheric pressure rises or falls, and/or if the pressure in the analyzer room differs from the local barometric pressure, the 865 analyzer will automatically read the correct pressure. The 865 will also compensate for the correct altitude to give accurate dissolved oxygen partial pressures during calibration. While the barometric pressure measurement only affects the 100% saturation reading at calibration, its use eliminates calibration errors that may cause all readings to be off by as much as 5% or more.

When metric units (the default) are selected, pressure is displayed in kPa. When imperial units are selected, psi are used.

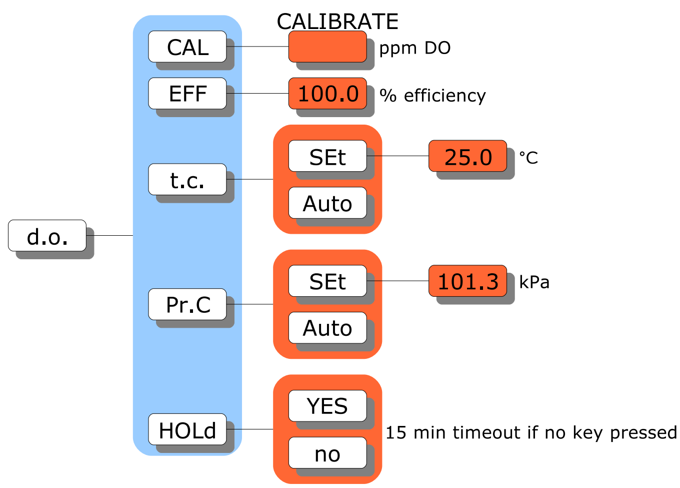


Illustration 20: Dissolved oxygen menu

Selecting Manual Pressure Compensation

To see the current pressure compensation method used by the 865 analyzer during calibration, select [d.o.] [Pr.C] from the menu; refer to illustration 20. Either [Auto] (for automatic pressure compensation), or [SEt] (for manual pressure compensation set-point) will be displayed, depending on the current setting. To change the setting from [Auto] to [SEt], press *ENTER* to edit the current setting. The display will start blinking, indicating that a selection needs to be made. Use the *Up* or *Down* arrow key to display [SEt]. Press *ENTER* to select manual pressure compensation.

With [SEt] displayed, press *SELECT* to display and/or adjust the pressure setting to be used with manual pressure compensation. If the current value needs to be changed, press *ENTER* to edit the current setting; the display will start blinking. Use the *Up* or *Down* arrow key to display the desired pressure for manual pressure compensation. Press *ENTER* to accept the displayed value.

D.O. Range — Auto or Manual

The 865 dissolved oxygen analyzer is an auto-ranging analyzer. The analyzer has four D.O. input ranges and will automatically switch between them to avoid going off-scale (the output range numbers associated with the 4 mA to 20 mA output are part of the output module and are independent of the input ranges described here).

The input range currently being used by the D.O. measuring circuit can be determined by selecting [CONF] [in] [d.o.] [rANG]; refer to illustration 21. If the analyzer is using manual ranging for the D.O. measurement, the user can go into edit mode and switch ranges. If the analyzer is using automatic ranging then this setting can be viewed only.

Manual Ranging

By default, the analyzer is configured to automatically switch between ranges. The auto switching capability can be disabled in the configuration menu by changing the setting of [CONF] [in] [d.o.] [AUtO] from [YES] to [no]; refer to illustration 21. Once automatic ranging has been disabled, the measuring range can be manually selected by changing the setting in [CONF] [in] [d.o.] [rANG]; refer to illustration 21.

NOTE: *Before starting a calibration, the analyzer needs to use automatic range switching or manual range [rNG.4] must be selected. Calibrating using manual ranges 1, 2 or 3 will generate error 1.3.*

Displayed Range

The measuring range of the instrument, 0 ppb to 10 000 ppb dissolved oxygen, is determined by the gain used by the analyzer itself and the cell current of the dissolved oxygen sensor. The displayed measuring range is determined by multiplying the cell current by the analyzer range gains.

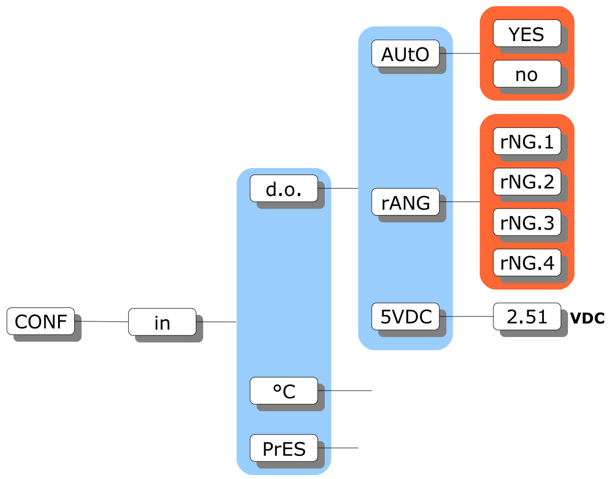


Illustration 21: Configuration menu for D.O. input

ERROR MESSAGES

Detected errors and/or cautions are displayed by the analyzer - press the *ERROR* key or select [Err] from the main menu. If there are no error or caution messages, [NONE] will be displayed, otherwise scroll through the error list using the *Up* or *Down* arrow keys. Errors and cautions cannot be removed from this list directly; each error or caution will be removed automatically when appropriate, e.g. errors associated with improper calibration will be cleared after a successful calibration.

Input / Source	***Input Number for Error and Caution Messages***
D.O.	1
°C	2
Pressure	3
Alarm A	7
Alarm B	8

Table 1: Input numbers

Error messages are numbered. Errors are identified as [E*n.e*] where *n* is the input number and *e* is the error number. For example, E1.1 is error 1 for the dissolved oxygen input. Cautions are identified as [CA*n.e*], where the *e* is 6 through 9.

Off-scale errors are not numbered and are identified as [+Err] and [-Err], depending on whether the input is at the top or the bottom of the scale. The off-scale error is displayed instead of the sample reading and does not show up in the error menu with the numbered error messages, if any.

The error LED will remain on as long as there is an unacknowledged error message or as long as any input is off-scale. Each source of error must be removed or acknowledged before the error LED will go off. Caution messages will not cause the error LED to come on.

If no electrode or sensor is attached to an input, it may be most convenient to “turn off” the input. For example, if there is no temperature input, the temperature display would consistently be off-scale without a resistor across the input terminals, causing the error LED to always remain lighted.

Acknowledging an Error Message

To turn off the error LED and shut down the external fault alarm contact, the error must be acknowledged. To acknowledge the error, press the *ERROR* key or select [Err] from the main menu. Use the *Up* or *Down* arrow key until the error message to be acknowledged is displayed.

Errors are displayed with either a positive (+) sign or a negative sign (-) in front. The + sign is used to indicate an active or unacknowledged error, the - sign indicates an inactive or acknowledged error. Acknowledging the error will change the sign from + to -.

Press *ENTER* to go into edit mode. The + or - sign will be flashing. Use the *Up* or *Down* arrow key to change the sign, then press *ENTER* again.

An acknowledged error message is cleared for one occurrence of the error only. If the error reappears, the sign changes from - to + and the error message must be acknowledged again.

Error Messages for Dissolved Oxygen

Error	***Description***	***Causes***	***Solutions***
E0.00	No dissolved oxygen measurement.	Open circuit.	The sensor is not connected or there is a bad connection.
		Sensor reading is below the low end of range selected.	Manual range switching in effect and analyzer needs to be on a lower range.
E1.1	Electrode has not stabilized after 5 minutes of calibration.	Poor electrode performance; sample D.O., temperature, or pressure is not stable; interference.	Check electrode for proper assembly and redo calibration.
			Monitor D.O., temperature and pressure until stable, them redo calibration.
			Water drop on membrane - wipe it off, then redo calibration.
E1.2	Electrode efficiency would be greater than 500%. Previous setting retained.	Improper electrode setup, assembly, or electrode failure.	Recharge and reassemble the sensor, setup sensor, then redo calibration. Refer to *Troubleshooting* section.
		Rip or puncture in membrane.	Replace membrane module and redo calibration.
E1.3	Electrode efficiency would be less than 33%. Previous setting retained.	No D.O. signal or, signal from sensor is very weak.	Check electrode connections, then redo calibration.
		Incorrect membrane module in use.	Membrane is too thick. Replace membrane module.
		Black or red discoloring in sensor.	Sensor needs service - has seen long exposure to high D.O. levels. Refer to *Troubleshooting* section.
		Manual range on low range during calibration.	Change to automatic range switching or change range to range 4.
E1.4	Pressure compensator is off-scale	Atmosphere outside of pressure operating range of 75 kPa to 130 kPa.	Use manual pressure compensation or refer to *Error Messages for Pressure.* Check electronic calibration.
E1.5	Temperature compensator (TC) is off-scale.	Sample outside of TC operating range of -5 °C to 105 °C.	Should not be - D.O. sensor will fail (refer to sample requirements). Use manual temperature compensation or refer to *Error Messages for Temperature.* Check electronic calibration.
		TC not connected.	Check TC wiring connections or install TC.
		TC open.	Replace TC (use new D.O. sensor), or use manual temperature compensation.

Error Messages for Temperature

Error	Description	Causes	Solutions
E2.1	Temperature reading off-scale, low.	Temperature is lower than -5 °C.	Verify process and sensor location.
		Electronic calibration needed.	Follow procedure in *Hardware Alignment* section.
E2.2	Temperature reading off-scale, high.	Temperature compensator (TC) not present or open circuit.	Install TC, check TC wiring or replace D.O. sensor.
			Turn off temperature input. Follow *Input On/Off Switch* procedure in *Edit Mode* section. Use manual temperature compensation.
			Connect resistor to TC terminals to simulate a constant temperature. Refer to *Hardware Alignment* section.
		Temperature is higher than 105 °C.	Verify process and sensor location.
		Electronic calibration needed.	Follow procedure in *Hardware Alignment* section.

Error Messages for Pressure

Error	Description	Causes	Solutions
E3.1	Pressure reading off-scale, low.	Pressure less than 75 kPa.	Use manual pressure compensation. Turn off pressure input. Follow *Input On/Off Switch* procedure in *Edit Mode* section.
		Electronic calibration needed.	Follow procedure in *Hardware Alignment* section.
E3.2	Pressure reading off-scale, high.	Pressure greater than 130 kPa.	Use manual pressure compensation. Turn off pressure input. Follow *Input On/Off Switch* procedure in *Edit Mode* section.
		Electronic calibration needed.	Follow procedure in *Hardware Alignment* section.

Caution Messages for Alarms

Caution Number	Description
CA7.6	Alarm A, High alarm
CA7.7	Alarm A, Low alarm
CA7.8	Alarm A, Deviation alarm
CA7.9	Alarm A, Fault alarm
CA8.6	Alarm B, High alarm
CA8.7	Alarm B, Low alarm
CA8.8	Alarm B, Deviation alarm
CA8.9	Alarm B, Fault alarm

OUTPUT SIGNALS

Two assignable 4 mA to 20 mA output channels are provided. The user may configure the analyzer to determine which input signal will be transmitted by each 4 mA to 20 mA output channel. Each output channel can be independently configured to transmit the dissolved oxygen, temperature, or pressure signal. Output 2 can also be used to transmit a range number indication when output 1 is in auto-range mode.

The output channels function independent of each other. Each output channel has a separate on/off switch and adjustable low and high span (or scale) adjustments. This makes it possible, for example, to transmit two dissolved oxygen signals, each using separate high and low adjustments. All output settings are selected from the [out] menu.

To adjust the output span or output window, set [LO] to correspond to the low end of the scale or 4 mA output, and set [HI] to correspond to the high end of the scale or 20 mA output. The analyzer will automatically scale the output according to the new settings.

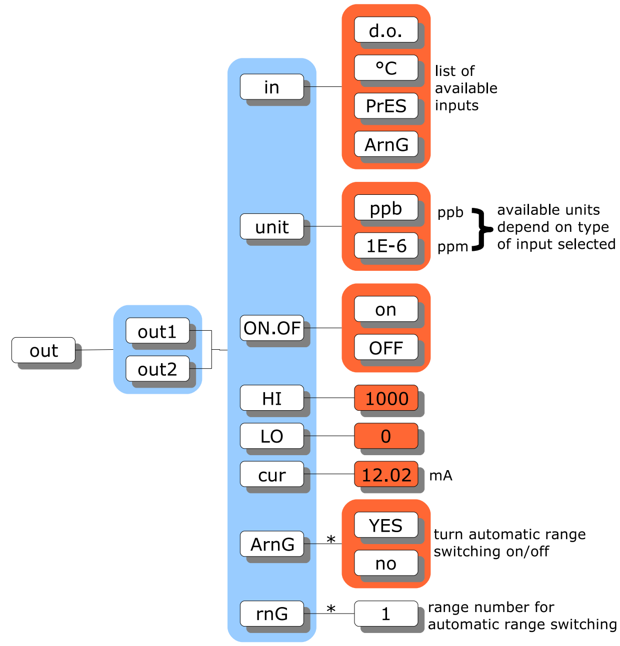


Illustration 22: Output menu

Wiring and Calibration

Refer to illustration 23 and drawing D5920101 for wiring diagram.

The factory output default is 4 mA to 20 mA, however, the outputs can be calibrated for 0 mA to 20 mA. For electronic calibration, refer to *Calibration of 4 mA to 20 mA Outputs* in the *Troubleshooting* section.

0 VDC to 5 VDC or 1 VDC to 5 VDC output can be achieved by placing a 250 Ω, 1% resistor across the 4 mA to 20 mA output.

The setting in [CONF] [out] [out1] and [out2] can be changed to [0-5], [1-5], [0-20], and [4-20] to agree with the hardware calibration of the particular output.

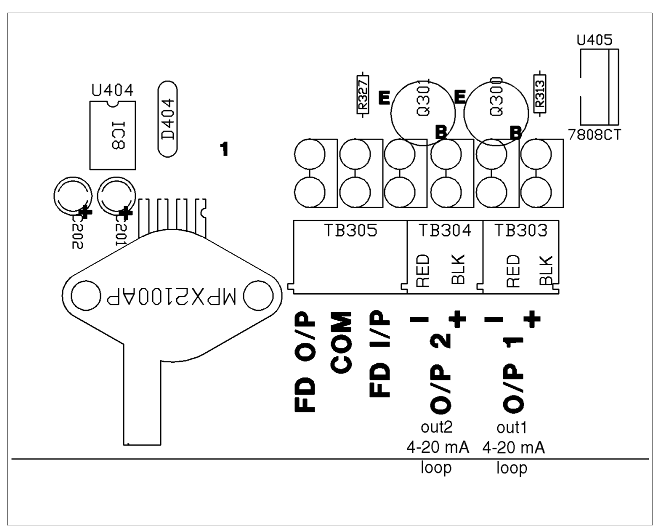


Illustration 23: Output wiring

Reversing the 4 mA to 20 mA Output

The low scale setting will normally be lower than the high scale setting. It is possible to reverse the output or "flip the window" by reversing the settings of the low and high scale.

Simulated 4 mA to 20 mA Output

Select [cur] from the menu to display the output current in mA that is presently being transmitted by the output signal. The display will be updated as the output signal changes based on the input signal and the program settings. From here, one can watch the output respond to the change in the input signal. This is useful for verifying program settings and for testing the hardware calibration.

To simulate a different 4 mA to 20 mA output signal press *ENTER* to access edit mode. Edit the displayed mA value to display the desired output needed for testing the output signal. Press *ENTER* to select the displayed value. The output signal will be adjusted to put out the desired current. This process can be repeated as often as necessary.

The output signal is held at the displayed level until the program leaves this part of the menu.

Automatic Range Switching

Automatic range switching greatly enhances the resolution capability of the 4 mA to 20 mA output. A typical application would track the D.O. input from 0 ppb to 20,000 ppb. As soon as the D.O. level drops below about 1,000 ppb, a typical recorder would be able to show very little resolution; refer to illustration 24. The alternative of having an operator change the scale adjustment is impractical in most cases.

Automatic range switching will automatically expand the span adjustment by a factor of 10 each time the output level is within the bottom 10% of zero. With automatic range switching in effect, the output will adjust automatically, moving from range 1 which is 0 ppm to 20 ppm down to range 5 which is 0 ppb to 2 ppb.

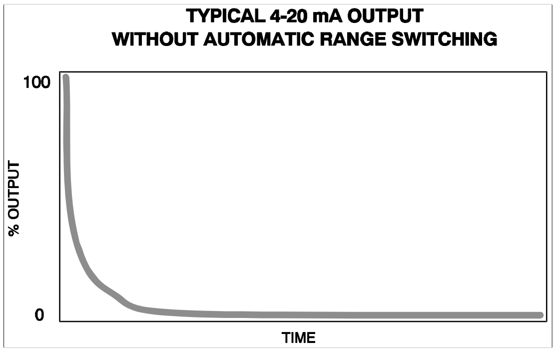


Illustration 24: Output without range switching

Enabling Output Auto-Range Switching

NOTE: *Only output 1 has automatic range switching available.*

From the menu, select [out] [out1] [ArnG], then edit the setting to show [YES].

With automatic range switching for output 1 enabled, the user can see which range output 1 is on by selecting [out] [out1] [rnG] from the menu. This frame gives a live update of the range number. The [rnG] frame can only be selected from the menu if [ArnG] is set to [YES].

Example of Output Auto-Range Switching D.O.

Illustration 25 shows the effect of adding range switching to the 4 mA to 20 mA output - it shows the 4 mA to 20 mA recovering to stay within 10% to 100% of scale by automatically switching between ranges. Only on the last range, range 5, does the 4 mA to 20 mA output fall below 10% of scale. Illustration 24 shows the D.O. level coming down after a calibration, but has virtually no resolution at the operating level.

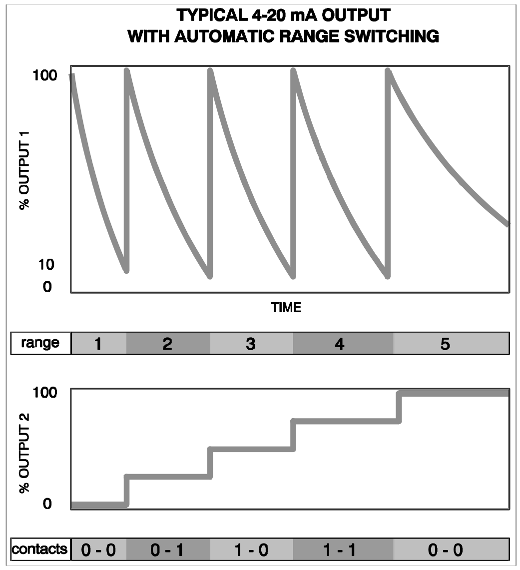


Illustration 25: Output with range switching

Remote Indication of Range

When output 1 is auto-ranging, the user needs to indicate to the recorder, DCS or computer, which range it is on. This can be accomplished by using the serial output, the alarm contacts or the second 4 mA to 20 mA output. The analyzer will allow the methods to be used simultaneously.

To achieve results similar to those in illustration 25, use the following settings:

To use the serial output refer to the *Serial Communication* section for complete details.
NOTE: *It may be easier to simply use the serial link digital data all the time and discontinue 4 mA to 20 mA auto-range monitoring.*

To use the relay contacts for range indication set [AL] [ArnG] to [on].
NOTE: *If the relays are used for alarms, they cannot be simultaneously used for range indication. The alarm LED, type indication on the display, and serial indications are still active even when the relays are used for range indication.*

To use the second 4 mA to 20 mA output for range indication, the following settings must be used for the selected output.

OUTPUT 1		***OUTPUT 2***	
[in]	[d.o.]	[in]	[ArnG]
[ON.OF]	[on]	[ON.OF]	[on]
[unit]	[1E-6] (for ppm)	[LO]	1
[HI]	20	[HI]	5
[LO]	0		
[ArnG]	[YES]		

Also set the [HI] and [LO] parameters to indicate which values represent 4.00 mA and 20.00 mA. Table 2 shows the relationship between the range number and and some of the possible LO/HI settings. Table 3 summarizes the results for these settings.

Range Number	***LO=0 HI=5***	***LO=1 HI=5***	***LO=5 HI=1***	***LO=5 HI=0***
OUT2=OFF	4.00	4.00	4.00	4.00
1	7.20	4.00	20.00	20.00
2	10.40	8.00	16.00	16.80
3	13.60	12.00	12.00	13.60
4	16.80	16.00	8.00	10.40
5	20.00	20.00	4.00	7.20

Table 2: Using output 2 for range

Range Number	***Output 1, % full scale***	***Output 1, scale ppm D.O.***	***Output 2, mA***	***Relay Contacts***
1	100	20000	4.00	A = 0, B = 0
2	10	2000	8.00	A = 0, B = 1
3	1.0	200	12.00	A = 1, B = 0
4	0.1	20	16.00	A = 1, B = 1
5	0.001	2	20.00	A =0, B = 0

Table 3: Example of range switching for D.O. input

Unit Selection

The dissolved oxygen input allows the user to select between ppm and ppb units. Edit the unit setting to choose the desired units for the HI and LO settings.

Temperature uses Celsius for metric units and Fahrenheit for imperial units. Pressure uses kPa for metric units and psi for imperial units. The choice between metric or imperial units is made in the configuration menu.

The output units will be different for high and low settings, depending on the input selected. To display the input units, use select [unit] in the output menu.

Testing With 4 mA to 20 mA

The 4 mA to 20 mA outputs can be used to test or calibrate downstream instruments such as recorders. Select [cur] from the output menu to display the signal currently transmitted in mA. The display will update as the output signal changes based on the input signal.

To generate a test 4 mA to 20 mA output, press *ENTER* to access edit mode. Use the arrow keys to display the desired signal for the test (typically 4.00 mA or 20.00 mA). Press *ENTER* to have the displayed value transmitted. The output signal will change to the displayed value. This process can be repeated as often as necessary.

The output signal is held at the value displayed until the program leaves this part of the menu.

ALARM FUNCTIONS

Two alarms, alarm A and alarm B, are a standard feature. Each alarm has an alarm contact associated with it which can be used for remote alarm indication or for control functions. The two alarms function independently of each other. Either alarm can monitor the dissolved oxygen, temperature, or pressure input.

Each alarm features an adjustable set-point, user-selectable alarm type, adjustable differential (also called hysteresis), unit selection, and an on/off switch. The alarm types which are available are high, low, deviation, and fault. Alarms can be set anywhere between 0 ppm and 9,999 ppm *or* 0 ppb and 9,999 ppb for the dissolved oxygen input, –5 °C and 105 °C for the temperature input, and between 75 kPa to 130 kPa for the pressure input. The differential setting is adjustable from 0 ppm to 100 ppm *or* 0 ppb to 100 ppb for dissolved oxygen.

Wiring and NO/NC Contacts

The alarm contacts for alarms A and B may be wired as normally open or normally closed. By default, the analyzer assumes the alarm contacts are wired normally open. A normally open alarm contact will be inactive if there is no alarm condition and will be active when there is an alarm condition. If the program configuration and the wiring for each alarm do not match then the incorrectly configured alarm contact will generate an alarm when there is no alarm condition and vice versa.

The factory default for each relay is to be jumpered in the N.O. position. To change an alarm relay from N.O. to N.C., remove the jumper from the N.O. position and jumper the N.C. position. The jumper positions for the two relays are circled in illustration 26.

Relay B has additional jumper positions marked NORM and ACAL. For normal alarm operation the NORM position is jumpered. The ACAL position is used for the optional auto-calibrator. Factory default is NORM jumpered and ACAL not jumpered.

To change the configuration of the alarm contacts, select [CONF] [AL] from the menu.

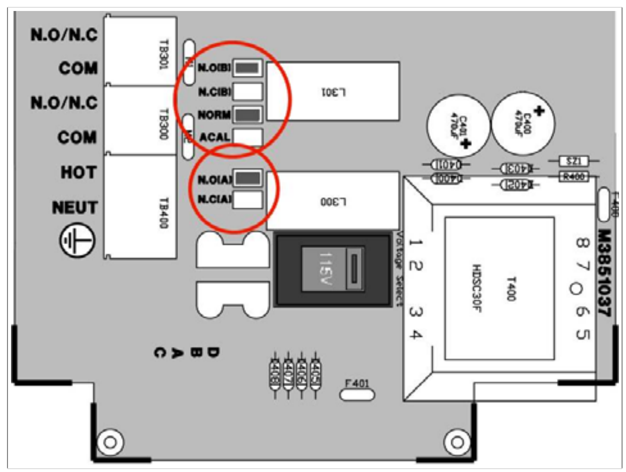


Illustration 26: Alarm wiring

Use of Relay Contacts

By default, the relay contacts will be used to indicate alarm conditions. If there is an alarm condition for either alarm, then the alarm will be indicated using both the alarm LED and the relay contact. This function of the relay contacts can be selected by setting [AL] [ArNG] to [OFF].

The relay contacts can also be used for remote indication of the range number for the first 4 mA to 20 mA output. In this case the alarms will continue to function. An alarm is indicated using the alarm LED but not the relay contact. This usage of the alarm contacts is selected by setting [AL] [ArNG] to [on]. Remote range indication is described in the *Output Signals* section.

Unit Selection

The alarm module will be using different units for its settings depending on the input selected and does not necessarily use the same units as the sample display. Select [unit] from the alarm menu to display the units in use for an alarm. The [unit] setting affects the set-point, differential, and deviation settings for the alarm.

The temperature and pressure inputs will use different units depending on whether metric or imperial units are selected. For temperature and pressure the unit selection can be viewed only. The choice between metric or imperial units is made in the configuration menu.

The D.O. input allows the user to select between ppm and ppb units. Edit the unit setting to choose the desired units for alarm settings.

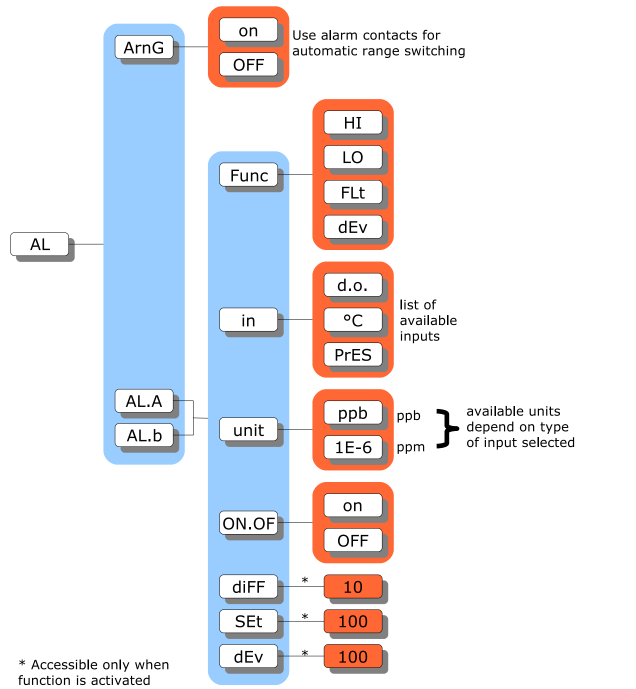


Illustration 27: Alarm menu

High or Low Alarm

A high alarm is set when the value of the dissolved oxygen, temperature, or pressure rises above the set-point and is cleared when the dissolved oxygen, temperature, or pressure drops to below the set-point minus the differential (refer to illustration 28). A low alarm is set when the value of the dissolved oxygen, temperature, or pressure drops below the set-point and is cleared when the dissolved oxygen, temperature, or pressure rises to above the set-point plus the differential (refer to illustration 29). The differential has the effect of setting the sensitivity of the alarm. The differential provides a digital equivalent of a hysteresis.

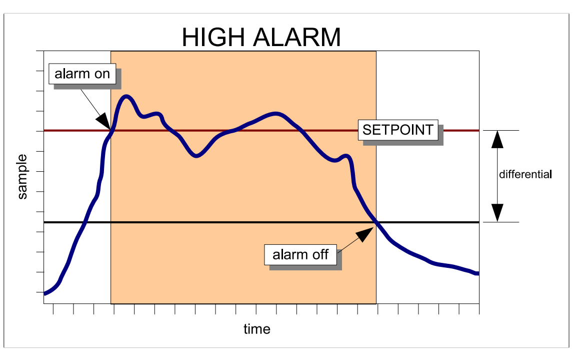


Illustration 28: High alarm

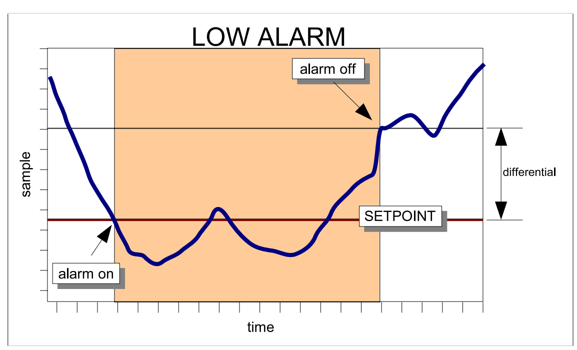


Illustration 29: Low alarm

Deviation Alarm

A deviation alarm is practical when the process is expected to stay within a certain range. An alarm will be set if the input deviates too far from a set-point. Please note that the [dEv] frame only shows up in the menu after the alarm function has been changed to deviation alarm, since it would have no effect for a high, low, or fault alarm.

Example:
If the dissolved oxygen is expected to stay between 100 ppb and 200 ppb, then we would set [in] to [d.o.], [Func] to [dEv], [SEt] to 150, and [dEv] to 50. Effectively, a high alarm at 200 ppb and a low alarm at 100 ppb has been set.

The differential setting will continue to function as for high and low alarms.

Fault Alarm

A fault alarm for an input will be set when anything goes wrong with that input. Something is wrong with an input if the input is off-scale or an unacknowledged error message exists for that input. Caution messages do not cause a fault alarm.

To use an alarm as a fault alarm, select [FUNC] from the alarm menu, then select [Flt]. To enable the alarm, make sure the on/off switch is set to [on]. Also, set the input in the alarm menu to the desired input, either dissolved oxygen, temperature, or pressure.

The set-point and differential for the alarm have no effect when the alarm is used as a fault alarm.

Alarm Indication

If there is an alarm condition on either alarm A or B, the alarm LED on the front panel will be lighted and the corresponding alarm relay will be set. The error menu will also show a numbered caution message for the alarm, however an alarm caution will not light the error LED. The heading *Caution Messages for Alarms* in the *Error Messages* section lists the codes used to indicate alarm conditions. In case of a fault alarm both the error and alarm LED's will be lighted.

In addition, an alarm condition for an input will cause the sample display for that input to alternate with the alarm function display, either [LO], [HI], [dEv], or [FLt]. Press *SAMPLE*, then use the *Up* or *Down* key to display each of the two samples, if necessary. Each sample frame will first display the sample reading, then after two seconds the alarm type for that input, if any.

Using Alarms for On/Off Control

The alarms can also be used for process control; the alarm contacts will then function as on/off signals for switches controlling a valve, pump, motor, etc. The set-point determines the control point of the system and the setting of the differential controls the amount of corrective action before a controlled shut-off occurs. Examples of high and low control using the alarms are shown in the following illustrations.

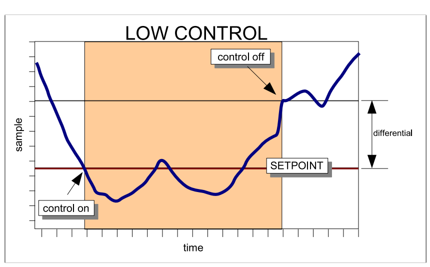


Illustration 31: Low control

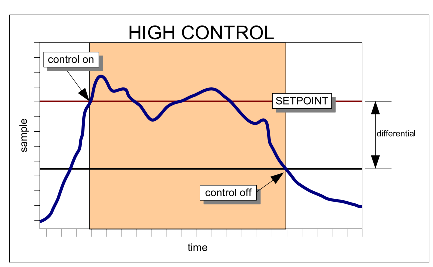


Illustration 30: High control

CONFIGURATION OF PROGRAM

The 865 analyzer has been designed with ease-of-use in mind. In most cases the analyzer factory configuration will handle the application and no configuration of the analyzer is necessary.

Relay Contacts; NO/NC

The 865 program by default assumes the relay contacts are wired normally open. A normally open relay contact will open if there is no alarm and will be closed by the microprocessor when there is an alarm condition. If the program configuration and the wiring do not match the incorrectly configured relay, it will generate an alarm when there is no alarm and vice versa.

Metric or Imperial Units

By default the analyzer will use metric units. This means that temperature will be displayed using degrees Celsius and that the prompt for the temperature input will be [°C]. Using metric units, the pressure is displayed as kPa. The analyzer can also be made to use imperial units. Using imperial units, temperature will be displayed using degrees Fahrenheit and the prompt for the first temperature input will be [°F]; pressure will be displayed as psi throughout the program.

For practical reasons the temperature input is always identified as °C throughout this instruction manual and in the menus.

To select imperial units for the analyzer, select [unit] from the configuration menu, then go into edit mode and change the [°C] prompt to [°F]. Since this is a global setting, both the units used for temperature and for pressure will change.

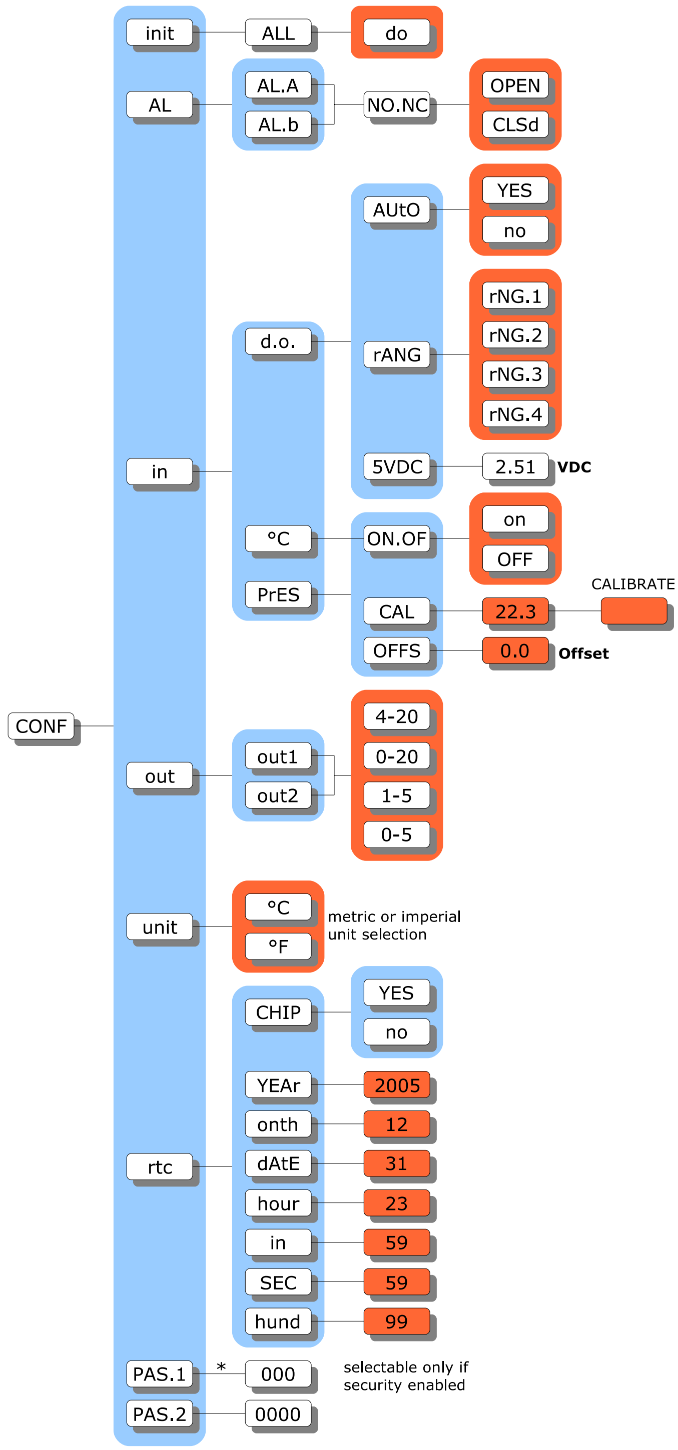


Illustration 32: Configuration menu

Re-initializing All Settings

Occasionally it may be desirable to reinitialize all of the program settings to bring them back to default. Executing an initialization will cause the analyzer to reset all the program variables and settings to factory defaults.

Parameters such as the output signal settings, alarm settings, and the program configuration will need to be re-entered if they were different from the factory default settings.

Select [CONF] [init] [ALL] from the menu. The display will flash [do]. Nothing will happen if you press *CANCEL* or *SAMPLE*. The analyzer will re-initialize only when the user presses *ENTER*.

Password Security

The factory default is no security. No password security should be necessary if you are the only user and no protection of settings is needed. Password security should be implemented for critical applications where program settings may only be changed by authorized personnel.

For minimal security, IC Controls advises that the user set a level 2 password. Leaving the level 1 password at “000" gives the operator complete access to all areas of the program but does not allow settings to be changed in the configuration menu. With minimal security in place, unauthorized users are prevented from enabling password security.

Appendix A describes how to enable or disable security.

Real-Time Clock

The analyzer maintains an internal date/time clock used for internal date/time stamping of system events and the internal data log. Both the system events and the internal data log are accessed using the IC Net™ Intelligence Access Program, which is available as an option.

The model 865 analyzer is equipped with a real-time clock which will maintain the correct time and date even with the analyzer power turned off.

To set the real-time clock, select [CONF] [rtc] from the menu. Set the year, month, date (day of the month), hour, minute, and second. The [hund] frame displays hundreds of a second but cannot be edited.

A faster way to set the clock in the analyzer is to use the IC Net™ program to synchronize the analyzer with the connected computer.

Temperature Input Calibration

Refer to the *Electronic Hardware Alignment, Alignment of Temperature Input Circuit* section for the procedure on calibrating the temperature input.

Pressure Input Calibration

Refer to the *Electronic Hardware Alignment, Alignment of Pressure Input Circuit* section for the procedure on calibrating the pressure input.

INSTRUMENT MAINTENANCE

The dissolved oxygen sensors provided by IC Controls are designed for simple maintenance. The sensors are robust and will withstand difficult applications when properly applied and maintained. Follow instructions in this section to promote proper operation.

NOTE: *Galvanic D.O. sensors need a continuous current drain. Maintenance should be done with the D.O. sensor wired to it's analyzer or with shorted coax center to shield.*

Weekly Maintenance

1) Check that there are no error indications and displayed concentration reading is reasonable.
2) Inspect unit for leakage.
3) Check that sample flow rate is OK - between 50 mL/min and 200 mL/min.

Monthly Maintenance

Certain applications may require occasional sensor cleaning.

1) Perform a calibration and return sensor to service if response is fast (D.O. measurement returns to low level in less than 15 minutes) and efficiency stays fairly constant. Refer to *Calibration* section for complete procedure.
2) If response is slow or a large efficiency change occurs, perform a visual examination of the sensor cell area. If needed, a soft wipe can be used to blot tip, plus detergent and water may be used to remove any deposits.
3) After cleaning, rinse the sensor cell area thoroughly with deionized water.
4) Black or red discoloration may be accompanied by very slow response that does not go away with standard maintenance. Refer to the *Troubleshooting* section.
5) Place the electrode back into service and run for one hour prior to calibration. If the response time is still very slow, check for air bubbles (see *Troubleshooting*) and remove, or the membrane module may require replacement. Follow *Yearly Maintenance* procedure.
6) Calibrate and return the sensor to service.

Yearly Maintenance

Replace the membrane module and electrolyte as follows.

1) Unscrew the electrode cap and dump the contents.
2) Flush the cell internals with deionized water and examine the lead coils for black or red discoloration or heavy gray coating. Such coatings should be removed for best performance (**CAUTION:** *The lead coils are soft metal, never use force in cleaning*). Clean light fouling by wiping in the direction of the coils until a shine appears. Heavier fouling may come off with a toothbrush, worked along the coils so the bristles get down in the cracks, followed by rinse and wiping to achieve a dull shine.
3) Remove the old membrane module from the cell and replace with a new one; refer to the *Installation* section for complete procedure on *Assembly of the Dissolved Oxygen Sensor*. Re-assemble the cell, calibrate, check efficiency and if above 50%, return to service.

Sensor Chemical Cleaning

Recovery of a failing D.O. sensor can sometimes be achieved with P/N A1100194, D.O. sensor cleaning solution.

This procedure should be done over a sink. ***Wear plastic or rubber gloves and protective eye wear as the solution is acidic.*** Wash hands thoroughly with lots of water if the solution comes in contact with the skin.

1) Remove the protective cap exposing the coils and gold tip.
2) Immerse in cleaning solution (refer to illustration 33) for 5 minutes to 10 minutes, or until deposits disappear.
3) Remove and rinse in deionized water; use a soft cloth to wipe in direction of coils or a toothbrush to speed removal.
4) Repeat steps 2 & 3 until coils and tip look clean and coils have a gray shine.
5) Re-assemble the D.O. sensor with a new membrane module.

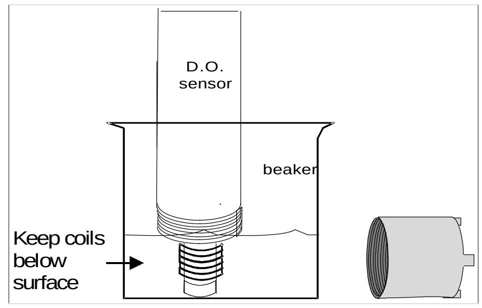


Illustration 33: D.O. sensor cleaning

6) Fill membrane cap with fill solution and re-assemble sensor as per *Assembly of the Dissolved Oxygen Sensor* in the *Installation* section..
7) Calibrate and check that efficiency is above 50%.
8) Repeat steps 2 to 7 as needed to get at least 50% efficiency. If 50% efficiency unattainable, D.O. sensor should be replaced.

Instrument Cleaning

1) For light dust, use deionized water on a lint-free wipe and clean the LED window first, then the remaining parts of the enclosure.
2) For heavy dirt, use methyl hydrate on a lint-free wipe and clean the LED window first, then the remaining parts of the enclosure.

TROUBLESHOOTING

High D.O. Readings
The most common problem with low level ppb dissolved oxygen is with air leaks into the sample. Fittings, pressure regulator valves, rotameters, valves and plastic tubing are prone to air leaks. Air leaks can be confirmed by increasing the sample flow. If the D.O. reading decreases with increased flow and returns when the flow returns, a leak is strongly suspected since more volume dilutes the oxygen leaking in. Some components may trap air bubbles producing a similar flow change but not quite full return, plus will slowly fall toward the low ppb readings. Alleviate the problem by finding and eliminating the leak (or bubble retaining housing).

NOTE: *Air contains 20.9% oxygen or in parts per billion, 209,000,000 ppb. Water is saturated with dissolved oxygen at 8,240 ppb (refer to Appendix B, 25 °C and 101.3 kPa) so air can saturate about 25,000 times as much water, or at 1 ppb can add an extra ppb to 25,000,000 times as much sample.*

Slow Response
Typically due to excessive sample line length and low flow, producing long sample transport lags. Resolve by adding a fast-flow loop with the sensor in a short side stream, or by shortening the line. Slow response can also be caused by a buildup of dirt in the sample line which greatly increases the porous surface area that can absorb and release oxygen. Resolve by adding a fast-flow loop with the sensor in a short side stream, or by shortening the line. Alternatively, a dirty-water sample system may be needed.

Readings drop fast after calibration but hang up well above expected level, then fall slowly
Due to an air bubble trapped in the sample system. Refer to the heading *Tip: How to clear an air bubble*, below.

Readings go high or off scale and won't come down. Also the efficiency goes high
Typically an indication of a pinhole or rip in the membrane. Replace the membrane module with a new one.

Readings consistently low or spike low
Characteristic of wiring problems between the analyzer and the sensor; an open circuit in the field wiring will result in zero cell current and a reading less than 1 ppb.
Also, characteristic of of oxygen consuming bacteria growing on a sample line filter, inside the sample line or even the D.O. sensor membrane. Actual D.O. at the sensor is lower. Remove any sample filter and use a dirt bypass arrangement.

Readings gradually falling
The analyzer can no longer be calibrated properly. This problem is typical of scale or sludge/slime deposits on the sensor face; and/or in the sample line. The sensor and/or line will need to be cleaned. Sample lines can often be cleaned with a weak solution of bleach. Refer to the *Instrument Maintenance* section for sensor cleaning procedures.

Black or red color in D.O. sensor
Not necessarily a problem, especially when seen as orange. Caused by long exposure to air, producing red lead oxide. May go away gradually if left running in a low ppb D.O. sample for several days and the speed of response will improve as well.

a) Correct by disassembling the cell and wiping away deposits using a rag or a toothbrush.
NOTE: *Ensure that you wipe in the direction of the coils to prevent damage to the cell.*

b) If cell response remains slow, chemically clean and restore using IC Controls P/N A1100194 dissolved oxygen sensor renew solution. Replace the membrane module and return to service.

Readings trend where expected but spike high
This problem is typical of air bubbles in the sample line. If a bubble hangs up in the D.O. flow cell, a high surge that slowly falls over some hours may be observed. Correct by finding air in-leakage point and stopping leak.

TIP: How to Clear an Air Bubble
You can clear an air bubble stuck in the flow cell by loosening the cell retaining nut, and letting the cell rise up a bit, then pressing it back in until it bottoms. Another way to clear an air bubble is to temporarily increase the sample flow. This is easy to do when using a dirt bypass arrangement with a head tank. Simply force the bypass flow through the flow cell by placing a finger over the standpipe in the head tank.

ELECTRONIC HARDWARE ALIGNMENT

Alignment of Dissolved Oxygen Detection Circuit

1. Set up a precision multimeter, Fluke 8051A or equivalent, to read VDC.
2. Use the "D.O.+" sensor connections, TB200-1, and "D.O.-" sensor, TB200-3, as common. Refer to wiring diagram, D5920101.
3. Place analyzer on manual range selection by selecting [CONF] [in] [d.o.] [Auto] from the menu and editing the setting to read [no].
4. Set the D.O. input range to range 4 by selecting [CONF] [in] [d.o.] [rANG] from the menu and editing the setting to read [rNG.4].
5. Set the D.O. efficiency constant to 100% by selecting [d.o.] [EFF] from the menu and editing the value to read 100.0%.
6. Adjust the electronic standardize with blue trimpot VR200, located mid-board above the D.O. terminal block. Adjust the trimpot to a reading of 2.50 V at TP200 while inputing 0.120 VDC through a 10K 1% resistor. 0.120 VDC simulates 8,240 ppb D.O. at approximately 100 % efficiency under the above conditions.
7. Return analyzer to automatic range selection by selecting [CONF] [in] [d.o.] [Auto] from the menu and editing the setting to read [YES].

Alignment of Temperature Input Circuit

The temperature input can be adjusted both by making electronic adjustments and/or by having the program compensate for differences in offset. Both procedures are described below.

Adjusting Electronic Calibration

1. Remove any offset calculated by a previous software calibration of the temperature input. Select [CONF] [in] [°C] [OFFS] from the menu and edit the offset to read 0.0.
2. Set up a precision multimeter, Fluke 8051A or equivalent, to read VDC.
3. Use the "- TEMP" sensor connection; TB201-2, as common. Place a 100 Ω 1% resistor across T+ and T- terminals. Adjust blue trimpot VR201 for a reading of 0.200 V at TP202. Refer to drawing D5920101 for component locations.
4. Place a 138.5 Ω 1% resistor across T+ and T- terminals. Adjust blue trimpot VR202 for a reading of 4.85 V at TP202. Refer to drawing D5920101 for component locations.
5. Close the case and press *SAMPLE* followed by the *Down* arrow key to display the temperature reading.
6. Re-insert the 100 Ω 1% resistor and adjust VR201 until the display reads 0.0 °C ± 0.1 °C.
7. Re-insert the 138.5 Ω 1% resistor and adjust VR202 until the display reads 100.0 °C ± 0.1 °C.

Software Calibration

To do a software calibration of the temperature input, the correct temperature needs to be known.

1. Select [CONF] [in] [°C] [CAL] from the menu. The actual temperature as measured by the temperature sensor will be displayed. Edit the displayed value to the known correct temperature. Press *ENTER* to leave edit mode, then *SELECT* to start the calibration.
2. The current temperature will be shown using a flashing display. When the input appears to be stable, press *ENTER* to set the new temperature. The software offset for the temperature input will be adjusted automatically.

3. The calculated offset in degrees Celsius can be viewed by selecting [CONF] [in] [°C] [OFFS] from the menu. Whenever the hardware alignment is 'correct', the offset will be 0.0. The displayed offset can be edited.

Alignment of Pressure Input Circuit

The pressure input can be adjusted both by making electronic adjustments and/or by having the program compensate for differences in offset. Both procedures are described below.

Adjusting Electronic Calibration

1. Obtain the current barometric pressure from your local weather station or from a barometer.
2. Remove any offset calculated by a previous software calibration of the temperature input. Select [CONF] [in] [PrES] [OFFS] from the menu and edit the offset to read 0.0.
3. Set up a precision multimeter, Fluke 8051A or equivalent, to read VDC.
4. Use the "TEMP-" sensor connection, TB201-2, as common. See wiring diagram D5920101. Adjust blue trimpot VR203, located at top of board, for a reading of 2.50 V at TP204.
5. Close the case and press the *SAMPLE* key followed by the *Down* arrow key twice to display the pressure reading. Reading should be within 0.1 kPa of the pressure obtained in step 1.

Software Calibration

1. Obtain the current barometric pressure from your local weather station or from a barometer.
2. Select [CONF][in] [PrES] [CAL] from the menu. The actual pressure as measured by the pressure sensor will be shown. Edit the displayed value to the known, correct pressure. Press *ENTER* to leave edit mode, then *SELECT* to start the calibration.
3. The current pressure will be shown using a flashing display. When it looks like the input is stable, press *ENTER* to set the new pressure. The software offset for the pressure input will be adjusted automatically.
4. The calculated offset in kPa can be viewed by selecting [CONF] [in] [PrES] [OFFS] from the menu.

Calibration of 4 mA to 20 mA Outputs

Use one of the following two approaches to get the analyzer to output the desired current level, and then make electronic adjustments to calibrate the output.

Approach 1: Simulated 4 mA to 20 mA Output (Self Calibration)

1. Select [cur] from the output 1 menu to display the present output current in mA. The display will be updated as the output current changes based on the input signal and the program settings.
2. To simulate a different 4 mA to 20 mA output signal, press *ENTER* to enter edit mode. Use the arrow keys to display the desired output needed for testing the output signal. Press *ENTER* to select the displayed value. The output signal will be adjusted to put out the desired current. This process can be repeated as often as necessary to output different signal levels.
3. The output signal is held at the displayed level until the program leaves this menu selection. Make calibration adjustments while the analyzer shows the output at 20.00 mA.
4. Repeat the above steps for output 2.

Approach 2: Use Voltage Source to Adjust Input

This faster calibration approach requires a voltage source for the input.

1. To calibrate output 1, set [in] = [°C]. Input a low enough signal to cause analyzer to indicate [- Err]; the analyzer will output 4.00 mA. Reverse the polarity or input a high enough signal to cause the analyzer to indicate [+ Err] ; the analyzer will output 20.00 mA.
2. Repeat step 1 for output 2.
   TIP: *Both outputs can be simultaneously calibrated if you set [in] = [°C] for both inputs.*
3. Be sure to return the inputs back to the desired parameters to be transmitted. Typically D.O. for output 1 and temperature for output 2.

Adjusting 4 mA to 20 mA Electronic Calibration

1. The outputs are isolated from the main circuit, therefore, measurements are made with common at the output 2 terminal, TB304, '-' terminal.
2. Measure output 1 'zero' at TP301 (pin 8 of U304) while output 1 is outputting 4.00 mA. The reading should be between -0.870 V and -0.890 V. Adjust #2 voltage with VR300.
3. Change analyzer output to 20.00 mA; switch multimeter to mA and measure '+' terminal of output 1, and adjust VR301 so that the current reads 20.00 mA. Return analyzer output to 4.00 mA and trim actual output to 4.00 mA using VR300. Check again at 20.00 mA and repeat adjustments until satisfied.
4. Measure output 2 'zero' at TP300 (pin 7 of U304) while output 2 is outputting 4.00 mA. The test point should read between -0.870 V and -0.890 V. Adjust #2 'zero' voltage with VR302.
5. Change output at output 2 to 20.00 mA; switch multimeter to mA and measure '+' terminal of output 2, at TB304, and adjust VR303 (span pot) until the current reads 20.00 mA.
   NOTE*:* *Zero and span are very wide range adjustments which show small interactions. Recheck zero and span to confirm good calibration.*
6. If so desired, all software settings can be returned to factory default condition by following the procedure in *Configuration of Program; Re-initializing All Settings*.

Testing Relay Outputs

1. Relay output operation can be verified by testing for contact closure or continuity at each relay. To activate a relay, select [CONF] [NO.NC] [AL.A] from the menu. Press *ENTER* to go into edit mode, then press the *Up* or *Down* arrow key to change the normally open/normally closed configuration from open to closed. Press *ENTER* to accept the new value. A closed contact should open and an open contact should close.
2. Repeat step 1 for the Alarm B contact.
3. If so desired, all software settings can be returned to factory default condition by following the procedure in *Configuration of Program; Re-initializing All Settings*.

DISPLAY PROMPTS

[0-5]	Use 0 VDC to 5 VDC configuration for output.
[0-20]	Use 0 mA to 20 mA configuration for output.
[1-5]	Use 1 VDC to 5 VDC configuration for output.
[1E-6]	dissolved oxygen units in parts per million, ppm; unit selection in scientific notation.
[4-20]	Use 4 mA to 20 mA configuration for output.
[5VDC]	Diagnostic to display 0 VDC to 5 VDC raw input voltage for D.O. input.
[ACC.*n*]	Access level for security. Displayed after password entered by user.
[AL]	Alarms.
[AL.A]	Alarm A.
[AL.b]	Alarm B.
[ArnG]	Automatic range switching for 4 mA to 20 mA output.
[ASCI]	ASCII serial output log.
[Auto]	Automatic.
[BAud]	Baud rate for serial communications.
[°C]	Temperature in degrees Celsius; use metric units.
[CAL]	Calibrate analyzer.
[CHIP]	Chip: Is this analyzer equipped with a real-time clock chip?
[CLr]	Clear the internal data log.
[cnt]	Count of number of readings in internal data log.
[CLSd]	Normally closed alarm contact.
[CONF]	Configuration of program menu.
[Cont]	Continue internal data log when buffer full.
[cur]	Signal output in mA, or current.
[dAtE]	Date: Real-time clock setting for day of the month.
[dEv]	Deviation alarm.
[diff]	Differential for alarm settings.
[dLAY]	Alarm activation delay.
[d.o.]	Dissolved oxygen input.
[do]	Do: press *ENTER* to execute the reset/clear action.
[donE]	Done: reset/clear action has been taken.
[EFF]	D.O. cell efficiency constant; adjusted via calibration.
[Err]	Error or warning number.
[Er.94]	RAM checksum failed. Some settings may be lost.
[°F]	Temperature in degrees Fahrenheit; use imperial units.
[FLt]	Fault alarm.
[FrEq]	Frequency of internal data log updates in seconds.
[FULL]	Full: What to do when internal data log is full; continue or stop.
[Func]	Function, alarm type.
[HI]	High alarm; high limit (20 mA) for 4 mA to 20 mA output window.
[Hold]	Output hold during calibration.
[hour]	Hour: Real-time clock setting.
[hund]	Hundredth of a second: Real-time clock display.
[iLOG]	Internal data log.
[in]	Input OR Minute: real-time clock setting.
[kPa]	kPa units for pressure.
[LO]	Low alarm; low limit (4 mA) for 4 mA to 20 mA output window.
[NodE]	Node number for IC Net communications.

DISPLAY PROMPTS CON'T

[NO.NC]	Normally open/Normally closed.
[OFF]	Off.
[OFFS]	Offset.
[on]	On.
[ON.OF]	On/off switch.
[onth]	Month: Real-time clock setting.
[OPEN]	Normally open alarm contact.
[out]	Output menu.
[out 1]	First 4 mA to 20 mA analog output channel.
[out 2]	Second 4 mA to 20 mA analog output channel.
[PAS.1]	Set password 1, operator access.
[PAS.2]	Set password 2, complete access.
[PASS]	Enter password to change access level.
[ppb]	Parts per billion D.O. unit selection.
[Pr.C]	Pressure compensation setting.
[PSI]	psi units for pressure.
[rANG]	Analyzer dissolved oxygen input range selection.
[rnG]	Range number.
[rtc]	Real-time clock.
[SEC]	Seconds: Real-time clock setting.
[SEr]	Serial communications menu.
[SEt]	Set-point: Select manual compensation.
[StAr]	Start internal data log.
[StbY]	Standby mode for analyzer.
[StOP]	Stop internal data log.
[t.c.]	Temperature compensation setting.
[unit]	Display/setting of units.
[YEAr]	Year: Real-time clock setting.

GLOSSARY

D.O. Dissolved oxygen.

EPROM Erasable Programmable Read Only Memory. The EPROM chip holds the program which determines the functioning of the 855 analyzer. Replacing the EPROM chip with a chip containing a new or an updated program changes the way the analyzer functions. The EPROM chip is programmed by the manufacturer.

Hysteresis **t**he reading at which an alarm is turned on is not the same reading at which the alarm is turned off again. This phenomenon is referred to as the hysteresis.

LED Light Emitting Diode. LEDs are used as on/off indicators on the front panel of the 855.

Menu the series of prompts which determine the layout of the program used by the analyzer.

Microprocessor an integrated circuit (chip) which executes the program on the EPROM chip and controls all the input/output functions.

NC Normally closed

NO Normally open

Normally closed each of the alarm contacts can be wired and configured as normally open or normally closed. A circuit which is wired normally closed will be closed (i.e. the external device wired to it is turned on) when the analyzer is not powered.

Normally open a circuit which is wired normally open will be open (i.e. the external device wired to it is turned off) when the analyzer is not powered.

ppb Concentration as parts per billion.

ppm Concentration as parts per million.

RAM Random Access Memory. Memory in a RAM chip can be both written to and read from. The contents of RAM will disappear as soon as the RAM chip loses power. The RAM chip has a battery backup device which preserves the contents of the RAM chip for a considerable time even if the analyzer is turned off. All settings are stored in RAM.

TC Temperature compensator

Temperature compensation correction for the influence of temperature on the sensing electrode. The analyzer reads out concentration as if the process were at 25 °C or 77 °F, regardless of actual solution temperature.

Appendix A — Security

The analyzer has a built-in password protection system. This security system is disabled by default and does not need to be enabled if no password protection is necessary. If you choose not to enable the password protection system then the user will have unrestricted access to all analyzer settings available through the menu as described in this manual.

Having security disabled gives the user the same access to the program as being at access-level 2 at all times.

With security enabled anyone can view settings anywhere in the program. When you do not have proper access rights, the program will display [PASS] for 2 seconds, indicating that a proper password must be entered before being allowed to proceed.

This appendix contains instructions for setting passwords in the configuration section of the menu. Daily usage of the analyzer by the operator does not require knowledge of setting passwords in the configuration section since all passwords are entered by selecting [PASS] directly from the main menu.

access level	***description***
0	View-only access. **Usage:** operator and for information-only.
1	Access to editable settings (calibration, setpoint, span, etc.) except for configuration menu. **Usage:** calibration and technical adjustments.
2	Master access to all settings. **Usage:** configuration of analyzer, installation, management. Passwords can be changed.

Table 5: Access levels

ENTERING A PASSWORD

With security enabled, select [PASS] from the main menu. The analyzer will display [0000]. Use the arrow keys to display your level 1 or level 2 password, then press *ENTER*. The program will display [good], followed by your access level before returning to the main menu. If an incorrect password was entered, the program displays [bAd] instead. Refer to illustration 34 to determine how the program validates a password.

You will now have level 1 or level 2 access for as long as you are working with the analyzer. The access level will automatically be restored to level 0 after no key has been pressed for 15 minutes. This 15-minute timeout will also return to display the main sample.

It is good practice to return the analyzer to level 0 access (or level 1 access if password 1 is set to "000") when you have finished using the analyzer. This is accomplished by selecting [PASS] from the main menu, then pressing *ENTER* with [0000] displayed.

ENABLING PASSWORD SECURITY

When security is disabled, both password 1 and password 2 are set to "0000." Security is enabled by setting password 2 to a non-zero value.

Level 2

Select [CONF] [PAS.2] from the menu. The analyzer will display [0000]. Use the arrow keys to change the display to the desired password for level 2. You can press *SAMPLE* at any time to safely cancel password entry. Press *ENTER* to enter the password into memory and to enable password security. The analyzer program automatically returns to the configuration menu.

With only password 2 set to a non-zero value, level 2 access is required to make changes in the configuration menu but all other settings are unprotected. Effectively the user will always have at least level 1 access.

Level 1

At this point, password 1 is still "000." You may optionally enable operator access control or level 1 security by changing the level 1 password from "000" to a non-zero value. Change the password by selecting [CONF] [PAS.1] from the menu, then entering an appropriate 3-digit password.

RECORDING YOUR PASSWORDS

You may want to write down the passwords you set and store them in a secure place. Once a password has been set, there is no way to redisplay it. Since passwords are set in the configuration menu, level 2 access is required to change either password. If you have forgotten the level 2 password, there is no simple way to regain access to the analyzer. Contact the factory if you find yourself locked out of the analyzer.

DISABLING PASSWORD SECURITY

Password security can be disabled by setting the level 2 password to "0000." In order to change the password you must first have level 2 access to the program.

Select [CONF] [PAS.2] from the menu, then press *ENTER* when the program displays [0000]. Both passwords 1 and 2 are set to "0000" and security is now disabled. The main menu will be changed to exclude the [PASS] frame , and the configuration menu will no longer have the [PAS.1] frame.

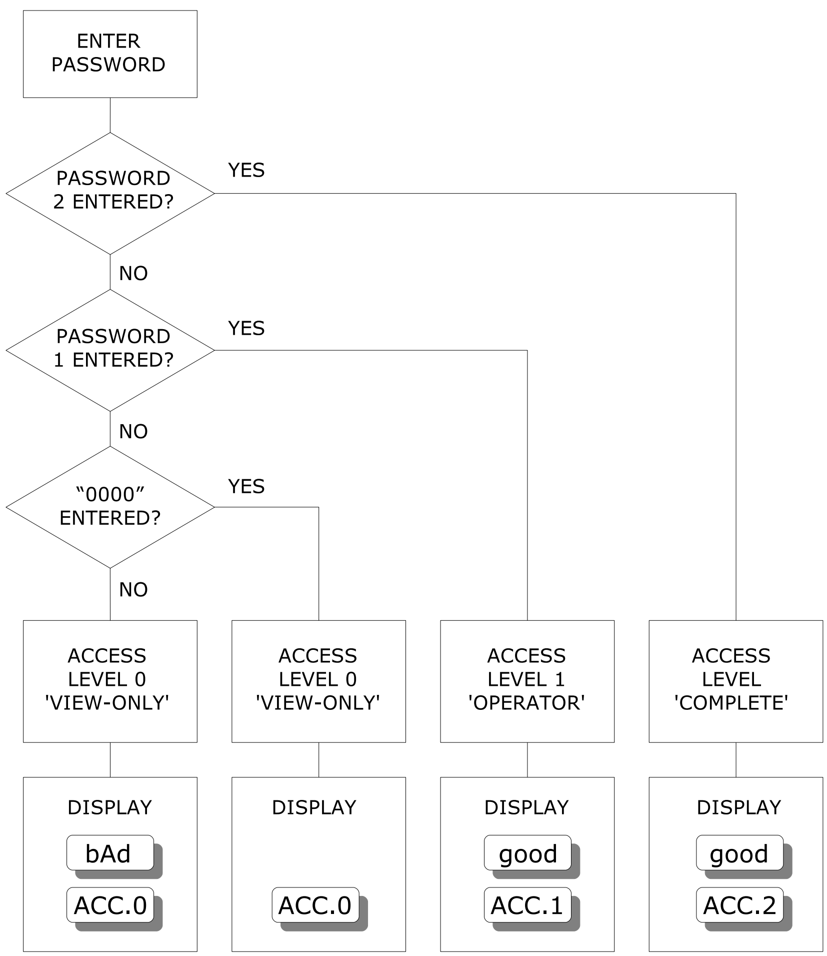


Illustration 34: Password validation

PASSWORD EXAMPLE - A QUICK TOUR

With security disabled, select [CONF] [PAS.2] from the menu. Set the level 2 password to “0002". Select [CONF] [PAS.1] from the menu. Set the level 1 password to ”001." Security is now enabled.

Select [PASS] from the main menu. Press *ENTER* with [0000] displayed. The analyzer will display [ACC.0] to indicate we are now at access level 0.

Try changing the output 1 low setting. Select [out] [out1] [LO] from the menu. The current value will display. Press *ENTER* to go into edit mode. The analyzer will display [PASS] for 2 seconds because we need to enter a password first. Level 1 security is needed to change this setting.

Select [PASS] from the main menu again. Change the displayed value to [0001], which is the level 1 password. Press *ENTER.* The analyzer will display [good], followed by [ACC.1], indicating that the password is valid and that we now have level 1 access.

Try changing the output 1 low setting again. You will find that this time we can go into edit mode unhindered.

Select [PASS] from the main menu again. Enter the level 2 password, which is “0002.” We are going to set the level 2 password to “0000” again to disable password security. Password 2 is found in the configuration menu and therefore requires level 2 access before it can be accessed. Select [CONF] [PAS.2] from the menu. Press *ENTER* with [0000] displayed. Both passwords are set to “0000” again and password security is disabled.

Appendix B — Unit Conversion

Dissolved Oxygen Units

$$ppm = parts\ per\ million$$

$$ppb = parts\ per\ billion$$

$$ppt = parts\ per\ trillion$$

$$1\ ppm = 1000\ ppb$$

$$1\ ppb = 0.001\ ppm$$

$$1\ ppb = 1000\ ppt$$

1 ppm is approximately 1 mg/L. Some variation occurs because the weight of water varies slightly with temperature.

Percent saturation is directly related to the temperature and pressure of the system. A given ppb reading will give a different percent saturation depending on the variation in temperature and pressure. Refer to *Appendix C* for a table of saturated D.O. values.

Temperature Units

$$°C = \frac{5}{9}(°F - 32)$$

$$°F = (\frac{9}{5} X °C) + 32$$

Pressure Units

$$psi = \frac{kPa}{6.895}$$

$$kPa = psi\ X\ 6.895$$

$$1\ psi = 6.895\ kPa$$

$$1\ atmosphere = 1.01325\ B\ A\ H$$

$$1\ atmosphere = 760\ mm\ Hg\ (o\ H\ Torr)$$

$$1\ atmosphere = 14.70\ psi$$

$$1\ atmosphere = 101.3\ kPa$$

$$1\ b\ A\ r = 100\ kPa$$

Appendix C — Saturated D.O. Values

The table below lists shows the concentration of dissolved oxygen in water over a range of temperature and pressure. Dissolved oxygen values are reported as parts per million. During calibration, the 865 analyzer uses the table below to determine the efficiency of the cell. The column for atmospheric pressure, 1 atmosphere = 101.3 kPa, is in italics.

°C/kPa	***94.0***	***95.0***	***96.0***	***97.0***	***98.0***	***99.0***	***100.0***	***101.0***	***101.3***	***102.0***	***103.0***	***104.0***	***105.0***	***106.0***
0	13.51	13.65	13.80	13.94	14.09	14.23	14.37	14.52	***14.57***	14.67	14.811	14.95	15.10	15.25
1	13.15	13.29	13.43	13.57	13.71	13.85	13.99	14.13	***14.17***	14.27	14.41	14.56	14.70	14.84
2	12.79	12.93	13.06	13.20	13.34	13.48	13.61	13.75	***13.79***	13.88	14.02	14.16	14.30	14.43
3	12.46	12.59	12.72	12.86	12.99	13.13	13.26	13.39	***13.43***	13.52	13.66	13.79	13.93	14.06
4	12.13	12.25	12.38	12.52	12.65	12.77	12.90	13.04	***13.08***	13.17	13.29	13.42	13.56	13.69
5	11.82	11.95	12.07	12.20	12.33	12.45	12.58	12.71	***12.74***	12.83	12.96	13.09	13.21	13.34
6	11.52	11.64	11.76	11.89	12.01	12.13	12.25	12.38	***12.42***	12.50	12.62	12.75	12.87	13.00
7	11.23	11.36	11.48	11.60	11.72	11.84	11.96	12.08	***12.11***	12.20	12.32	12.44	12.56	12.68
8	10.95	11.07	11.19	11.30	11.42	11.54	11.66	11.77	***11.81***	11.89	12.01	12.13	12.25	12.37
9	10.69	10.81	10.93	11.04	11.15	11.27	11.39	11.50	***11.53***	11.61	11.73	11.85	11.96	12.08
10	10.44	10.55	10.66	10.77	10.89	11.0	11.11	11.22	***11.26***	11.34	11.45	11.56	11.67	11.79
11	10.20	10.31	10.42	10.52	10.64	10.75	10.86	10.96	***10.99***	11.08	11.19	11.30	11.40	11.52
12	9.96	10.07	10.17	10.28	10.39	10.50	10.60	10.71	***10.74***	10.82	10.93	11.03	11.14	11.24
13	9.74	9.84	9.95	10.05	10.16	10.26	10.37	10.47	***10.50***	10.58	10.68	10.79	10.89	11.00
14	9.52	9.62	9.72	9.83	9.93	10.03	10.13	10.24	***10.27***	10.34	10.44	10.54	10.65	10.75
15	9.31	9.41	9.52	9.62	9.72	9.81	9.92	10.02	***10.05***	10.12	10.22	10.32	10.42	10.52
16	9.11	9.21	9.31	9.41	9.51	9.60	9.70	9.80	***9.83***	9.90	10.00	10.10	10.20	10.28

Illustration 35: Recommended sample configuration

°C/kPa	***94.0***	***95.0***	***96.0***	***97.0***	***98.0***	***99.0***	***100.0***	***101.0***	***101.3***	***102.0***	***103.0***	***104.0***	***105.0***	***106.0***
17	8.92	9.02	9.12	9.21	9.31	9.41	9.50	9.60	***9.63***	9.70	9.79	9.89	9.99	10.08
18	8.74	8.83	8.92	9.02	9.12	9.21	9.30	9.40	***9.43***	9.50	9.59	9.68	9.78	9.87
19	8.56	8.66	8.75	8.84	8.93	9.03	9.12	9.21	***9.24***	9.31	9.40	9.49	9.58	9.67
20	8.39	8.48	8.57	8.66	8.75	8.84	8.93	9.03	***9.06***	9.12	9.21	9.30	9.39	9.47
21	8.23	8.32	8.41	8.50	8.59	8.67	8.76	8.85	***8.88***	8.95	9.04	9.13	9.21	9.30
22	8.07	8.15	8.24	8.33	8.42	8.51	8.59	8.68	***8.71***	8.77	8.86	8.95	9.03	9.12
23	7.92	8.00	8.09	8.18	8.26	8.35	8.44	8.52	***8.55***	8.61	8.70	8.79	8.87	8.96
24	7.77	7.85	7.94	8.02	8.11	8.19	8.28	8.36	***8.39***	8.45	8.53	8.62	8.70	8.79
25	7.63	7.71	7.80	7.88	7.96	8.04	8.13	8.21	***8.24***	8.30	8.38	8.47	8.55	8.64
26	7.49	7.57	7.65	7.73	7.82	7.90	7.98	8.06	***8.09***	8.15	8.23	8.31	8.39	8.48
27	7.36	7.44	7.52	7.60	7.68	7.76	7.84	7.92	***7.95***	8.01	8.09	8.17	8.25	8.33
28	7.23	7.31	7.38	7.46	7.55	7.63	7.70	7.78	***7.81***	7.87	7.95	8.02	8.10	8.18
29	7.10	7.18	7.26	7.34	7.42	7.50	7.57	7.65	***7.68***	7.73	7.81	7.89	7.79	8.05
30	6.98	7.06	7.13	7.21	7.29	7.37	7.44	7.52	***7.55***	7.60	7.68	7.76	7.84	7.91
31	6.87	6.94	7.02	7.09	7.17	7.25	7.32	7.40	***7.42***	7.48	7.55	7.63	7.71	7.78
32	6.75	6.83	6.90	6.98	7.05	7.13	7.20	7.28	***7.30***	7.35	7.43	7.50	7.58	7.65
33	6.64	6.71	6.79	6.86	6.94	7.01	7.09	7.16	***7.18***	7.23	7.31	7.38	7.46	7.53
34	6.53	6.60	6.67	6.75	6.82	6.90	6.97	7.05	***7.07***	7.12	7.19	7.26	7.34	7.41
35	6.42	6.49	6.57	6.64	6.71	6.79	6.86	6.93	***6.95***	7.00	7.07	7.15	7.22	7.30
36	6.32	6.39	6.46	6.53	6.60	6.68	6.75	6.83	***6.84***	6.89	6.96	7.03	7.11	7.18
37	6.22	6.28	6.36	6.43	6.50	6.57	6.64	6.71	***6.73***	6.78	6.85	6.92	7.00	7.07
38	6.12	6.18	6.25	6.33	6.40	6.46	6.53	6.61	***6.63***	6.68	6.74	6.81	6.89	6.95
39	6.02	6.09	6.16	6.23	6.30	6.36	6.43	6.50	***6.52***	6.57	6.64	6.71	6.78	6.85
40	5.93	5.99	6.06	6.13	6.20	6.26	6.33	6.40	***6.42***	6.47	6.53	6.60	6.68	6.74
41	5.83	5.90	5.97	6.03	6.10	6.16	6.23	6.30	***6.32***	6.37	6.43	6.50	6.57	6.64
42	5.74	5.80	5.87	5.94	6.00	6.06	6.13	6.20	***6.22***	6.27	6.33	6.40	6.47	6.53
43	5.64	5.71	5.78	5.84	5.91	5.97	6.04	6.10	***6.13***	6.17	6.24	6.30	6.37	6.43
44	5.55	5.61	5.68	5.75	5.82	5.88	5.94	6.01	***6.03***	6.08	6.14	6.20	6.27	6.33

Appendix D — Default Settings

The following program settings are the default settings for the analyzer. New analyzers will have these settings unless the setup has already been customized for your application.

Outputs

	Output 1	**Output 2**
Input to be transmitted	dissolved oxygen	temperature
Low setting	0.00	0.0
High setting	100	100.0
ON/OFF switch	ON	ON
Units	ppb	° C
Automatic range indication	OFF	-

Alarms

	Alarm A	**Alarm B**
Input for alarm	dissolved oxygen	dissolved oxygen
Alarm function	High	High
ON/OFF switch	OFF	OFF
Set-point	10.0	100
Differential	1.0	1.0
Units	ppb	ppb

Global units, metric units:

temperature	degrees Celsius
pressure	kPa
dissolved oxygen concentration	ppb (parts per billion)

Alarm contacts
Configured normally open.

Security
Not enabled.

Temperature compensation
Automatic TC using temperature input.

Pressure compensation
Automatic pressure compensation using pressure input.

Input on/off configuration
The temperature input is on and will show up in the sample menu.

Appendix E — Parts List

Part Number	*Description*	*Drawing Number*
	865 Dissolved Oxygen Analyzer	
A9051027	Assembly, 865 D.O. power PCB	D5920101
A9051028	Assembly, 865 display board	
A9101012	Circuit breaker switch, 0.25 A	
A9141012	Assembly, 865 case, complete with keypad	D5970171
A9201015	18 position, inter-board connector	
	865-25 Sample Conditioning Panel	
A2103004	ppb stainless steel flow cell	
A3010009	Teflon ferrule for ppb flow cell, P/N A21030004	
A7201113	Stainless steel nut for ppb flow cell, P/N A21030004	
A7201490	Stainless steel inlet fittings and O-ring	
A9551054	O-ring for inlet fitting	
	Dissolved Oxygen Sensor	
A2103012	Replacement dissolved oxygen sensor, 1 m lead	
A2103001	Replacement dissolved oxygen sensor, 3 m lead	
A2103042	Replacement dissolved oxygen sensor, PEEK, 1 m lead (to 65 °C)	
A2103041	Replacement dissolved oxygen sensor, PEEK, 3 m lead (to 65 °C)	
A2103003	Replacement membrane module and fill solution kit	
A2103043	Replacement membrane module and fill solution kit, PEEK	
A2103007	Electrode cap	
A2103047	Electrode cap, PEEK	
	Consumable Supplies	
A1100192	Deionized water, 500 mL (A1100192-6P for 6-pack)	
A1100193	Zero D.O. standard, 500 mL (A1100193-6P for 6-pack)	
A1100194	D.O. sensor cleaning solution, 500 mL (A1100194-6P for 6-pack)	
A7010003	Low range grab sample test kit for 0 ppb to 40 ppb D.O.	

Appendix F — Installation: No Sample Panel

Flow Cell Mounting

1) There are mounting screws on the bottom of the cell and a triangle bracket. Allow 8 inches to 12 inches clearance above the flow cell nut for sensor removal.
2) Arrange the cell for up-flow to the inlet, with the cell at an angle of 15 degrees to 45 degrees from vertical (refer to illustration 36). This arrangement will encourage bubbles to pass through the system with minimum dissolved oxygen upset.
   NOTE: *Air has 20.9% oxygen or in parts per billion, 209,000,000 ppb. Water is saturated with dissolved oxygen at 8,240 ppb (see Appendix C, 25 °C and 101.3 kPa) so an air bubble can saturate about 25,000 times as much water, or at 1 ppb can add an extra ppb to 25,000,000 times as much sample.*
3) Refer to illustration 35 for recommended sample system arrangement. Sample tubing should use gradual bends rather than 90 degree elbows to avoid entrapped air bubbles producing slow D.O. pull down.
4) Avoid, if possible, pressure reducing valves, filters, flow adjust needle valves and rotameters which frequently have dead chambers that entrap air bubbles that cause slow D.O. pull down.
5) Hook up the sensor to cell grounding wire for best static interference resistance - provides good, stable, low level ppb dissolved oxygen readings.

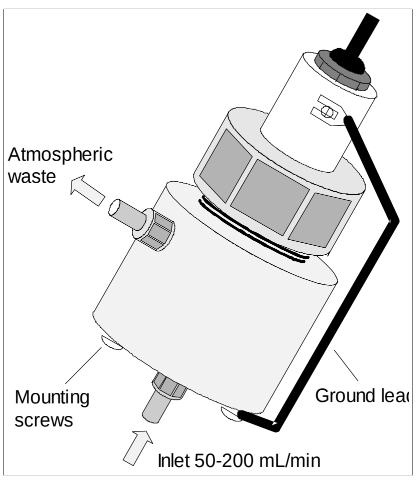
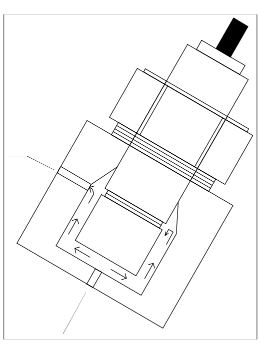
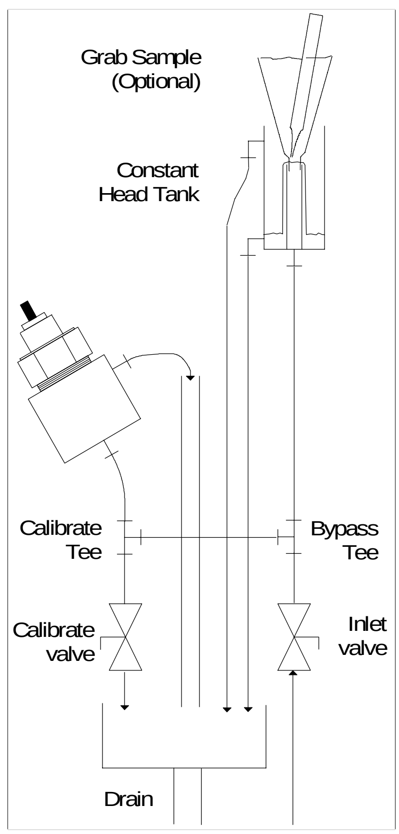


Illustration 36: Sensor flow cell set up



NOTE: *Angle mounting is recommended to encourage any bubbles in the sample to rise to the exit and be swept to drain.*



NOTE: *Additional sample stream components are recommended for easy calibration, and where entrained solids may be encountered or pressure fluctuates. A bypass helps to protect the electrode membrane, extending it's lifetime, by bypassing magnetite grains and other solids to drain. the bypass provides a convenient point to obtain calibration samples plus provides a constant pressure at the sensor.*

Appendix G — Serial Communications

Format of Analyzer Output

Data transmitted by the analyzer is in simple ASCII format. No special software is needed on the computer to receive the ASCII data. The 865 continuous output consists of three data fields separated by commas. Each line of data is terminated by a linefeed/newline. Comma-separated fields are designed to make it easy to import the data into other programs for analysis, for example into a spreadsheet (see Appendix H).

The RS232 port can be used as a data port to send ppb D.O., temperature, pressure and auto-range number (default frequency is 60 seconds), or as a two-way communication port for remote operation if an interface format program is available. The ASCII data port function can be turned on/off and controlled from the Internal Data Log menu, both ASCII and serial must be on. The 865 analyzer uses 8 data bits, no parity, 1 stop bit and 9600 baud.

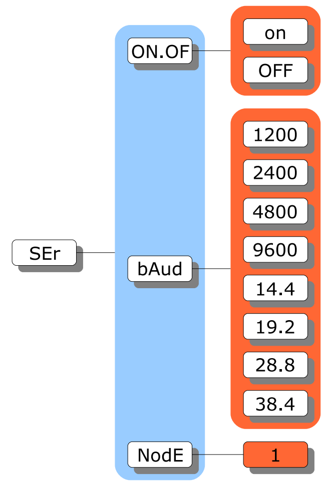


Illustration 37: Serial communication menu

IC Net™ INTELLIGENCE ACCESS

The 865 D.O. analyzer has advanced intelligence which allows the operator to recall factors leading to upset conditions, and requires digital communication for access. It keeps track of calibrations, their date and results, upset events such as power outages, alarms, and also logs into its memory a running history of 1000 plus dissolved oxygen readings.

Serial communications give the analyzer the ability to communicate with the IC Net™ Advanced Intelligence Access Program running on a personal computer running MS Windows 3.1 or higher. The IC Net™ program can be used to operate the analyzer in a network of analyzers using RS485 communications, display and log each analyzer's inputs graphically, retrieve internal data logs, and view event information.

Wiring and Enabling

To connect the 865 analyzer to a computer serial port, consult illustration 38 for the wiring diagram. To enable serial transmission by the analyzer, set the serial ON/OFF switch to ON (default is ON). Configure the analyzer for the desired baud rate. Select [SEr] [baud] from the menu. Baud rates from 1200 baud to 38400 baud can be selected, the default is 9600 baud; see illustration 37. After selecting the baud rate at the analyzer, ensure that the baud rate selected in the IC Net™ program in the computer is identical. If not, the analyzer and the computer will not be able to communicate.

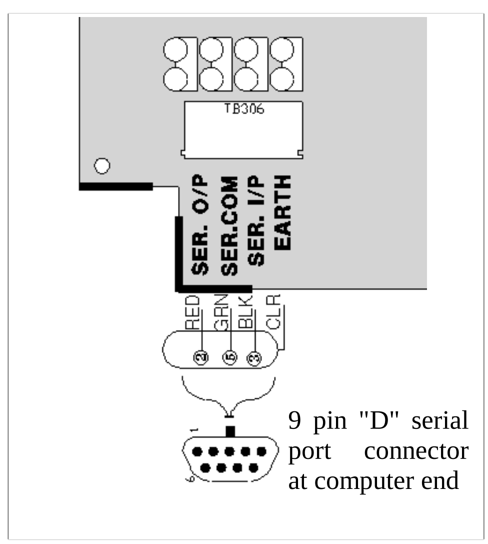


Illustration 38: Serial communication wiring

When using RS232 communications, default for the 865, it is recommended that you leave the node number at its default value of 1. On an IC Net™ RS485 network each unit needs a unique node, plus an RS232 to RS485 converter, part number A7900014-115 or A7900014-230.

Internal Data Logging

The 865 analyzer will log more than 1000 dissolved oxygen values internally, storing readings at specified intervals. The computer used to download the data does not need to be connected or turned on while the analyzer is logging data points. The logged data can be retrieved later from the analyzer using a computer running the IC Net™ program. The IC Net™ program can also display the exact number of data points available to the analyzer.

Internal logged data is date/time stamped by the analyzer. The data log cannot be displayed directly from the analyzer , but instead, the serial communications link and the IC Net™ program are used to retrieve the complete data log of date/time stamped D.O. data that was logged.

Setup for Data Logging

1) Select [iLOG] [FrEQ] from the menu. This number is the logging frequency, specified in seconds. For 1-second intervals use 1, for 1-minute intervals use 60, for 1-hour intervals use 3600.
2) Select [LOG] [FULL] from the menu. This setting specifies what the analyzer should do when the internal buffer has been filled. Set to [cont] for continuous logging when the buffer is full. Each new data point that is stored will erase the oldest data point. Set to [StOP] to stop logging when the buffer is full. The analyzer will fill up the internal data logging memory (approximately 1000 data points), and then simply stop logging, preserving all data points that have been taken.

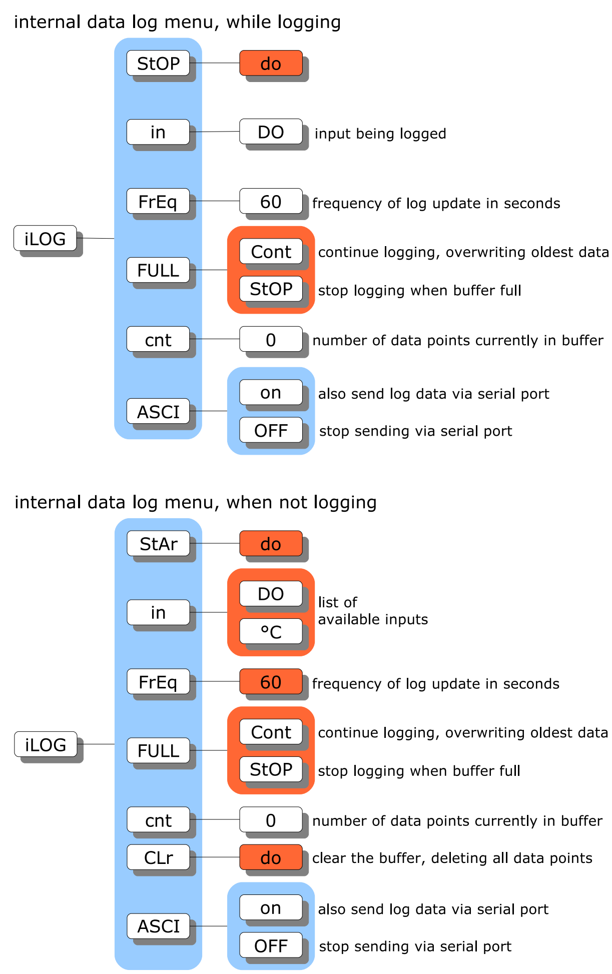


Illustration 39: Internal data log menu

Retrieving the Internal Data Log

The IC Net™ program running on a computer is used to retrieve the internal data log from the analyzer using the RS232 or RS485 serial communications link.

Displaying Logging Status

From the menu select [LOG] [cnt]. This count number shows the number of data points that have been logged. While the analyzer is logging, you will be able to see this number incrementing. The data point count will be 0 after the data log has been cleared from memory. Also, the [cnt] frame must show 0 before a new data log can be started. The [StAr] frame won't be in the menu while the analyzer is actively logging data.

Ending a Data Log

To end a data log, i.e., to stop logging more points, select [StOP] from the internal logging menu. Press Enter when the analyzer displays the blinking [do]. The analyzer will briefly display [donE] to indicate that it has stopped the logging operation.

Data logging will stop automatically if the [FULL] setting is set to [StOP] and the entire logging buffer has been filled.

Clearing the Data Log from Memory

The data log can be cleared (erased) from the analyzer memory. The menu will not allow you to start a new log until the existing log has been explicitly erased. This is a safety feature to ensure that you don't accidentally wipe out an existing log when starting the next log.

To erase the data log from memory:

1) Select [LOG] [CLr] from the menu.
2) With the display flashing [do], press Enter. **Note:** *there is no way to recover a data log once memory is cleared. Be very sure that you* ***do*** *want to clear the log from memory before pressing Enter.*

Calibration & Event History

The analyzer stores important information automatically, tagged with a date/time stamp. The analyzer stores the last 12 calibration records for each input, which is sufficient for a year's worth of calibration history when monthly calibrations are performed.

Events such as power down, power up, and alarms are recorded in a separate log which tracks the last 20 events, time/date stamped. When combined with the internal data logging capability, this allows the operator to recall factors leading to alarm conditions.

Retrieving Calibrations and Events

At any time, the date/time-stamped events can be retrieved from the analyzer using a computer running the IC Net™ program. The display limitations of the analyzer leave no way to view event records using only the analyzer. There is no menu for events, and logging is done without any user intervention.

Event Records

Sample output of event records:

1, Thu Dec 18 14:50:47 1997, ANALYZER OFF

2, Thu Dec 18 17:47:30 1997, ANALYZER ON

3, Thu Dec 18 17:47:30 1997, E1.5

4, Thu Dec 18 17:47:31 1997, E2.2

5, Thu Dec 20 10:11:21 1997, CA7.6

The first number is sequential. The next part of each line is the date/time stamp. The final part is the event record. Different time/date formats are available.

Calibration Records

Each time a calibration for D.O., temperature, or pressure is changed, the change is recorded in a date/time stamped log. The log is written both when a normal calibration is performed and when a calibration parameter such as offset or efficiency is manually adjusted. Any change in any factor affecting the calibration is recorded.

Another feature is when the calibration is committed to the internal log. The internal log is not written until the analyzer has not been used for 15 minutes, then a single record is written the current calibration. If for example, two consecutive calibrations are done and then a number of manual changes to % efficiency, these changes only create a single log entry rather than filling 6 of the 12 available calibration event tag spaces.

For the ppb D.O. input the following factors are logged:

- % efficiency
- ppb D.O. at time of calibration
- temperature at time of calibration
- pressure at time of calibration
- manual or automatic temperature compensation
- manual or automatic pressure compensation

For temperature the following factor is logged:

- offset

For pressure the following factor is logged:

- offset

Appendix H — Data Capture

Example: Windows 3.1 Terminal Program

To illustrate the capturing of data on a computer, following is the description for loading and setting up the TERMINAL program which is part of the standard Windows 3.1 operating system.

1) Load Windows 3.1, then switch to the program manager.
2) From the accessories group double-click on the "Terminal" icon.
3) From the menu select Settings | Communications...Set the communications settings as shown in illustration 40. The connector setting in the figure is set to COM1, match this setting to reflect the connection on your computer.

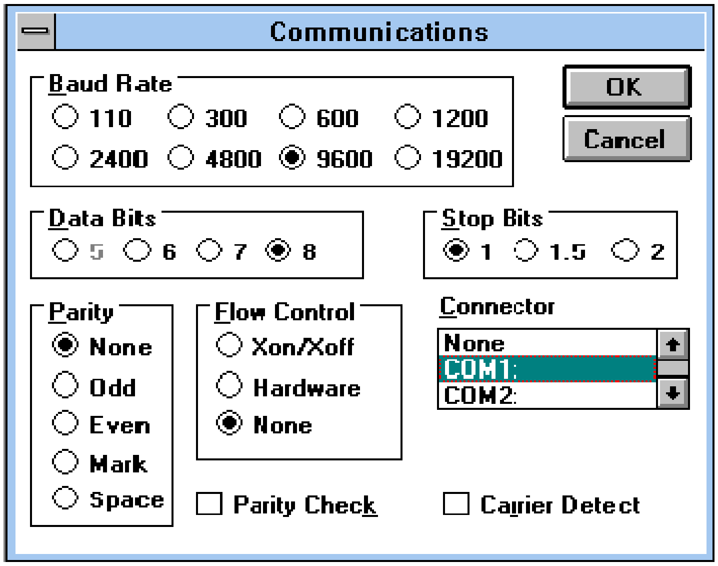


Illustration 40: Communications screen

4) To capture data into a file, select Transfers | Receive text file... from the menu. Specify the file name and location (Example: C:\logs\log01.dat). The terminal program will now store any ASCII data sent out by the analyzer into the specified file.
5) To stop or pause data collecting, use the buttons at the bottom left of the window.

Windows 98 ?

Try - Start | Programs | Accessories | Communications Folder - Hyperterminal

Windows NT ?

Try - Start | Programs | Accessories | Hyperterminal Folder - Hyperterminal

Example: Load Log File in Excel

The following example illustrates how to load a log file into Microsoft Excel 5.0.

1) By default, the IC Net™ Access program uses the .DAT extension for its log files. Excel prefers .TXT, .PRN, or .CSV. You can keep the .DAT extension or use .TXT or .CSV.
2) Open Excel, then select File | Open from the menu.
3) Navigate to the log file. If you used the .PRN, .TXT, or .CSV extension for the log file, you may want to change “List Files of Type” to “**Text Files**”, otherwise use **All Files (*.*)**. Select the log file, then click on OK.
4) The “Text Import Wizard” dialog box should open. In “Original Data Type” select **Delimited**, then click the “Next >” button.
5) Under **Delimiters** select “Comma”.
6) Click the “Finish” button to load the log file into Excel.
7) The date/time stamp will be loaded in column A, and the input values will be loaded in columns B, C, etc. The date/time stamp will be treated as text, while the input values will be treated as numeric values that can be graphed, manipulated, etc.

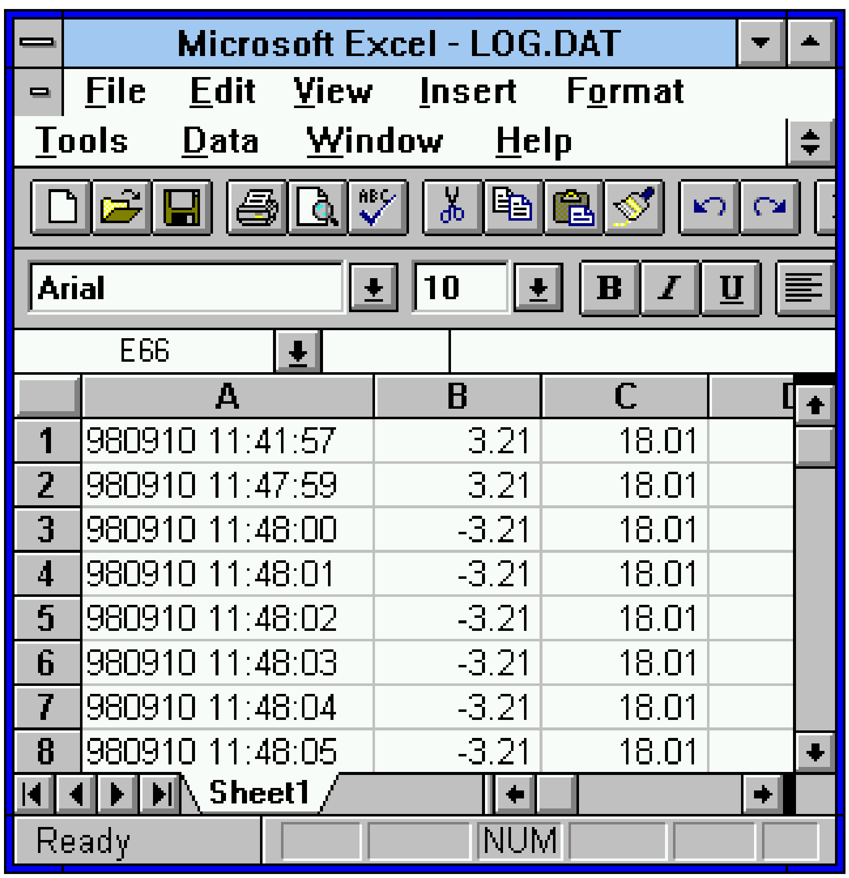
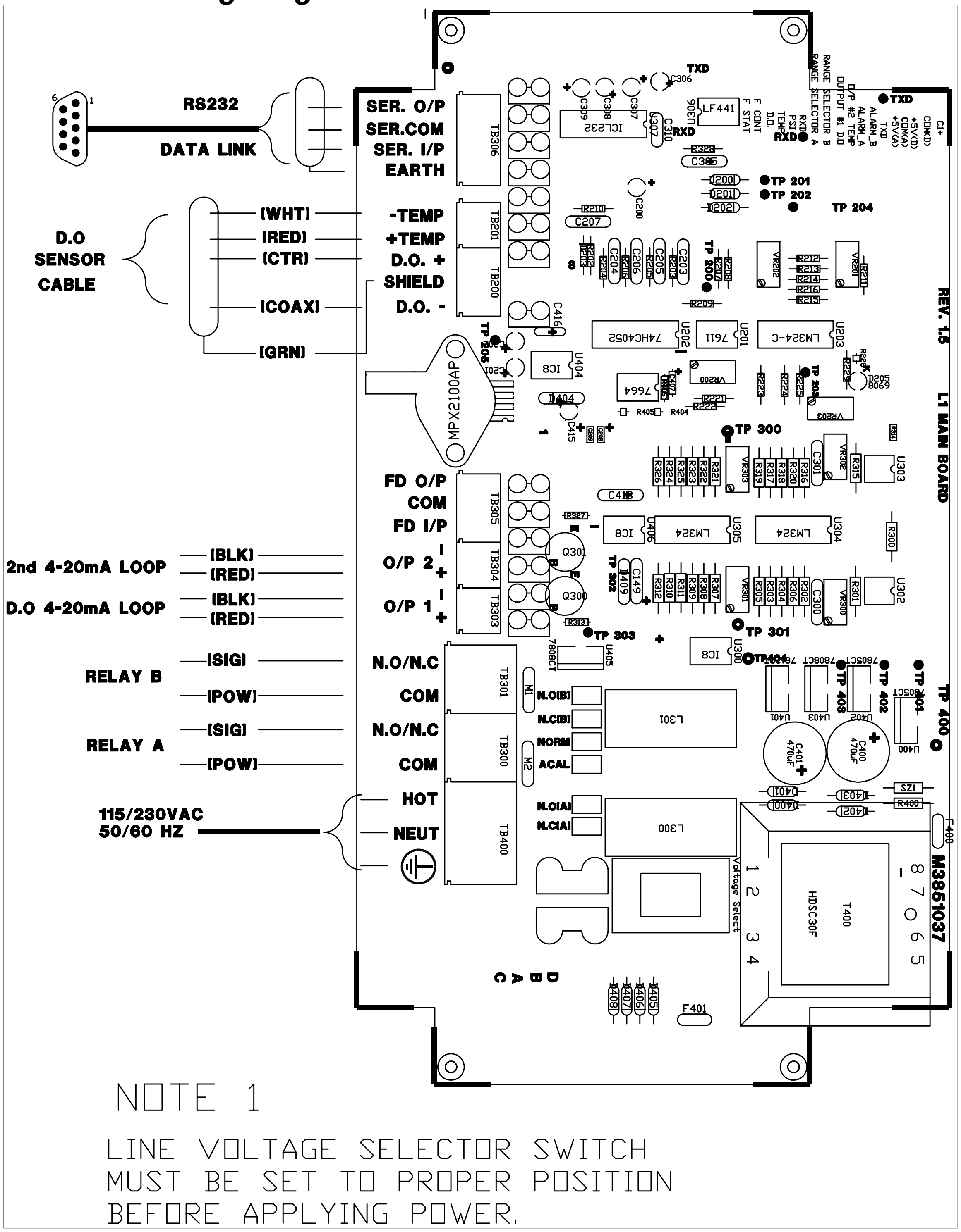


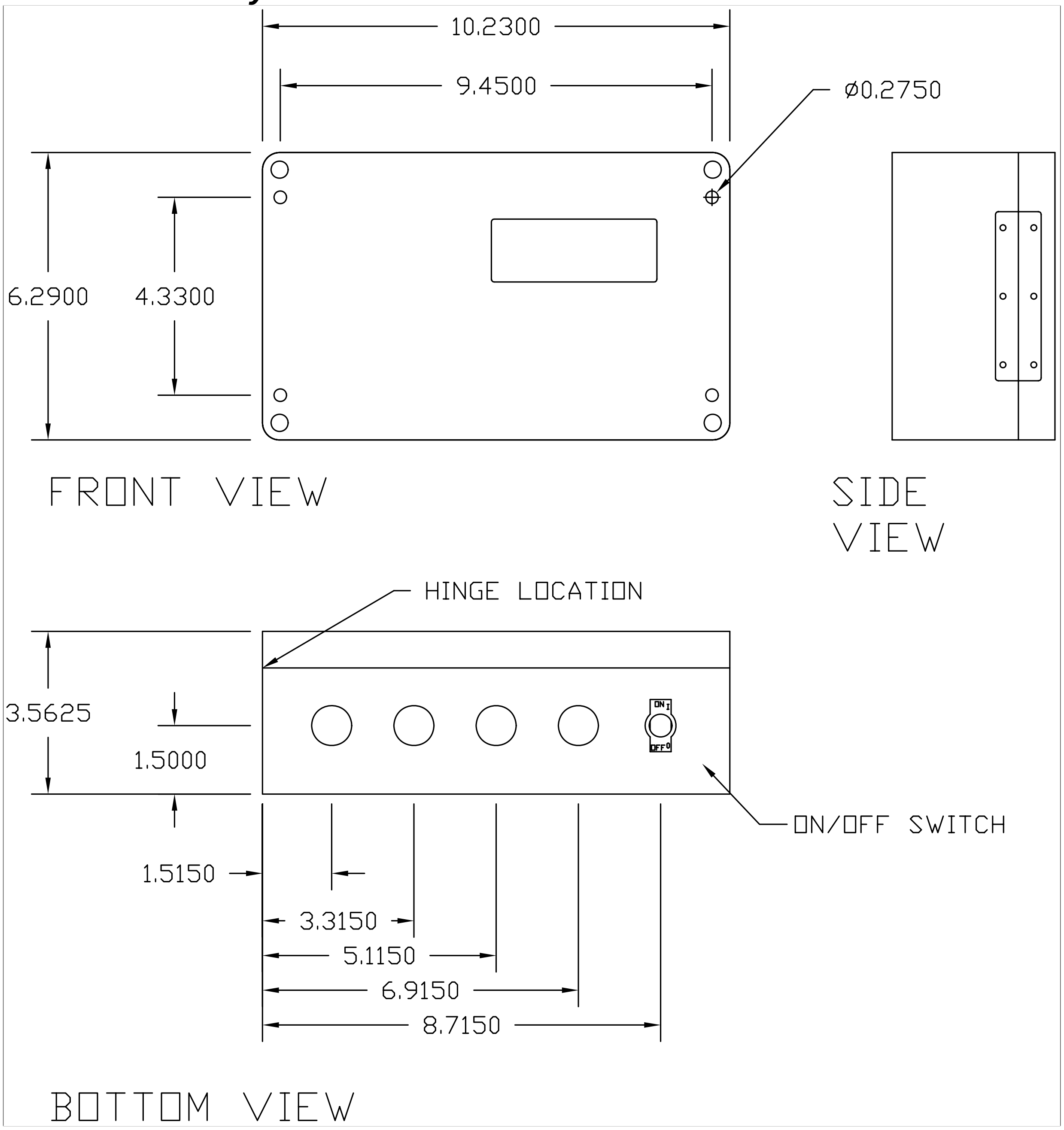
Illustration 41: Loaded log file in Excel

DRAWINGS

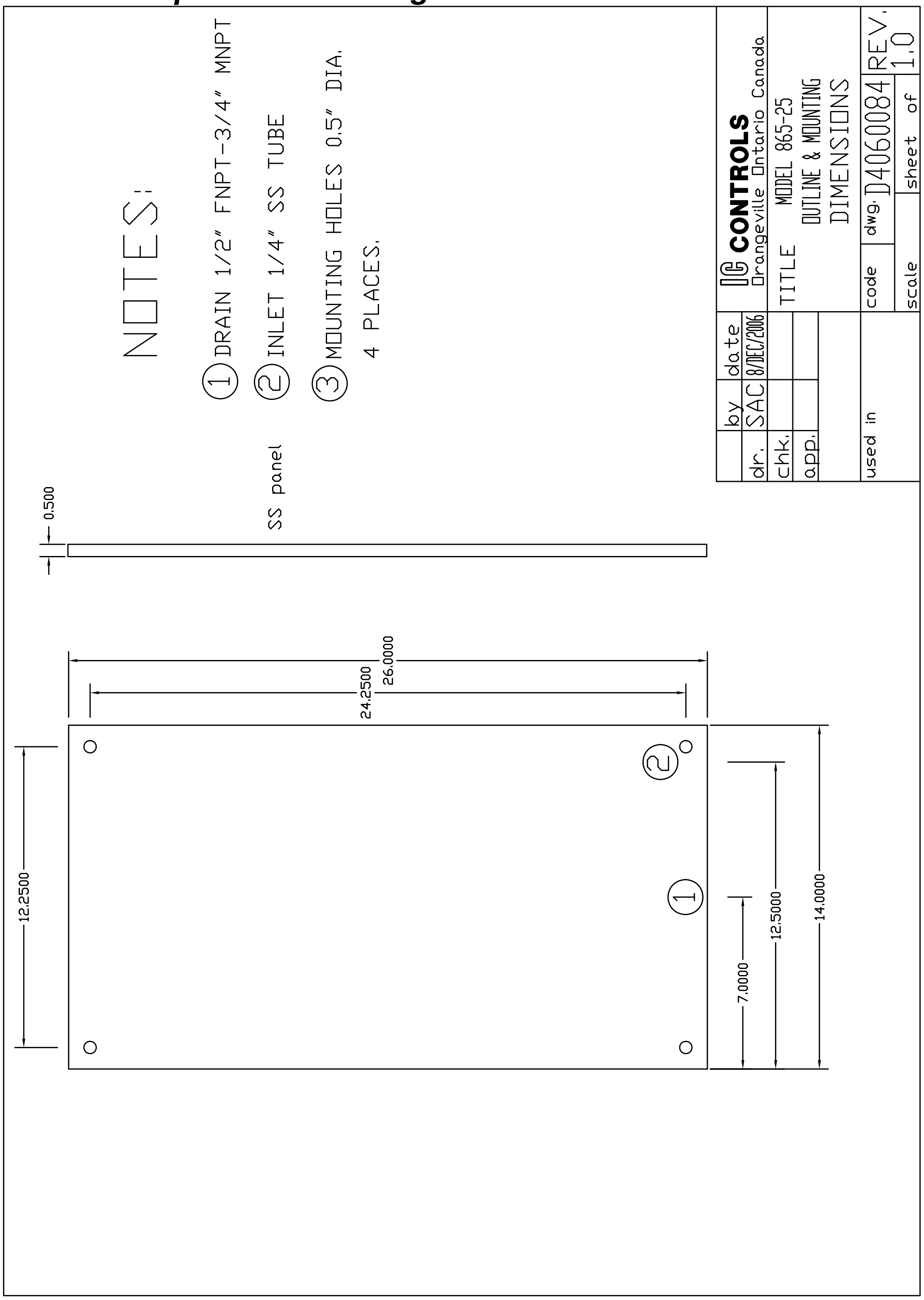
D5920101: Wiring Diagram



D5970171: Analyzer Dimensions



D4060084: Sample Conditioning Panel Dimensions



INDUSTRIAL PRODUCTS WARRANTY

Industrial instruments are warranted to be free from defects in material and workmanship for a period of twelve (12) months from the date of installation or eighteen (18) months from the date of shipment from IC CONTROLS whichever is earlier, when used under normal operating conditions and in accordance with the operating limitations and maintenance procedures in the instruction manual, and when not having been subjected to accident, alteration, misuse, or abuse. This warranty is also conditioned upon calibration and consumable items (electrodes and all solutions) being stored at temperatures between 5 °C and 45 °C (40 °F and 110 °F) in a non-corrosive atmosphere. IC CONTROLS consumables or approved reagents must be used or performance warranty is void. Accessories not manufactured by IC CONTROLS are subject to the manufacturer's warranty terms and conditions.

Limitations and exclusions:

Industrial electrodes, and replacement parts, are warranted to be free from defects in material and workmanship for a period of three (3) months from the date of installation or eighteen (18) months from the date of shipment when used under normal operating conditions and in accordance with the operating limitations and maintenance procedures given in the instruction manual and when not having been subjected to accident, alteration, misuse, abuse, freezing, scale coating, or poisoning ions.

Chemical solutions, standards or buffers carry an "out-of-box" warranty. Should they be unusable when first "out-of-box", contact IC CONTROLS immediately for replacement. To be considered for warranty, the product shall have an RA (Return Authorization) number issued by IC CONTROLS service department for identification and shall be shipped prepaid to IC CONTROLS at the above address.

In the event of failure within the warranty period, IC CONTROLS, or its authorized dealer will, at IC CONTROLS option, repair or replace the product non-conforming to the above warranty, or will refund the purchase price of the unit.

The warranty described above is exclusive and in lieu of all other warranties whether statutory, express or implied including, but not limited to, any implied warranty of merchantability or fitness for a particular purpose and all warranties arising from the course of dealing or usage of trade. The buyer's sole and exclusive remedy is for repair, or replacement of the non-conforming product or part thereof, or refund of the purchase price, but in no event shall IC CONTROLS (its contractors and suppliers of any tier) be liable to the buyer or any person for any special, indirect, incidental or consequential damages whether the claims are based in contract, in tort (including negligence) or otherwise with respect to or arising out of the product furnished hereunder.

Representations and warranties made by any person, including its authorized dealers, distributors, representatives, and employees of IC CONTROLS, which are inconsistent or in addition to the terms of this warranty shall not be binding upon IC CONTROLS unless in writing and signed by one of its officers.

COMPLIANCE & CONFORMITY

NOTICE OF COMPLIANCE

US

This meter may generate radio frequency energy and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. It has been type-tested and found to comply with the limits for a Class A computing device in accordance with specifications in Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in an industrial installation. However, there is no guarantee that interference will not occur in a particular installation. If the meter does cause interference to radio or television reception, which can be determined by turning the unit off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

* Reorient the receiving antenna
* Relocate the meter with respect to the receiver
* Move the meter away from the receiver
* Plug the meter into a different outlet so that the meter and receiver are on different branch circuits

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet prepared by the Federal Communications Commission helpful: *How to Identify and Resolve Radio-TV Interference Problems*. This booklet is available from the U.S. Government Printing Office, Washington, D.C., 20402. Stock No. 004-000-00345-4.

CANADA

This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.

Le present appareil numérique n' émet pas de bruits radioélectriques depassant les limites applicables aux appareils numériques (de la class A) prescrites dans le Règlement sur le brouillage radioélectrique édicté par le ministère des Communications du Canada.

DECLARATION of CONFORMITY

Manufacturer's name:	IC CONTROLS
Manufacturer's address:	29 Centennial Road, Orangeville, Ontario, Canada, L9W 1R1
Product type:	Industrial process analyzer
Model:	865
Application of Council Directive:	89 / 336 / EEC ammended by 93 / 68 / EEC
EMC emissions specification:	EN50081-2 (CISPR PUB.11, Class A {Group 1}) EN61000-3-2:1995 Section 2.
EMC immunity specifications:	EN55011:1993, EN50082-2:1995 (IEC 1000-4-2, IEC 1000-4-3, IEC 1000-4-4)
Voltage Fluctuations immunity	EN61000-3-3:1995
Safety specification:	CAN/CSA-C22.2 No. 1010.1-92, (eqv. IEC 1010-1) UL Std No. 3111-1 ANSI/ISA S82.01 1994 NRTL /C LR 109591-3

I hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

Place and date of issue:
Orangeville, Ontario
Feb. 11, 1999

Signed: ______________
Jon R. Fleet, Electronics Quality Assurance Group Leader

Signed: ______________
Edward F. Crossland, Director, Electronics Quality Assurance

CE

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