USER MANUAL

MODEL 855

ppm DISSOLVED OXYGEN ANALYZER

um-855-221

IC CONTROLS

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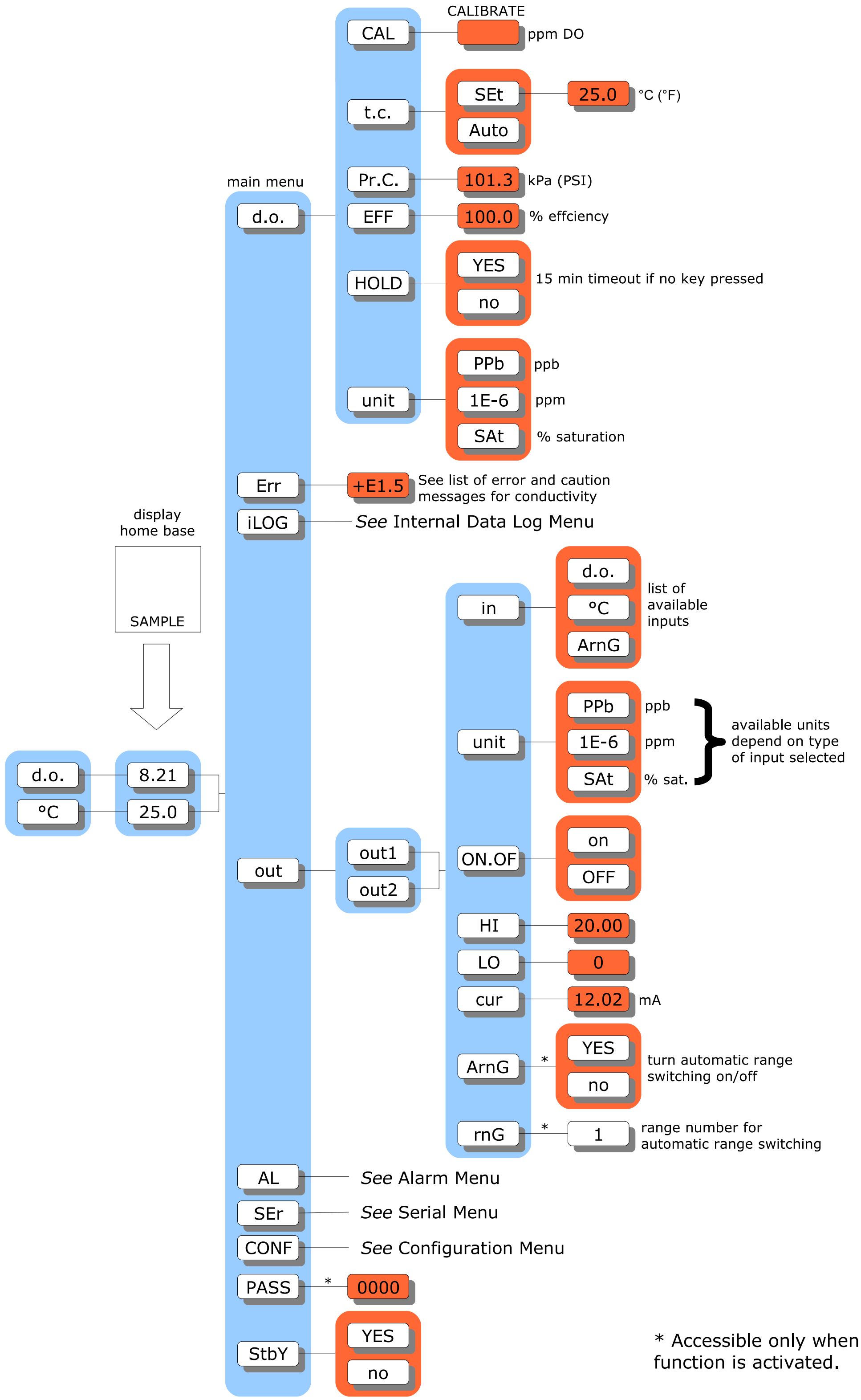

Illustration 1: Menu overview

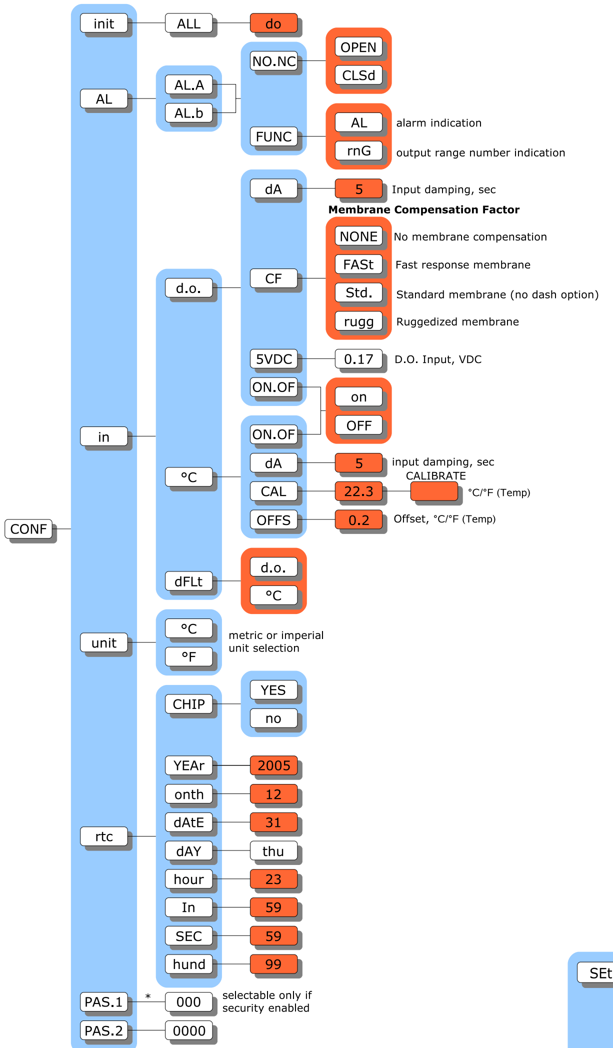

Illustration 2: Configuration menu

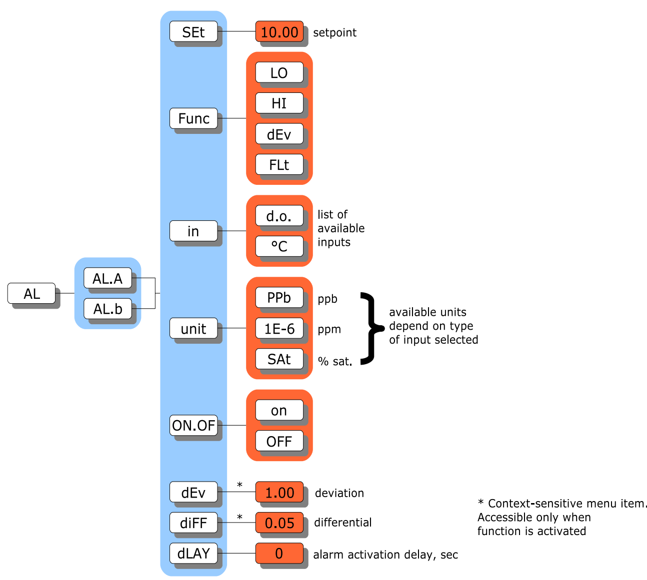

Illustration 3: Alarm menu

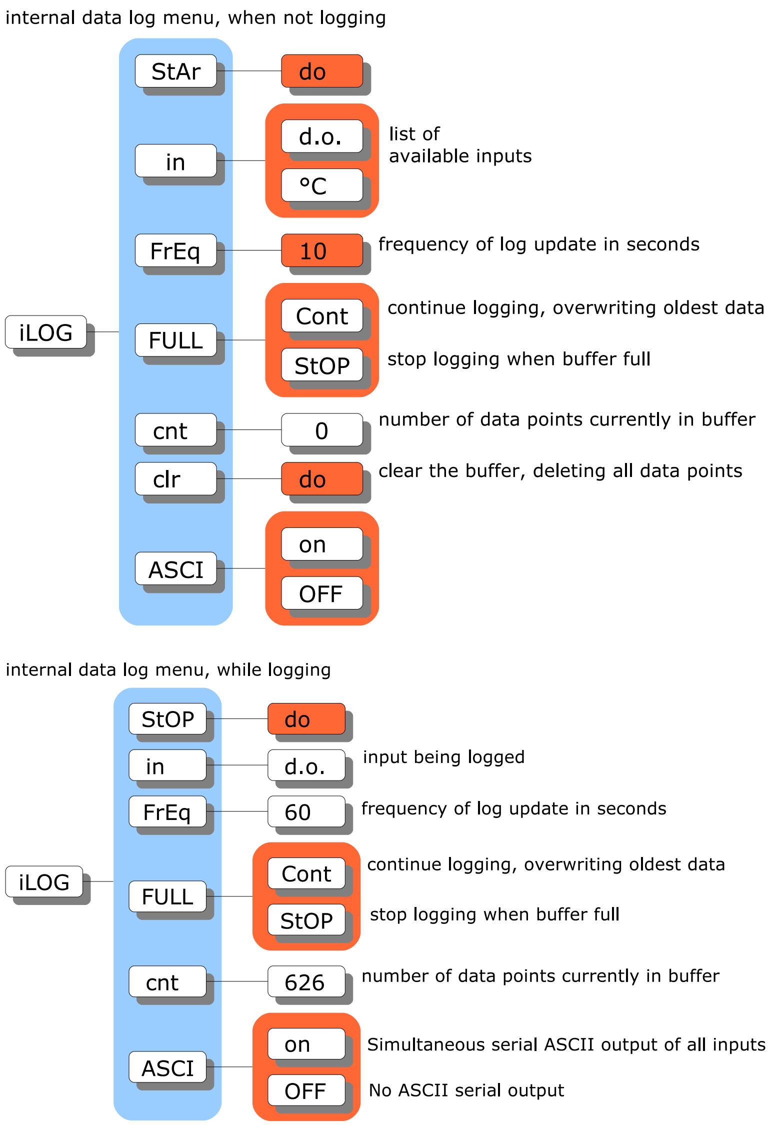

Illustration 4: Internal data log menu

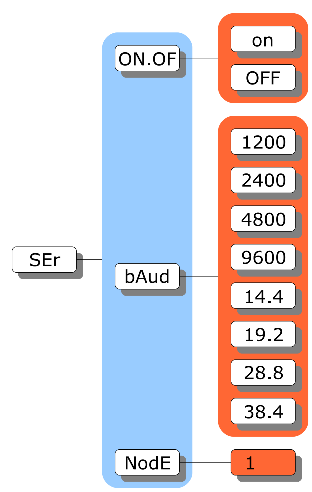

Illustration 5: Serial menu

INTRODUCTION

The model 855 is IC Controls' industrial quality remote operational dissolved oxygen analyzer, designed to give maximum flexibility, reliability, and ease-of-use. The model 855 is shipped from the factory calibrated at 0 ppm to 20 ppm and 4 mA to 20 mA and should not require recalibration. It has two isolated 4 mA to 20 mA outputs, two 10 A SPDT relays, plus a serial communication port. Its microprocessor intelligence 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 855 is one of a series of 115/230 VAC process analyzers supplied in a corrosion resistant IP65 (NEMA 4X) water and dustite 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 855 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. Optional auto-chemical cleaning.
12. Two level security to protect settings.
13. Durable housing; IP65, NEMA 4X.

Specifications

Physical Data	
PROPERTY	***CHARACTERISTIC***
Display	Four and one half LCD digits, 1.5 cm (0.6 in) displays for dissolved oxygen, temperature, efficiency, error codes, prompts and diagnostic information (*back-lit display optional*)
Display Ranges	Dissolved Oxygen: 0.00 mg/L to 20.00 mg/L *or* 0.00 µg/L to 9,999 µg/L *or* 0.00 % to 100.0 % saturation Temperature: -5.0 °C to 105 °C (23.0 °F to 221 °F)
Keypad	8 pushbutton entry keys
LED's	2 alarms (A and B), 1 auto, 1 error
Case Dimensions	12.0 cm (H) × 20.0 cm (W) × 7.5 cm (D) (4.7 in (H) × 7.9 in (W) × 3.0 in (D))
Weight	1.1 kg (2.5 lb)
Shipping Weight	2.3 kg (5.0 lb)
Shipping Dimensions	30 cm × 23 cm × 23 cm (12 in × 9 in × 9 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

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Specifications

Operational Data	
PROPERTY	***CHARACTERISTIC***
Accuracy	Dissolved Oxygen: ± 2 % reading *or* 0.02 mg/L, whichever is greater. Temperature: ± 0.1 °C
Precision	Dissolved Oxygen: ± 1 digit *or* 0.01 mg/L, whichever is greater. Temperature: ± 0.1 °C
Response Time	90% within 5 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)
Preamplifier	Require model 800 interface for sensor separation greater than 100 ft.
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 alarm relays; SPDT, Form C, rated 10 A 115 V/5 A 230 V.
Controls	Single PID (optional); standard, pump pulser or time proportional.
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 RS485 bidirectional serial data port; require IC Net™ 2000 software.

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INSTALLATION

Analyzer Mounting

The dissolved oxygen sensor is typically supplied with at least a 1.5 meter (5 feet) lead as standard. The 855 analyzer should be kept within the sensor lead length and mounted on a wall, ideally at eye level. Position the analyzer to allow the sensor, still connected to the analyzer, to be removed and the electrode tip placed in a beaker on the floor for cleaning or calibration. Assume the safest place for the beaker is on the floor the service person stands on. Horizontal separation between rows of analyzers should allow for electrode leads which need periodic replacement, and the electrical conduit. IC Controls recommends a minimum separation of 10 cm (4 in) between rows/columns.

As standard, the 855 comes with four internal 0.43 cm (0.17 in) holes for surface mounting screws spaced 18.8 cm (7.41 in) wide and 8.8 cm (3.47 in) high. Case dimensions are 20 cm x 12 cm x 7.5 cm (w, h, d) or 7.87 in x 4.72 in x 2.75 in (w, h, d) as shown on drawing D4830022.

Pipe mounting kit, option -8 for 5cm (2 in) pipe, P/N A2500255, is shown on drawing D4950053. It may also be used to surface mount the analyzer by removing the 2 inch U bolts and using the holes in the mounting plate for wall studs (*using customer-supplied studs*). The mounting plate dimensions are 20.3 cm x 21.6 cm (8 in x 8.5 in) with elongated U bolt holes.

Panel mounting kit, option -9, P/N A2500201, is shown on drawing D4950054. It requires a customer supplied panel cut-out, 20.6 cm (8.1 in) wide x 12.2 cm (4.8 in) high, with two 0.4 cm (0.15 in) screw holes centered 22.6 cm (8.9 in) apart and 6.1 cm (2.4 in) below top of cutout. The panel bezel dimensions are 24.1 cm x 15.9 cm (9.5 in x 6.25 in).

Wiring

Power for the 855 analyzer is 115/230 VAC ± 10%, single phase 50/60 Hz, and 0.25 A. Connections are made at TB400 inside the instrument enclosure; refer to drawing D5940109. The microprocessor requires a suitable ground to ensure stable operation. A power line with the third wire connected to earth ground should be adequate, however, a local earth rod may prove more fitting.

There are three 2.0 cm (0.875 in) holes for 0.5 inch conduit in the bottom of the enclosure. IC Controls recommends that AC be brought in through the right-hand entrance for power and alarms; 4 mA to 20 mA and digital low voltage wiring be brought in through the center entrance, and sensor leads be passed through the left-hand entrance. Conduit should be flexible, watertight, and sealed using a gasket to maintain environmental integrity within the enclosure.

Connect the two relay/alarm contacts;

Alarm A: contact TB300
Alarm B: contact TB301

Connect the two isolated 4 mA to 20 mA outputs;

Output 1: contact TB303
Output 2: contact TB304

Sensor Mounting

It is recommended that the sensor be located as near as possible to the D.O. analyzer to minimize any effects of ambient electrical noise interference. Flow and insertion sensors can be in any orientation but should be mounted tip down at an angle anywhere from 15 degrees above horizontal to vertical. 15 degrees above horizontal is best because air bubbles will rise to the top and debris will sink, both bypassing the sensor.

Submersion sensors should not be mounted where a lot of air bubbles rise in the tank, they will cause spikes in the D.O. readout.

Removal of the Dissolved Oxygen Sensor; Flow and Insertion Type

1) Stop the sample flow to the dissolved oxygen sensor and vent the sample line to atmosphere.
2) If installed by insertion directly into a tank wall, ensure the level in the tank is below the sensor before removing sensor.
3) 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 levels. Parting the membrane will cause dissolved oxygen sensor failure.*
4) When the dissolved oxygen sensor has been fully removed, wipe the sensor clean and then proceed to the calibration procedure or monthly/yearly maintenance, as necessary.

D.O. Sensor Insertion

1) Inspect the inside of the flow cell and/or insertion fitting for any foreign matter and wipe out any dirt which may be inside. It should appear clean, shiny and bright.
2) Feed the sensor cable through the union nut and collar, if not already assembled.
3) Insert the assembled and calibrated D.O. sensor into the flow cell or vessel. Gently rock the sensor back and forth to pass the O-rings through the flow cell or vessel.
4) Press slowly all the way down until the D.O. sensor cannot go any further into the flow cell - the flow cell is designed with a sensor stop-point.
5) By hand, turn the union nut until tight.

CAUTION: *Do not use a large wrench to turn the union nut. The plastic could be broken or become deformed.*

NOTE: *The union insertion fitting is not intended for use at high pressure.*

Sensor Wiring

The basic wiring scheme for all IC Controls D.O. sensors is shown in illustration 6. Refer to drawing D5940109 for wiring and component location. This wiring scheme is intended for cable runs less than 3 m (10 feet) where electrical interference is expected not to be severe.

For sensor to analyzer distances greater than 9 m (30 feet), a preamp interface is suggested. Refer to drawing D5950127 for interface wiring.

The D.O. sensor at 1 ppb D.O. produces a current of less than 1 microamp. 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.

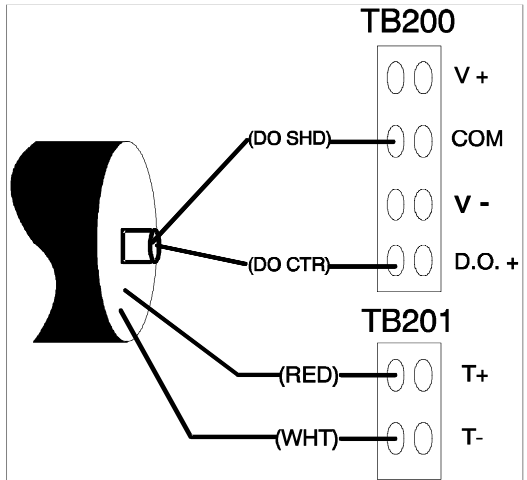


Illustration 6: Sensor wiring; direct connect

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 future time. Avoid excessive twisting or coiling of all instrument cable to minimize possibilities for broken wire. Make sure all connections are clean and tight.

Instrument Shop Test Startup

1. Apply 115/230 VAC power to the analyzer.
2. Hook up the sensor and remove orange protective cap. Keep for future use.
3. Rinse the sensor in deionized water and blot tip dry. Fill a beaker ½ full with tap water and place the sensor 1 inch above water surface.
4. The 855 should come up reading around 8 ppm to 9 ppm, depending on the temperature and barometric pressure. Refer to *Appendix C* for saturated D.O. values at various temperatures and pressures.
5. Perform a calibration. Allow 30 minutes warm-up time for electronics to stabilize.
6. Check the calculated efficiency - sensor efficiency should be greater than 50%.
7. To check for general performance, place the sensor in zero D.O. standard, P/N A1100193. The display should read near 0 ppm within a few minutes.
8. Before placing the analyzer into operation, verify settings to ensure that they coincide with the intended setup. Refer to *Appendix D: Default Settings* section.
9. For the 4 mA to 20 mA output, set high limit and low limit.
10. Set preference for temperature units as °C or °F in [CONF] [unit].
11. Set preference for dissolved oxygen units as ppb, ppm, or percent saturation in [d.o.] [unit].
12. Set preference for input damping, if known; default is 5 seconds.
13. Install password security, if desired.
14. The unit is now ready for field installation.

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.

STARTUP

If the analyzer is new and has not been installed, then follow the procedures described in *Installation, Electronic Hardware Alignment* and *Configuration of Program* before mounting. Mounting and wiring procedures for new installations vary with equipment options — refer to drawing section for instructions. If the analyzer has been previously installed, all that is required is to attach the sensor to the analyzer and then turn on the power.

The analyzer will go through its automatic startup procedure any time power to the analyzer is lost for more than a few seconds. The startup procedure will initialize the analyzer program, perform error checks and then proceeds to display the D.O. reading and function normally.

All program settings, calibration settings, and default values will have been retained by the analyzer as the memory has battery backup.

Start-up Procedure

1. Install the model 855 analyzer 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 or insert sensor into sample.
3. Power up the 855 analyzer.
4. The startup procedure will begin by alternately flashing [tESt] and [----] while performing the memory tests.
5. The analyzer will display in sequence the analyzer model number, in this case [855], and the program version number, eg. [2.20].
6. 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.
7. If the analyzer passes all the tests, then the hardware is functioning properly and the analyzer will proceed to display dissolved oxygen.
8. 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 go to the error display section by selecting [Err] from the main menu to see what errors have been detected by the analyzer.
9. After completing the above steps, the analyzer is now in normal operational mode. Analyzer settings and parameters can be viewed and/or changed at any time using the keypad.

Start-up Settings

The 855 dissolved oxygen analyzer uses a sensor with a galvanic cell which has an electrochemical zero current output at 0 ppm dissolved oxygen. Full-scale calibration is easily done using atmospheric air as the oxygen standard. The 855 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 855 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 855 also has pressure vs. dissolved oxygen at saturation tables stored in it's memory.

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

Refer to *Appendix D* for a list of all analyzer default settings.

Changing Settings

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

EASY MENU

The layout of the program is shown in the 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 and temperature, 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.

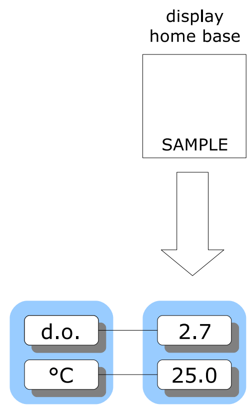


Illustration 7: Home base

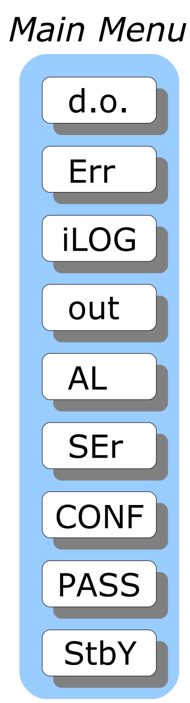


Illustration 8: Main menu

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.
2. When the sample value is displayed, pressing the *Left* arrow key will show which of dissolved oxygen or temperature is displayed. Pressing *Right* arrow key displays the sample reading again.
3. Each input can be turned off and thereby effectively disappear from the menu if it is turned off in the configuration menu. To change the configuration, refer to *Input On/Off Switch* in the *Configuration of Program* 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]. Refer to *Configuration of Program* section for details.

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 8) 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.

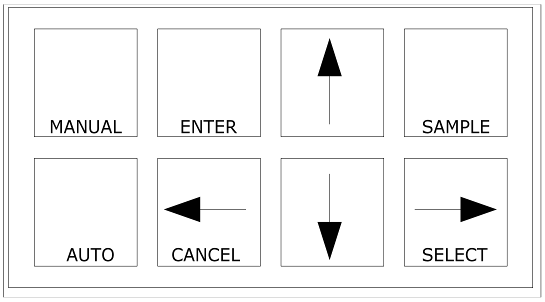


Illustration 9: Analyzer keypad

AUTO and MANUAL Keys

The AUTO and MANUAL keys are used to implement the alarm override feature. Refer to the *Alarm Override* heading in the *Alarm Functions* section for a description of these key functions.

Standby Mode

In standby, 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].

The analyzer will not resume normal operation until the analyzer is taken out of standby. While in standby, the entire menu and all of the 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.

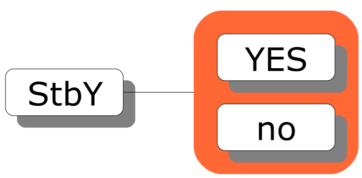


Illustration 10: Standby menu

Input Damping

The dissolved oxygen and temperature measurements can be damped to provide the user with a means to alleviate rapidly-varying or noisy signals. The available damping range is 3 s to 99 s; with 0 s, there would be no damping and each reading the analyzer made would be used to directly update the display and 4 mA to 20 mA output. The factory default of 5 s adds the next four seconds worth of readings to the first and divides by five; this provides a fast response. Selecting 99 s adds the readings for 99 s and divides by 99, providing smooth damping out of turbulent readings. Any selection between 3 s and 99 s can be made.

Select [CONF] [in] from the menu. Use the up or down arrow key to select the input to be adjusted, then select the [dA] frame. Press *ENTER* to edit the input damping to the selected seconds. Press *ENTER* to leave edit mode.

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.

Editing a Numeric Value

Numeric values such as an alarm set-point are adjusted by going into edit mode and then adjusting each digit until the new value is displayed. Use the ← and → keys to move between digits and use the ↑ and ↓ keys to adjust each digit.

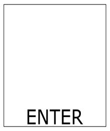
When *ENTER* is pressed to go into edit mode, two things will happen. First, the last digit will start blinking to show that this digit can be changed. Second, any blank spaces will change to zeros and a plus or minus sign will appear. Now each digit can be accessed. Change between positive and negative numbers by switching between plus and minus sign using the ↑ or ↓ key when the plus/minus segment is blinking.

Press *ENTER* again to leave edit mode. Before the new value is changed, the analyzer will check the new value to make sure that it is within range. If the new value is lower than the lowest value allowed for that frame then the analyzer will use the lowest allowable value instead of the new value entered. Likewise, if the new value entered is higher than allowable then the highest allowable value is used instead. The analyzer will display whatever value it has stored in memory.

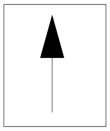
Example: Change the low output setting from 0 ppm to 2 ppm.

From the menu, select [out] [LO]. The current set-point (e.g. [0.00]) will be displayed. Press *ENTER* to select edit mode. The display will change to [+ 00.00] and the last digit will start blinking. Press ← twice to move left two digits. The third digit from the end will now be blinking. Press the ↑ key to change the '0' to '2'. Press *ENTER* again and the display will change from [+00.00] to [+02.00] indicating that the new value has been stored in memory.
The 4 mA to 20 mA low set-point has now been changed from 0.00 ppm to 2.00 ppm.
Press the ← key to display [LO], [out] etc.

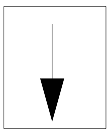
Summary of Key Functions in Edit Mode



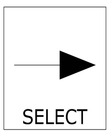
Enters edit mode. The entire display or a single digit will blink to indicate that the analyzer is in edit mode. Press the *ENTER* key again to leave edit mode and accept the new value.



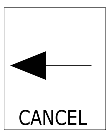
Adjusts blinking digit upward or selects the previous item from the list. If a 9 is displayed then the digit will loop around to show 0.



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 11: Edit keys

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 use imperial units. For 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.

In this instruction manual, the temperature input is always identified as [°C] throughout the menus.

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

Real-Time Clock

The analyzer clock is 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 Intelligent Access Program, which is available as option -35. Analyzers purchased with option -34 have a real-time clock which will maintain the correct time and date even when the analyzer power is turned off.

Display Units

By default the 855 analyzer will come up reading parts per million dissolved oxygen. The unit setting allows the analyzer to display the dissolved oxygen reading using either ppm (parts per million), ppb (parts per billion), or percent saturation units.

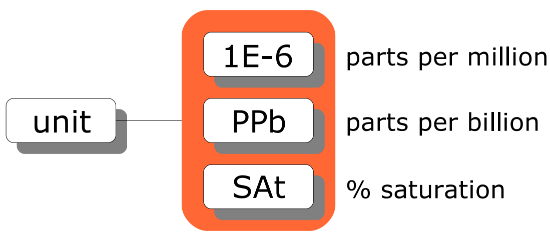


Illustration 12: Display units menu

The terms "parts per million" and "parts per billion" are not part of the International System of Units (SI). These units are in common usage in many parts of the world. In the United States the translation to SI units for concentrations in liquid is as follows:

parts per thousand: $1\ ppt = 1\ g/L$
parts per million: $1\ ppm = 1\ mg/L$
parts per billion: $1\ ppb = 1\ \mu g/L$

A problem with the use of these units is that their meaning is language-dependent. In the U.S., a billion refers to a thousand million, whereas in Britain a billion is typically understood to mean a million million. For scientific purposes the meaning of a "billion" is ambiguous. Additionally, the term "ppt" could equally well refer to "parts per thousand" or "parts per trillion". Add the language ambiguity to the 'thousand vs. trillion' ambiguity and "ppt" can mean any of "parts per thousand", "parts per 10^{12}", or "parts per 10^{18}". This manual uses the term "billion" to mean a thousand million, so that ppb is denotes "parts per 10^{9}".

The percent saturation unit displayable by the analyzer displays the calculated percent of maximum concentration of dissolved oxygen at the current temperature and pressure. For example, at 25 °C (77 °F) and 101.3 kPa (1 atmosphere, 14.69 psi) the maximum amount of oxygen that can be dissolved in water is 8.24 ppm. If at this temperature and pressure the analyzer is measuring 2.0 ppm, the percent saturation would be:

$$\frac{2.00}{8.24}\,ppm \times 100\% = 24.3\%$$

Switch between display units by changing the setting in [d.o.] [unit]. The options are [1E-6] for ppm (1E-6 is scientific notation for millionth), [PPb] for ppb (equivalent to 1E-9), and [SAt] for percent of saturation.

The conversion between ppm and ppb is as follows:

$$1\ ppm = 1{,}000\ ppb$$

$$1\ ppb = \frac{1}{1000}\ ppm$$

The conversion between ppm or ppb to percent saturation is somewhat more complicated because this conversion is not a simple multiplication factor, but depends on the temperature and pressure of the solution. Illustration 13 shows the D.O. concentration at various temperatures and pressures. Both the temperature and the atmospheric pressure need to be known in order to accurately calculate the percent saturation of the solution.

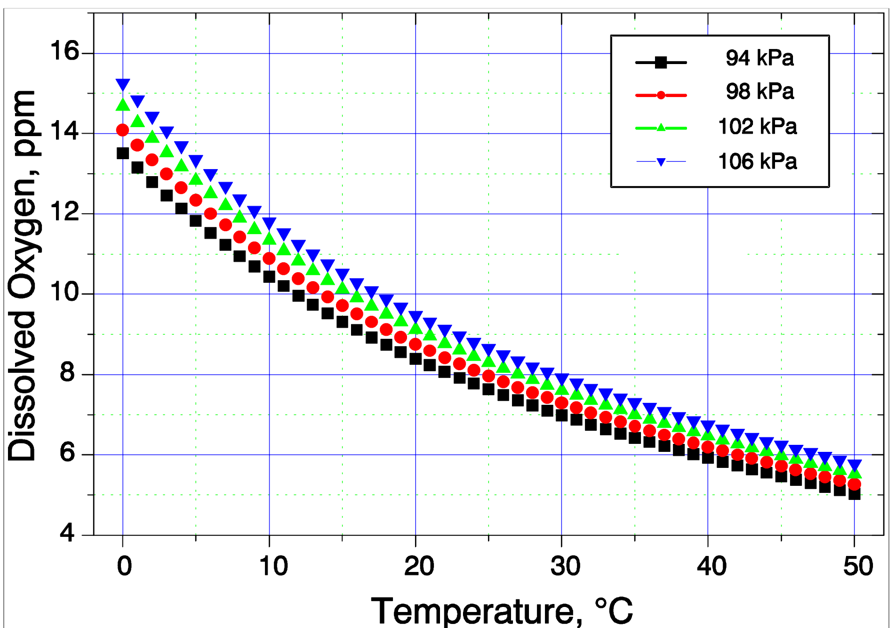


Illustration 13: ppm D.O. values at various temperatures and pressures

855 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.

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.

Galvanic Measuring Cell

The 855 dissolved oxygen measuring sensor 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 shows how such an electrode system works in a simple laboratory test. Illustration 15 shows how these scientific principles can be implemented into a working dissolved oxygen electrode. 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 855 uses a galvanic cell separated from the sample by an oxygen permeable PTFE (teflon) membrane. The cell has a gold 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.

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

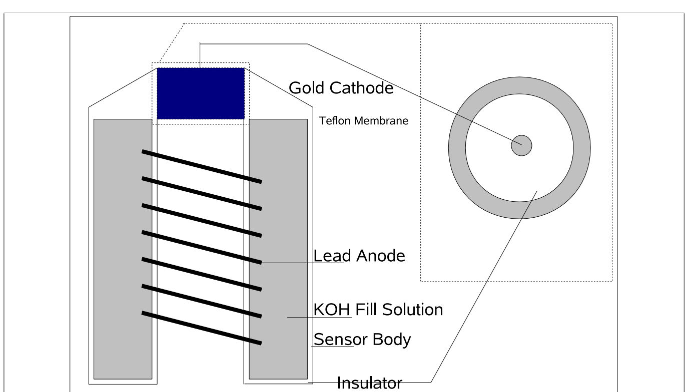


Illustration 15: Galvanic dissolved oxygen sensor

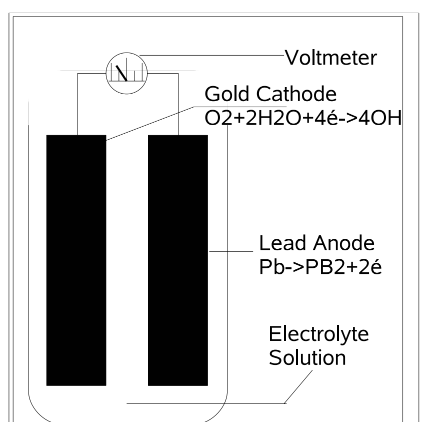


Illustration 14: Basic galvanic cell

D.O. CALIBRATION

Saturated Air Calibration Technique

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 855 has a microprocessor memory programmed with all the values, plus automatic temperature compensation, 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 tap water. This calibration technique will give a 100% saturation reading for the temperature and pressure which the 855 will display as ppm dissolved oxygen (actual dissolved oxygen table values are listed in *Appendix C*).

To calibrate the D.O. sensor, suspend the probe above water in a beaker and let the analyzer auto calibrate; refer to illustration 16.

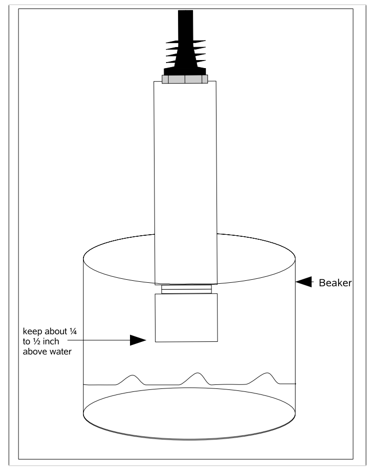


Illustration 16: Calibration setup

Zero Test Technique

The best way to zero check at the point of use, is to use a zero oxygen standard (sodium sulfite oxygen scavenger with a cobalt chloride catalyst) available from IC Controls as P/N A1100193 in a 500 mL bottle, or as a 6-pack as P/N A1100193-6P.

Caution: If zero standard gets on hands, wash with running water.

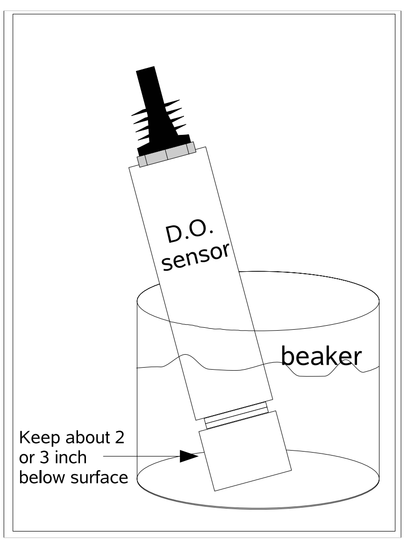


Illustration 17: Zero test setup

Preparation of Zero Oxygen Standard:

To 1 liter of distilled water add 20 grams of Na_2SO_3 and 10 milligrams of Co_2Cl_2 and mix thoroughly. Make sure that the zero standard is used within 8 hours because the oxygen scavenger will be used up quickly with exposure to air.

Submerge the D.O. sensor in a deep beaker so that it is 2 inches to 3 inches below the surface of the liquid; refer to illustration 17. Provide slow gentle movement to ensure the oxygen present is consumed. The D.O. sensor should rapidly fall to 0.1 ppm to 0.2 ppm levels, confirming operation of the sensor.

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 855 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 855 analyzer during calibration and for calculation of percent saturation, select [d.o.] [tc] from the menu; refer to illustration 18.

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.

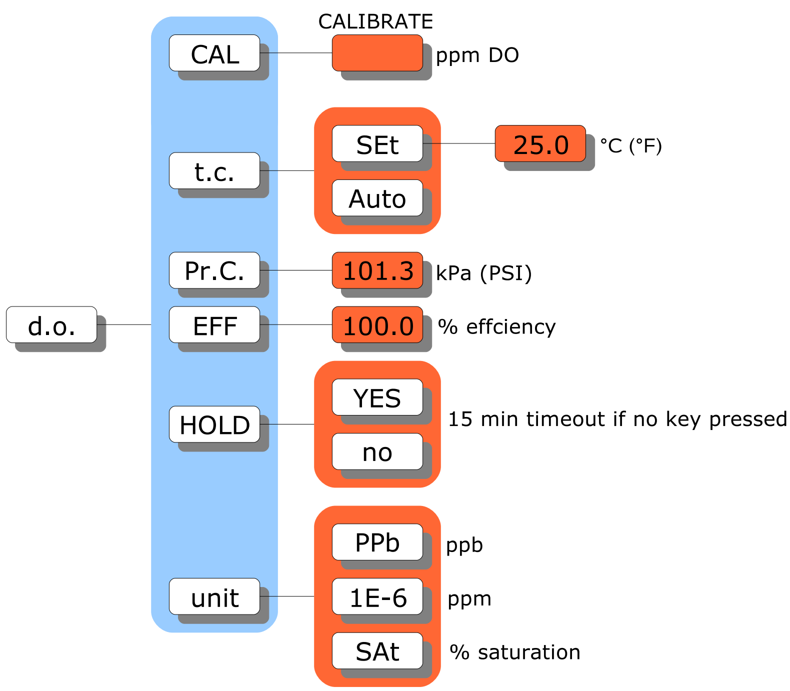


Illustration 18: Dissolved oxygen menu

Barometric Pressure Compensation

The 855 uses manual pressure compensation by way of a manual pressure compensation set-point.

When the analyzer is calibrated, the specified pressure is used to determine the concentration of dissolved oxygen. The 100% saturation reading is affected both by temperature and by pressure. While the barometric pressure only affects the 100% saturation reading at calibration, its use reduces calibration errors that could cause readings to be off by as much as 2%.

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

Manual Pressure Compensation

Atmospheric pressure is affected by altitude and weather conditions; refer to illustration 19 as a guideline for adjusting pressure compensation for altitude.

Select [d.o.] [Pr.C] from the menu. Press *SELECT* to display a numeric value. 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.

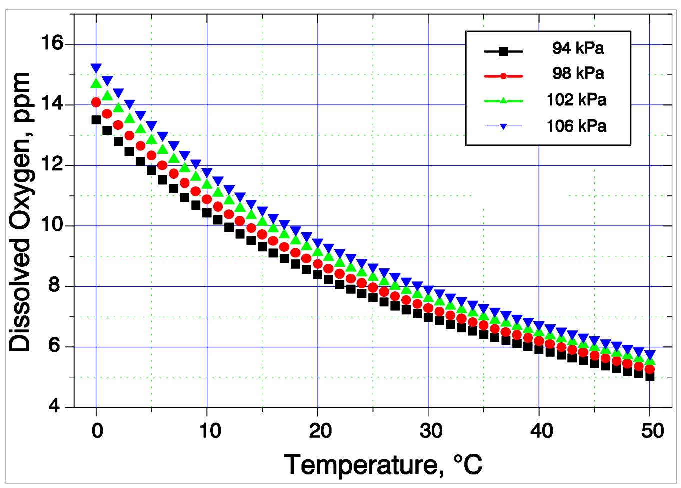


Illustration 19: Effect of altitude on barometric pressure

Calibration Procedure

When executing the calibration procedure the analyzer will adjust the efficiency constant for the D.O. cell.

Before performing the calibration, take the D.O. sensor and suspend it above water. Select [d.o.] [CAL] from the menu. The analyzer will show the D.O. reading using ppm units. The display will be blinking to indicate that the analyzer is calibrating and testing for stability.

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. The calibration setting will be based on the temperature used for temperature compensation and the pressure used for pressure compensation. The proper ppm D.O. reading is obtained from an internal table. See *Appendix C* for a table of values used by the analyzer. As soon as the display stops flashing the calibration will be completed.

It is possible to 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 D.O. reading. Also, the calibration may be redone or started over at any time. Press *CANCEL* to display the [CAL] frame, then press *SELECT* to restart the calibration.

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 has been retained. Press any key to acknowledge the error message. Take corrective action and redo the calibration. Consult the error table in the *Error Messages* section for details.

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

When the reading stops blinking the calibration has been completed. The reading will be displayed using the new calibration value.

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. A good functioning sensor will have an efficiency greater than 50%.

When leaving the calibration display, the analyzer will again display D.O. using the units used before doing the calibration. If ppb was being used then the analyzer will again display the D.O. reading as ppb when you press *SAMPLE* or leave the calibration display using the arrow keys.

Output Hold

The 855 allows the user to hold the output for dissolved oxygen. Output hold affects both 4 mA to 20 mA outputs and alarms which monitor the D.O. 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 their 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 D.O. will not remain in effect for longer than 15 minutes if the analyzer is left unattended.

ERROR MESSAGES

Detected errors and/or cautions are displayed by the analyzer. From the main menu select [Err]. If there are no error or caution messages, [NONE] will be displayed, otherwise scroll through the error list using the *Up* and *Down* arrow keys. Errors and cautions cannot be removed from this list directly; each error or caution will be removed automatically when appropriate, eg. 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
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.

Off-scale errors for dissolved oxygen 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.

Error message indicators can be annoying when one has already been made aware of them. A method has been provided to turn off the error LED and the fault alarm for a particular error message. Refer to the heading *Acknowledging an Error Message* for the exact procedure.

The error LED will remain on as long as there is an unacknowledged error or caution 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.

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. Refer to the *Configuration of Program* section.

Acknowledging an Error Message

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***
E1.0	Reading off-scale. Display shows + Err.	The internal A/D converter is at the top of the scale. The analyzer cannot measure higher dissolved oxygen values.	The analyzer is at the limit of it's measuring capability. Check the sensor setup to ensure sensor is functioning properly. Service or replace the sensor if necessary.
			The analyzer needs electronic adjustments. Arrange for servicing.
E1.1	Electrode has not stabilized after 5 minutes of calibration.	Poor electrode performance; sample is not stable; interference.	Check electrode and setup until stable reading is achieved; redo calibration.
E1.2	Electrode efficiency would be less than 20%. Previous setting retained.	Improper electrode setup or electrode failure.	Setup electrode, then redo calibration. Refer to *Troubleshooting* section.
E1.3	Electrode efficiency would be greater than 300%. Previous setting retained.	No D.O. signal or, signal from sensor is very weak.	Check electrode connection, then redo calibration. Refer to *Troubleshooting* section.
E1.5	Temperature compensator (TC) is off-scale.	Sample outside of TC operating range of -5 °C to 105 °C.	Use manual temperature compensation.
		TC not connected.	Check TC connections or install TC.
CA1.6	Display shows 0.00 ppm dissolved oxygen. There is no dissolved oxygen measurement.	Sensor reading is below measuring capability of analyzer.	Sensor is not connected, or there is a bad connection. Connect the D.O. sensor or check connections.
CA1.7	Display shows +Err, reading is too high for display.	Dissolved oxygen displayed using ppb units and dissolved oxygen is greater than 9,999 ppb.	Display D.O. using ppm units. Select [d.o.] [unit] from menu, set to [1E-6] to display ppm dissolved oxygen.

Error Messages for Temperature

Error	*Description*	*Causes*	*Solutions*
E2.1	Temperature reading off-scale; less than -5 °C.	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; greater than 105 ° C.	Temperature compensator (TC) not attached.	Attach temperature compensator.
			Turn off temperature input. Follow *Input On/Off Switch* procedure in *Software Configuration* section.
			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.

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 or temperature signal.

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.

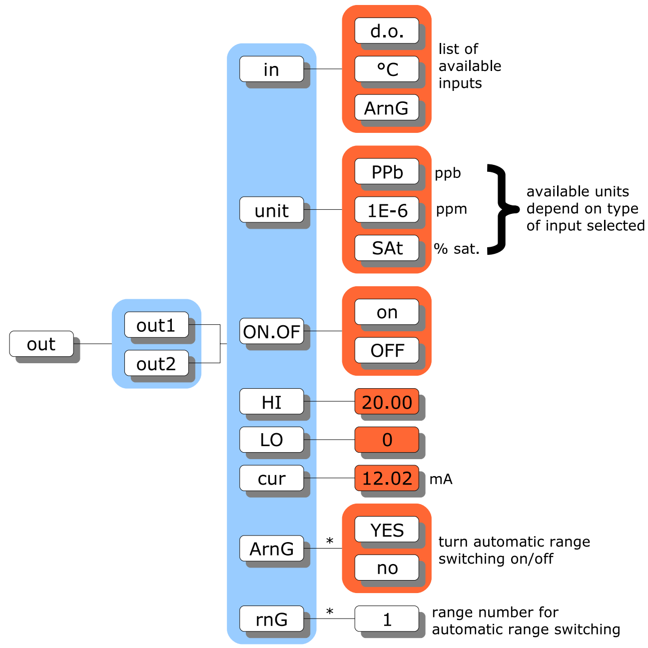


Illustration 20: Output menu

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 ppm to 20 ppm. As soon as the D.O. level drops below about 1 ppm, a typical recorder would be able to show very little resolution; refer to illustration 21. 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 the scale. With automatic range switching in effect for output 1, the output will adjust automatically over 3 ranges, moving from range 1 which is 100% of full- scale to range 3 which is 1% of full-scale. For dissolved oxygen, this means that with full-scale setting of 20 ppm the output will automatically switch down to range 3 which represents 0 ppm to 0.2 ppm or 0 ppb to 200 ppb.

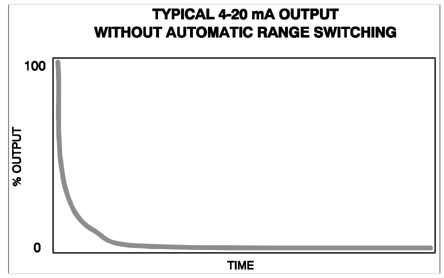


Illustration 21: Output without range

While automatic range switching is most practical for the D.O. input, the concept will work for the temperature input as well.

A hysteresis is built into the output logic to avoid having the output switch between ranges too frequently, thereby painting the chart recorder. The output will stay on the current range if the output level is between 9.5% and 100% of the current scale. The output will not switch downscale or to the next highest range number until the output reaches 9.5% of the current scale. The output will switch upscale again when the output reaches 100% of the current scale.

Enabling Automatic Range Switching

Only output 1 has automatic range switching available. From the menu select [out] [out1] [ArnG], then edit the setting to show [YES]. A common setting for [LO] is 0 , which is the lowest possible value for the D.O. input. Set the [HI] value to the full scale value for range 1. The [unit] selection for D.O. should be [1E-6] which represents ppm.

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

Range Switching for D.O. Input

Illustration 22 shows the effect of adding range switching to the 4 mA to 20 mA output. The top graph shows the D.O. level coming down after a calibration, but has virtually no resolution at the operating level. The bottom graph shows the 4 mA to 20 mA staying within 10% to 100% of scale by automatically switching between ranges. Only on the last range, range 3, is the output of the 4 mA to 20 mA allowed to go below 10% of scale.

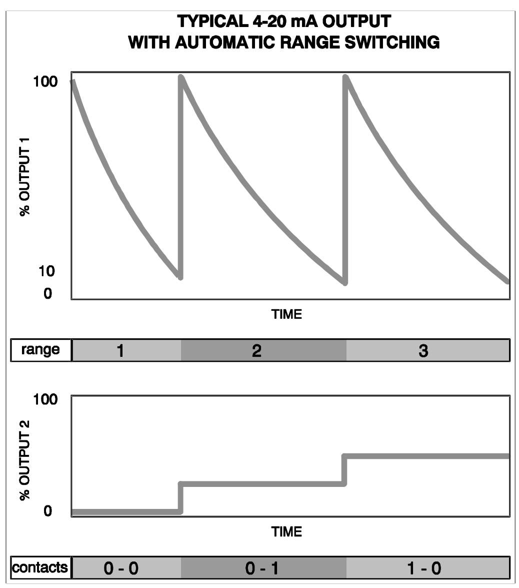


Illustration 22: Output with auto-range

To achieve results similar to those in illustration 22, use the following settings:

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]			

Table 2 summarizes the results for these settings.

Range Number	***Output 1, % full scale***	***Output 1, scale ppm D.O.***	***Output 2, mA***	***Relay Contacts***
1	100	20	4.00	A = 0, B = 0
2	10	2.0	8.00	A = 0, B = 1
3	1.0	0.2	12.00	A = 1, B = 0

Table 2: Example of range switching for D.O. input

Remote Indication of Range Number

Once output 1 is set to switch between ranges automatically, we still need to be able to indicate to a recorder or a digital control system which range number output 1 is on. This task can be accomplished either by using the alarm contacts or by using the second 4 mA to 20 mA output. The analyzer will also allow both methods to be used simultaneously.

Using the Alarm Contacts

The alarm contact method uses the two alarm contacts to distinguish between ranges. With two contacts there are four possible combinations. The on/off combinations for the A and B contacts are shown in table 2.

Set up the alarm contacts for range indication by selecting [CONF] [AL] [Al.A] or [Al.b] [FUNC] from the menu, and editing the setting to show [rnG]. While the alarm contacts are being used for remote range indication of output 1, the alarms will continue to function as normal, i.e. LED indication and alarm type display in *SAMPLE* frame will continue. It is not possible to use an alarm contact for alarm indication and range indication at the same time. Also note that while the alarm contacts are being used for range indication the normally open/normally closed configuration will be observed. Consult *Configuration of Program* section for further details.

Using the Second 4 mA to 20 mA Output

A more versatile method for indicating the range number for output 1 remotely is to use output 2. The following settings for output 2 will transmit the range number: [in] = [ArnG], [ON.OF] = [on]. Also set the [HI] and [LO] parameters to indicate which values represent 4.00 mA and 20.00 mA. Table 3 shows the relationship between the range number and some of the possible LO/HI 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

Table 3: Using output 2 for range

Unit Selection

The output module will be using different units for the high and low settings, depending on the input selected. Select [unit] from the output menu to display the units in use for this output.

The temperature input will use different units depending on whether metric or imperial units are selected. Celsius units are used for metric and Fahrenheit units are used for imperial units. The choice between metric or imperial units is made in the configuration menu. Refer to *Configuration of Program* section for further details.

The D.O. input allows the user to select between ppm, ppb, and % saturation units. Edit the unit setting to choose the desired units for the HI and LO settings.

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 or the temperature 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 or –5 °C and 105 °C for the temperature input.

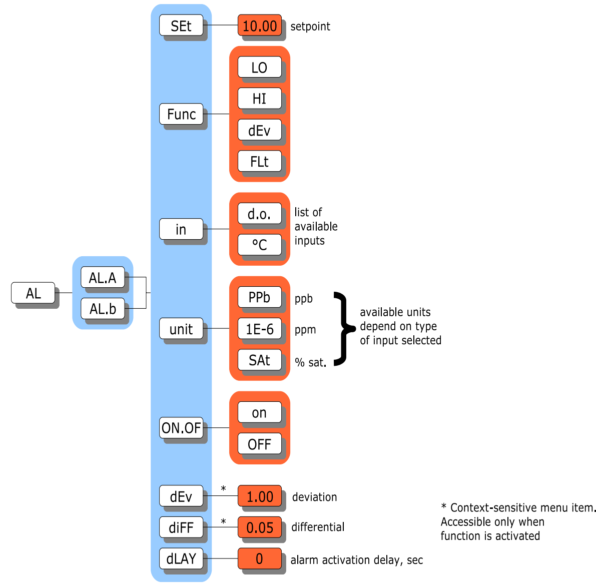


Illustration 23: Alarm menu

Use of Alarm Contacts

By default, the alarm contacts will be used to indicate alarm conditions. If there is an alarm condition then it will be indicated using both the LED and the alarm contact. This function of the relay contacts can be selected by setting [CONF] [AL] [Al.A] or [Al.b] [FUNC] to [AL].

The alarm 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 alarm contact. This usage of the alarm contacts is selected by setting [CONF] [AL] [Al.A] or [Al.b] [FUNC] to [rnG]. Remote range indication is described in the *Output Signals* section.

Alarm Indication

The A and B LEDs on the front panel show the current state of each alarm and alarm contact. In addition, an alarm condition for an input will cause the sample display for that input to alternate with the alarm function, either [LO], [HI], [dEv], or [FLt]. This way the operator can quickly determine which alarm caused the alarm condition (alarm A or alarm B LED lighted), and the type of alarm. An LED that is "blinking" or "on" shows the alarm condition. The status of the relay contact can also be determined at a glance as it is activated when the LED is "on" and deactivated while the LED is only "blinking" or "off". The alarm LED will "blink" while the alarm override is in MANUAL because this situation deactivates the alarm contacts.

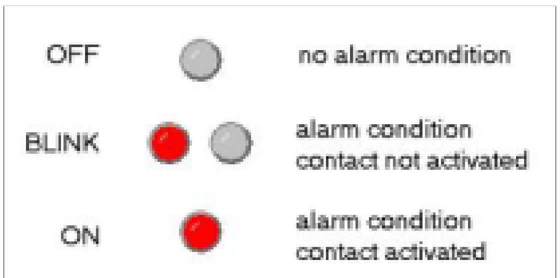


Illustration 24: Alarm status indication, alarm LEDs

Each alarm will simultaneously generate a caution number in the error menu. Refer to *Caution Messages for Alarms* in the section entitled *Error Messages* for a description of each alarm caution. The alarm cautions will not cause the error LED to come on because the error LED only comes on if there are any errors. To view alarm caution(s) using the error menu, select [Err] from the main menu, then use the *Up* or *Down* arrow key to scroll through the list of errors and cautions, if any.

Alarm Override

For normal alarm operation the alarms are said to operate in auto-mode. If the operator wishes to intervene and switch off the alarm contacts temporarily while attending to a problem, the alarms can be switched to manual override using the *MANUAL* key.

In AUTO mode: the green AUTO LED is on and the analyzer alarms will activate and deactivate the relay contact as programmed. Press the *MANUAL* key to temporarily deactivate the alarm contacts.

In MANUAL mode: the green AUTO LED will blink. The relay contacts are deactivated, but the alarm LEDs continue to indicate alarm condition(s). Press the *AUTO* key to return to AUTO mode immediately and reactivate the relays. If no key is pressed for 15 minutes, the 15-minute timeout will return the alarms to AUTO mode.

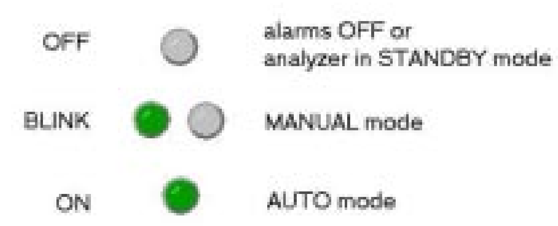


Illustration 25: Alarm override status, AUTO LED

Delayed Activation

Alarm relay activation, by default, is immediate upon alarm condition. Alarm relay activation may be delayed. Activation delay gives the operator a chance to correct alarm situations before the relay contacts activate, or can eliminate alarms based on temporary or spurious changes in the process.

The delay time is programmable by the operator. To change or view the delay time, select [dLAY] from the alarm menu. The default value of 0 seconds is for immediate contact activation. The delay time can be set from 0 s to 9,999 s.

Unit Selection

The alarm module 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 alarm module will be using different units for the settings, depending on the input selected. Select [unit] from the alarm menu to display the units in use for this alarm.

The temperature input will use different units depending on whether metric or imperial units are selected. For temperature the unit selection can be viewed only. The choice between metric or imperial units is made in the configuration menu. Refer to *Configuration of Program* section for further details.

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

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.

To edit the configuration, select [CONF] [AL] from the menu.

The normally open/normally closed configuration selected will remain in effect even when the alarm contacts are used to indicate the range number for the first 4 mA to 20 mA output.

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 2.0 ppm and 4.0 ppm, then we would set [in] to [d.o.], [Func] to [dEv], [SEt] to 3.0, and [dEv] to 0.5. Effectively, a high alarm at 4.0 ppm and a low alarm at 2.0 ppm has been set.

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

High or Low Alarm

A high alarm is set when the value of the dissolved oxygen or temperature rises above the set-point and is cleared when the dissolved oxygen or temperature drops to below the set-point minus the differential (refer to illustration 27). A low alarm is set when the value of the dissolved oxygen or temperature drops below the set-point and is cleared when the dissolved oxygen or temperature rises to above the set-point plus the differential (refer to illustration 39). The differential has the effect of setting the sensitivity of the alarm. The differential provides a digital equivalent of a hysteresis.

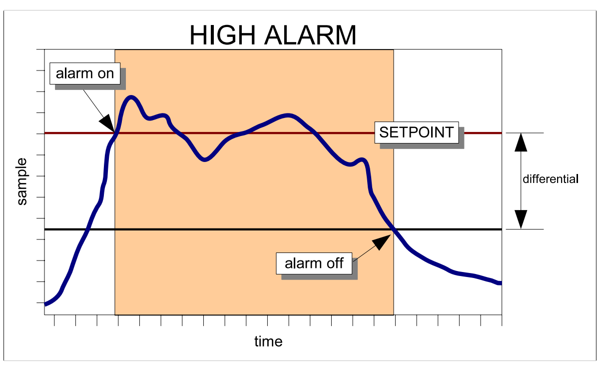


Illustration 27: High alarm

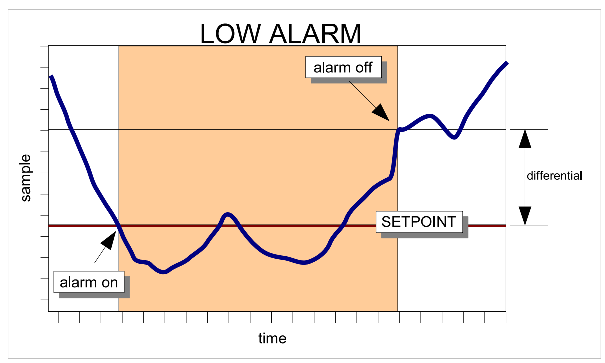


Illustration 26: Low alarm

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 or temperature.

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

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.

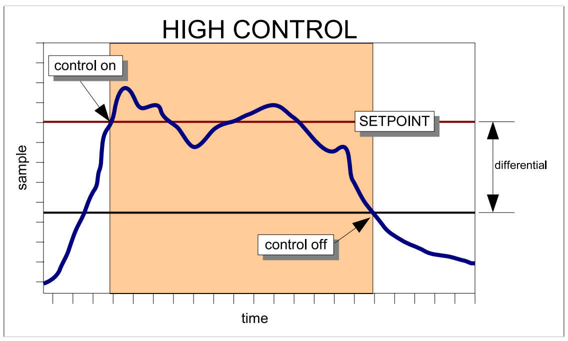


Illustration 28: High control

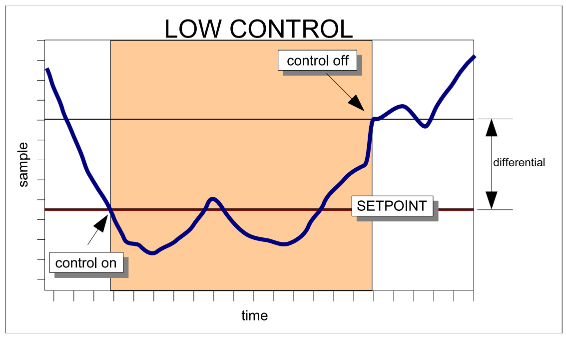


Illustration 29: Low control

CONFIGURATION OF PROGRAM

The 855 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 855 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.

Input On/Off Switch

The inputs have been provided with an on/off switch. By default the D.O. and temperature inputs are on. The most common use of this feature is to "turn off" the temperature input if no temperature compensator has been installed. Turning off an input will make the respective input's display at the left side of the menu disappear, as if it did not exist.

To turn off the temperature input, for example, select [CONF] [in] [°C] [ON.OF] from the menu, and edit the setting to show [OFF].

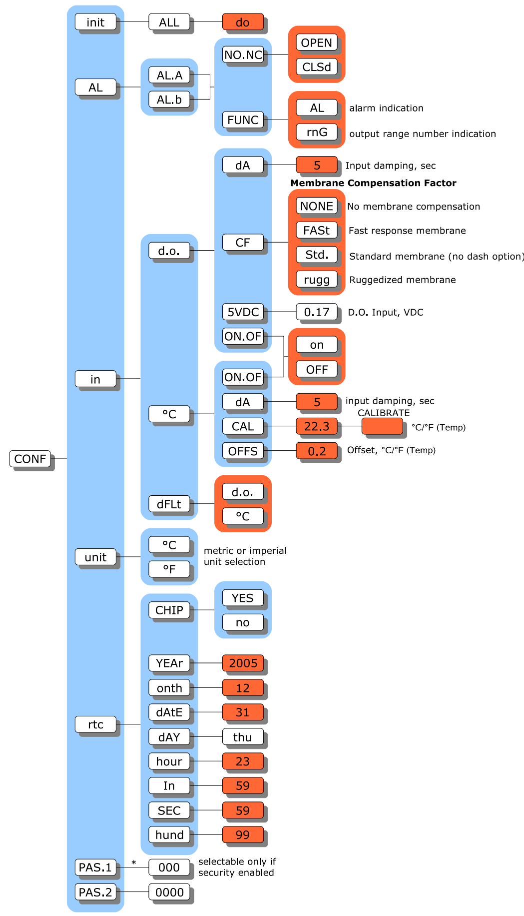


Illustration 30: Configuration menu

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*.

Auto-Ranging Dissolved Oxygen

The analyzer program allows the user to select either manual or automatic ranging. By default, the analyzer will automatically switch between ranges. Refer to the section entitled *Automatic Range Switching* for further details.

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.

Refer to *Appendix A* for details on how to enable and/or disable security.

Membrane Selection

Dissolved oxygen sensor models 802 and 825can be ordered with a choice of membranes:

Standard membrane; no dash option specified.
Fast response membrane; thinner and less durable, specified with -4 option.
Ruggedized membrane; thicker and slower response, specified with -5 option.

For more accurate response, the analyzer configuration should be adjusted to reflect the membrane used by the sensor.

From the menu select [CONF] [in] [d.o.] [CF], then select the appropriate membrane.

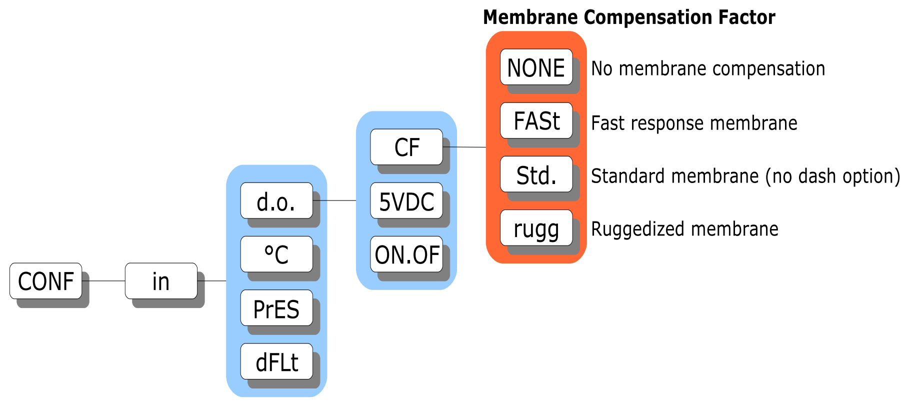


Illustration 31: Membrane compensation factor menu

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.

SENSOR 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.

IMPORTANT: 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.

Monthly Maintenance

Certain applications may require occasional sensor cleaning. A monthly maintenance check is recommended by visual examination of the sensor cell area. If needed a soft wipe can be used to blot the area, plus detergent and water can be used to remove any deposits. Rinse thoroughly after cleaning with water. Perform a calibration and if the sensor efficiency is above 50%, return to service.

Black or red discoloration inside the sensor cap may not cause problems. However, if after calibration the electrode response is slow, replace the electrolyte and wipe the coils and surface lightly using a soft wipe, or a little more vigorous cleaning can be done using a toothbrush. Recharge with fresh electrolyte. Calibrate and return the sensor to service.

Yearly Maintenance

Replace the membrane module and electrolyte. Unscrew the electrode cap and dump the contents. Flush the cell internals with deionized water and rinse with electrolyte. Examine the lead coils for black or red discoloration or heavy gray coating. Such coatings should be removed for best performance. **Note:** *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.

Remove the old membrane module from the cell and replace with a new one. Re-assemble the cell, calibrate, check efficiency and if above 50%, return to service.

Chemical Cleaning Maintenance

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) Unscrew the tip retainer exposing the coils and gold tip.
2) Immerse in cleaning solution (refer to illustration 32) 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.

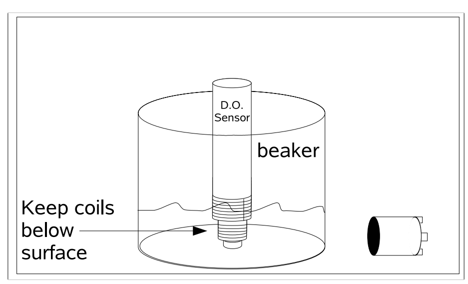


Illustration 32: D.O. sensor cleaning

5) Re-assemble the D.O. sensor with a new membrane module (see illustration 33).
6) Fill the membrane module with fill solution and re-assemble sensor as per illustration 34.
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, the D.O. sensor should be replaced.

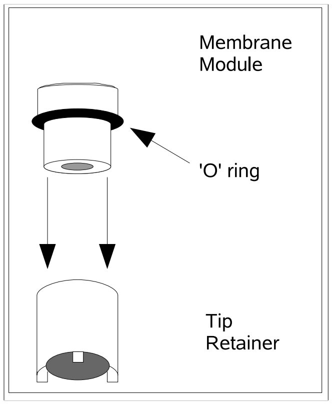


Illustration 33: Membrane module assembly

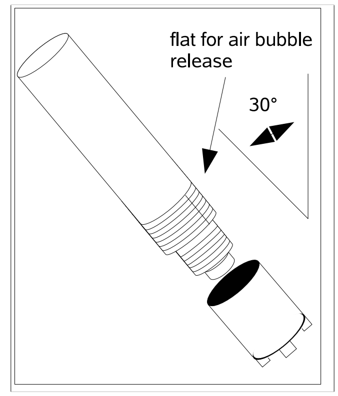


Illustration 34: Membrane cap installation

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.

1) Galvanic D.O. sensors need to have a current drain at all times. Assemble sensor wired to analyzer or, if not possible, short the coax center to shield.
2) Unscrew the tip retainer exposing the lead coils and gold tip. Inspect the electrode to ensure the coils are clean and the gold electrode is bright.
3) Assemble a membrane module in the cap with the membrane facing down so that it covers the center hole in the cap.
4) Flush the coils of the electrode with electrolyte solution, then holding the electrode cap in an upright position, with membrane module installed, fill with electrolyte until the center cavity is full. Tilt at about 30 degrees from vertical and add an extra 1/8 inch of electrolyte, observing that the crack around the membrane module fills with electrolyte.
5) Next hold the cap like a cup, (refer to illustration 34) and slowly lower the electrode coils vertically down into the cap until the threads touch. 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. 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 gold electrode should be clear. There should be no lines from trapped bubbles between the membrane and the gold electrode. If there are no visible problems, the D.O. sensor is ready to be put into service.

TROUBLESHOOTING

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. In this case, the problem may be alleviated by changing the take-off point or by installing a knock-out pot. Alternatively, a dirty-water sample system may be needed.

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 very low reading. Review the installation instructions.

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; the sensor will need to be cleaned. Refer to the *Chemical Cleaning Maintenance* section in this manual.

Readings at maximum - "+Err" message under all conditions
Usually an indication that the D.O. sensor is in air but still set to display in ppb oxygen. Caution 1.7 will appear in the error menu. Select [d.o.] [unit] from the menu, then set units to ppm ([1E-6] frame). With units as ppm, displayed readings can be greater than 10 ppm or 9,999 ppb. "+ Err" message means off-scale high.

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.

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 connection, TB200, terminal 4, and “COM” sensor, TB200, terminal 2, as common. Refer to drawing D5940109 for component location.
3. Set the D.O. efficiency constant to 100% by selecting [d.o.] [EFF] from the menu and editing the value to read 100.0%.
4. Adjust the electronic standardize with blue trimpot VR200, located mid-board above the D.O. terminal block; refer to drawing D5940109. Adjust the trimpot to a reading of 2.575 VDC at TP200 while inputing 0.180 VDC through a 200K 1% resistor. Under these conditions the 0.180 VDC input simulates a 0.9 microamp sensor signal for 8.24 ppm D.O. at approximately 100% efficiency, atmospheric pressure, and 25 °C.

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. The temperature input of the 855 microprocessor analyzer requires a 1000 Ω TC in the sensor.

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, terminal 2, as common. Place a 1000 Ω 1% resistor across T+ and T- terminals. Adjust blue trimpot VR202 for a reading of 0.200 VDC at TP202. Refer to drawing D5940109 for component locations.
4. Place a 1385 Ω 1% resistor across T+ and T- terminals. Adjust blue trimpot VR203 for a reading of 4.85 VDC at TP202. Refer to drawing D5940109 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 1000 Ω 1% resistor and adjust VR202 until the display reads 0.0 °C ± 0.1 °C.
7. Re-insert the 1385 Ω 1% resistor and adjust VR203 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.

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 select 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]; 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.*

Adjusting Electronic Calibration

1. The outputs are isolated from the main circuit, therefore, measurements are made with common at the output 2 terminal, TB304.
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 VDC and -0.890 VDC. 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 VDC and -0.890 VDC. 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

[1E-6]	Dissolved oxygen units in parts per million, ppm; from E-6 = millionth
[5VDC]	D.O. input voltage
[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?
[CF]	Compensation factor, membrane
[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
[dA]	Damping of input signal
[dAtE]	Date: Real-time clock setting for day of the month
[dAY]	Day: day of the week, real-time clock setting
[dEv]	Deviation alarm
[dFLt]	Default
[diFF]	Differential
[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
[FASt]	Fast response membrane
[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
[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]	kilopascal (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

[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 (ppb) D.O. unit selection
[Pr.C]	Pressure compensation setting
[PSI]	Pounds per square inch (psi) units for pressure
[rANG]	Analyzer dissolved oxygen input range selection
[rnG]	Range number
[rtc]	Real-time clock
[rugg]	Rugged membrane
[SAt]	Percent saturation D.O. unit selection
[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
[Std.]	Standard response membrane
[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 4: 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 35 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.

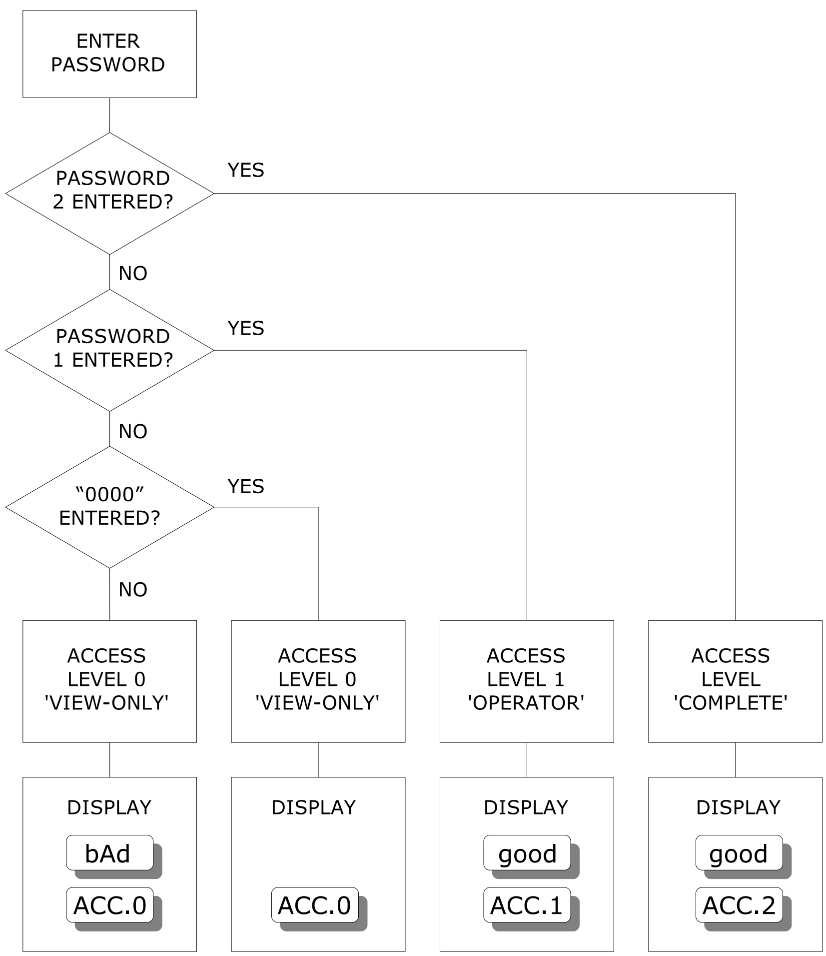


Illustration 35: Password validation

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

Relation of ppb, ppm, mg/L, % saturation for D.O.

$$1000\ ppb = 1\ ppm$$

$$1\ ppb = 0.001\ ppm$$

1 ppm is approximately 1 mg/L. The 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

$$°C = \frac{5}{9}(°F - 32)$$

$$°F = (\frac{9}{5} \times °C) + 32$$

Pressure Units

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

$$kPa = psi \times 6.895$$

$$1\ atmosphere = 1.01325\ \text{bar}$$

$$1\ atmosphere = 760\ mm\ Hg = 760\ Torr$$

$$1\ atmosphere = 14.70\ psi$$

$$1\ atmosphere = 101.3\ kPa$$

$$1\ \text{bar} = 100\,000\ Pascal$$

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 855 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

°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	20.00	100.0
ON/OFF switch	ON	ON
Units	[1E-6] ppm	° C
Automatic range indication	OFF	-

Alarms

	Alarm A	**Alarm B**
Input for alarm	dissolved oxygen	dissolved oxygen
Alarm function	High	Low
ON/OFF switch	OFF	OFF
Set-point	10.0	1.0
Differential	0.05	0.05
Delayed activation	0 s	0 s
Units	[1E-6] ppm	[1E-6] ppm

Global units
Metric units; D.O. concentration in ppm (parts per million), temperature in degrees Celsius, pressure in kPa

Alarm contacts
Configured normally open

Security
Not enabled

Temperature compensation
Automatic TC using temperature input

Pressure compensation
Manual pressure compensation to 101.3 kPa (14.69 psi)

Input damping:

Signal damping for: $Dissolved\ oxygen = 5\ seconds$
$Temperature = 5\ seconds$

Appendix E — Parts List

Part Number	***Description***	***Drawing Number***
	855 ppm Dissolved Oxygen Analyzer	
A9051019	Assembly, 855 D.O. power PCB	D5940109_R2.1
A9051009	Assembly, M55 micro/display board	D5980176_R2.0
A9141007	Assembly, M55 case, complete	D4830022_R1.0
A9201014	16-wire interconnect cable, two-end	
A9160024	0.25 A microfuse	
A9160035	3 A microfuse (used with option -51; timer)	
A3200070	Hardware set; M55 front panel; 4 each of standoff, lock washer, 4-40 nuts	
A2500201	Panel mounting kit, M55 series	D4950054_R1.0
A2500255	Pipe/wall mounting kit, M55 series	D4950053_R1.1
	Interconnect Cable to 800 Interface	
A9200007	D.O. cable, 6 conductor with shield; per foot	D5950127_R1.4
	800 D.O. Interface, Pipe Top, Explosion-Proof Type	
A2500053	D.O. Preamp	D5950127_R1.4
A9120098	Terminal strip, 6 CKT	
A2101513	Explosion proof J-box (only)	
	800-71 D.O. Interface, Wall Mount Type	
A2500053	D.O. Preamp	D5950127_R2.1
A2100049	Preamp holding bracket	
A9120050	Terminal block, 6 CKT	
A2101514	Weatherproof, wall mount J-box (only)	
	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)	

Appendix F — Serial Output

RS485 can be used to send ASCII format serial pH and temperature (default frequency is 60 seconds), or as a two-way communication port for remote operation if an interface format program is available. No special software is needed on the computer to receive ASCII data. 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.

Data transmitted by the analyzer is in simple ASCII format. No special software is needed on the computer to receive the ASCII data, only an ASCII terminal program such as Hyperterminal on MS Windows systems. The 855 continuous output consists of two data fields containing input values separated by commas. Each line of data is terminated by a linefeed/newline. Comma-separated fields make it easy to import the data into other programs for analysis, for example, into a spreadsheet.

Wiring and Enabling

1) It is good practice to first turn off the analyzer and the computer before connecting a serial cable.
2) Wire the RS485 cable into the terminal block TB1 located on the display board. Refer to illustration 36. Connect pin1 RD(A) to pin 3 TD(A) and connect this to terminal A on TB1 in the analyzer. Connect pin2 TD(B) to pin 9 RD(B) and connect this to terminal B in the analyzer. Connect earth or shield at one end only!
3) Turn on the analyzer and the computer.
4) Configure the analyzer for the desired baud rate. Select [SEr] [baud] from the menu. Baud rates from 1200 to 38400 baud can be selected, the default is 9600 baud. For RS485 systems with automatic send data control the lowest baud rate that can be used is 9600.
5) To enable serial transmission by the analyzer, set the serial ON/OFF switch to ON; select [SEr] [ON.OF] and edit to display [on].
6) Turn on ASCII output; select [iLOG] [ASCII] and edit to display [on].

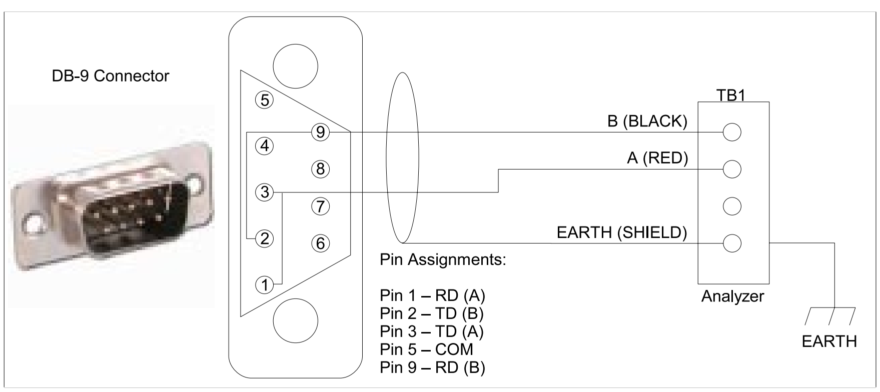


Illustration 36: RS485 wiring

Portable Laptop Hookup

Illustration 37: RS232 to RS485 converter

RS232 to RS485 Converter

The P/N A7900015 is a port-powered, half-duplex RS232 to RS485 converter. The unit supports two-wire RS485 communications. The converter handles the enabling and disabling of the transmitter. This works regardless of the operating system or program you are running. The RS232 side has a DB9 female connector. The RS485 side has a six-position RJ11 connector.

Material List:

- P/N A7900015, RS232 to RS485 converter
- P/N A2500192, 10 foot cable with RJ11 connector at one end, data wires at other end

Installation:

1) It is good practice to first turn off the analyzer before connecting a serial cable.
2) Bring the RS485 cable into the analyzer through the center hole. Wire the RS485 cable into the terminal block TB1 located on the display board. Connect the black to terminal B, red to terminal A, and the clear to EARTH.
3) Connect the converter to a free COM port on your laptop computer.
4) Insert the cable's RJ11 connector into the converter.

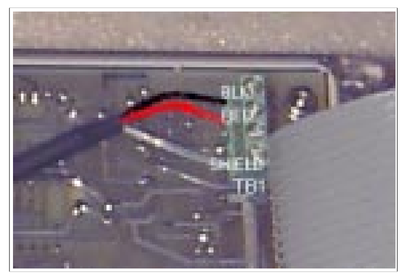


Illustration 38: Wiring RS485 cable

Making a Custom Cable:

A cable has been provided with the adapter. If this cable is not long enough, use the following information to create your own cable. Connect shield at one end only.

Converter Signal	*RJ11 Pin Number*
Data A (-)	2
Data B (+)	5
Signal Ground	4

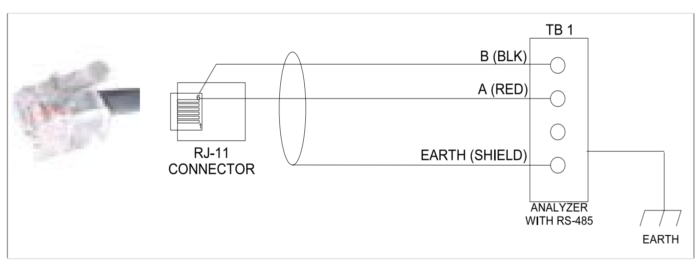
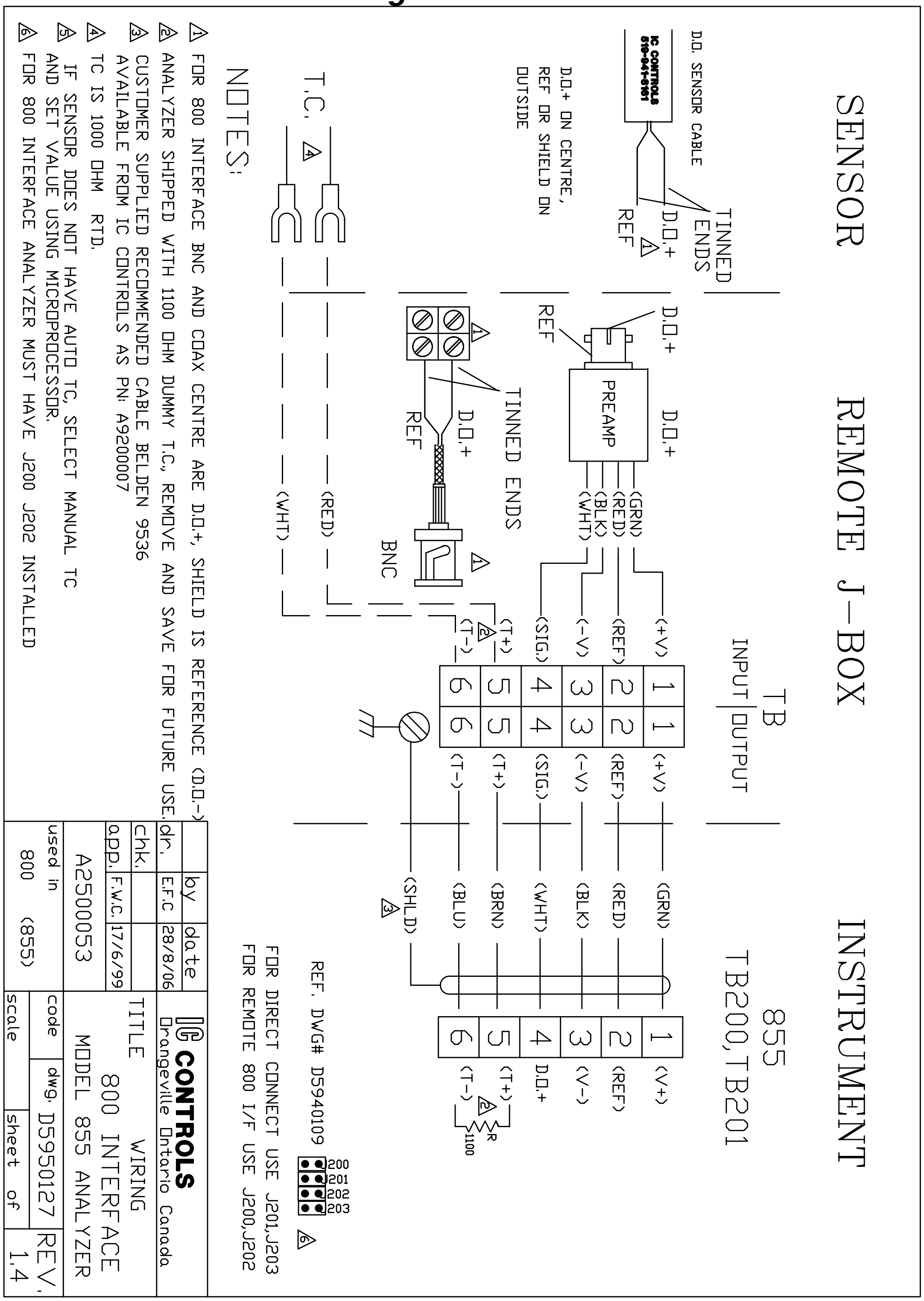


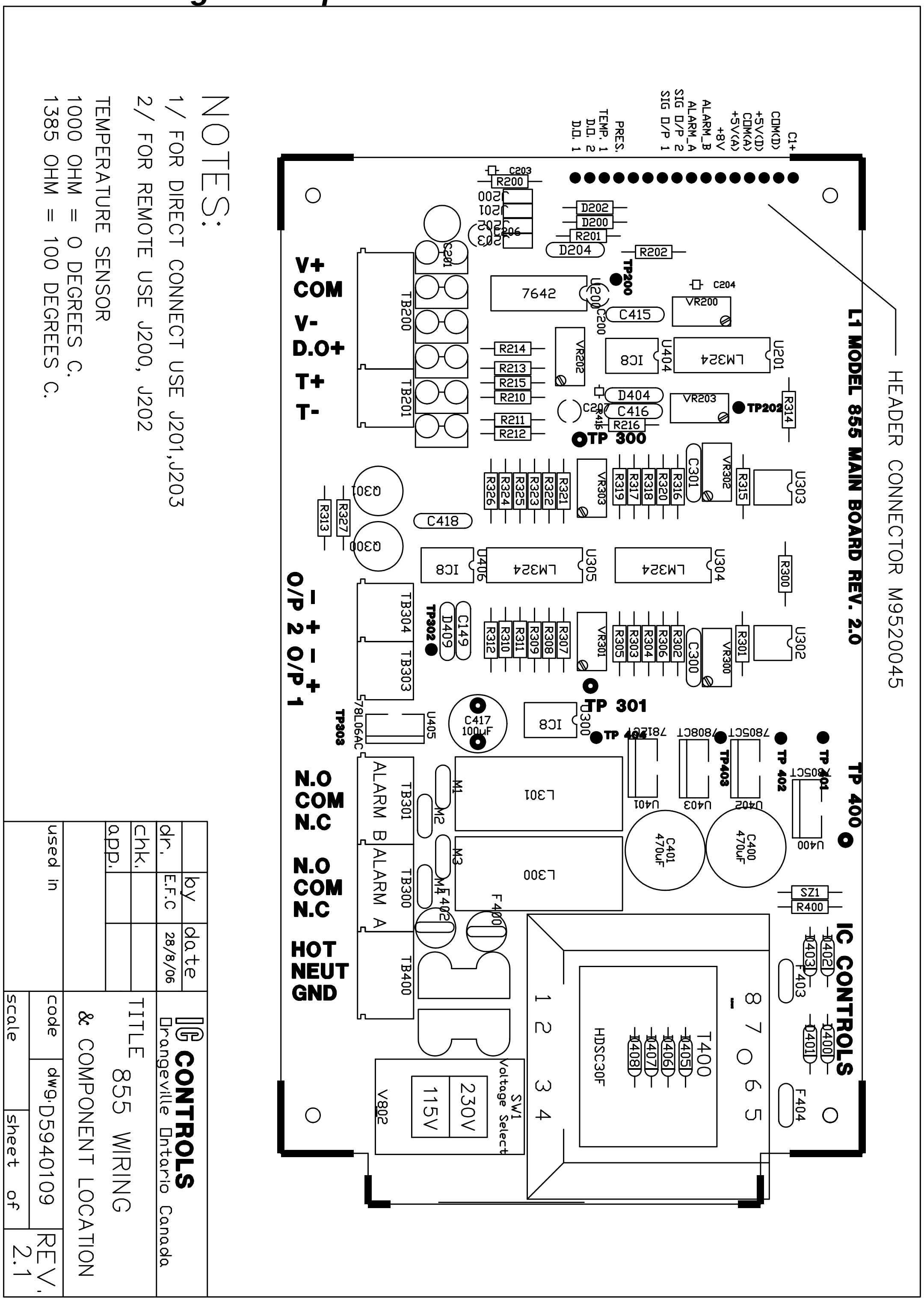
Illustration 39: Wiring RJ11

DRAWINGS

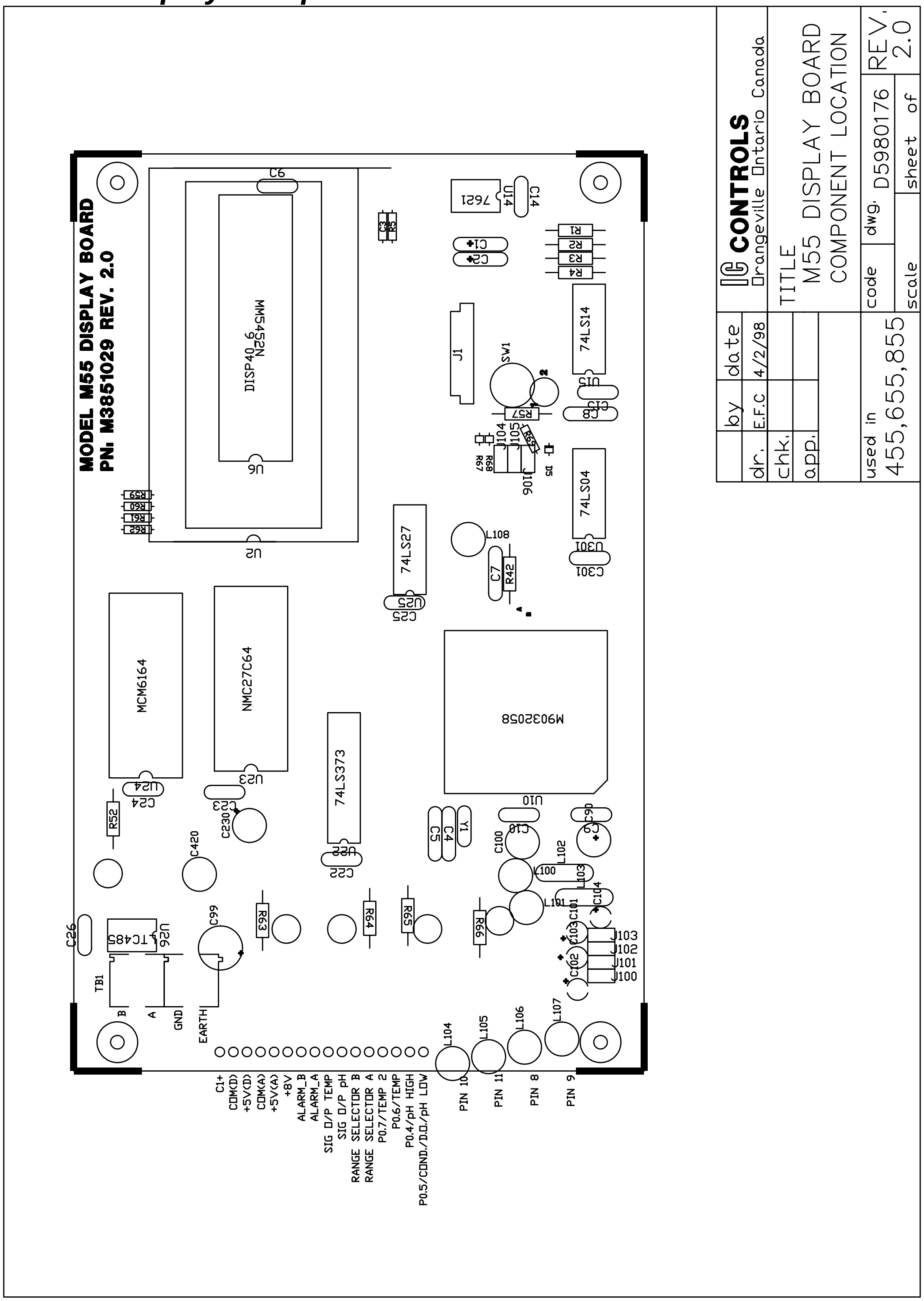
D5950127: 800 Interface Wiring



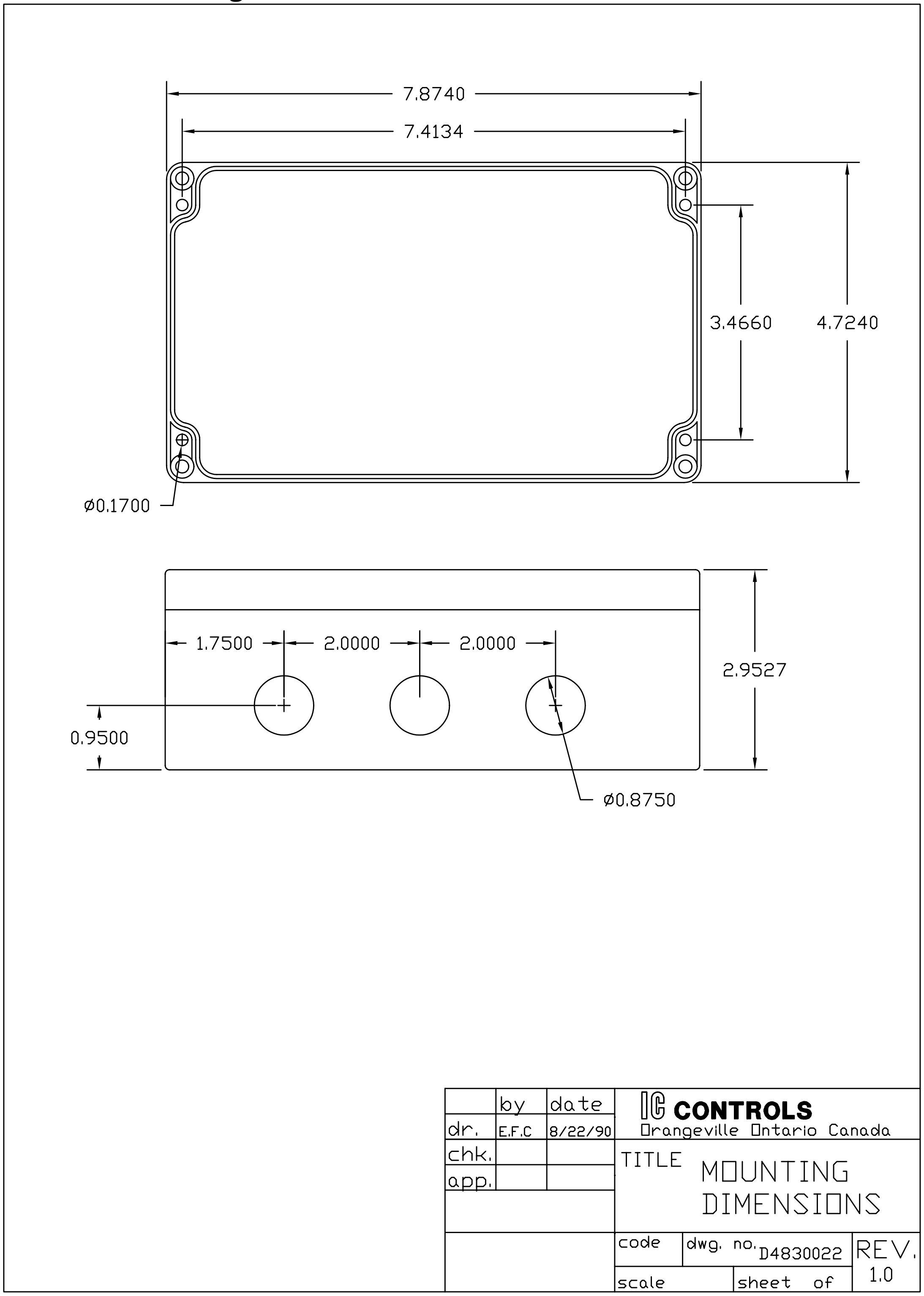
D5940109: Wiring & Component Location



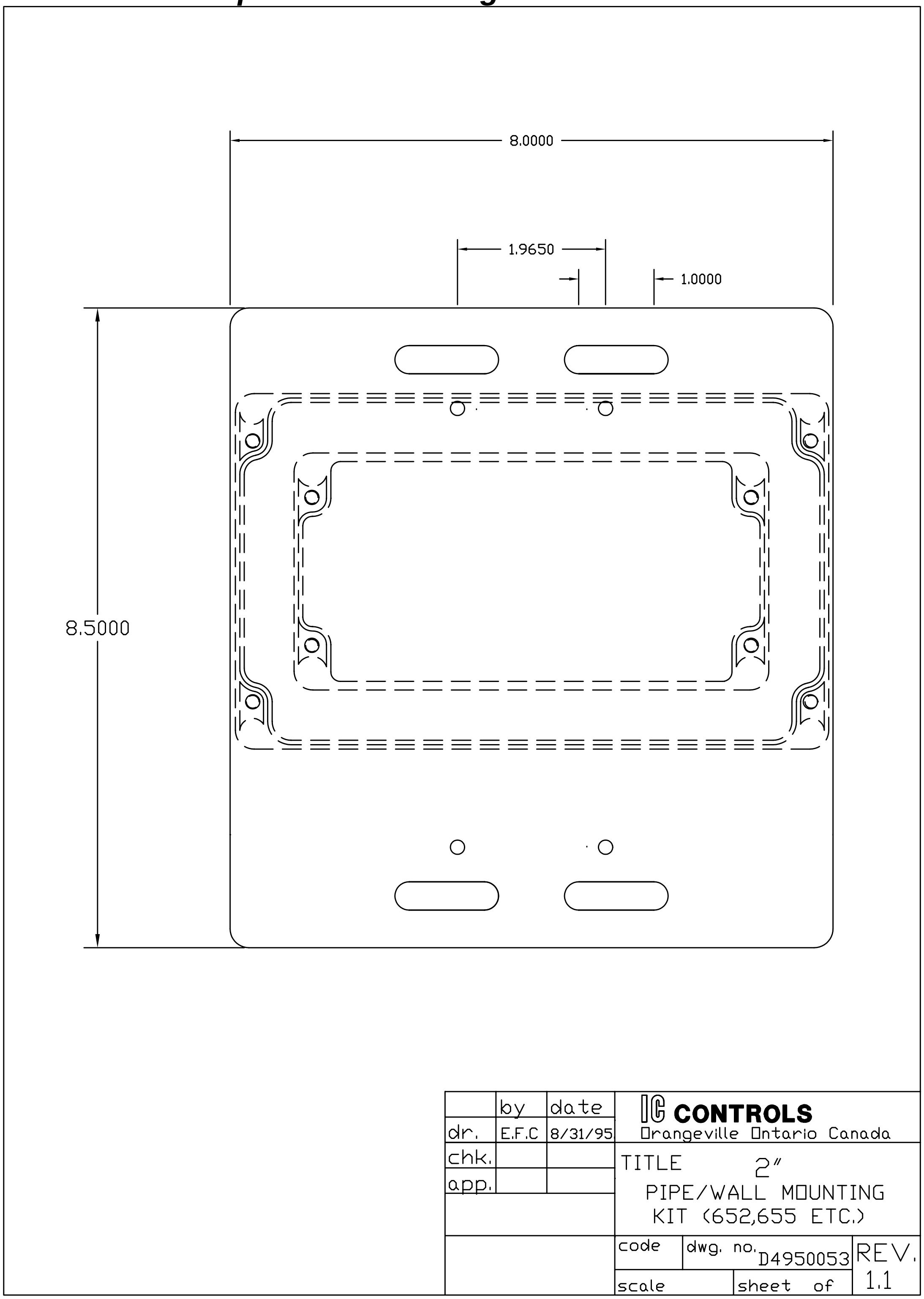
D5980176: Display Component Location



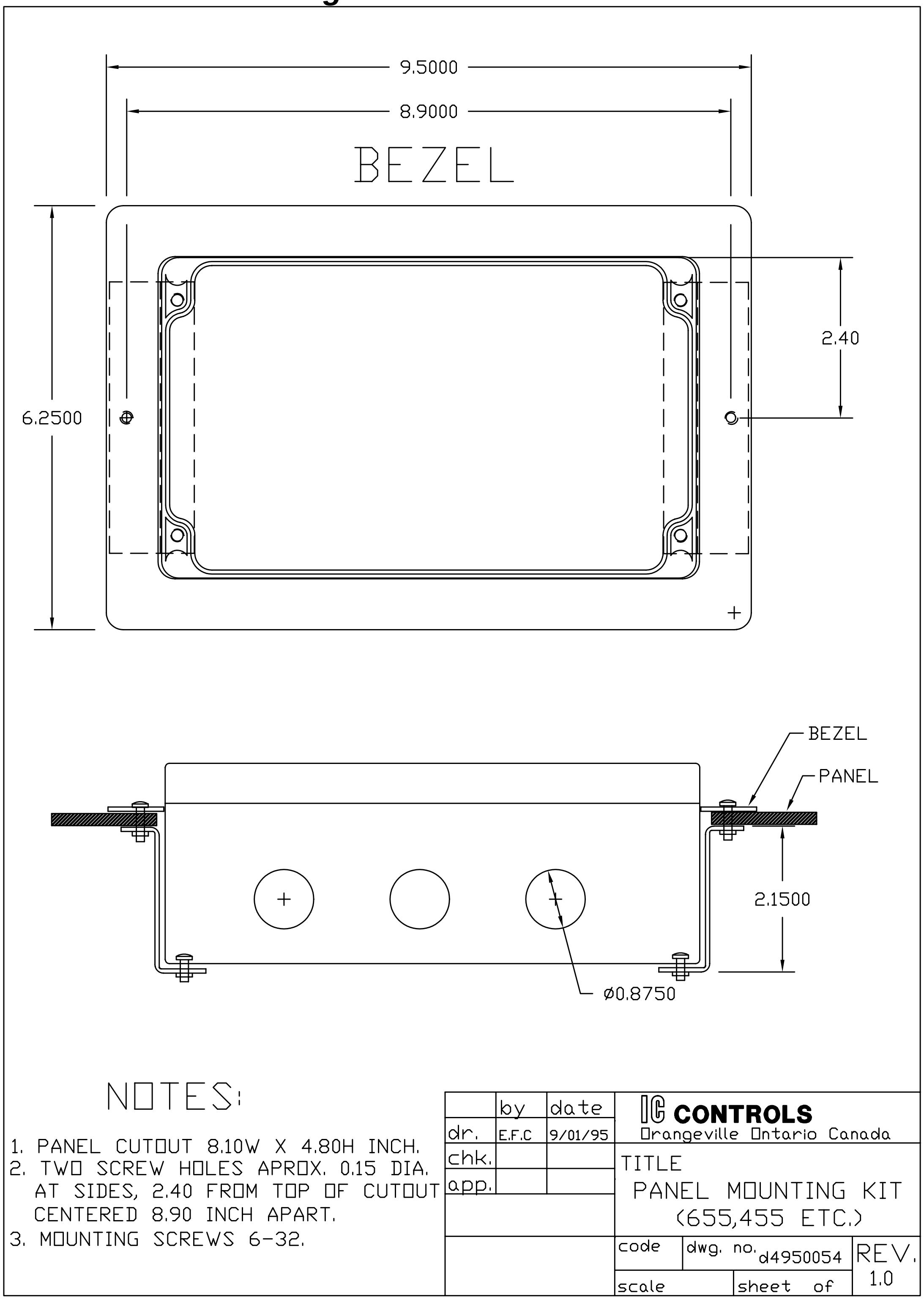
D4830022: Mounting Dimensions



D4950053: 2 inch Pipe/Wall Mounting Kit



D4950054: Panel Mounting Kit



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.

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