Foxcroft Equipment & Service Co. Inc.
Model FX-300-F
Drinking Water Ion Selective Electrode
Fluoride Analyzer Instruction Manual

Please Read Carefully and Save.

The FX-300 analyzer includes an instruction manual that contains important information about its operation. Purchasers who install this product for use by others must leave this instruction manual or a copy with the user.

Document No. MANFX300FDW 2020

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1 Theory of Operation

The FX-300 series analyzers use ion selective electrodes to directly measure the ion of interest in water without converting the ion to a gaseous form and without the use of reagents. It provides an online continuous measurement for daily monitoring, trending and process control in applications including municipal drinking and waste water, and industrial process water and waste streams.

A complete explanation of ion selective electrode theory and operation is beyond the scope of this manual. A brief general summary is provided below only to distinguish the analytical method used from methods used by other types of instrumentation.

The FX-300 uses an electrochemical potentiometric sensor with a membrane that is selective to, but not exclusive to, the ion of interest. This means that it is possible for other ion types to permeate the membrane and react with the sensor. This presents an interference which is present to some degree in all ion selective electrodes.

When the ions in the fluid being measured reach equilibrium with the internal ion concentration of the sensor an electrical potential difference develops across the membrane between the solution and the sensor's internal reference system. The electrical charge in the sensor is proportional to the ion concentration in the fluid being measured. The relationship between ionic concentration and the electrode potential is governed by the Nernst equation $E = E0 + (2.303RT/ nF) \times Log(A)$.

It's important to note the FX-300 ion selective sensors provide a measurement of free ion activity (those ions that are not bound to other ions or molecules), and not the actual total ion concentration. An ion in solution may exist as a free iron, meaning it is not bound to other ions or molecules, or it may interact and bind with other ions or molecules in the solution. The activity of an ion relates to the number of free ions of interest per unit volume of solution. The concentration of the ion of interest refers to the TOTAL number of those ions both free and bound per unit volume of solution

The FX-300 ion selective measurement does not use a method approved for reporting levels to a governing agency since the sample is not conditioned with reagents or buffers to produce a result. It will however provide a status of ion activity in the process stream and indication of actual concentration by using the 1-point offset calibration to concentration standards that is determined by an approved grab sample or laboratory analysis instrument that determines the actual concentration.

The activity of free fluoride ions in solutions is pH and temperature dependent over some pH and temperature ranges. The extent of ionization (HF) conversion to the measurable (F^-) ion form is also a pH and temperature dependent process.

Temperature dependence is described by the Nernst equation. The effect on a measurement in simple terms means that if the temperature fluctuates or the sensor temperature is not in equilibrium with the solution, the readings will also even if the ion activity remains unchanged.

2 Introduction

2.0 Fluoride Ion Selective Electrodes

The combination fluoride sensor includes both the measuring and reference electrodes with electrolyte, electronics and a high-impedance PVC organic membrane system in a sealed plastic body. As such there are no replaceable or serviceable items in the sensor. The only service required is occasional cleaning and calibration.

The recommended pH range of the general purpose fluoride sensors is 5.5 to 9.5pH on a continuous basis for optimum sensor lifetime. We recommend a pH less than 9.5 to minimize aging on the crystal. Sensors will start to have some loss of linearity at pH 10. **Solutions at pH 11 will destroy the fluoride crystal.**

It is not recommended to operate the general purpose drinking water sensors below 5.5 pH. If the fluoride sensor must operate below 5.5 pH you must contact the factory for assistance in selecting a different sensor or sample point for your application.

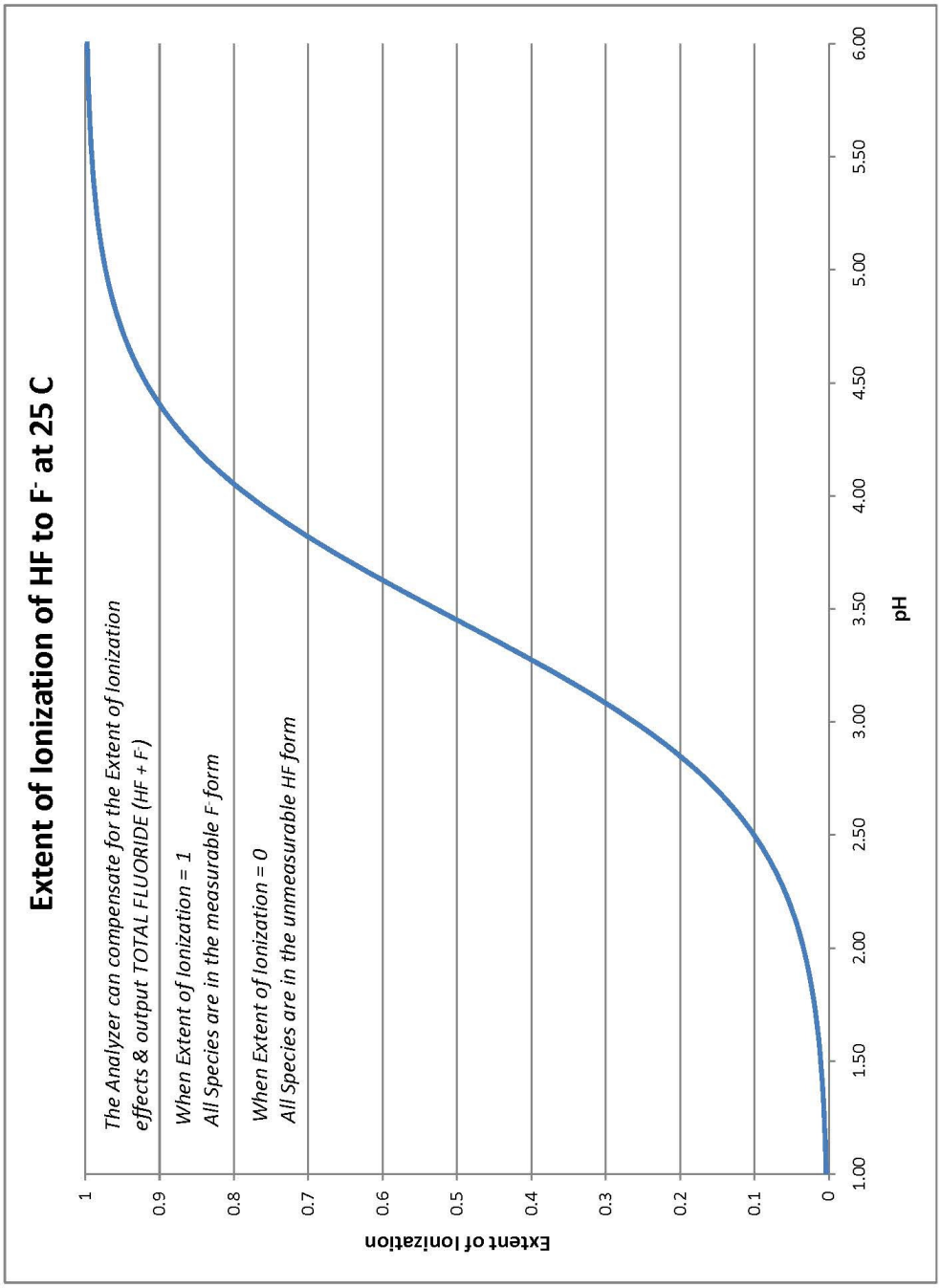
At pH levels below 5.5, the fluoride sensor will not detect the total fluoride content, as some of the fluoride ion will be converted into the form of dissolved HF gas. To convert the measured fluoride ion activity (free fluoride) into a total fluoride reading the free fluoride measurement must be compensated for the effect of pH using the FX-300-TOT module and a pH sensor with FX-300 pH measurement module. See the pH dependent extent of ionization curve for HF dissolved gas and fluoride ions (F) for a graphical representation of this phenomenon.

If you have purchased the FX-300-TOT module, you will be able to compensate for the pH induced effects on the extent of ionization to find the “total unbound free fluoride” as defined by the sum of the free ionized fluoride ion species together with the protonated HF bound form.

Please also note that these pH effects are a temperature dependent phenomenon. The provided extent of ionization curve is only completely valid for pure two component systems with deionized (DI) water. Real world water solutions of a much more complex makeup may vary somewhat from these idealized curves, although the deviation is not expected to be vast for most typical systems.

2 Introduction

2.1 HF Ionization



2.2 FX-300 Transmitter Navigation and Operation

Each module has a 3 digit display and LEDs to indicate operating modes. The module is programmed by the use of 3 keys located on the front panel.

- 'Mode' key is used for navigation. The 'Mode' key is used to toggle between operating modes and for selecting a mode.
- "ppm/mV" indicates the run mode.
- °C mode displays the temperature.
- "Offset" is the mode for the 1-point offset calibration
- "Slope" is the mode to modify sensor slope.
- "Setup" mode provides access to program the analyzer.
- "Com" LED is illuminates when the Modbus (if included) is active.

For viewing or changing setup / operating parameters use the Mode key to select SETUP and use the 'Up' and 'Down' keys to scroll through the parameters. Select a parameter by pressing the Mode key.

To make a change you must first unlock the software by selecting parameter P01, then use the 'Up' or 'Down' keys to toggle the lock to "off".

NOTE: The raw uncompensated (a.k.a. "absolute") mV potential of the ISE sensor is displayed by pressing the "Down" key in the main ppm display mode. The display now changes from ppm to absolute mV units. Negative values will be displayed flashing. The temperature can be calibrated pushing the "Up" or "Down" buttons when in the temperature display (°C) mode.

2.3 FX-300-ISE Module Function and Programming List of Parameters

If the software lock (parameter. no.1) is "on" the parameter can only be read. Set software lock P01 to "off" to change values.

Par. no.2 sets the module's address for Modbus communication.
Par. no.3 indicates the type of sensor for the temperature input.
Par. no.4 If Par no.7 is set to ISE, the signal is temperature compensated. Par. no.4 sets the temperature compensation to either set (manual) or based on the measured temperature.
Par. no.5 sets the temperature for when temperature compensation of the pH is in fixed (manual) mode.
Par. no.6 If a long cable is used for the Pt100 sensor the cable impedance should be entered and compensated for this offset.
Par. no.7 selects the output to be either ISE or temperature.
Par. no.8 sets the analog output to either 0-20mA or 4-20mA.
Par. no.9 sets the analog output scaling to either low (0.00-9.99ppm), mid (00.0-99.9ppm) or high (000-999ppm) range.
Par. no.10 and no.11 are used to set the ppm value that corresponds to 0/4mA output setpoint (**Par. no.10**) and sets the ppm value that corresponds to 20mA output setpoint (**Par no.11**). The difference between Par. no.10 and 11 must be at least 20% of the working output range selected (either low, mid or hgh range). The display and output ranges are altogether decoupled.
Par no.12 Variable to define the mV change for each "Up" or "Down" button depression when calibration is performed.
Par. no.13 Displays formula weight of measured ion (next page details how to determine which ion correspond to this value)
Par. no.14 View and edit the working (effective) sensor offset
Par. no.15 View and edit the working (effective) sensor slope
Par. no.16 Offset adjustment for low 0/4mA analog output trim.
Par. no.17 Gain adjustment for 20mA high analog output trim.
Par. no.18 If no keys are pressed for 10 min the display will show flashing bar (Energy Save).Press any key to return.
Par. no.19 The Modbus standard requires a baudrate of 9,600 or 19,200 set in accordance with the Modbus-master.
Par no.20 Feature to reset the analyzer back to factory default.

NOTE: *To exit setup mode, press the 'down' button until parameter P00 is displayed, then press 'mode' until PPM (run) mode indicator lights.*

2.3 FX-300-ISE Module Function and Programming List of Parameters

No	Parameter	Description	Range	Default
1	Lock	Software lock	On / Off	On
2	Address	Address on Modbus	Off, 1...247	Off
3	Temperature	Type of input	Pt100, Pt1000	Pt1000
4	Compensation	Temp. Comp. of pH	Auto, Set (Manual)	Auto
5	Comp. Temp.	Compensating temperature	0..150	25
6	Cable impedence	Impedance of Pt100 cable	0.0 .. 9.9Ω	0.0
7	Output variable	ISE or temperature	ISE, °C	ISE
8	Analog output range	ISE output range	0-20, 4-20	4-20
9	ISE ppm output range	Low (0-10.0), mid (0-100) and high (0-999)	10.0, 100, 999	10.0
10	0/4mA Set	Low ppm setpoint	0.00 .. 999	0.00
11	20mA set	High ppm setpoint	0.00 .. 999	10.0
12	Step change	mV increment per ‘Up’ or ‘Down’ button depression	0=0.02, 1=0.05, 2=0.10, 3=0.20, 4=0.50, 5=1.0, 6=2.0	2 (0.10mV)
13	View formula weight of ion	Grams per mol of ion	XX.XX per ion weight	19 (F^-only)
14	View current sensor offset	mV at iso-concentration	Per ISE sensor	-47 (F^-) **a**
15	View current sensor slope	mV per decade response	Per ISE sensor	-57.2 (F^-) **a**
16	0/4mA offset	Trim low	+/-9.99%	0.00
17	20mA gain	Trim high	+/-9.99%	0.00
18	Energy save	Energy save	On/ Off	On
19	Baudrate	Modbus	9,600/19,200	19,200
20	Back to default	Reset to default	Def = reset Par = no reset	Par

a On the display this value will be flashing, which indicates a negative value.

2.4 FX-300-ISE Module Description

2.41 Sensor Input

The sensor without preamplifier is connected directly to the FX300-pH/ORP/ISE module. The mV signal from the sensor is processed by an integrated high impedance amplifier. The FX300-pH/ORP-X hardware version can support internal or external preamplifiers to enable installations that require long cable lengths or to operate in high interference areas. Temperature measurement with a Pt100/Pt1000 element in the sensor allows automatic temperature compensation to be performed.

2.42 Analog Output

The FX300 transmitters have a single scalable analog output of either 0-20 or 4-20 mA (selectable). The difference required between the minimum (0/4mA) and maximum (20mA) output is 20% of the selected range (low 0-10, mid 0-100 or high 0-1000 ppm). For example, if the low range (0-10) is selected then the output could be as narrow as 0-2 ppm for the 0/4-20 mA scaling. The output is proportional to ISE ppm or temperature and is galvanically insulated from the input.

2.43 Factory Reset

You can use parameter (P20) on the FX-300-ISE transmitter to reset the unit back to the factory dispatched configuration. If you perform a factory reset you will need to re-scale the current output and and re-configure alarm settings and limits. You will also need to repeat your 2-point calibration using calibration solutions that are one decade (lOX) apart in value. In addition, you will need to once again place the ISE sensor back into service and allow it to reach equilibrium. You will then also need to repeat your 1-point grab sample offset calibration.

2.44 RS485 Modbus (Optional)

RS485 Modbus output is available in two ways.

1. It can be integrated into the pH or ISE module at time of order only.
2. It is also available in the FX-300-TOT module, which can be added at any time.

Acquired data is transferred using Modbus standard for multi-drop communication and is connected using RS485. The Modbus-master may be the FX300-DAT data logger module or any SCADA system. When units are ordered with Modbus option, the free of charge Windows data logging and graphing software and be used to monitor and record all process and temperature values from up to 247 transmitter simultaneously at distances up to 6500 feet (2 kilometers).

In order to utilize the Modbus interface the FX-300-ISE must be ordered with Modbus. FX-300-ISE may be used as a slave for the ‘Dat’ - unit FX-300-DAT or as a slave in a SCADA system. The setup / communication for each case will be explained in the following.

<u>Modbus With FX-300-DAT</u>

If FX-300-ISE is used together with the FX-300-DAT data logger, the user must pay attention to two things: The baud rate on the Modbus as well as the address of the FX-300-ISE. The baud rate **(P14)** must be set to the baud rate of the FX-300-DAT. Whether a baud rate of 19,200 or 9,600 is used is of no importance, as long as all units on the Modbus are set to the same baud rate.

2 Introduction

FX-300-ISE Module Description

2.44 RS485 Modbus

The address (P02) must be unique in the network; two units are not allowed to have the same address. In a network with the FX-300- DAT as master, all addresses must be assigned without leaving any address out; i.e. if 3 units are connected to a FX-300-DAT, the addresses 1, 2 & 3 must be assigned to the three units. The order of the addresses is of no importance. In a network with an FX-300- DAT, up to 14 slaves may be connected, allowing addresses 1..14.

In a SCADA system

Since different SCADA systems may have different restrictions only the general are mentioned here: **The baud rate (P14)** must be set to the baud rate of the SCADA system. **The address (P02)** must be unique in the network; Two units are not allowed to have the same address.

Modbus Scaling

The scaling for the ISE output is per parameter no. 9 (low, mid or high) that may differ from the 0/4-20 mA analog output scaling.

Modbus

The FX-300-ISE contains 2 measurements (ISE/mV and temperature). Access to these are gained through the function code *Read_Input_Registers (04)*. The FX-300-ISE gives access to different diagnostic values via *Diagnostics (08)*, as shown below.

Read_Input_Registers

Function code	Start address	Number of values
04	1	1 or 2

Value 1 is ISE ppm and value 2 is temperature. The measurements are transmitted in sequence; If 2 values are chosen both ISE ppm and temperature are transmitted. If the value for temperature is wanted, 2 values must be requested. Both values are rated to 0- 1000 corresponding to the range, but the temperature has an offset of 1024; i.e. 0-999 ppm is transmitted as 0-1000 and 0-150°C as 1024-2024. The start address is of no importance but rather only that the number of values determines the returned values.

Diagnostics

Function code	Sub code (HEX)	Description
08	00	Return Query Data
	0A	Clear counters and diagnostics register
	0B	Return Bus Message count
	0C	Return Bus Communication Error count
	0D	Return Exception Error count
	0E	Return Slave Message count
	0F	Return Slave No Response count
	12	Return Bus Character Overrun count

2 Introduction

FX-300-ISE Module Description

2.45 Default Ion Settings

Your FX-300-ISE has been preconfigured at the factory for your ion selective measurement requested at the time of order. The ISE measurement type configured for the FX-300-ISE transmitter cannot be modified in the field.

Below are the default nominal values for the parameter P14 and P15 for the fluoride ion selective measurement.

Slope Fluoride Ion (Parameter P15 on FX-300-F): -57.2 mV per decade default value

Offset Fluoride Ion (Parameter P14 on FX-300-F): -47 mV default value

Formula Weight of Fluoride Ion (parameter P13 on FX-300-F): 19.00 grams per mol. This is a display only value that clearly denotes the ISE measurement type.

The slope parameter will only be changed when a 2-point slope calibration is performed. After calibration the slope should be at or very close to the default value. If not this indicates the calibration was not performed properly. Parameter P 15 allows you to both view and manually modify the working slope.

2.46 Transmitter Specifications

Housing	Levan UL94V-0 (Upper part) Noryl UL94V-0 (Lower part)
Mounting	M36 for 35mm DIN rail
Dimensions	D 58 x W 36 x H 86 mm (2.3 x 1.4 x 3.4 in)
Temperature range	-15 to +50°C
Power supply	24VDC +/- 10%
Consumption	60mA max
Sensor type	Combination sensor
ISE/mV range	0-10, 0-100, 0-999 ppm; +/- 1000mV
ISE input	<1pA, >10GΩ
Accuracy	+/- 2%
Temp sensor	Pt100, Pt1000
Temp range	0-150°C +/- 0.3°C
Temperature Compensation	Fixed (manual) or Automatic (using Temperature (TC) measurement)
Analog output	0-20mA or 4-20mA, max 250Ω
Enclosure	Wall mount windowed NEMA 4X reinforced fiberglass

3 Installation

3.0 General Information Power Requirements

CAUTION: It is critical that the 24VDC power supply used to power the FX-300 transmitters is COMPLETELY separate from all other equipment. This also includes all other instrumentation as well other equipment such as pumps and motors.

This is because the FX -300 measurement module is a 3 -wire transmitter. The 3-wire aspect can be explained as follows: the 4-20mA analog current loop output sent from terminal 7 returns back to terminal 8; the +24VDC is connected to terminal 6 while the ground DC common from the power supply is shared with the return of the 4-20mA scalable current loop output on terminal 8.
In this way all of the ground terminals are shared between the current loop output and the DC common amongst all measurement modules energized from a single 24VDC power supply source.

There is 3000V opto-coupler isolation between the inputs and outputs of the measurement transmitter. The outputs are not, however, isolated from each other as the ground terminal is shared in the manner described above. Because of these reasons whatever 24VDC power supply is used to energize the transmitters should be altogether dedicated to only power these modules only.

The isolation on the AC/DC transformer of the FX-300 PS acts to isolate the 24VDC power from any other electrical devices at the installation site ensuring that no potential ground issues occur to the modules themselves nor any devices powered from the FX-300 measurement modules such as preamplifiers and contacting conductivity cells.

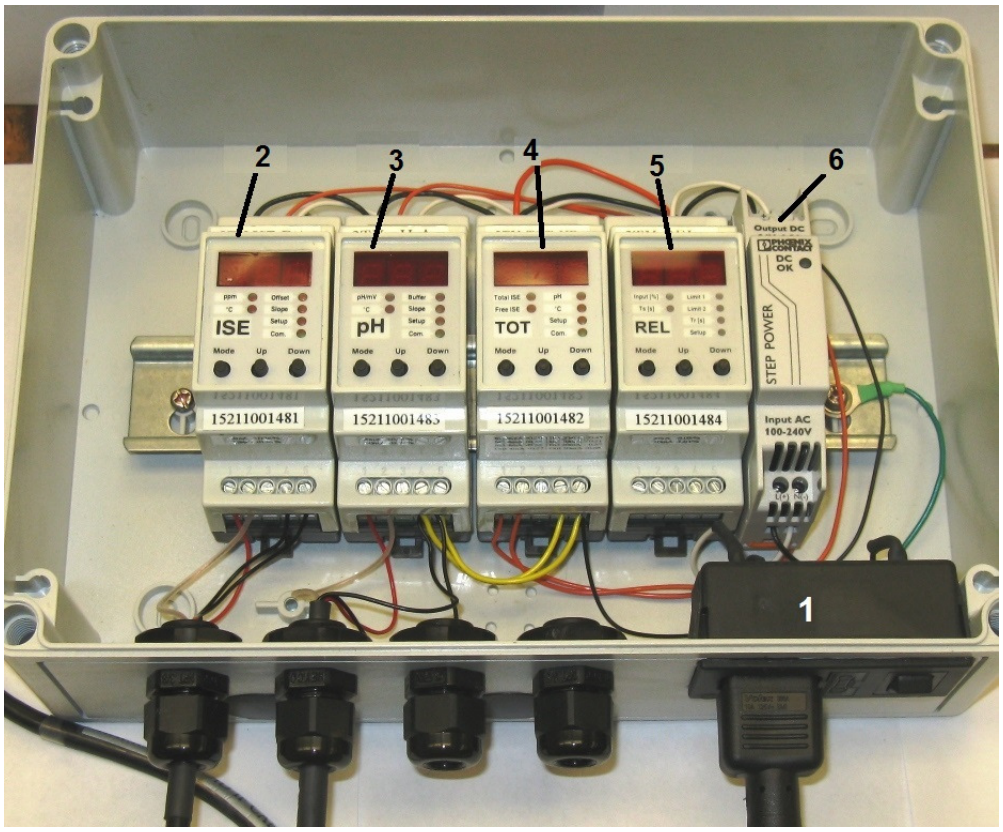
This isolation in the FX-300-PS also ensures that no issues present themselves regarding ground on the analog 4-20mA current loop output or RS485 Modbus outputs emanating from the power supply side of the system. It is still possible to have ground loop and electrical isolation issues that emanate from the process side of the system.

- **CAUTION: IT IS ABOLUTELY CRITICAL TO ENSURE THAT THE ANALOG CURRENT INPUTS OF A PLC OR SCADA ARE ISOLATED.**

- The analyzer is designed for wall mounting. Although the analyzer may be mounted outdoors, do not install it in direct sunlight or in areas of extreme temperatures.
- Install the analyzer in an area where vibration and electromagnetic and radio frequency interference are minimized or absent.
- Keep the analyzer and sensor wiring at least one foot from high voltage conductors. Ensure there is easy access to the analyzer.
- NOTE: Use watertight fittings and hubs that comply with your requirements. Connect the conduit hub to the conduit before attaching the fitting to the analyzer.

3 Installation

3.1 Component Identification, Standard Configuration



1	Fused Power Entry Module with On/Off Switch
2	ISE (Fluoride) Measurement Module, FX-300-ISE (F)
3	pH Measurement Module, #FX-300-pH
4	pH Compensated Total ISE Module, #FX-300-TOT
5	Relay Control Module, #FX-300-REL
6	24VDC Power Supply, 100-240VAC Input

The FX-300 includes a 3-wire CSA/UL/CE approved universal 100/240 VAC input 24V power supply protected by a 6 amp fuse located in the power entry module.

Ensure the instrument is properly grounded.

CAUTION: THE 24VDC UNIVERSAL POWER SUPPLY CANNOT BE USED TO POWER ANY OTHER DEVICES. IT MUST BE DEDICATED TO POWER THE FX-300 MEASUREMENT MODULES ONLY. THE MEASUREMENT MODULES CANNOT SHARE 24VDC WITH ANY OTHER DEVICES. FAILURE TO DO SO WILL CAUSE GROUND LOOP ISSUES THAT WILL IREPARABLY DAMAGE THE MEAUREMENT MODULES AND ISE SENSOR.

NEVER apply voltage across terminals 7 & 8 on any FX-300 transmitter

3 Installation

3.1 Component Identification, Power Entry Module, Input Output Terminals

Wiring Access

Turn off power to the instrument using the on / off switch on the power entry module. To access the measurement modules for wiring remove the four screws that retain the instrument enclosure lid. Each terminal is labeled.

Sensor Inputs

Voltage Inputs, mA & Digital Outputs

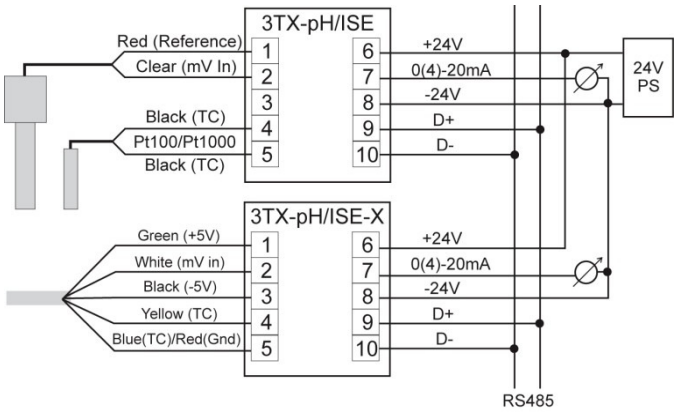
Power Entry Module with Fuse Holder

3 Installation

3.2 Default Wiring Sensors to the Measurement Modules

NEVER apply voltage across terminals 7 & 8 on any 3-wire FX-300 transmitter

For reference the wiring for ISE sensors with and without preamplifiers is detailed below. The top diagram “FX-300-pH/ISE” is for sensors without internal/ integrated preamplifiers. The bottom diagram “FX-300-pH/ISE-X” is for sensors with internal/integrated preamplifiers.



The lead providing +24VDC power always goes to terminal 6 and the 4-20mA current loop output is always sent from terminal 7. The DC common (ground) is shared as terminal 8. The current loop output is sent from terminal 7 and return to terminal 8 (ground / DC common). The FX-300 transmitters are always energized on terminal 6 with the DC ground of the 24VDC power supply (a.k.a. rail) always being the (shared) terminal 8.

3 Installation

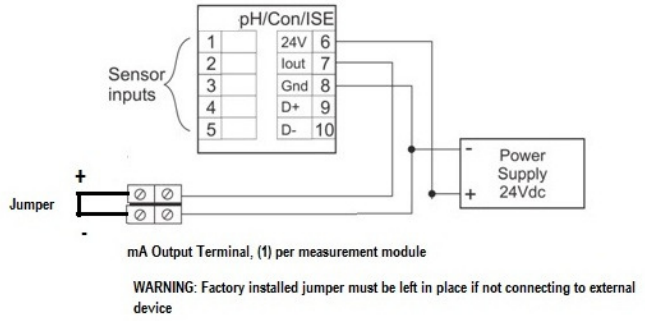
3.3 Wiring the 4-20 mA Output

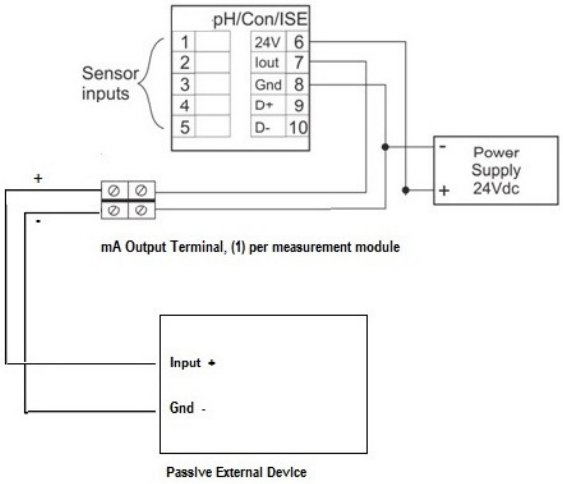
Standard Wiring Configuration: 4-20 mA Output

See the photo on previous page for complete output labeling instructions

NOTE: Some configurations DO NOT have the 4-20mA bridge terminal block shown below.

Leave the factory installed jumper from the mA output terminal block (if supplied) intact unless you are connecting to an external device that passively measures current. **EXTERNAL DEVICE ANALOG INPUTS MUST BE ISOLATED and must not apply voltage to the active current loop, doing so will damage the transmitter and is not considered a warranty repair issue.**





Keep in mind that all FX-300 transmitters are 3-wire devices. This means they have an ACTIVE 4-20mA analog current loop output, like a 4-wire type device. The data acquisition or control device to which this active 4-20mA output is connected should passively measure the current. Most PLC's have a hardware or software toggle that allows you to select whether the 4-20mA received is from a 4-wire (or 3-wire) active type device or else if it is a 2 -wire device which must be energized from the PLC power supply.

The current output from the FX-300 MUST ALWAYS be connected to isolated analog inputs. If your PLC, SCADA or other external device does not have isolated analog inputs, then you must add an isolator for each current loop to be used.

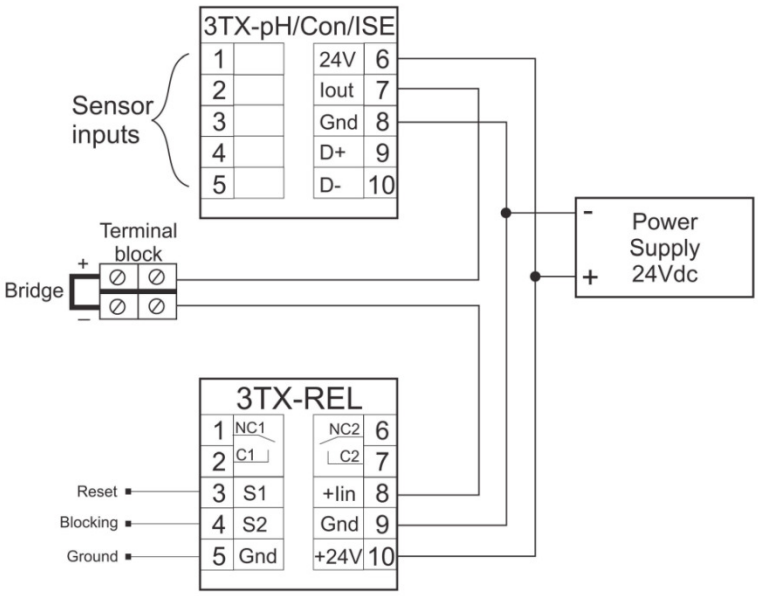
The ground cannot be shared on both the analog current output from the FX-300 (since it is a 3-wire device) and on the analog input on the PLC. The ground for each analog input on the PLC must then always be isolated.

3 Installation

3.4 Wiring the 4-20 mA Output & FX300-REL Alarm /Relay Control Module

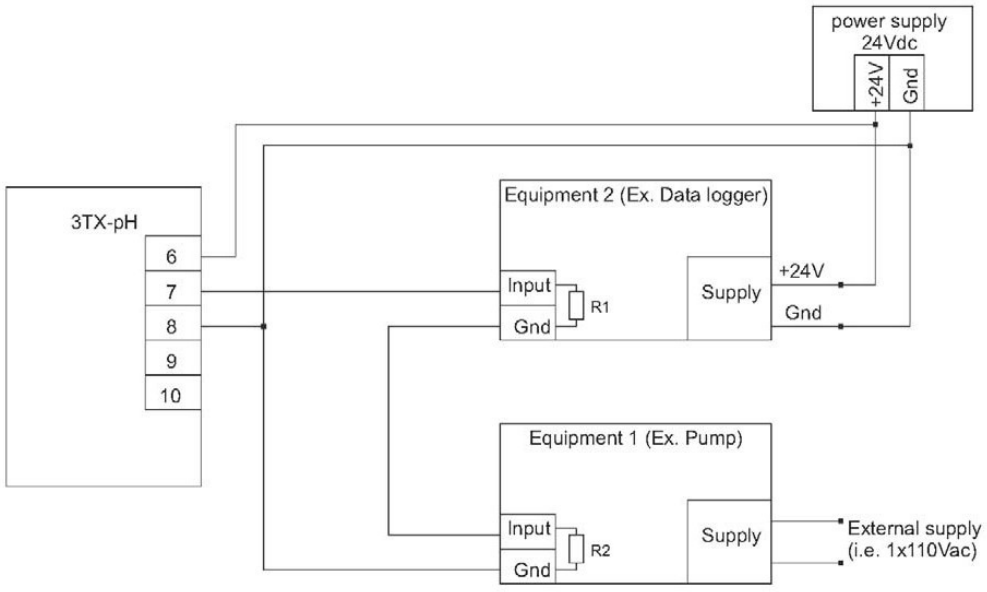
NEVER apply voltage across terminals 7 & 8 on any FX-300 transmitter

Standard Factory Default Wiring Configuration: 4-20mA output terminal to FX-300-REL



3.5 Alternate wiring schematic for adding multiple devices to the 4-20mA transmitter output loop.

EXTERNAL DEVICE ANALOG INPUTS MUST BE ISOLATED and must not apply voltage to the active current loop, doing so will damage the transmitter and is not considered a warranty repair issue.



Note:
R1 and R2 are internal resistors.
R1 + R2 < 500Ω

3 Installation

3.6 New Sensor Installation

The industrial ISE sensor can be installed into service by use of an inline installation (in a pipe tee or flow cell), by immersion or submersion into a tank or basin.

For any installation, be sure not exceed the flow and pressure rating of a given sensor. Optimal performance and sensor lifetime will be achieved by having a slow continuous flow past the sensor. Maximum continuous flow rate of 2 GPH In 1" schedule 40 or 80 pipe.

Do not allow air bubbles to get trapped near the fluoride ion selective organic membrane. This will cause erroneous readings and drift. This potential problem is alleviated by installing the ISE sensor at between 45 - 80 degrees above the horizontal (whether inline or in a tank).

Ion Selective sensors should NEVER be installed in a horizontal or inverted configuration as this may lead to erratic and unreliable reading.

In addition, most industrial ISE sensors are liquid or semi-liquid filled and as such may have a small air pocket inside the sensing element. To ensure that there is not an air pocket caught inside the sensing element, shake the ISE sensor firmly downward. The small capillary force holding the air bubble in place inside the sensing element will be overcome by a firm downward shake.

Thermal equilibrium between the sensor and process solutions at elevated or depressed temperature (not at 25 degrees Celsius) is generally better achieved via immersion or submersion installation styles. Submersion style sensors do require sensor cable waterproofing.

Approximate Time to Allow Sensor to Reach Process Equilibrium	
pH	1/2 hour maximum
Ammonium	4 - 24 hours
Nitrate	1 - 2 days
Nitrite	1 - 2 days
Fluoride	4 - 24 hours
Conductivity	1/2 hour maximum
Ultralow Ammonium, Nitrate, Nitrite	Several days to weeks in wastewater

3.61 Submersible Sensor Installation

The sensor can be submerged into an aeration basin if it has been supplied with cable waterproofing. Do not simply submerge the sensor into the water by the cable. Use the rear mounting threads on the sensor body to attach a pipe or other device to secure the sensor.

The sensor should be mounted at a 15-45 degree angle to prevent an internal air pocket from contacting the sensor tip resulting in erratic and unreliable readings.

The sensor should be placed at least 2 feet from the wall or side of the basin, and completely submerged at least below the surface.

You may need to install the sensor into a stilling well in order to meet the less than 0.5 ft/sec. flow velocity requirement of the sensor for stable readings and to extend sensor life.

Sensor cables should be installed in conduit to avoid interference of low level sensor signals.

3 Installation

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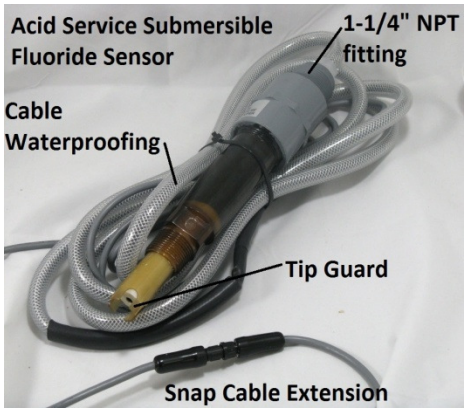

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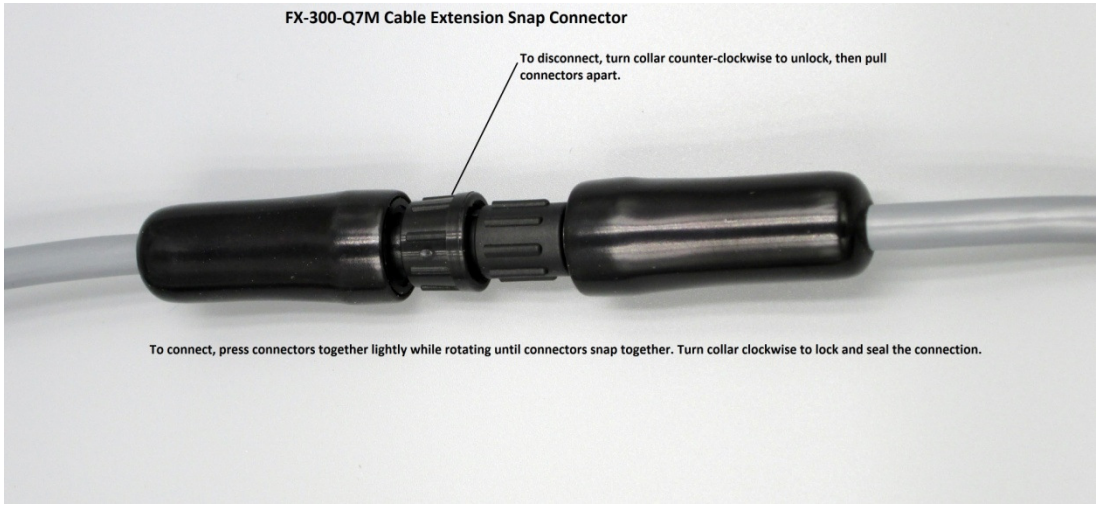
Sensor cables should be installed in conduit to avoid interference of low level sensor signals.

Snap cable extensions are available for cable runs longer than 20-feet. One cable half remains permanently wired to the fluoride transmitter, the other half is permanently attached to the sensor and sealed. The two cables are joined with a pin connector.

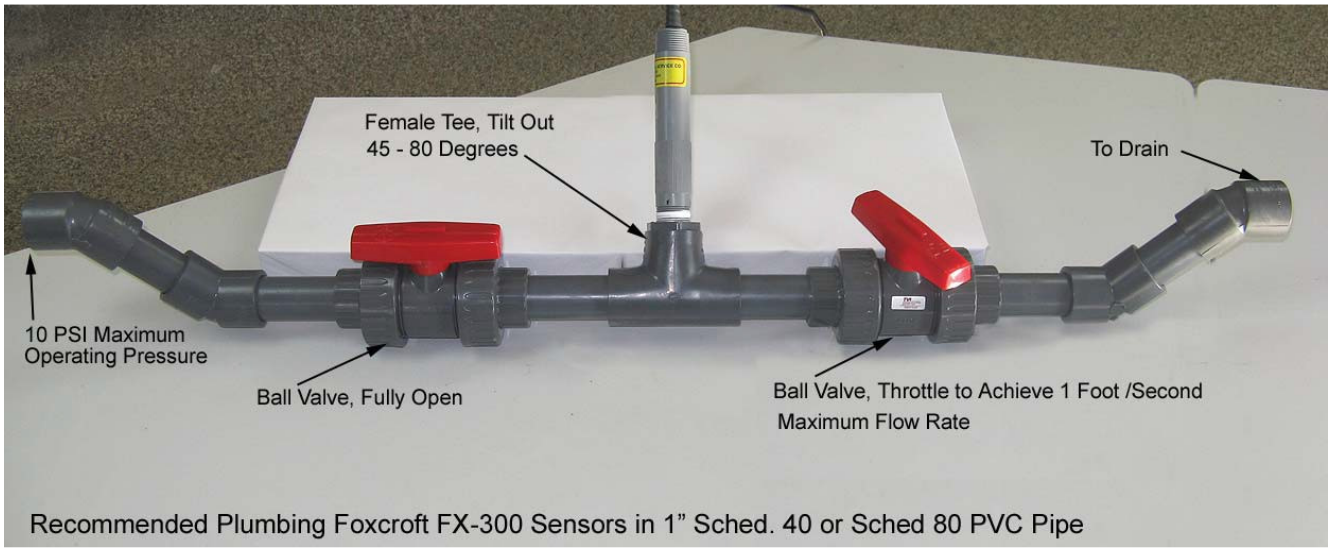
To disconnect, turn the lock collar counterclockwise to unlock, then pull the connectors apart. To connect, push the connectors together lightly while rotating them slowly until the internal pins align and the connectors snap together. Rotate the lock collar clockwise to seal and lock the connector halves.



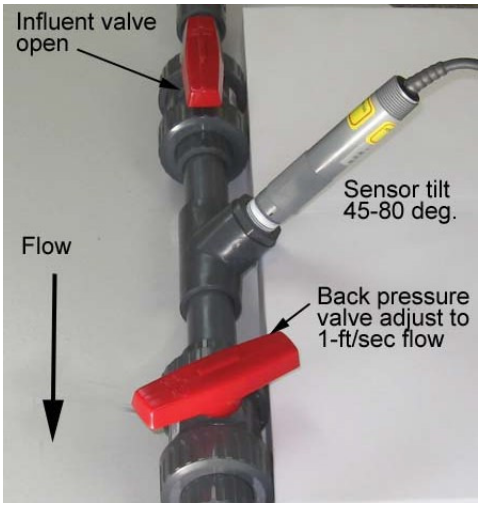
3 Installation

3.62 Installation (Inline Sensor Plumbing)

Please refer to the photos below which illustrate the recommended inline sensor plumbing installation using 1” Schedule 40 or 80 PVC pipe. The exact layout is determined by site requirements or limitations. However, the layout shown will ensure the electrode tip stays submerged and minimizes the opportunity for bubbles to collect at the electrode tip. Flow is from left to right.



Recommended Plumbing Foxcroft FX-300 Sensors in 1” Sched. 40 or Sched 80 PVC Pipe



The sensor orientation should be between 45 and 80 degrees above horizontal to prevent air bubbles becoming trapped near the ion selective membrane or on the sensor tip. Sensors should NEVER be mounted with the sensor tip pointing straight down, horizontally, or pointing up as this may cause a bubble on the sensor tip and lead to erratic or unreliable readings.

DO NOT OVERTIGHTEN THE SENSOR AS THIS MAY CRACK THE FLUORIDE ISE CRYSTAL

Pressure must be stable and should not exceed 20 PSIG, if needed install a pressure reducing regulator.

Recommend flow rate is about 2-3 GPH in 1” schedule 80 PVC pipe, or 1-foot /sec. velocity. Flow rate must be stable. Open the influent ball valve on the left fully, and use the backpressure valve on the right to control flow and provide back pressure. Optionally a flow rotometer can be substituted for the flow control valve to more easily set the flow to the desired rate.

3.63 Installation (FX-300-FP Inline Flow Panel)

4 Start Up

4.0 Startup Overview

Do not touch or move the sensor or sensor cable during operation. Doing so will induce a static charge and disrupt the readings from the high impedance fluoride sensor.

1. Mount the analyzer on the wall.
2. Install the sensor into the process fluid measuring tee/cell with water flow off.
3. Connect the sensor wires to the transmitter input terminals. Make sure that your ISE sensor is properly wired according to the schematic for "Sensors Without Preamplifiers" or “Sensors With Preamplifiers" depending the sensor type ordered.
4. Secure the sensor cable to the wall or mounting panel with cable ties to prevent cable movement during operation which can disrupt the readings.
5. Connect your 4-20mA output wires to ***isolated inputs*** in your control or recording device per the label on the output terminals and or the schematic. Do not apply power to the 4-20mA output.
6. Make sure your wiring connections are secure.
7. Apply 3-wire 100 to 240 VAC 50/60 Hz power to the analyzer by plugging the power cord into the socket on the right hand underside of the enclosure.
    i) You may also connect to 3-wire 24VDC power if you have a dedicated (i.e. not shared with other equipment) 24VDC power supply available.
8. Turn on the analyzer using the rocker switch next to the power cord socket.
9. The correct operating parameters are set at the factory to suit your application and can be viewed in “Setup” mode. The only parameters normally changed in the field are the high and low mA output values (P10 & P11). If you have problems review the parameters and if needed configure the analyzer module(s) as required. See Sections 4.1 and 4.2 below.
10. With the flow rotometer closed, open the input flow control valve and verify that water pressure will remain steady and not exceed 20 psig.
11. Use the flow rotometer and the backpressure valve to achieve a steady flow of 3 minimum to 5 GPH. The flow rate must not fluctuate to achieve valid results.
12. With the sensor in the process fluid, ***allow at least 4 hours for the sensor to reach electrochemical and thermal equilibrium.*** Any readings produced before equilibrium is reached are meaningless.
13. After the sensor has reached equilibrium and the readings have stabilized, perform the 1-point offset calibration to standardize the sensor with an approved grab sample analysis result. DO NOT PERFORM A TWO POINT CALIBRATION WITH STANDARD SOLUTIONS FOR A NEW SENSOR INSTALLATION.

NOTE: If no keys are pressed for 10 minutes the display will show a flashing bar indicating it is in Energy Save mode. Press any key to return normal display mode. To turn off energy saving mode and show a display continuously, go to parameter 18 and toggle to off.

4 Start Up

4.0 Startup Overview continued

4.1 Parameter settings to check for systems with Fluoride modules only

Check by entering “setup” mode and ensure parameter settings match the defaults shown on page 6. To change any parameter you must first turn off the software lock, parameter P01.

i) **For systems supplied with ISE measurement module (transmitter) only**:

(1) Make sure the operating range (P09) matches the needs of your process: Low (0-9.99 ppm); Mid (0-99.9) or High (0-999)

(2) Make sure the mA input of an external device you connect to matches the scaling of the transmitter's mA output (P10 & P11).

(3) Make sure the temperature input (P03) is set to “999” for the PT1000 temperature element.

4.2 Settings to check for systems with alarm relay modules

ii) For systems supplied with the FX-300-REL alarm relay & control module:

(1) Make sure the analog input (P03) on the REL module matches the analog output of the ISE module (P08). Selections are 0-20mA or 4-20 mA.

(2) Make sure display mode (P06) on the REL module matches the output variable (P07) on the ISE module (factory set to ISE).

(3) Make sure the ISE Output (operating) range (P09) of the ISE module matches the ISE input range (P07) of the REL module.

(4) Enter the value for the 0/4mA input (P09) on the REL module to match the 0/4 mA output (P10) of the ISE module.

(5) Enter the value for the 20mA input (P09) on the REL module to match the 20 mA output (P11) of the ISE module.

(6) On the REL module set the type of limit for alarm limit 1: Hi (max), Lo (min). Default is Hi.

(7) On the REL module set the type of limit for alarm limit 2: off, Hi (max), Lo (min). Default is Lo

(8) On the REL module set the alarm trip point for each limit by using the limit buttons on the face of the module. First unlock the software. Return to run (input) mode, press the Mode button until Limit 1 LED lights, and use the up/down keys until the set point is displayed. Press Mode button to light the Limit 2 LED, and use the up/down keys to enter the set point. Press the Mode button to return to run mode. The software will lock automatically after 10 minutes.

4 Start Up

Startup Overview continued

4.3 OFL and UFL Error Codes

The flashing “OFL” means that an overflow issue exists on the input while a flashing “UFL” means that an underflow issue exists on the input. When this error exists you will not be able to perform any programming or configuration of the transmitter until the issue is resolved. The “OFL” or “UFL” condition can be due to a variety of possible causes which are summarized below:

POTENTIAL TEMPERATURE INPUT RELATED PROBLEMS

- A temperature element is not properly connected to the transmitter input board. Electrochemical transmitters require a valid temperature input in order to operate properly.
    - Check that each of the leads are firmly connected to the proper terminals per the wiring schematic
    - If no sensor is available or the sensor employed does not have a temperature compensation element, please use a 110 Ohm axial resistor to simulate a P100 TC input @ 25°C or a 1100 Ohm axial resistor to simulate a Pt1000TC input @ 25°C.
    - Check that the transmitter setting for the Pt100 or Pt1000 TC type matches the temperature element in the sensor.

POTENTIAL SIGNAL INPUT RELATED PROBLEMS

- The input signal value obtained from the connected sensor exceeds the lower or upper boundary limits possible for the input circuit. There are a variety of potential causes itemized below:
- Confirm that the proper type of sensor is being connected to the correct type of mating transmitter. For example: transmitters come in separate versions that are for use with sensors without integral preamplifiers and sensors that have integral preamplifiers.
- Leads are not secure or the color coding is not correct. Please refer to the documentation supplied in documentation with your shipment or contact the factory for assistance.
- The connected sensor is either damaged or expired. Connect a different known working sensor on the same transmitter to determine if the issue is with the input board or to the connected sensor.
- If you have gone through all of the troubleshooting steps and are still receiving the “OFL” or “UFL” error then most likely your input board has stopped working properly. Contact the factory.

5 Calibration

5.0 Calibration Notes

DO NOT PERFORM A TWO POINT CALIBRATION WITH STANDARD SOLUTIONS FOR A NEW SENSOR INSTALLATION.

All calibration solutions and process grab samples should be calibrated and tested at temperatures identical to the process temperature for optimal results. The actual temperature of the process solution (and thereby the calibrating solutions as well) is not as critical as the fact that they are calibrated at the same temperature to eliminate all potential sources of uncertainty.

For greatest overall accuracy of the fluoride (F-) measurement, however, all tests should be performed as close to 25 degrees Celsius (room temperature process solutions) as possible. The valid (permissible) temperature range for all fluoride ion selective sensors is five to fifty (5-50) degrees Celsius (41 to 122 degrees Fahrenheit).

Please note that accuracy is a function of the uncertainty of the instrument being used or compared to, the accuracy of standard solutions, and accuracy of the procedure used by the calibration technician.

A 1-point offset calibration will only be as accurate as the instrument used to analyze the grab sample and if performed promptly after making a grab sample determination.

Calibration solutions should be kept clean and out of direct sunlight and/or other high-energy radiation sources to maximize accuracy of their ppm values.

In 2-point calibration, Calibration Point 1 (always the lower concentration value and calibration solution) and Calibration Point 2 (always the higher concentration value and calibration solution) determines the response curve of a given fluoride ion selective sensor.

Before purchasing any commercial calibration solutions, be sure that they have a TISAB- II background and that their values will bracket your desired measurement range.

Since the fluoride transmitter has a 3-digit display, a 1,000 mg/L (ppm) calibration solution will only display as “999”. It’s suggested to use a “non-standard” solution of lower concentration in order to display 3 significant digits during calibration.

Many fluoride calibration solutions are commercially available from a variety of chemical supply houses. Be sure the solution is mixed or purchased premixed with TISAB II ionic strength adjusting buffer because it is more stable than TISAB III.

NOTE: *Be sure to rinse the sensor tip with distilled or deionized water and blot dry before placing the sensor into a different calibration standard.*

5 Calibration

5.0 Calibration Notes

There is a time averaging (dampen) function that is set in the FX-300-ISE at the factory. This value is configurable for both the extent of time averaging for the measure and calibrate modes separately. If you find that you wish to have more or less time averaging than what is provided on your unit at present, contact the factory for assistance with this. These values cannot be modified in the field but rather need to be changed at the factory. The preset values are fine for the vast majority of users and applications although they can be modified upon request without incurring any cost.

The slope parameter will only be changed when a 2-point slope calibration is performed. After calibration the slope should be at or very close to the default value. If not this indicates the calibration was not performed properly. Parameter P 15 allows you to both view and manually modify the working slope.

You can view the sensor slope resulting from a 2-point calibration with parameter P15 and the sensor offset resulting from a 2-point calibration with parameter P14. If you perform a 1-point grab sample offset subsequently the offset (P14) will change whereas the sensor slope (P15) will remain from your 2-point slope calibration.

All settings are stored in EEPROM so the unit can be powered down without loss of configuration or calibration. The ‘hold’ feature is automatically activated each time any 2-point or 1-point calibration is performed. This means that the last process value will continue to be sent via the analog 4-20mA and Modbus digital output before entering the calibration mode. This is the default behavior and can only be modified at the Foxcroft factory if this is not desired.

The decimal place on the display will automatically move as appropriate based upon the ppm value of the sensor reading. Note that the display will always auto-range from 0.00 to 9.99, 00.0 to 99.9 and 000 to 999 ppm. Your analog and digital Modbus output will, however, be defined as selected in parameter P09. This means that your output may be maxed out and not reflect the exact process reading if you selected too low a range for your output scaling in P09.

5 Calibration

5.1 One-Point Offset Calibration

The 1-Point offset calibration is used to bring the ISE sensor into agreement with a grab sample analysis obtained by an alternate method to determine fluoride ion concentration. It is also used to adjust for occasional sensor drift.

It is not necessary to remove the sensor from service to perform a 1-point grab sample offset "Standardize" calibration.

Offset calibration simply requires the use of the Offset and UP / Down buttons only (after the software is unlocked), to enter the calibration result. It can be performed as often as desired. This is in most cases the only calibration required.

Please note that a 1-point offset calibration will only be as accurate as the instrument used to analyze the grab sample and if performed promptly after making a grab sample determination.

The grab sample should be analyzed in as timely a manner as possible for best results.

There are a variety of methods to perform the grab sample analysis. This includes portable photometers and laboratory fluoride ion selective electrode methods with the addition of TISAB-II to the unknown sample to adjust for all background ion effects.

When this method is used, it is typical to add the TISAB-II on a one to one volume basis to the unknown, and then to determine the fluoride concentration of this diluted sample. The actual fluoride concentration will then just simply be double the TISAB-II diluted unknown sample.

This grab sample determined concentration of the process sample (by whatever method employed) will then be entered into the analyzer as described below.

1-point offset calibration procedure

1. With the sensor installed in service, allow at minimum 3-5 minutes for the sensor to display a stable reading with the process.
2. On the ISE module enter Setup and press the UP button to Parameter No. 01, which is a "software lock". Toggle to 'Off' using the up or down key.
3. Exit Setup by pressing the down button to parameter P00, then press Mode.
4. Use the 'Mode' key to select 'OFFSET'.
5. Use the Up/Down keys to adjust the displayed reading until the display shows the correct value in accordance with the concentration determined by the grab sample analysis.

   NOTE: If your system includes the FX-300-TOT module that provides a pH compensated total unbound ion measurement, enter the calibration value by pressing the keys on the ISE module until the display on the FX-300-TOT module displays the correct reading.
6. Press the "Mode" button to return to PPM (run) mode.

5.3 Two-Point Slope Calibration

We do not recommend 2-point slope field calibration for new sensor installations; for most if not all applications the factory set slope will provide the best results.

The 2-point calibration should only be done when the sensor begins to lose response or sensitivity. The 1-point offset is the only calibration required on a regular basis.

Performing calibration with fluoride standards will not get the inline installation dialed-in. This can only be done with a proper grab sample offset calibration.

The 2-point calibration determines the sensitivity or slope of each sensor, which is then stored in the analyzer.

The 'hold' feature is automatically activated each time any 2-point or 1-point calibration is performed. This means that the last process value will continue to be sent via the analog 4-20mA and Modbus digital output before entering the calibration mode. This is the default behavior and can only be modified at the Foxcroft factory if this is not desired.

For a 2-point calibration you will need:

- A clean sensor. Please refer to the cleaning procedure in the previous section.
- A 250 ml glass or plastic beaker that is heavy enough to prevent the sensor from tipping the beaker over.
- Low Fluoride Standard Solution (low ppm) mixed with TISAB II total ionic strength adjusting buffer
- High Fluoride Standard Solution (high ppm) mixed with TISAB II total ionic strength adjusting buffer

NOTE:

- *The calibration solutions need to be at least 1 decade (10 times) apart.*
- *Always use the more stable TISAB II rather than TISAB III total ionic strength adjusting buffer for both self prepared and premixed solutions purchased from a lab supply company.*
- *Since the fluoride transmitter has a 3-digit display, a 1,000 mg/L (ppm) calibration solution will only display as "999". It's suggested to use a "non-standard" solution of lower concentration in order to display 3 significant digits during calibration.*

If you wish to make your own calibration solutions instructions to do so are below.

NOTE: If your system includes the FX-300-TOT module that provides a pH compensated total unbound ion measurement, you must first ensure the temperature matches between the ISE, pH and TOT modules, and you must also calibrate your pH sensor if needed. To enter the calibration value use the keys on the ISE module until the display on the FX-300-TOT module displays the correct reading.

5 Calibration

5.4 2-point slope calibration procedure

We do not recommend 2-point slope field calibration for new sensor installations; for most if not all applications the factory set slope will provide the best results.

The 2-point calibration should only be done when the sensor begins to lose response or sensitivity. The 1-point offset is the only calibration required on a regular basis.

Performing calibration with fluoride standards will not get the inline installation dialed-in. This can only be done with a proper grab sample offset calibration.

> ***NOTE:*** *Always use the more stable TISAB II rather than TISAB III total ionic strength adjusting buffer for both self prepared and premixed solutions purchased from a lab supply company.*

1. Fill a 250 ml beaker with enough standardization solution so that the entire tip of the Fluoride sensor will be submersed.
2. Place the sensor into the first low ppm ISE standard solution.
3. Allow a minimum of 3 – 5 minutes for the sensor to stabilize once it has been removed from the process and placed into the low standard solution (low ppm).
4. Parameter No. 01 is a “lock” that must be set to ‘Off’ to change ANY parameter, including the temperature, offset and slope calibrations.
5. Press the ‘Mode’ key to select ‘Offset’.
6. Adjust the reading using the Up/Down keys until the display shows the correct value for the first low ppm ISE solution standard.
7. When done press the “Mode” key until the PPM (Run) mode indicator lights, indicating the run mode.
8. Rinse the sensor in distilled or deionized water, blot dry with a paper towel and place the sensor into the second high ppm ISE standard solution.
9. Allow a minimum of 3 – 5 minutes for the sensor to stabilize between the low and high Calibration Solutions (low ppm to high ppm).
10. Press the “Mode” key to select SLOPE.
11. Use the Up/Down keys until the display reads the second desired value for the second high ppm ISE solution standard.
12. Press the “Mode” key until the PPM (Run) mode indicator lights, indicating the run mode.
13. **CAUTION:** When finished you must verify that your calibration has resulted in a slope (parameter #15) that is at or near the default fluoride slope of -57.2. If it is not the calibration was not performed correctly; either re-calibrate or re-set the transmitter back to the default slope of negative 57.2 using parameter #15.
14. CAUTION: Before returning the calibrated sensor into service you must perform the 1-point offset calibration to ensure agreement with grab sample analysis.

5 Calibration

5.5 How to prepare a fluoride standard solution

We do not recommend 2-point slope field calibration for new sensor installations; for most if not all applications the factory set slope will provide the best results.

The 2-point calibration should only be done when the sensor begins to lose response or sensitivity. The 1-point offset is the only calibration required on a regular basis.

Performing calibration with fluoride standards will not get the inline installation dialed-in. This can only be done with a proper grab sample offset calibration.

Materials

- Sodium fluoride (Analytical or ACS Reagent Grade or better, brand new sealed dry bottle preferred)
- TISABII (Total Ionic Strength Adjustor Buffer) **USE TISAB II ONLY**
- 1L volumetric flask (one each minimum, four each recommended)
- 5L volumetric flask (one each) or 2L volumetric flask (two each)
- 1ml volumetric pipette
- 10ml volumetric pipette
- 1L opaque plastic bottles with air-tight sealing cap (five each)
- DI water (15mΩ or higher resistivity grade recommended but not critical)

NOTES: *Ensure that all glassware is clean and dry before proceeding.*

- *Thoroughly clean volumetric flasks after preparing any solution with distilled or deionized water.*
- *Solution prepared from this procedure will stay good for 1 year from date of manufacture if stored in a sealed, opaque plastic bottle in a cool, dry location.*
- *Always use the more stable TISAB II rather than TISAB III total ionic strength adjusting buffer for both self prepared and premixed solutions purchased from a lab supply company.*
- *Since the fluoride transmitter has a 3-digit display, a 1,000 mg/L (ppm) calibration solution will only display as "999". It's suggested to use a "non-standard" solution of lower concentration in order to display 3 significant digits during calibration.*

<u>Stock solution preparation procedures</u>

Preparation of diluted TISAB II background stock solution (DO THIS FIRST)

1. Measure out 2L of TISAB II solution and pour into a 5L volumetric flask.
2. Dilute with distilled or deionized water to 5L mark. Mix solution well until all the two solutions are completely miscible and the resulting solution is homogenous.
3. Seal 5L volumetric flask with glass stopper.

Preparation of 10,000ppm fluoride stock solution (DO THIS FIRST)

1. Measure out 22.101g of sodium fluoride salt.
2. Place this sodium chloride salt into 1L volumetric flask.
3. Dilute with distilled or deionized water to 1L mark. Mix solution well until it is completely homogenous (dissolved).
4. Transfer this 10,000ppm fluoride stock solution to a 1L plastic bottle and label appropriately.

5 Calibration

5.5 How to Prepare a Fluoride Standard Solution

Fluoride calibration solution preparation procedures

Preparation of 10ppm sodium fluoride standard on solution

1. Draw 1ml of 10,000ppm fluoride stock solution and transfer to a 1L volumetric flask.
2. Dilute with TISAB II diluted background solution to 1L mark. Mix solution well until completely homogenous.
3. Transfer this 10ppm fluoride calibration solution to a 1L plastic bottle and label appropriately.

Preparation of 100ppm sodium fluoride standard ion solution

1. Draw 10ml of 10,000ppm fluoride stock solution and transfer to a 1L volumetric flask.
2. Dilute with TISAB II diluted background solution to 1L mark. Mix solution well until completely homogenous.
3. Transfer this 100ppm fluoride calibration solution to a 1L plastic bottle and label appropriately.

Preparation of 20ppm sodium fluoride standard ion solution

1. Draw 2ml of 10,000ppm fluoride stock solution and transfer to a 1L volumetric flask.
2. Dilute with TISAB II diluted background solution to 1L mark. Mix solution well until completely homogenous.
3. Transfer this 20ppm fluoride calibration solution to a 1L plastic bottle and label appropriately.

Preparation of 200ppm sodium fluoride standard ion solution

1. Draw 20ml of 10,000ppm fluoride stock solution and transfer to a 1L volumetric flask.
2. Dilute with TISAB II diluted background solution to 1L mark. Mix solution well until completely homogenous.
3. Transfer this 200ppm fluoride calibration solution to a 1L plastic bottle and label appropriately.

6 Sensor Maintenance & Cleaning

6.0 Fluoride Sensor Maintenance & Cleaning

No maintenance is required other than cleaning the sensor. The sensor is sealed, as such there is no need or means to add electrolyte.

For the best lifetime possible you will need to perform regular periodic cleaning and maintenance. The frequency of cleaning will depend on the quality of the process water and the buildup of process deposits on the probe tip.

The fluoride (F^-) sensor should also be cleaned when transferring a sensor in or out of solution; before being placed into standard solutions with different concentrations, or before a 2-point calibration is performed.

If no contamination or buildup is evident the simple rinsing procedure can be used. Cleaning is only required if the ISE membrane or reference junction appears to be fouled.

NOTE: *Any noticeable deposits on the tip of the sensor will result in a less accurate calibration and measurement.*

CAUTION: DO NOT SCRATCH THE SENSING ELEMENT

6.1 Cleaning Procedure for High pH & Drinking Water Applications

Rinsing Only Procedure

1. Thoroughly rinse the sensor tip with distilled or deionized (DI) water. Gently blot the sensor tip dry. Be careful not to scratch or damage the sensitive fluoride ion selective membrane.

Cleaning Procedure

1. Thoroughly rinse the sensor tip with distilled or deionized water. Gently blot the sensor tip dry. Be careful not to scratch or damage the sensitive fluoride ion selective membrane.
2. The fluoride sensor tip can be cleaned with isopropyl alcohol to remove any oily or waxy build-up. No other solvents or reagents should be used without contacting the factory to ensure that it is suitable.
3. Scrape the entire reference area clean with a sharp blade or Stanley knife. This reference is solid-state and cannot be damaged with ordinary cleaning techniques.
4. Once the reference junction has been cleaned the entire sensor tip can be soaked in either the low or high standardization solution. Allow about 5 minutes for conditioning before performing a 2-point calibration.

NOTE: *Do not allow the sensor to be exposed to air for prolonged periods of time, this will cause the reference junction to become dehydrated. Always store the sensor in standardization solution when the sensor is not in service.*

Fluoride Sensor Specifications

FX-300 Integrated Fluoride Ion Selective Sensor Specifications Twist Lock Mounting

Part Number: SF-8T-UL-10

1" MNPT Twist Lock Immersion Integrated, Fluoride Ion Selective Sensor for use in high pH Applications

Recommended Applications: Fluoride ion concentration in aqueous solution from drinking water through waste water. Not suitable for use in etching solutions.

Special Features: Crosslinked polymer in the reference system is resistant to heat, solvents and to most chemicals. Sensor holds an excess of KCl, assuring saturation at all temperatures and extending the life of the sensor.

The construction of the sensor permits easy access to the sensing and reference surfaces for cleaning or inspection.

General Specifications:

Concentration Range:	1 to 10^{-6} Molar, 19,000 to 0.019 ppm
Lowest Limit of Detection	5 X1 0^{-8} Molar, .001 ppm
pH Range:	5.5 to 9.5 pH (continuous), intermittent up to 11 pH with measuring crystal degradation
Temperature Range:	5 to 50 °C
Temperature Compensation:	Fast Temp PT1000 for variable temperature conditions
Pressure Range:	1 to 20 psig (6.9 to 138 kPag)
Body Material:	Ultem (Poly-Ether-Imide)
Junction Material:	Kynar (Poly-Vinylidene-Fluoride)

Cable: RG 174/U Coaxial (without preamplifier)
Connector: BNC (unless otherwise specified)

Ion Sensor Specifications:

Measuring Membrane:	Selective Fluoride Sensitive Membrane (solid state)
Dimensions:	0.310", (7.8 mm) DIA
Initial Impedance:	Less than 100 M Ohms @ 25 °C

Interfering Ions in Ratios of Permissible Excess:

Interfering Ion / Measured Ion (in Molarity):	OH- above 12.0 pH

Reference System Specifications:

Type: Double Junction
Reference Half Cell: Ag/AgCl, Saturated KCl
Primary Junction: Porous Ceramic, Saturated KCl in crosslinked polymer
Secondary Junction: Porous Kynar, Saturated with KCl in crosslinked polymer
Surface Area: 366,000 mil^2, (236 mm^2)

Storage and Shelf Life: 1 year from date of manufacture at room temperature with protective cap on

8 Additional Measurement & Function Modules
FX-300-REL Relay & Control

FX-300-REL *Alarm Relay and Controller Module*

- FX-300-REL is a versatile controller and alarm module with 2 independent limits
- Performs alarm relay and/or controller function for FX-300-pH, FX-300-ISE or FX-300-CON measurement modules
- Offering Simple On/Off as well as more sophisticated Time Proportional Control (TPC) and Proportional Frequency Control (PFC) a.k.a. Variable Pulse
- One FX-300-REL module is required for control and/or alarm function for each FX-300 measuring module (i.e., 1 each analog input per FX-300-REL module)
- Analog input: 0-20mA or 4-20mA
- Maximum or minimum limits can be configured for each of the 2 relays
- Configurable start timer and reaction timers
- 24VDC power operation, 5A max load/rating for each dry contact relay
- Hold function to disable relays during calibration and maintenance of measureming transmitters and sensors
- Scaling in native measurement units (pH, ppm, µS/mS) for all configurable parameters for ease of use and programming
- DIN rail mountable; small form factor for tight space installations
- Field installations using NEMA 4X enclosures, supporting up to a total of 8ea FX-300 transmitter modules in a single enclosure.

Application
FX-300-REL modules are ideal for supervising mA signals. This unit is fully compatible with the output provided by all of our FX-300 measuring transmitters (FX-300-pH, FX-300-ISE, and FX-300-CON). Simple On/Off as well as programmable control functionality is possible with the FX-300-REL module.

Analog Input
The analog input is a current input, and may be set up to either 0-20mA or 4-20mA. The FX-300-REL can be scaled so as to match exactly the 0-20mA or 4-20mA analog output from the FX-300-pH, FX-300-ISE & FX-300-CON measurement modules.

Digital Input
The FX-300-REL may be configured to both positive and negative logic on the digital inputs. Using parameter no. 21, the input may be set to either active high or active low. With positive logic, the accepted input voltage range is 5- 30VDC. Negative logic is achieved by connecting the input to ground; for example by using a switch. The supervision may be blocked by activating the S2 input.

Relay Output
The unit contains two relays, one for each limit. The relays are both connection relays, but the polarity may be inverted independently using parameters no. 19 and 20 when in simple supervision and On/Off control mode.

8 Additional Measurement & Function Modules
FX-300-REL Relay & Control

FX-300-REL

Alarm Limits

The FX-300-REL integrates two limits. All settings for one limit may be altered independently of the other. Each limit may be set up as a Max. or Min. limit. All limits can be entered in the native unit of the measurement module to which it is connected (pH, ppm, µS/mS).

Start Timer (Ts)

The start timer may be used to avoid alarms during startup of an unstable process. It is activated when the input reaches 5%. If the timer is set to 0, supervision is performed without using the start timer.

Reaction Timers (Tr)

Each limit has a corresponding reaction timer used to avoid alarms if the limits are exceeded for short periods of time.

Control Modes

The FX-300-REL module can operate in four modes: 1) Simple supervision (alarm function only); 2) On/Off control with deadband; 3) Time Proportional Control (TPC) or 4) Proportional Frequency Control (PFC a.k.a. Variable Pulse).

Reset

During simple supervision (i.e. control mode is “Off”) an alarm may be reset in two ways: 1) by activating the external reset input (S1 – terminal 3) or 2) by pressing the ‘Mode’ key in the “input” display mode. A reset requires the alarm condition to be cleared.

Specifications

Mechanical

Housing	Lexan UL94V-0 (Upper Part) Noryl UL94V-0 (Lower Part)
Mounting	M36 for 35mm DIN rail
IP Class	Housing IP40. Connector IP20
Connector	Max 16A. Max 2.5mm^2. Max torque 0.6 Nm
Temperature	-15 to +50 °C
Weight	200 grams (7.04 ounces)
Dimensions	D 58 x W36 x H86 mm (2.3” x 1.4” x 3.4”)
CE mark	EN61326A

Electrical

Power supply	24VDC +/- 10%
Consumption	60mA max
Input current range	(0)4-20mA, 70Ω
Digital input	Pos. logic: 5-30VDC; Neg. logic: 0V
Input S1	External reset
Input S2	Alarm block
Relay spec	250VAC/5A

8 Additional Measurement & Function Modules
FX-300-REL Relay & Control

Function and Settings

If the software block (par. no.1) is "on" the parameter can only be read. Set software lock to "off" to change values. To access parameters, press 'Mode' key until 'Setup' LED is lit and displays 'P00'. Use 'Up' and 'Down' keys to scroll through the parameters. Select parameter with 'Mode' key, and change value using 'Up' or 'Down' keys. To exit, select 'Par. no. 00' and press 'Mode' key.

Par. no.2 Hold (Relay condition held – signaled by flashing input LED)
Par. no.3 Type of input is selected - 0-20mA or 4-20mA.
Par. no.4 Indicates the type of limit 1: Min. or Max.
Par. no.5 Indicates the type of limit 2: Off, Min. or Max.
Par. no.6 Select if display will show % (4mA=0%, 20mA=100%), pH units, Conductivity Units (either µS or mS), or ISE units (ppm)
Par. no.7 When P05 is ISE, selects full scale range on FX-300-ISE module's 4-20mA output. 'Lo' is 0-10 ppm, 'Mi' is 0-100 ppm & 'Hi' is 0-999 ppm.
Par. no.8 When P05 is set to CON, this selects the full scale range on the corresponding FX-300-CON measurement module 4-20mA. Each cell constant will define the full range scale. For K=0.01, Max=0.5mS; K=0.1, Max=5mS; K=1.0, Max=50mS; K=2.0, Max=100mS, K=10.0, Max=500mS
Par. no.9 * This defines the value of the 4mA input. When P06 is % there are no adjustments possible. When P06 is ISE the value should match P10 on the FX-300-ISE module to which is it connected. When P06 is CON, then this will always be 0mS (no matter what the cell constant). When P06 is pH, the value should be match P13 on the FX-300-pH module.
Par. no.10 * This defines the value of the 20mA input. When in P06 is % there are no adjustments possible. When P06 is ISE the value should be adjusted to match P11 on the FX-300-ISE to which is it connected. The difference between P09 and P10 when P06 is ISE must be at least 20% of the operating range (P09 on the FX-300-ISE). When P06 is CON then this will by default be the maximum full range scale associated with the conductivity cell constant selected. This value should match value of P12 on the FX-300-CON. The minimum value is 10% of full range. When P06 is pH, the value should match P14 on the FX-300-pH module. The minimum difference between P09 & P10 when P06 is pH is 3 pH units.
Par. no.11 Off means simple supervision with alarm relays set to limits only. If 1, then
and no.12 On/Off Control is enabled. If 2, then time proportional control (TPC) is enabled. If 3, then proportional frequency control (PFC) is enabled (a.k.a. variable pulse control).
Par. no.13 Sets basic time for limit 1 when in TPC mode (P11=2)
Par. no.14 Sets basic time for limit 2 when in TPC mode (P12=2)
Par. no.15 Sets basic pulse rate for limit 1 when in PFC mode (P11=3)
Par. no.16 Sets basic pulse rate for limit 2 when in PFC mode (P12=3)
Par. no.17 Common parameter - If On/Off mode (P11=1) then hysteresis (dead band) - If TPC or PFC (P11=2/3) then proportional band – For Limit 1
Par. no.18 Common parameter - If On/Off mode (P12=1) then hysteresis (dead band) - If TPC or PFC (P12=2/3) then proportional band – For Limit 2
Par. no.19 Polarity of relay 1: Non inverted/ Inverted ***
Par. no.20 Polarity of relay 2: Non inverted/ Inverted ***
Par. no.21 Digital input configured to be active high (Hi) or low (Lo).

Function and Settings

Par. no.22 Allows calibration offset of 0mA or 4mA current signal input.
Par. no.23 Allows calibration gain adjustment of 20mA current signal input. **Par. no.24** Displays result of 0/4mA trim offset calibration (P22) in % units **Par. no.25** Displays result of 20mA trim gain calibration (P23) in % units **Par. no.26** Feature to reset the analyzer back to factory default.

** Value is 50% of range determined by Display mode (P06) and scale parameters P09 & P10
*** Relay polarity does not apply when in TPC mode (P11/P12=2) or PFC mode (P11/P12=3)
**** Default values will depend upon 4mA and 20mA calibration performed at THE factory.

List of Parameters

No	Parameter	Description	Range	Default
1	Lock	Software lock	On / Off	On
2	Hold	Relay on hold	On / Off	Off
3	Input	Analog input	0-20mA, 4-20mA	0-20
4	Limit 1	Type of limit	Min (lo), Max (Hi)	Hi
5	Limit 2	Type of limit	*Off, Min (Lo), Max (Hi)*	Lo
6	Display mode	Type of input measurement	%, pH, CON, USE	%
7	ISE range	ISE range input	Lo, Mid, Hi	Lo
8	Con range	Conductivity Cell Constant	0.01, 0.1, 1.0, 2.0, 10.0	1.0
9	4mA scale	Reading @ 4mA	*	*
10	20mA scale	Reading @ 20mA	*	*
11	Mode Lim1	Control mode limit 1	Off, 1, 2, 3	Off
12	Mode Lim 2	Control mode limit 2	Off, 1, 2, 3	Off
13	Time Lim1	Time for limit 1	1...250s	10
14	Time Lim2	Time for limit 2	1...250s	10
15	Pulse Lim1	Pulse rate for limit 1	1...250 pulse/min	60
16	Pulse Lim2	Pulse rate for limit 2	1...250 pulse/min	60
17	Hysteresis 1	Dead band limit 1	1...50% **	10%
18	Hysteresis 2	Dead band limit 2	1...50% **	10%
19	Polarity 1	Polarity for relay 1 *Non-inverted, inverted*	n.inverted, inverted	n.inv
20	Polarity 2	Polarity for relay 1 *Non-inverted, inverted*	n.inverted, inverted	n.inv
21	Logic	Logic for digital inputs	Neg (Lo), Pos (Hi)	Lo
22	Trim Low	Calibrate 4mA input	As defined	-
23	Trim High	Calibrate 20mA input	As defined	-
24	% trim low	Display 4mA offset	+/- 9.99%	****
25	% trim low	Display 20mA gain	+/- 9.99%	****
26	Back to default	Reset to default	Def=Reset, Par=NoReset	Par

Control Functions and Modes

The unit contains two relays, one for each limit. The relays are both connection relays, but the polarity may be inverted independently using parameters no. 19 and 20 when in simple supervision and On/ Off control mode.

On/Off Control
When the measurement crosses the chosen setpoint, the relay will open and not close again until the measurement exceeds the hysteresis band.

Hysteresis Band
A hysteresis band (a.k.a. dead band) always lies above a Min & below a Max limit. This is P17 for Limit 1 & P18 for Limit 2 in On/Off mode.

Proportional Band
The proportional band is a range where a variable control is performed. A proportion band lies above a minimum and below a maximum limit. This is P17 for Limit 1 & P18 for Limit 2 in TPC control mode.

Basic Frequency
The basic frequencies for Limit 1 & 2 may be set from 1 to 250 pulse per minute (default 60). This is valid in the PFC control mode only.

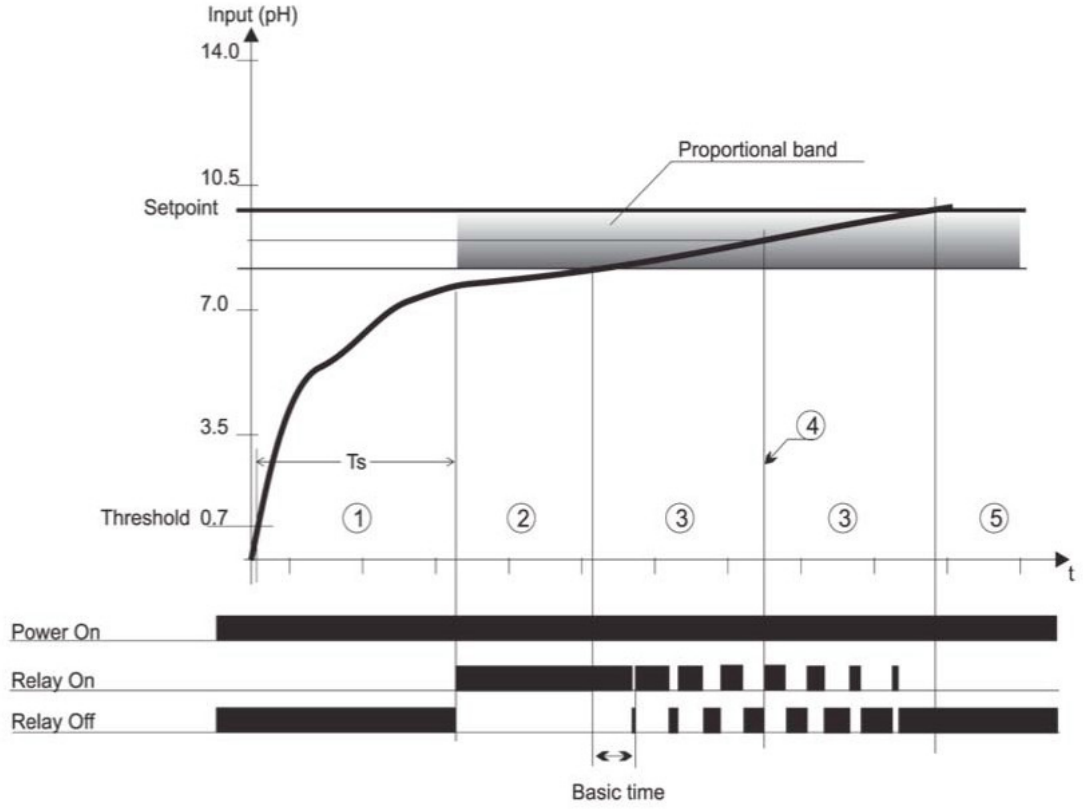
Proportional Frequency Control (PFC a.k.a. Variable Pulse)
If the measurement lies outside the proportional band the relay will pulsate with the basic frequency. Inside the proportional band the frequency is changed linearly towards zero as the measurement approaches the setpoint.

Time Proportional Control (TPC)
The time is constant and equal to the basic time. Instead the duty cycle is changed according to the same principle as for PFC control. If the measurement lies outside the proportional band the relay is closed permanently and open permanently if limit is exceeded.

Control examples
On/Off control may be used for alarms and simple control of pumps. Proportional frequency control is primarily designed for the control of dosing pumps. Proportional time control may be used for control where more fine approach is required than simple on/off control offers.

Parameters Accessible from LED Menu
In addition to the parameters in the setup menu, the FX-300-REL also features parameters directly accessible from the main LED menu (see next column top). The parameters are accessible by pressing the ‘Mode’ key until the LED for the parameter to be altered is lit. Use the ‘Up’ and ‘Down’ keys to alter the parameter. These parameters and their functions are shown in the table below. Par No. 01 is a “lock” which must be ‘Off’ to change ANY parameter at all.

The figure below shows in principle how the TPC algorithm works. The curve depicts a process where a certain pH value (setpoint) is required. This example is taken from conditioning of heating water from a district heating plant, where the required pH value lies on 9.8 pH



Parameter	Description	Range	Default
Ts [s]	Start up - timer	0.0 to 999s	10.0
Limit 1	Setpoint for limit 1 * *Display mode %* *Display mode pH* *Display mode Con* *Display mode ISE*	 *5.0 - 99.9%* *0.1 - 14.0pH* *1 - 500* ** *1 - 999* ***	 *80.0* *11.2* *400* ** *800* ***
Limit 2	Setpoint for limit 2 * *Display mode %* *Display mode pH* *Display mode Con* *Display mode ISE*	 *5.0 - 99.9%* *0.1 - 14.0pH* *1 - 500* ** *1 - 999* ***	 *20.0* *2.8* *100* ** *200* ***
Tr [s] (limit 1)	Reaction time limit 1 ^	00.0 to 99.9s	10.0
Tr [s] (limit 2)	Reaction time limit 2 ^	00.0 to 99.9s	10.0

** Values depend on display mode and range selected with P06, P07 and P08
*** Decimal point depends on selected range for conductivity
**** Decimal point depends on selected range for ISE
^ During this time period, no relay action will be undertaken when P06 is set to Off (supervision/alarm function only) or On/Off Relay control mode

Typical Installation Wiring

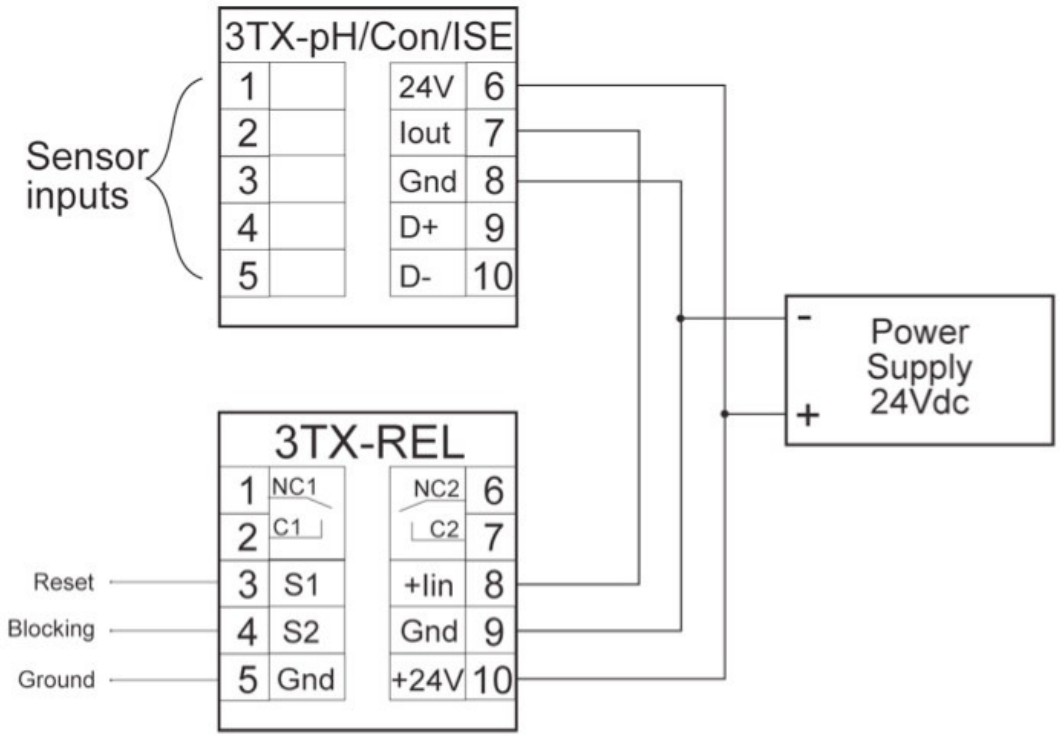


Figure 12

Note*: An alternate wiring configuration is required if the 0/4-20mA transmitter output is to be first (also) sent to another data acquisition or control device.*

Example of pH Control Application using TPC Mode
The required settings needed for this TPC implementation are:

Limit: Hi (Max limit) or Lo (Min limit); Here a max limit is needed.
Control mode: TPC
Setpoint: Requested pH value; here 9.8pH
Proportional band: Band where the actual regulation is performed; here 1pH
Unit Basic time: "Cycle time" for the TPC algorithm
Start timer: Startup time for the sensor to settle

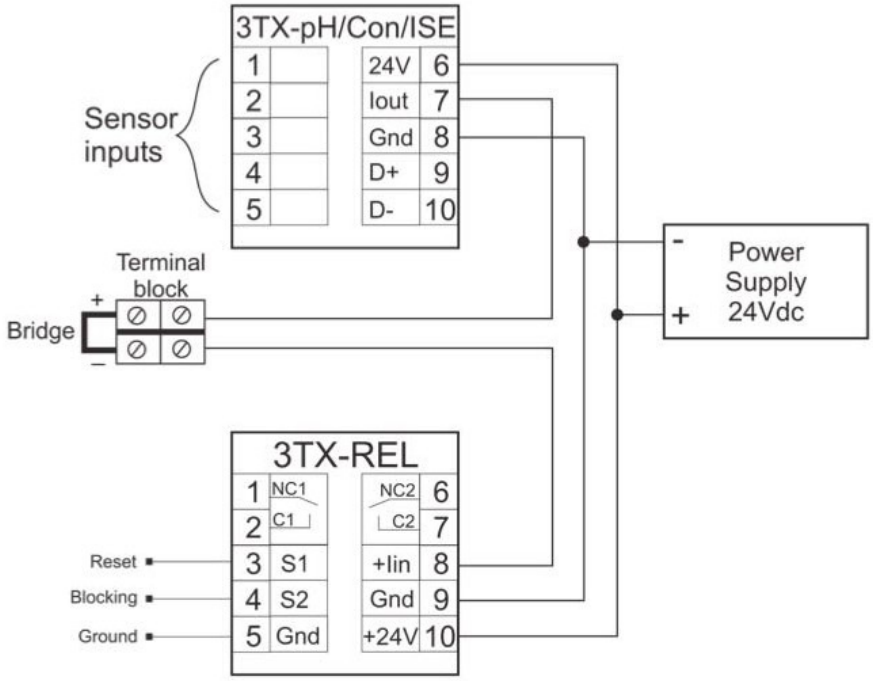
When the measured value crosses 5% of the measuring range (here corresponding to 0.7pH) the startup timer is activated to avoid false readings during settling time of the sensor. This time should be selected large enough to give the sensor time to settle, but not much longer than this, since the supervision and control will be disabled in this period. The relay is off in this condition (see period 1 on figure).

After expiration of the startup timer the FX-300-REL starts to control. In the example, the measured value lies below the setpoint minus the proportional band (Period 2) and the relay will be continuously on to use maximum conditioning fluid. When the measured value exceeds the setpoint minus the proportional band the values is said to lie

within the proportional band (Period 3) and the on-time of the relay is regulated proportional to the distance up to the setpoint. This is illustrated with the two “bars” below the curve, where it is shown that the on-time drops as the value comes closer to the setpoint. At the point (4) the value is exactly in the middle of the proportional band where the on-time and off-time of the relay are equal (The relay is on half the time).

Finally when the setpoint is reached the relay is kept off and will not be set on again until the measured value drops below the setpoint. This is illustrated with period (5)

Wiring Schematic for FX-300 Measurement Transmitters (FX-300-pH, FX-300-CON or FX-300-ISE) when used together with FX-300-REL Relay Module and a 4-20mA Output is Required to connect with additional Data Acquisition or Control Devices



If you wish to “insert” an external device into the current loop, it can be done by removing the bridge jumper and connecting the two terminals to the external device (“+” to device input and “–“ to device output, which may also be device ground). If no external device is to be connected, the bridge jumper must be in place to ensure normal operation of the FX-300-REL relay module.

9 Repair Service Contact & Return Policy

Customer Service Department

If you need spare parts, assistance in troubleshooting, or repair service, please contact Foxcroft Customer Service at:

Foxcroft Equipment and Service, Co. Inc.
2101 Creek Road, P.O. Box 39
Glenmoore, PA 19343

Tel: (800) 874-0590
(610) 942-2888
Fax: (610) 942-2769
Email: service@foxcroft.com
www.foxcroft.com

Customer Repair / Returns Policy

All systems returned for repair or replacement must be freight prepaid and include the following information:

1. A clearly written description of the malfunction.

2. Name of person to contact and the phone number where they can be reached.

3. Proper return address for shipping system back. Include preferred shipping method.

4. A purchase order if the system is out of warranty to cover costs of repair.

5. A Return Material Authorization Number (RMA) is required before shipping any products for service. Call telephone number above to receive a RMA number.

NOTE: *Returns will only be held at Foxcroft for 90 days. If a decision is not made regarding the repair, the product will be returned.*

10 Product Warranty

Foxcroft Equipment & Service warrants all products obtained hereunder to be free from defects in material and workmanship for a period of one year from the date of shipment. In the event of a product failure or defect requiring warranty repair, the customer must obtain an RMA number by calling 1-800- 874-0590, before returning the product, at the customer's expense to Foxcroft for repair. Warrantor (Foxcroft Equipment and Service) will repair the unit, without charges for parts, labor and return freight.

Foxcroft Equipment & Service is not responsible for damage to its products through improper installation, maintenance, act of God, use or attempts to operate such products beyond their functional capacity, intentionally or otherwise, or for any unauthorized repair.

Buyer agrees to hold Foxcroft Equipment & Service harmless from all claims for damages arising out of injury or death to any person or damage to any facility, or any other property, or loss of use of any such property, whether such person or property is on or off the installation or activity site for which the equipment or material furnished hereunder is destined and whether such damage, loss destruction or loss of use, injury or death results directly or indirectly from a nuclear incident or for any other cause.

Statements and instructions set forth herein are based upon the best information and practices known to Foxcroft Equipment & Service but it should be assumed that every acceptable safety procedure is contained herein. Of necessity this company cannot guarantee that actions in accordance with such statements and instructions will result in the complete elimination of hazards and it assumes no liability for accidents that may occur.

FOXCROFT

EQUIPMENT & SERVICE COMPANY, INCORPORATED

Serial Number Label of FX-300 Series Analyzer:

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