AM-2250 / AM-2250TX /AM-2251
Multi-Parameter Controller / Transmitter

Installation and Operation Manual

Contents

1 Introduction

1.1 Third in a Long History of Controllers

The AM-2250 multi-parameter controller is the third-generation controller built on the 30-year AquaMetrix legacy of building durable and easy-to-use controllers. Many of the 2200 controllers sold those three decades ago are still in use today in some of the most hostile environments found in industry. Orders continue to come in today for 2200 pH, ORP or conductivity models, years after they entered end-of-life status.

The AM-2250 controller, AM-2250TX transmitter and AM-2251 controller. Some of the design improvements over previous generation analyzers include:

- An advanced conductivity measurement design that results in a ten-fold improvement in accuracy at low and high conductivity values.
- Form factor optimized for wall or panel mounting.
- Large LCD screen (backlit in the AM-2250 and AM-2251).
- A revamped menu structure that is so intuitive that the manual is unnecessary.
- The ability to calibrate conductivity solutions in TDS units (mg/l) and % concentration.
- Live readings during calibration to determine when the
- Three-point calibration for pH to give more accurate pH values over a wide pH range.
- Multi-point (<16) calibration routine for conductivity for measurement of acid and base concentrations.
- PID control.

1.2 Differences between the AM-2250, AM-2250TX and AM-2251

The AM-2250 and AM-2251 are AC-powered controllers consisting of three relays and two 4-20 mA outputs. The AM-2250TX is a transmitter version of AM-2250. It is loop-powered and does not contain the power-relay circuit board. Because of power constraints the LCD is not backlit. This table summarizes the parameters the three models measure.

Table 1 - Summary of Analyzers and Associated Probes

Model	60-series pH/ORP	500-series pH/ORP	Conductivity Contacting	Conductivity Inductive	Dissolved Oxygen	Flow Pulse	4-20 mA Output #1	4-20 mA Output #2	Relays
AM-2250TX	√	√	√			√	√		
AM-2250	√	√	√			√	√	√	√
AM-2251	√	√		√	√		√	√	√

2 Specifications

2.1 AM-2250 Technical specs

Probe Parameters				
	pH	ORP	Conductivity	Flow
Sensor	6-wire differential or combination	6-wire differential or b combination	2-electrode with cell constants: from 0.01 to 100	Pulse output: Paddle-wheel Magnetic Flow
Temperature Elements	Pt100 RTD, Pt1000 RTD, NTC 300Ω, NTC 3000Ω, NTC10k NTC With Auto Detect Feature			n/a
Sensor Input	-600 to 600 mV	-999 to 999 mV	0 to 9999 Ω	0 to 2000 Hz
Measurement Range	0 – 14 pH -20 – 120 ^{0}C	-999 to 999 mV	0.055 to 500,000 µS/cm, depending on cell constant	0 to 9999 in any available units.
Temperature Compensation	Automatic, manual or none	n/a	Automatic, manual or none	n/a
Calibration Mode	1, 2 or 3 points Automatic, manual.	Single point. Manual	Up to 16 points Wet or dry.	K-factor input
Outputs				
Analog	2 x fully scalable and optically isolated 4-20 mA. Max load: 800 Ω Channel 1: Process with optional PID. Channel 2: Temperature or Process			
Relays	3 independent relays: 10A @ 120/240 VAC or 8A @ 30 VDC (Resistive Load) 5A @ 120/240 VAC or 4A @30 VDC (Inductive load)			
Relay Modes	Rising/Falling/Range mode, Cycle On/Off, Relay Delay, Overfeed Timer, Override			
Ratings				
Ingress Protection	NEMA 4X			
Electrical	ETL, cETL and CE (pending)			
Max. Power Input	0.2 A @ 115 VAC or 15 W			
Temperature	-20 to 70 ^{0}C			
Humidity	0 to 90% Relative Humidity, non-condensing			
Physical				
Mounting	Wall mount, panel mount with kit provided, pipe mount optional			
Dimensions	Front cover: 5.5”x5.5” (14 cm x 14 cm). Depth: 5” (13 cm)			
Power	120/240 VAC 60 or 50 Hz			
Weight	2 lbs			

2.2 AM-2250TX Technical specs

Probe Parameters				
	pH	ORP	Conductivity	Flow
Sensor	6-wire differential or combination	6-wire differential or b combination	2-electrode with cell constants: from 0.01 to 100	Pulse output: Paddle-wheel Magnetic Flow
Temperature Elements	Pt100 RTD, Pt1000 RTD, NTC 300Ω, NTC 3000Ω, NTC10k NTC With Auto Detect Feature			n/a
Sensor Input	-600 to 600 mV	-999 to 999 mV	0 to 9999 Ω	0 to 2000 Hz
Measurement Range	0 – 14 pH -20 – 120 ^{0}C	-999 to 999 mV	0.055 to 500,000 µS/cm, depending on cell constant	0 to 9999 in any available units.
Temperature Compensation	Automatic, manual or none	n/a	Automatic, manual or none	n/a
Outputs				
Analog	Fully scalable and optically isolated 4-20 mA – Process with optional PID. Max load: 800 Ω			
Relays	None			
Ratings				
Ingress Protection	NEMA 4X			
Electrical	ETL, cETL and CE (pending)			
Max. Power Input	20 mA @ 24 VDC			
Temperature	-20 to 70 ^{0}C			
Humidity	0 to 90% Relative Humidity, non-condensing			
Physical				
Mounting	Wall mount, panel mount with kit provided, pipe mount optional			
Dimensions	Front cover: 5.5”x5.5” (14 cm x 14 cm). Depth: 5” (13 cm)			
Power	16-32 VDC			
Weight	2 lbs			

2.3 AM-2251 Technical specs

Probe Parameters				
	pH	ORP	Conductivity	DO
Sensor	6-wire differential or combination	6-wire differential or combination	Inductive	Clark cell 2-electrodes
Temperature Elements	Pt100 RTD, Pt1000 RTD, NTC 300Ω, NTC 3000Ω, NTC10k NTC With Auto Detect Feature			
Sensor Input	-600 to 600 mV	-999 to 999 mV	Cond: 0 to 9999 Ω	0 to 5000 nA
Measurement Range	0 – 14 pH -20 – 120 ^{0}C	-999 to 999 mV	0.055 to 500,000 µS/cm, depending on cell constant	10 ppb to 10 ppm 0 – 110% @ 25°C
Temperature Compensation	Automatic, manual or none	n/a	Automatic, manual or none	Automatic. salinity, pressure
Calibration Mode	1, 2 or 3 points Automatic, manual.	Single point. Manual	Up to 16 points Wet or dry.	100% and 0% air
Outputs				
Analog	2 x fully scalable and optically isolated 4-20 mA. Max load: 800 Ω Channel 1: Process with optional PID. Channel 2: Temperature or Process			
Relays	3 independent relays: 10A @ 120/240 VAC or 8A @ 30 VDC (Resistive Load) 5A @ 120/240 VAC or 4A @30 VDC (Inductive load)			
Relay Modes	Rising/Falling/Range mode, Cycle On/Off, Relay Delay, Overfeed Timer, Override			
Ratings				
Ingress Protection	NEMA 4X			
Electrical	ETL, cETL and CE (pending)			
Max. Power Input	0.2 A @ 115 VAC or 15 W			
Temperature	-20 to 70 ^{0}C			
Humidity	0 to 90% Relative Humidity, non-condensing			
Physical				
Mounting	Wall mount, panel mount with kit provided, pipe mount optional			
Dimensions	Front cover: 5.5”x5.5” (14 cm x 14 cm). Depth: 5” (13 cm)			
Power	120/240 VAC 60 or 50 Hz			
Weight	2 lbs			

3 Setup

3.1 AC Power Connections (AM-2250 and AM-2251)

Caution: This instrument uses 120 or 240 50/60Hz AC power. Opening the enclosure door exposes you to potentially hazardous line power voltage which may be present on the power and relay plugs. **Always remove line power before working in this area**. If the relay contacts are powered from a separate source from the line power, be sure to power off before proceeding. The flip-down door contains low voltage circuitry and is safe to handle. Figure 3-1 shows the controller power board and connectors.

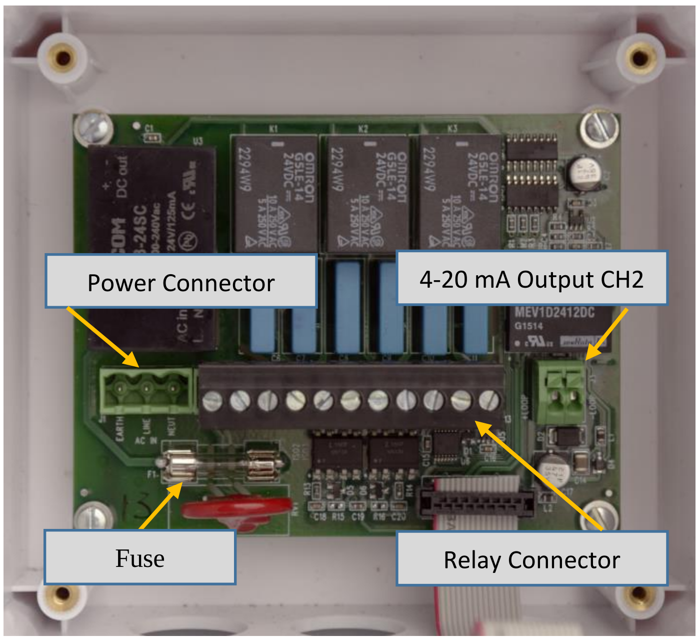


Figure 3-1 Power circuit board showing power and relay connectors. The second 4-20 mA output is also on the board.

To power the controller, remove the 3-pin power terminal block (not shown) and connect the wiring as printed on the board and shown on Figure 3-2. There are no jumpers or switches to convert the controller between 120 VAC and 240 VAC; the controller automatically configures for the correct voltage.

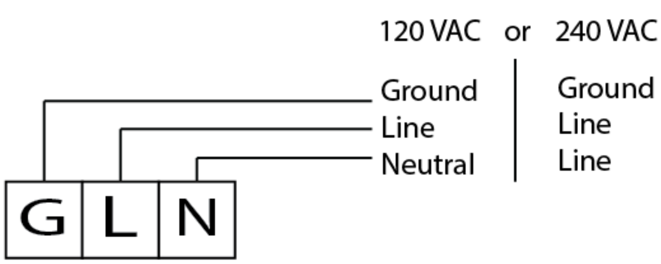


Figure 3-2 Power connection for 2250 Controller

3.2 Loop power connection (AM-2250TX)

The AM-2250TX is a low-power transmitter that has three options for being powered:

1. Most commonly it is loop powered by a PLC or the AquaMetrix 2300 web-enabled controller. The AM-2300 Web-enabled controller can power up to four AM-2250TX transmitters using its internal power supply.

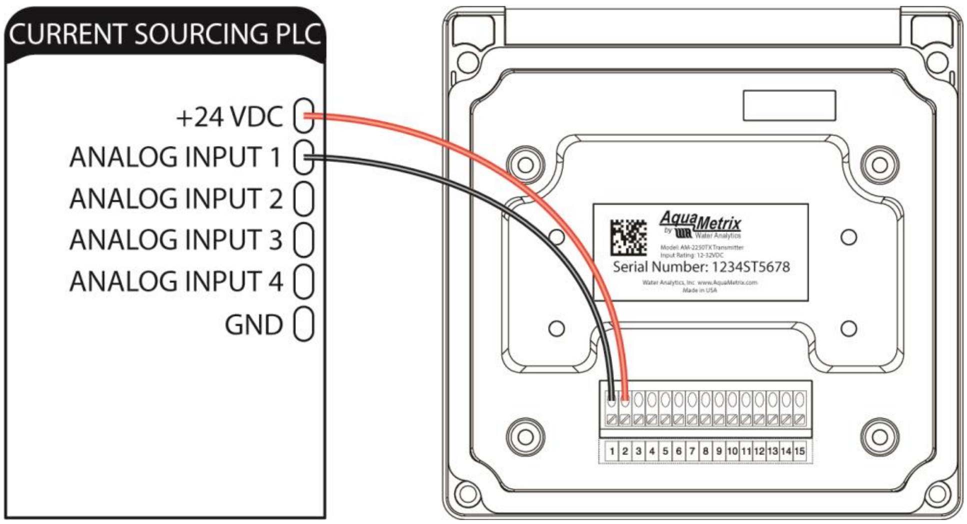


Figure 3-3 Loop powered AM-2250TX from a current sourcing PLC

2. Any current sourcing device supplies between 12 and 32 VDC. In this configuration the 2250TX is used as a readout device.

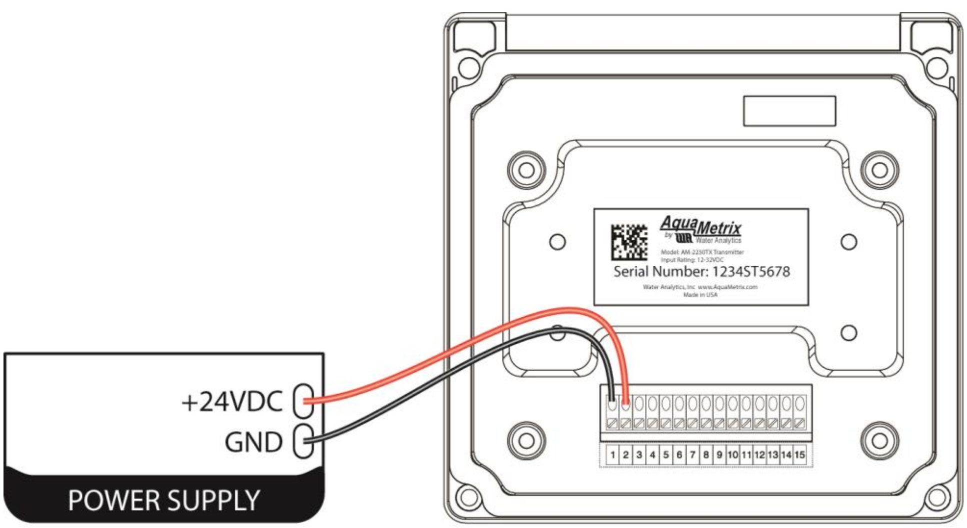


Figure 3-4 AM-2250TX wiring with external power supply.

3. The AM-2250TX can be used with a PLC or data logger without internal loop power. Connect the power supply in series, as shown on the right of Figure 3-5. The required power supply voltage will vary depending on the resistance in the PLC or recorder. Figure 3-6 shows the power needed as a function of the PLC loop resistance.

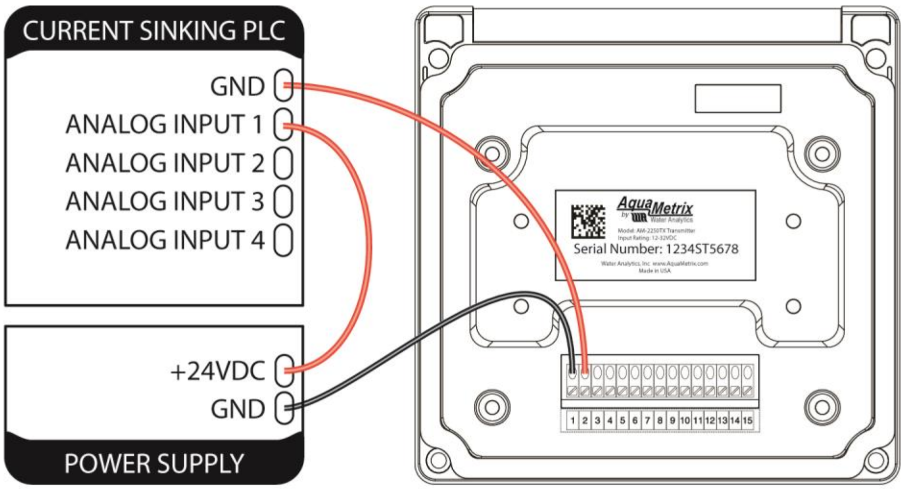


Figure 3-5 AM-2250TX with current sinking PLC

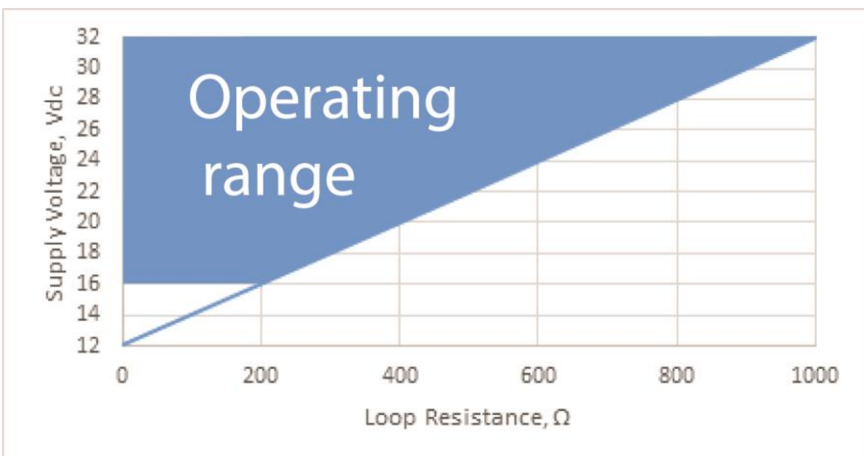


Figure 3-6 Required voltage for power supply for current sinking devices

3.3 Conduit Connection

The 2250 has six ½" (7/8" ID) conduit holes at the bottom of the enclosure. The unit is shipped with three conduit fitting and three holes plugged with liquid tight conduit seals. These must be left in unused holes to maintain the NEMA 4X integrity. Use approved conduit glans to ensure ingress protection.

Wire specification: Size and fuse wire according to local electrical code. Maximum current not to exceed relay specifications when used to power auxiliary devices via internal connections.

3.4 Mounting

All 2250 series controllers and transmitters can be mounted on a wall, panel or pipe. Figure 3-7 shows these three options. All hardware for wall and panel mounting is included.

There are two optional kits that are available for sale:

1. 2250-PIPE-MNT is a mounting kit for pipes up to 2”
2. 2250-DIN-MNT is a kit to mount on a DIN rail. Only the 2250TX can be DIN rail mounted. To do so you replace the back of the transmitter with the mounting brackets.

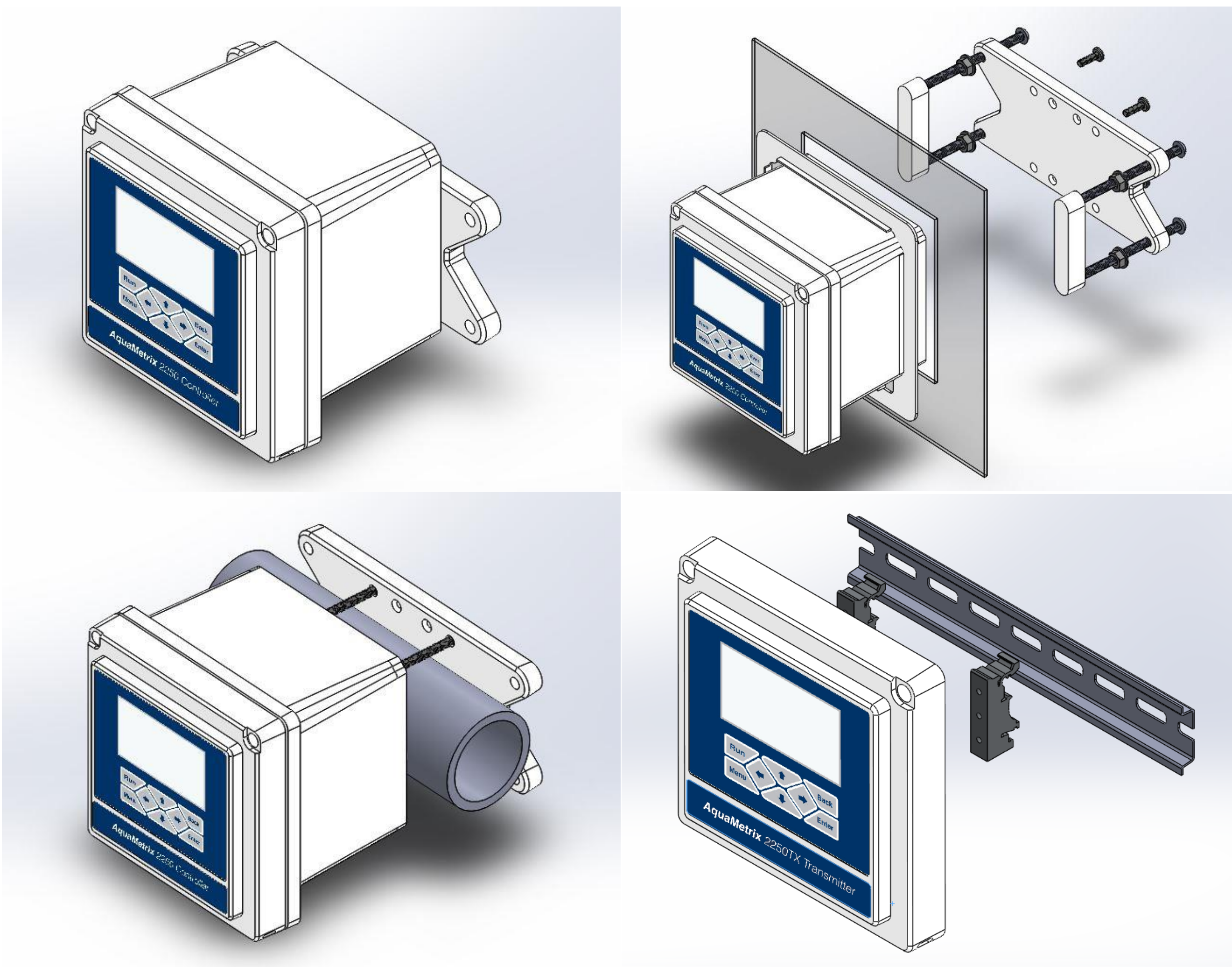


Figure 3-7 - Four mounting options: wall, panel, pipe and DIN rail (DIN rail option for AM-2250TX only).

3.5 Connecting Probes

As shown in Figure 3-8, the cover of the cover of the AM-2250 swings open to reveal a connector block for connecting probes. A label inside the controller identifies the terminals so reference to this manual is unnecessary. Note than connectors 1 and 2 are used for the 4-20 mA output (CH1) of the AM-2250 and AM-2251 controllers. The AM-2250TX transmitter also uses them for power input.

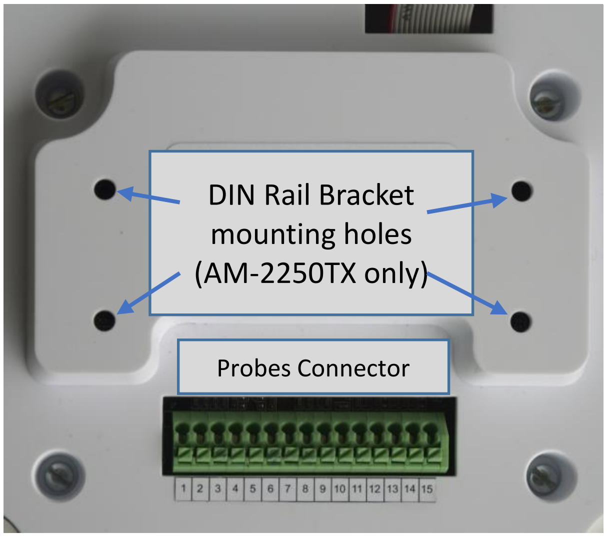


Figure 3-8 - This view of the inside of the front cover shows the connector for the probes and mounting holes for DIN rail brackets.

Figure 3-9 and Figure 3-10 shows probe connections to the connector block. The colors of the cells refer to the colors of the wires of the AquaMetrix probes. Color coding of AquaMetrix differential probes match that of Hach/GLI analog probes. Other manufacturer probes may use different colors.

	4-20mA (-)	4-20mA (+)	3 VDC out (-)	GND	3 VDC out (+)	pH/ORP (+)	GND	pH/ORP (-)	Thermistor	GND	Conductivity	3 VDC out (+)	Flow Input	3 VDC out (-)	Flow reset
Connector	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
pH/ORP Differential			White	Clear		Red	Black	Green	Yellow						
pH/ORP Combination						Clear pH/ORP	Jumper wire Green	Black	White TC						
Conductivity Contacting							Green		Red	White	Black				
Flow Self-powered													Red	Black	
Flow 6VDC powered												Red	White	Black	

Figure 3-9 AM-2250 and AM-2250TX sensor wiring

Connector	1 4-20mA (-)	2 4-20mA (+)	3 3 VDC out (-)	4 GND	5 DO Detect	6 pH/ORP (+)	7 GND	8 pH/ORP (-)	9 Temperature	10 DO Cathode	11 DO Anode	12 Toroid Drive (+)	13 Toroid Drive (-)	14 Toroid Sense (+)	15 Toroid Sense (-)
pH/ORP Differential			White	Clear Shield		Red	Black	Green	Yellow						
pH/ORP Combination						Clear pH/ORP	Jumper wire Green	Black	White TC						
Conductivity Inductive				Clear Shield			Red		Black			Blue	White	Green	Yellow
DO Clark cell				Clear Shield	Blue		White		Yellow	Black	Red				

Figure 3-10 AM-2251 sensor wiring

All AquaMetrix pH and ORP sensors can be connected to any 2250-series analyzer. Table 1 lists the set of probes that connect to all three analyzers.

Sensor Part#	AM-2250	AM-2250TX	AM-2251
60 Series Sensors	√	√	√
65 Series Sensors			
500 Series Sensors	√	√	√
AS Series Sensors	√	√	
AM Series Sensors	√	√	
ES-5 Toroidal Sensors			
AM-ES1 Toroidal Sensor			√
AM-ODO Sensors			
AM-CDO Sensors			√
AM-FCL Chlorine Sensor			
AM-TBR Turbidity Sensor			
Seametrics Flow Sensors	√	√	

Figure 3-11 Sensor compatibility chart

3.6 Analog (4-20 mA) Outputs

The AM-2250TX contains one 4-20 mA output that is isolated from sensor input. It is the two terminals 1 and 2 on the probe connector as mentioned in the last section. The output can be configured for process value; it is reversible and scalable. It can also be configured for PID control. The output is labeled as “4-20 channel 1” or “CH1” in menu.

The AM-2250 and AM-2251 additionally have a second isolated, reversible and scalable 4-20 mA output that can be configured for either the process value or temperature. It is located on the power supply board, which is shown in Figure 3-1. The 2 push-pin connector is on the lower right of the board, next to relay connector.

3.7 Relays (AM-2250 and AM-2251)

3.7.1 Wiring relays

The AM-2250 and AM-2251 contains three dry contact relays. For a resistive load they are rated 10A @ 120/240 VAC or 8A @ 30 VDC. For an inductive load they are rated 5A @ 120/240 VAC or 4A @30 VDC. Though these relays will work in most process control applications, we advise, for safety reasons, to use them as switches, i.e. low power DC relays that activate a second set of AC-powered relays separate from the controller.

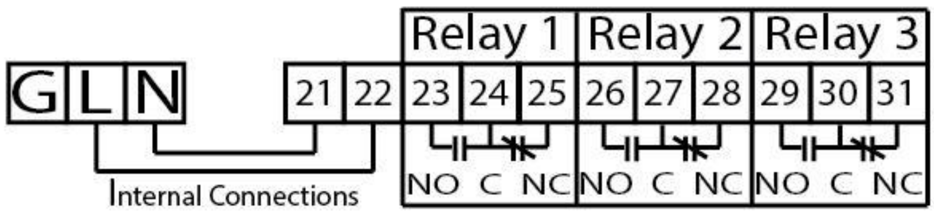


Figure 3-12 Wiring connections to the three relays. All relays are powered by internal jumpers between the ac power and terminals 21 and 22.

3.7.2 Snubber

When a relay is used to control an inductive device (relay coil, solenoid, transformer, small motor, etc.), the energy stored in the device will subject the relay contacts to a high voltage when the relay opens. When the switch contacts open, the contact gap is initially small. Arcing across this contact gap can occur immediately after the switch opens. This can happen in resistive as well as inductive loads, but inductive loads generate a higher voltage and causes increased arcing. Increased arcing decreases relay life. Arc suppression requires the use of an RC suppression network, called a snubber.

Each relay of AM-2250 and AM-2251 is connected to a snubber. Despite the fact that snubber prolongs relay life they have one disadvantage – they leak a small amount of AC current. If there is a low power LED or voltage meter connected between the COM and NO (or NC) terminals there will always be some AC voltage across them. If your application requires having only an LED use the alternative wiring shown in Figure 3-13 below.

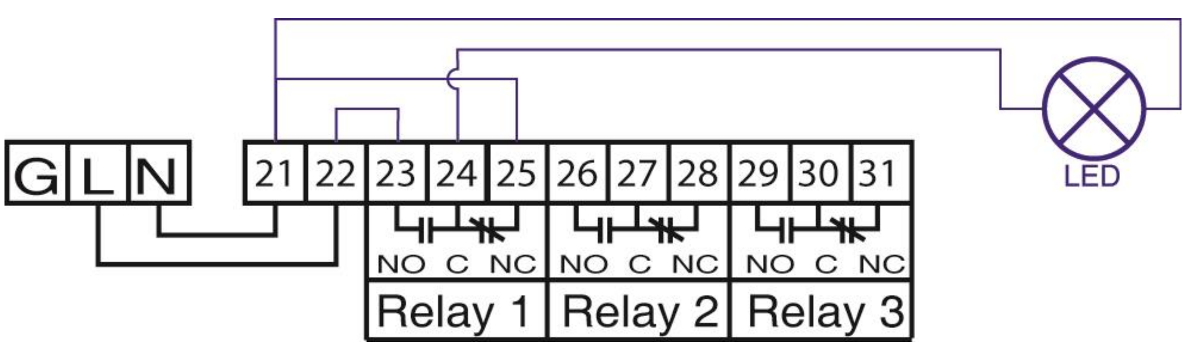


Figure 3-13 Alternative wiring for low power equipment (LED) only

4 Probe Setup

When powering up the 2250 the first screen presents options for configuring sensors.

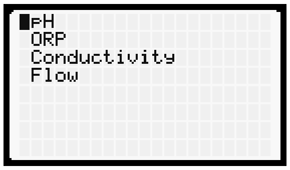
Figure 4-1 Initial start-up screen

1. Use the ↑ and ↓ buttons to scroll through the menu.
2. Use the ← and → buttons to move the cursor left or right.
3. Press Enter to select or confirm a selection.
4. Press Back to return to the previous screen or cancel your choice.
5. Press Menu to return to the main menu.
6. Press Run to exit from any menu and display the run display.

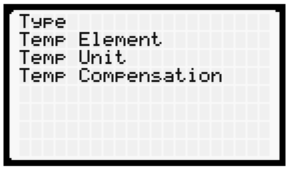
The top-level menu allows the user to configure the 2250 for a pH, ORP, conductivity, DO or flow sensor. The Setup option in the top-level menu allows you to completely configure a new probe or change an existing one.

4.1 pH

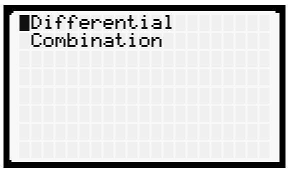
1. Scroll down the top-level menu to select Setup and press the Enter key.
2. Press Probe Selection.



3. Select pH and Press Enter. (As the first item in the list it is the default choice.)
4. The next menu lists the configuration options for the pH probe.



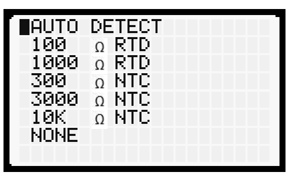
5. Type is either Combination or Differential.



The 2250 will accept virtually any combination or differential sensor. Entering a probe as the wrong type will simply result in an artificial offset and may not cause any noticeable reading or error. Combination probes may consist of only two wires for the process and reference or four wires, which includes two leads for the temperature element. Differential probes always have five or six (Including the shield) wires.

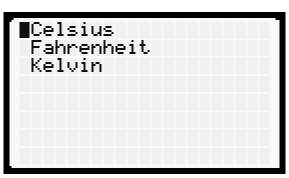
6. All differential probes and four-wire combination probes have a temperature element that must be selected. There are two types of temperature elements: RTD's (Resistive Temperature Device) and NTC's (Negative Temperature Coefficient). As the name implies, am NTIC displays a negative temperature correlation while a an RTD shows a positive one.

   Select Temp Element to bring up the choices of temperature element:

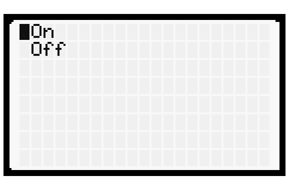


   AUTO DETECT recognizes most temperature devices. If it fails to properly configure the temperature device, check the temperature element wiring.

7. Select the preferred units of temperature (Temp Unit):



8. Choose whether you want to keep temperature compensation.



   The default selection is On. as most application requires pH slope to be corrected for temperature.

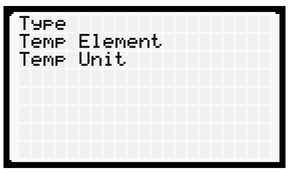
9. Press Run to confirm that controller displays pH units and reasonable temperature values.

4.2 ORP

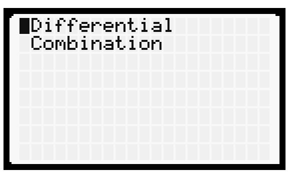
As with pH probes all differential ORP probes and four-wire combination probes contain temperature elements. However, ORP values are NOT temperature compensated. The temperature value is only for informational purposes.

1. From the top-level menu select Setup and press the Enter key.
2. Press Probe Selection to choose the probe type, ORP.

3. This selection automatically brings up the next menu for defining the configuration of the ORP probe.



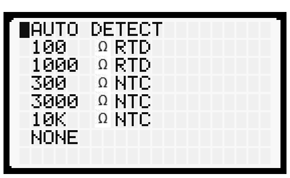
4. Type sets the probe as a Combination or Differential probe.



   As with pH probes, the 2250 will accept just about any type of combination or differential ORP probe. Entering the wrong type will simply result in an artificial offset and should not cause any noticeable reading or error. Combination probes may consist of only two wires for the process and reference or four wires, which includes two leads for the temperature element. Differential probes always have five or six (with the shield) wires.

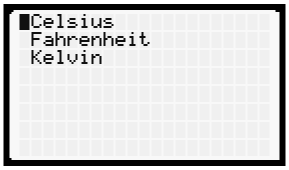
5. With the exception of the two-wire combination probe, the type of temperature element must be selected. There are two types of temperature elements: RTD's (Resistive Temperature Device) and NTC's (Negative Temperature Coefficient). As the name implies, an NTIC thermistor displays a negative temperature correlation while a an RTD shows a positive one.

   Select Temp Element to bring up the choices of temperature elements:



   AUTO DETECT recognizes most temperature devices. If it fails to properly configure the temperature device, check the temperature element wiring.

6. Select the preferred units of temperature (Temp Unit):

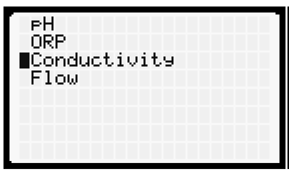


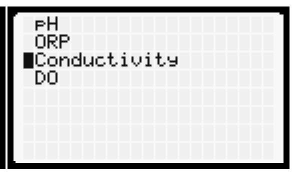
7. Press Run to confirm that controller displays mV units and reasonable temperature values.

4.3 Conductivity

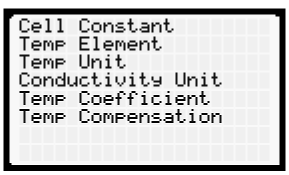
1. From the top-level menu select Setup and press the Enter key.
2. Press Probe Selection to choose the probe type, Conductivity, and press the Enter key.

The AM-2250 and AM-2250TX work only with contacting conductivity sensors. The AM-2251 works only with toroidal (also called non-contacting, inductive or electrodeless) sensors. The screen in the left shows the setup screen for a contacting conductivity sensor for the AM-2250 or AM-2250TX. The screen on the right shows the setup screen for a toroidal sensor.





3. This next menu defines the configuration of the conductivity sensor.

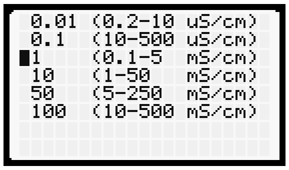


4. Cell constant selection.

AM-2250 & AM-2250TX: To enable the user to confirm that the cell constant is appropriate for his application, the 2250 menu for cell constants lists the approximate conductivity range for each cell constant It's important to understand that, although you are free to choose any cell constant, you will get inaccurate readings unless you choose the correct one. For instance, if your probe has a cell constant of 1 and you choose 0.1 (perhaps in an effort to measure lower conductivity levels) your readings will be high by a factor of 10. The cell constant is typically written on a label attached to the cable.

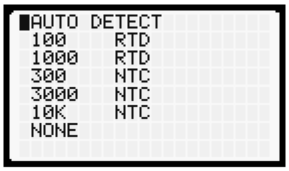
Note that the AM-2251 does not have a menu for the Cell Constant. The cell constant was originally defined as a geometric factor between electrodes (distance between electrodes/area). A cell constant can be viewed simply as a proportionality constant between conductance (e.g. µS) and conductivity (µS/cm) and thus a cell constant can be linked to a toroidal probe, the 2251 uses an analogous factor, called the transfer function.

AM-2251: The menu for the 2251 conductivity probe configuration therefore does not contain the cell constant.



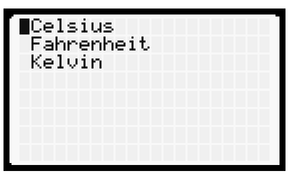
All conductivity sensors can measure conductivity values outside their ideal measurement range but the accuracy of the readings will suffer due mainly to the non-linear relationship between the reading and the conductivity value.

5. Choose Temperature Element.



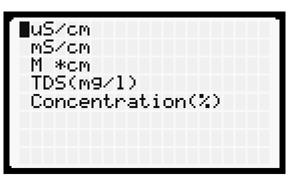
Conductivity readings are strongly influenced by temperature so nearly all conductivity probes have temperature elements. The same choices for temperature element for pH and ORP are present for conductivity. The default element for AquaMetrix AM series probes is the 1000 Ω RTD so that option is the default value.

6. Select Temperature Unit. Choices are Fahrenheit (°F) Celsius (°C) or Kelvin (K).



7. Conductivity values span a range of a million to one so one unit for representing all possible values is impractical. The metric (MKS) unit is Siemens/m. However, 1 S/m represents a level of conductivity higher than any water sample normally measured. Therefore, units of one thousandth of a Siemen per centimeter, mS/cm, or one millionth of a Siemen per centimeter, µS/cm.

The choices for Conductivity Unit are listed as:

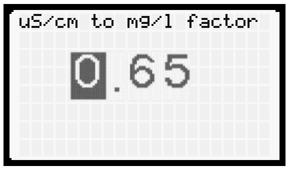


µS/cm. For clean, tap, surface or ground water this unit is the most common. RODI water typically has conductivity of 1 µS/cm or less. Tap water is around 300 µS/cm.

mS/cm. Salt solutions, acid and bases use the higher range. 1 mS/cm = 1000 µS/cm. Confusion between the two is responsible for nearly all problems selecting conductivity sensors and setting up the correct range.

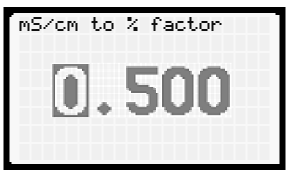
MΩ-cm. For very pure water many workers prefer to report resistivity units in place of conductivity units. One is the inverse of the other. Ultrapure water has a resistivity of 18.8 MΩ-cm (0.055 µS/cm). (Its finite resistance is the result of H^+ and OH^- ions.)

TDS (mg/l). The correlation between total dissolved solids (TDS) and conductivity varies with every sample of water. In order to display conductivity in terms of TDS units one must choose a conversion factor. The default value is 0.65 mg/l = 1 µS/cm. This menu selection allows you to select the conversion factor of TDS units to µS/cm units.

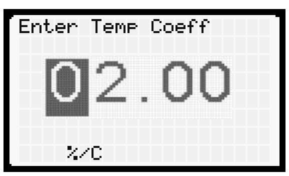


The only way to get an accurate conversion factor is to measure the TDS value by evaporating the water from a sample and weighing the leftover solids.

Concentration (%). This unit, in terms of weight per volume, is a TDS unit express as g/l. It is used for very high concentrations. It is typically used to characterize acids and bases. In order to display conductivity in terms of concentration units one must choose a conversion factor that converts mS/cm to %. The default value is 1 mS/cm = 0.5000 %.

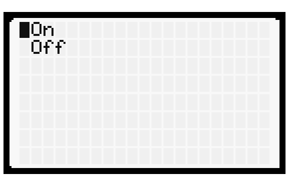


8. Temperature Compensation. Over a limited temperature range the variation of conductivity with temperature is linear. Conductivity values are typically reported in the literature at 25 ^{0}C.



The default value for α is 2.00 per degree C or 1.10 per degree F.

9. Temperature compensation for most applications should always be On.



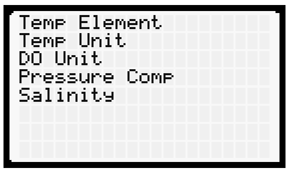
However, for diagnostic purposes and some isolated cases where you need to know the actual conductivity (and not the value at 25^{0}C) turn compensation Off.

10. Press Run to confirm that selected conductivity and temperature units are displayed correctly. Temperature may not be very accurate without calibration but should be close to expected value.

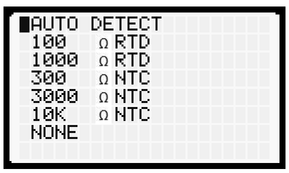
4.4 Dissolved Oxygen (AM-2251)

1. Scroll down the top-level menu to select Setup and press the Enter key.
2. Press Probe Selection and choose the probe type, DO.

3. This selection automatically brings up the next menu that defines the configuration of the DO sensor.

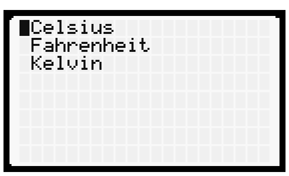


4. Choose the appropriate Temperature Element

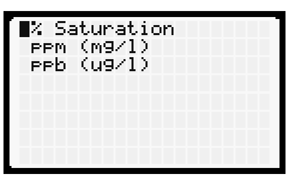


DO sensors are typically equipped with one or two temperature elements. In older D.O. probes (like the AquaMetrix P91) a second temperature element is used as an analog approximation to the change in membrane permeability with temperature. In newer probes, like the AM-CDO one temperature element is used to calculate both the membrane permeability factor as well as the conversion from % saturation to concentration (ppm or ppb) units.

5. Select Temperature Unit



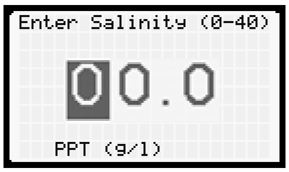
6. The choices for DO units are %sat (saturation) or ppm/ppb (concentration). PPB units are used in applications where oxygen concentration values are extremely low, e.g. in boilers.



7. DO value depends on the ambient (i.e. atmospheric) pressure therefore Pressure Compensation should be On..

The AM-2251 controller contains a pressure sensor that measure atmospheric pressure so manual entry is not required.

8. Salinity also affect the concentrations of oxygen in water. The amount of oxygen that can dissolve in water decreases as salinity increase. Seawater solubility is about 20% less compared to fresh water. Salinity is usually expressed in ppt (g/l) units. In most applications the salinity value should be between zero (fresh water) and 40 ppt.

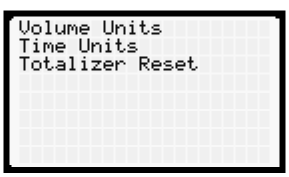


9. Press Run to confirm that selected DO and temperature units are displaying correctly. Even without temperature calibration the temperature reading should be within 1 °C of the correct value.

4.5 Flow (AM-2250 and AM-2250TX)

Any flow sensor that outputs a pulse will work with the AM-2250 and AM-2250TX. This includes paddle wheel meters and magnetic flow meters (aka “magmeters”). The 2250 measures both instantaneous flow and totalized flow. The latter is a running total of the volume and is equal to the flow integrated over time.

1. Scroll down the top-level menu to select Setup and press the Enter key.
2. Press Probe Selection to choose the probe type, Flow.
3. The following screen should appear



4. Set Volume Units. Choices are gallons, ft^3, cm^3 and liters.

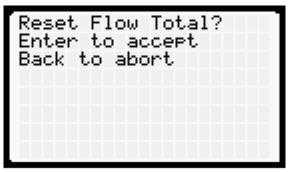
5. Set Time units.

6. Press Run to confirm that the selected flow unit displays correctly. Most flow sensors don’t have a temperature device, so the total flow value replaces the usual temperature value.

4.5.1 Totalizer Reset.

There are two ways to reset the totalizer.

1. The first option is via software: Navigate to Menu > Setup > Probe Config >Totalizer reset. After confirming that you really do want to reset the totalizer it will start again at 0.



2. There is also an option to reset the flow totalizer using hardware: Short pins 14 and 15 of the probe connector.

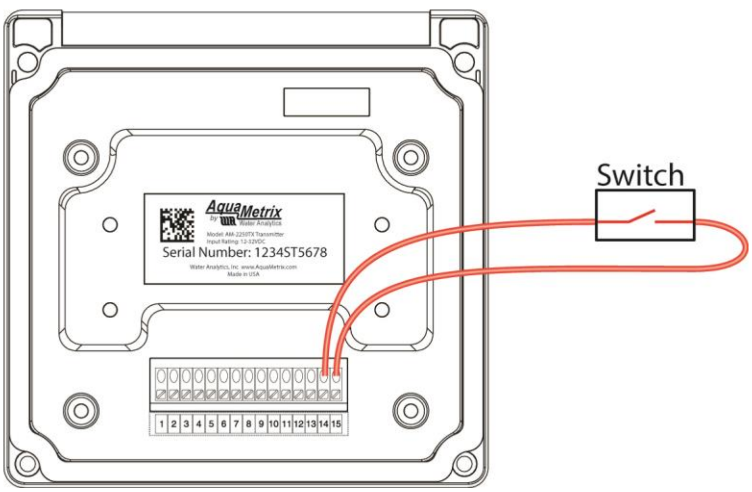


Figure 4-2 Flow Totalizer Reset using probe connector

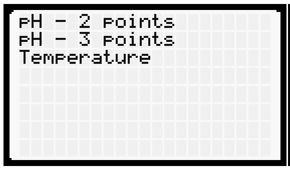
This hardware reset can be done via an external button or switch. For automating daily totals a mechanical or electrical timer can be used to short pins 14 and 15 at the start of each day.

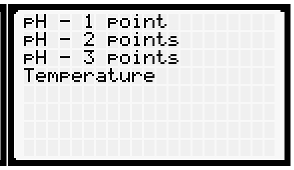
5 Calibration

The Calibration menu automatically presents choices appropriate for the probe chosen. If the menu choices for calibration appears wrong, you probably chose the wrong probe.

Note: If you select the probe type and wish to immediately calibrate you must put the controller in Run mode first. You can press the Run button while in any menu.

5.1 pH





5.1.1 About pH Calibration

Most pH analyzers allow the user to calibrate a probe with only two points, using two of three standard calibration solutions: pH 4, 7 and 10. For two-point calibration use the two standards that are closest to your expected process values. For example, if your process is mostly acidic (< pH 7) then calibrate using standards pH 4 and pH 7.

For the highest accuracy of pH readings that span a wide range encompassing neutral (7) the 2250 offers the option of three-point calibration. An algorithm uses linear least squares to calculate the slope. It is to algorithms that just interpolate between the two pairs of neighboring points.

A pH probe that operates according to theory outputs 59.16 mV at 25^{0}C for every unit change in pH. The actual change in output for a real probe is likely to be different and is the **slope** for that probe. An ideal probe in pH 7 solution (at 25^{0}C) outputs 0 volts. The actual output is likely to be different and is the **offset**. The slope yields the **efficiency** of the probe. A probe that outputs 59.16 mV at 25^{0}C is 100% efficient. If the probe outputs, say, 57.34 mV then the efficiency is 96.9% efficient.

When a probe leaves the AquaMetrix factory it is tested three times to ensure that its offset and efficiency are within an acceptable tolerance (±50 mV and >90% slope, respectively). As probes age their efficiency decreases. Note that a probe with low efficiency will still be accurate but it will not be precise, i.e. its reading will have a large uncertainty. We recommend cleaning or replacing a sensor when its efficiency drops below 80%. Before discarding a probe showing low efficiency make clean it according the probe manual's instruction or the AquaMetrix video https://www.wateranalytics.net/home/support/training-videos/. A large offset usually indicates that the reference solution is contaminated and should be replaced.

5.1.2 Two-Point Calibration

As stated above, use the two calibration standards that encompass the pH range of your process.

There is a choice between auto and manual calibration.

5.1.2.1 Auto Calibration

In auto calibration the 2250 reads the probe output when it is in a buffer and decides whether the buffer is pH 4, 7 or 10. Ideal voltages for these buffers are 177, 0 and -177 mV. If the output of the probe is within 59.16 mV (1 pH unit) from any of these values auto calibration assumes it "knows" the calibration standard in which the probe is immersed. If the output is greater than 59.16 mV auto calibration will fail.

```
Failed to detect pH
   Enter to retry
```

There are several reasons why this can happen:

1. The offset of the probe is greater than 59 mV.
2. The buffer is non-standard (i.e. neither 4, 7 or 10).
3. The buffer has aged and is no longer at its nominal pH value.

To initiate auto calibration:

1. Select Auto Calibration
2. Follow the directions on the next screen and immerse the probe in the first calibration standard. Allow at least one minute for the probe reading to settle down. It helps to swirl the probe around in the solution. After a minute or longer press the Enter key as instructed. (If you press the Enter key too soon the analyzer will accept an inaccurate probe reading and the efficiency is likely to be lower that it should.)

   ```
   Put probe in 1st Buf
   and press Enter
   ```

3. The screen will display Calibrating for a few seconds as it reads the probe output and stores the probe output value. The next screen will appear and will direct you to immerse the probe in the second calibration standard. (*Always rinse the probe in clean tap water before immersing it in a new buffer.*) As before, wait at least one minute before pressing Enter to record the probe output value of the second calibration solution.

   ```
   Put probe in 2nd Buf
   and press Enter
   ```

4. The screen will again display Calibrating for a few seconds and will display the results of the calibration—the efficiency and offset. An example is:

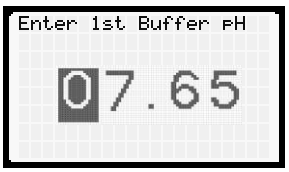
   ```
   Slope = 53.47 mV/pH
   Efficiency = 90.38%
   Offset = 18.54mV

   Press Enter to accept
   Press Back to cancel
   ```

   If you are satisfied with the measured efficiency and offset, press Enter to accept the calibration. If not press Back to repeat calibration. Pressing Menu brings you back to the top menu.

5.1.2.2 Manual Calibration

As explained above manual calibration can be used if the probe has a very large offset, has low efficiency or is being calibrated with non-standard buffer solutions.

1. Select Manual Calibration
2. Place the probe in the first buffer. As opposed to auto calibration, it is okay to press Enter without waiting for the probe output to settle down. The next screen will display the current output reading of the probe.
3. When the reading settles down press Enter. The next screen allows you to change the value of the displayed pH value to correspond to the actual pH of the calibration solution. Use the ↑ and ↓ arrow buttons to change the value and the ← or → button to change the cursor position. Press the Enter key to lock in the correct value.



4. The results of the calibration (identical to the one shown for auto calibration) will display.
5. Place the probe in the second buffer. Again, there is no need to wait for the probe reading to settle down prior to pressing Enter.
6. When the reading settles down press Enter. Change the pH value display to equal the pH of the calibration standard.

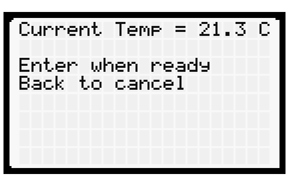
5.1.3 3-Point Calibration

The instructions for 3-point calibration are the same as for 2-point calibration with the obvious exception that three standards are used instead of two.

5.1.4 Temperature Calibration

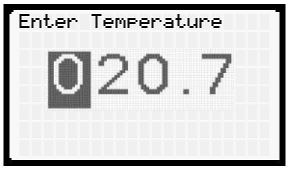
Since all pH readings are temperature compensated, an accurate pH readings depend on an accurate temperature.

1. Select Temperature.

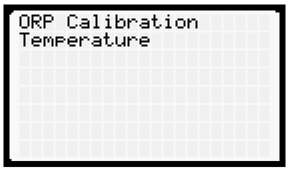


2. The screen displays the current temperature reading. Make sure the temperature reading has settled down. Keep in mind that most temperature elements in pH probes are encapsulated inside the probe, which results in a temperature lag of several minutes for the element to equilibrate with the temperature of the solution.
3. The temperature calibration procedure is analogous that for manual pH calibration. It's not necessary to immerse the probe in solution. Knowing room temperature enables you to calibrate the probe in air. As with manual pH calibration, ensure that the temperature reading settles

down prior to pressing Enter. The next screen allows you to change the temperature reading to match the actual temperature. Press Enter when done or Menu to go back to the top menu.



5.2 ORP Calibration



5.2.1 About ORP Calibration

ORP is a unique water quality parameter. For all other parameters a voltage, current or other electrical change corresponds to a value of the parameter and calibration determine that relationship. For instance, a pH probe generates a voltage that maps to a pH value. The ORP unit of measurement is different. It IS the actual output voltage of the probe. No translation to a dependent parameter takes place. An ORP analyzer is just a voltmeter. Therefore, no calibration is needed.

However, all voltmeters need to be calibrated. The only practical way of doing so for an ORP analyzer is to measure the offset of the voltmeter. This is called a **standardization**. This requires only one measurement. Though ORP calibration is strictly not a calibration we often refer to the standardization as a calibration. This manual follows this practice.

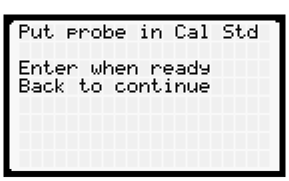
To “calibrate” an ORP probe simply immerse it in a calibration standard that produces a known voltage and adjust the reading of the analyzer until it matches the actual value of the solution.

There are no standard calibration solutions for ORP although Zobell’s (228mV @25°C) and Light’s (476mV @25°C) solutions are the most commonly used. AquaMetrix makes its own versions of these two solutions that are nominally 200 and 600 mV. ORP solutions are not buffered which means that their ORP values are not as stable as pH buffered standards are. Each calibration solution AquaMetrix is characterized by an ORP value that may vary within 20 mV of the nominal 200 or 600 mV value. The solution bottle will list the actual mV value. This value will change as chemicals in the solutions slowly oxidize, so ORP calibration solutions should be replaced at least every 6 months.

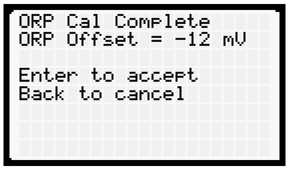
5.2.2 ORP Calibration

For reasons just stated, ORP calibration is a manual, one-point procedure.

1. Select ORP Calibration.
2. Place the probe in the calibration standard and press Enter. As in all manual calibrations there is no need to wait prior to pressing Enter.

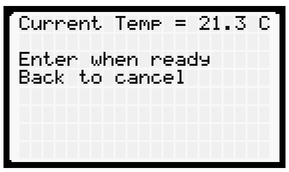


3. Observe the probe output reading and, when it has settled down, press Enter.
4. Adjust the value displayed in the next screen until it matches that of the calibration standard. Note that ORP standards can be negative so be careful to select the correct + or - sign.
5. As the screen instructions state, press Enter to accept the calibration or Back to repeat it. Pressing Menu brings you back to the top menu.

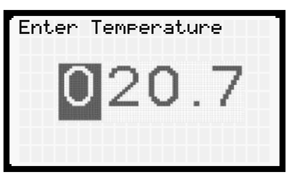


5.2.3 Temperature

1. Select Temperature.

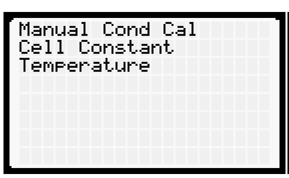


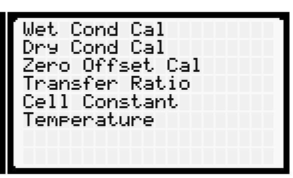
2. The screen displays the current temperature reading. Make sure the temperature reading has settled down. Keep in mind that most temperature elements in pH probes are encapsulated inside the probe, which results in a temperature lag of several minutes for the element to equilibrate with the temperature of the solution. As mentioned for pH probes, you can calibrate temperature in air—as long as you know room temperature.
3. Temperature calibration is similar to manual pH calibration. When the temperature reading settles down press Enter. The next screen allows you to change the temperature reading to the actual temperature. Press Enter when done or Menu to go back to the top menu.



5.3 Conductivity

The AM-2250 and AM-2250TX can work with contacting conductivity sensors (AS- and AM-series), while the AM-2251 can only work with toroidal (aka inductive or non-contacting) sensors. The calibration menu for the AM-2250 or AM-2250 TX is show on the left. The menu for the AM-2251 is shown on the right. It has a few more options.





5.3.1 About Conductivity Calibration

As with ORP calibration there are no recognized standard calibration standards so there is no auto calibration option. Also, as with ORP, conductivity calibration standards are not buffered and can change. Stability of the conductivity standard is only a problem for standards of very low conductivity, where introduction of impurities in the solution can induce large changes in conductivity. At conductivity standards below 5 µS/cm just carbon dioxide in the air can increase the actual conductivity.

In those cases where a conductivity standard is not available one may enter the cell constant of the probe as an approximate surrogate to calibration. Obviously, the calibration using the known cell constant is only as good as the cell constant is known. Usage of the probe will cause some scaling or fouling of the electrodes, which will result in an increased nominal cell constant. Therefore, calibration using real a real conductivity standard is always preferred.

Most conductivity analyzers employ a calibration routine that uses only one calibration standard. This is actually a two-point calibration routine inasmuch as the other point is assumed to be zero, i.e. that the conductivity for a zero-conductivity sample is zero. The AM-2250 allows as many as 16 points. Though one point is sufficient for most applications the ability to calibrate over several points allows one to use conductivity measurements to determine acid and base concentrations. As the figure below shows conductivity as a function of acid/base concentration is very non-linear and, therefore, several points are needed to construct the curved relationship. Therefore, multi-point calibration also enables greater accuracy over a wider range of conductivities.

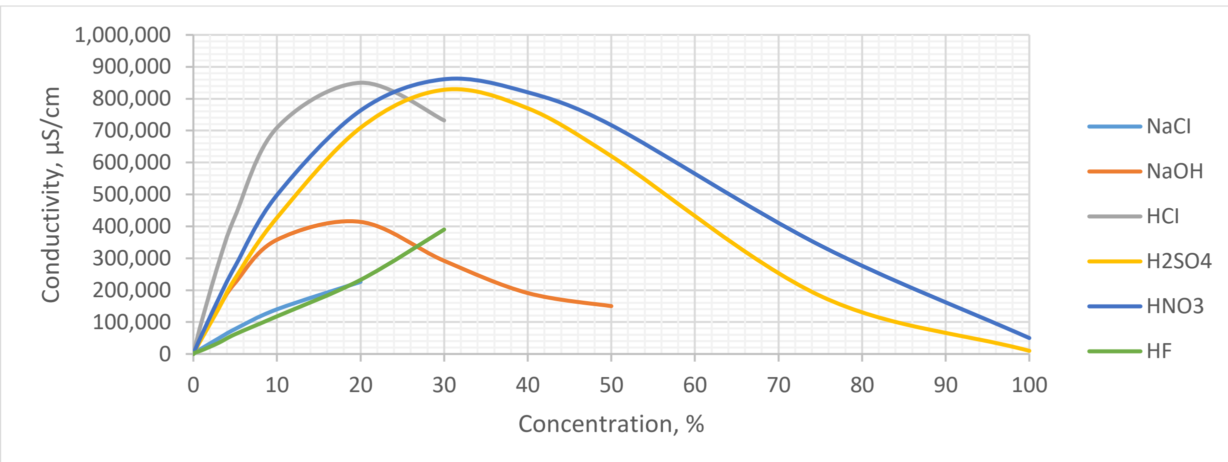
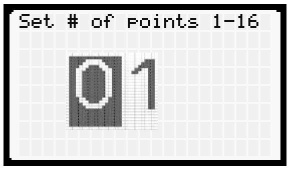


Figure 5-1 Relationship between Concentration of solution and conductivity (at 25° C)

5.3.2 Manual Conductivity Calibration or Wet Calibration

The procedure for manual conductivity calibration is similar to that for manual pH and ORP calibration. The only exception is that user can calibrate using as many as 16 points.

1. Select Manual Calibration.
2. Select the number of calibration standards to be used. In most cases choose 1. For greater accuracy choose 2 or 3. Only for measuring acid and base concentrations or conductivities over a wide range are more points needed. Press Enter to accept the number of points.



3. Immerse the probe in the first (or only) calibration standard. Press Enter.
4. The display will show the current conductivity reading. Adjust the conductivity reading to match the actual conductivity value of the standard.
5. Repeat for additional standards if there are any.
6. Press Enter to accept the calibration or Back to discard it.

5.3.3 Cell Constant

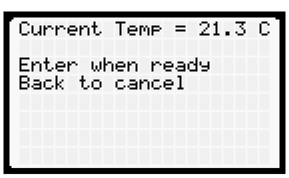
As explained above this procedure substitutes actual calibration with the input of the known cell constant. One might assume that this is the same cell constant value input during the Setup procedure. However, the actual cell constant of the probe is likely to be different from the nominal cell constant. For instance, the cell constant for a probe with nominal cell constant 1.0 cm^{-1} may actually be 1.05 cm^{-1}. If the actual cell constant is known, then this calibration option allows one to input it.

1. Select Cell Constant.
2. In the next screen enter the cell constant. Possible values are 0.01 to 999 cm^{-1}.
3. Press Enter when done.
4. Press Enter to accept or Back to cancel.

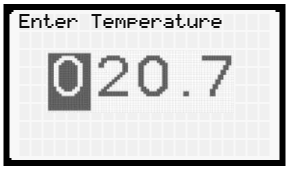
5.3.4 Temperature

The temperature dependence of conductivity is more pronounced than it is with pH or ORP. Temperature calibration is therefore critical.

1. Select Temperature.



2. The screen displays the current temperature reading. Make sure the temperature reading has settled down. Keep in mind that most temperature elements in pH probes are encapsulated inside the probe, which results in a temperature lag of several minutes for the element to equilibrate with the temperature of the solution. As previously stated temperature calibration can be done in air.
3. Temperature calibration is similar to manual pH calibration. When the temperature reading settles down press Enter. Adjust the temperature reading to match the actual temperature. Press Enter when done or Menu to go back to the top menu.



5.3.5 Dry Conductivity Calibration (AM-2251)

In a case of toroidal (inductive) conductivity sensor there is a coefficient that characterizes the relationship between the voltage of the drive coil and the voltage of the receive coil—the transfer ratio. The transfer ratio typically varies from one sensor to another even for the same model.

Some probes arrive with a transfer ratio already measured at the factory. If not, it can be precisely measured with just a resistor. Figure 5-1 shows how:

1. Splice a wire to a through-hole resistor. For best results use a resistor whose value is between 100 Ω and 1000 Ω (1% accuracy or greater).
2. Insert the wire-resistor combination through the toroidal probe and splice the loose end of the wire to the loose end of the resistor, thus creating a loop. The length of the wire is not important as long as it does not add resistance. You can use alligator clips to splice the wire and resistor.

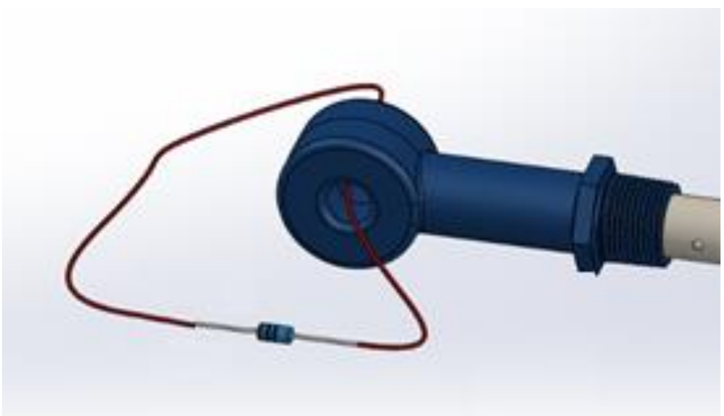
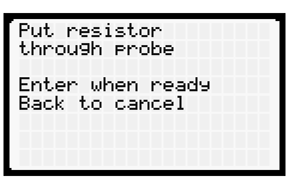
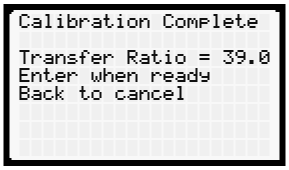


Figure 5-1 Dry calibration setup using resistor attached to a wire

1. Select Dry Calibration.
2. Press Enter.



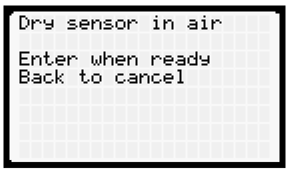
3. The display will show the current resistor reading. Press Enter when reading settles adjust the resistor reading to match the actual value.
4. Press Enter to accept the calibration or Back to discard it.



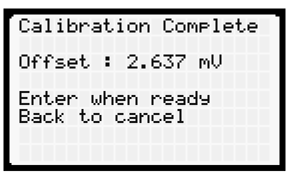
5.3.6 Zero Offset Calibration (AM-2251)

Zero offset calibration is only necessary for conductivity values less than 50 µS/cm. The zero offset should remain stable over time, so its calibration needs to be done only once if no changes are made to the sensor, controller or installation environment.

1. Select Zero Offset Cal.
2. Ensure that the sensor (dry) is far from possible sources of electromagnetic emission (VSD, transformers etc). Press Enter.



3. The display will show the current reading in air. Press Enter when stable. If the values fluctuates there is ambient EM noise. Move the sensor around until the reading becomes more stable.
4. Press Enter to accept the calibration or Back to discard it.



5.3.7 Transfer Ratio (AM-2251)

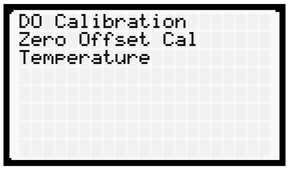
If the transfer ratio is already known (either supplied by the manufacturer or previously measured) then a dry calibration is not necessary.

1. Select Transfer Ratio.
2. Using the keypad to enter the known transfer ratio value. Press Enter.

5.4 Dissolved Oxygen (AM-2251)

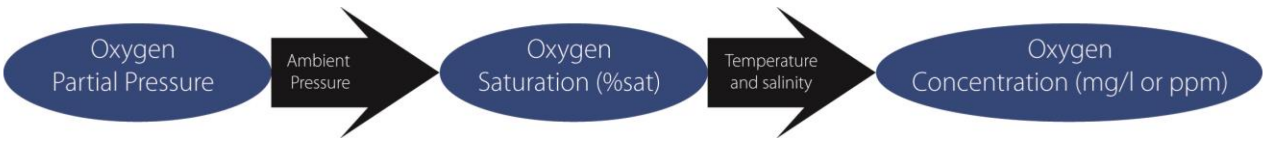
It is important to know that any amperometric sensor (like Clark cell) requires polarization, i.e. sensor has to be connected to the power/controller for up to 12 hours until readings are stable. Make sure that sensor was fully polarized before start calibration.

Also, due to pressure and temperature dependency calibration must be performed on installation site.



5.4.1 About DO calibration

For most applications single point DO calibration is sufficient. As with conductivity calibration a second point assumes zero signal at zero DO. DO sensors respond neither to concentration nor %-saturation. They respond to oxygen gas partial pressure (the 21% of the atmosphere comprised of oxygen) and, though it may seem counterintuitive, the gas pressure in ambient air is the same as that in fully saturated water. The analyzer algorithms uses the partial oxygen pressure to convert the probe reading to %-saturation and it uses the temperature and salinity to convert the partial pressure to concentration.



There are no calibration standards available. Because the %-saturation reading is the same in the air as it is in fully saturated water one can calibrate a DO sensor simply by holding it in the air. For greatest accuracy the air should be fully saturated with water vapor. Holding sensor directly above water surface or enclosing the probe in a sealed, moist container will guarantee an accurate calibration. Alternatively, you can calibrate the probe by immersing it in a sample of water containing an air-stone Keep in mind that there must be flow across the surface of an electrochemical D.O. probe to achieve an accurate reading.

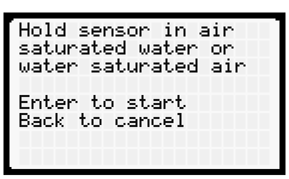
For applications containing very low DO concentrations (e.g. boilers and de-aerators) it is important to measure the zero point rather than assume that the signal is zero. To do so requires adding a reducing chemical to remove all dissolved oxygen.

Over time both the slope and offset will change. Refilling the electrolyte, polishing the cathode and periodically replacing the membrane will minimize this change.

5.4.2 DO Calibration

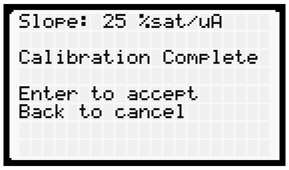
Accurate DO measurement requires a fully-polarized sensor, stable temperature and constant pressure.

1. Select DO Calibration.
2. Hold sensor above water or enclose the probe in the water saturated bag (or cap). Press Enter.



3. The display will show the current reading in µA. The value is unique for each sensor. For a fully polarized AM-CDO it should be around 4uA. Press Enter when reading settles.

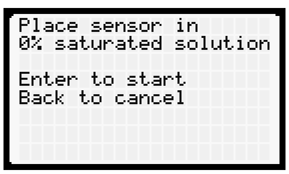
4. Press Enter to accept the calibration or Back to discard it.



5.4.3 Zero Offset Calibration

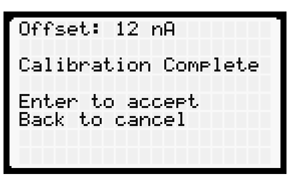
The factory default value for zero D.O. is 0 nA offset. In order to calibrate the actual offset, a fresh 0%-sat solution must be prepared. Do not stir it as this may force oxygen absorption.

1. Select Zero Offset Cal.
2. Submerse sensor in 0%-sat water. Press Enter.



3. The display will show the current reading in nA. It may take several minutes to reach absolute minimum (ideally 0 nA). Press Enter when the reading settles.

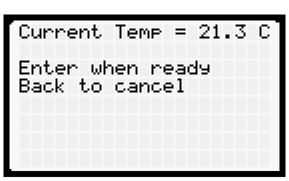
4. Press Enter to accept the calibration or Back to discard it.



5.4.4 Temperature Calibration

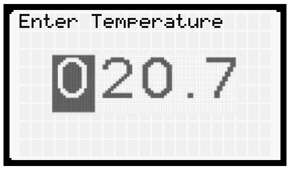
As stated above a dissolved oxygen sensor uses temperature to calculate D.O. concentration. It also uses the temperature reading to estimate the membrane permeability, which affects the D.O. reading.

1. Select Temperature.

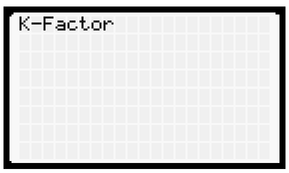


2. The screen displays the current temperature reading. Make sure the temperature reading has settled down. Keep in mind that most temperature elements in pH probes are encapsulated inside the probe, which results in a temperature lag of several minutes for the element to equilibrate with the temperature of the solution.

3. Temperature calibration is similar to manual pH calibration. When the temperature reading settles down press Enter. The next screen allows you to change the temperature reading to the actual temperature. Press Enter when done or Menu to go back to the top menu.



5.5 Flow (AM-2250 and AM-2250TX)



5.5.1 About Flow Calibration

There is no actual calibration procedure for a flow meter. The K-factor supplied by the manufacturer sets the conversion between the meter's pulse frequency and velocity of water flowing past the probe. The latter is proportional to the flow rate, with the proportionality constant dependent on the cross-sectional area of the pipe. The inner diameter of the pipe therefore allows the flow sensor manufacturer to convert the fluid velocity (e.g. cm/sec) into a flow rate (e.g. cm^3/sec).

For most applications the K-factor supplied by the manufacturer and is sufficient to yield accuracy of better than 5%. For greater accuracy one can determine the actual K-factor by measuring the time it takes to fill a container with a known volume of water.

5.5.2 Flow Calibration

To input the K-factor:

1. Select Manual. (It's currently the only choice but future firmware versions may allow the experimental determination of the K-factor though the exercise of filling a container with water.)

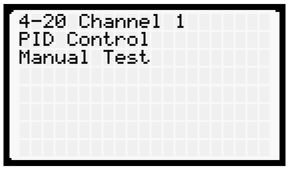
2. Enter the K-factor. It's important that the flow units of the K-factor are the same as the units selected during setup. If they are different then go back to Setup and change the units. Alternatively, one can perform unit conversion arithmetic to ensure that the K-factor entered has the units selected during setup.

3. Press Enter.

4. Press Enter again to accept the K-factor or Back to cancel.

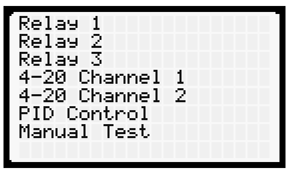
6 Output

The AM-2250TX transmitter has one 4-20mA output with optional PID.



The AM-2250 and AM-2251 has two output modes:

1. Three dry contact relays
2. Two isolated 4-20 mA current outputs (Channel 1 with optional PID)



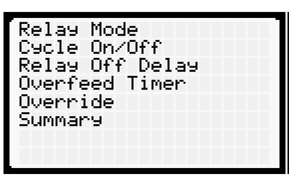
When the 2250 is used for process control then one to three of the relays are configured. When the 2250 is used in conjunction with PLC's or SCADA systems then the 4-20 mA outputs are configured. PID control is used for fine control of a process using the 4-20 mA output on the main board.

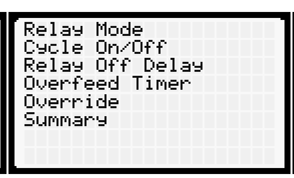
6.1 Relays (AM-2250 and AM-2251)

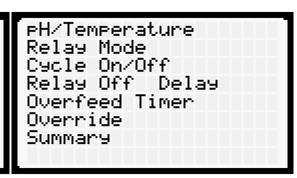
The AM-2250 and AM-2251 is equipped with three relays. Three relays give users the capability of controlling a falling process, rising process and a physical alarm.

Note: All instructions assume a relay is wired as normally open (NO). If a relay is wired normally closed (NC) then activate or open should be reversed, i.e. deactivate or close.

Relay 1 Relay 2 Relay 3







Relay 3 has additional option that allows activate relay based on temperature value. Other selections are identical for all three relays.

6.1.1 Relay mode

There are three relay mode available: rising, falling and range alarm:

1. A rising process is one that triggers a relay when the process value rises above the set-point.
2. A falling process triggers a relay when the process value drops below the set-point.
3. A range alarm is triggered when the process value is (a) either above the high set-point or below the low set-point or (b) inside the two set-points. In most applications it is an out-of-range alarm.

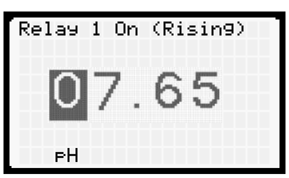
For rising and falling setpoint there is a second setpoint at which the relay deactivates. The gap between the set-point and the deactivation point is the dead-band. For instance, if you may be controlling a process whose pH naturally rises. If you want to lower the pH when it reaches pH 9 then set the relay set-point to 9. Presumably, at pH 9, a relay closes and starts a pump, which dispenses acid to bring the pH back down below 9. The pH value at which the relay opens again must be less than 9. If it is too close to 9.0, e.g. 8.9, the chemical pump will cycle on and off too frequently. Even more problematic is the relay activating before the pH has a chance to equilibrate. The result is that the process is never stabilizes. For these reasons the relay deactivation must be sufficiently below the activation, e.g. pH 8.0 in this menu figure below.

For obvious safety reasons, the relays of every new 2250 and 2251 are deactivated. The menu selection, None, signifies this choice. Selecting None the fastest way to remove an unwanted relay setting. The following describes the process for setting a relay in one of the three possible modes in the Relay menu.

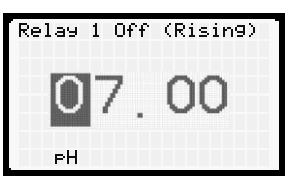
6.1.1.1 Rising Process

1. Select Rising. A relay cannot be set for a rising process AND a falling process. If you previously set a relay for a falling process and you set it again for a rising process, then the falling process mode automatically turns off.

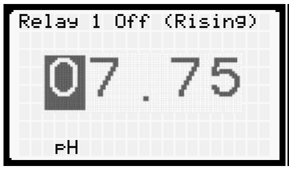
2. Enter the value of the process variable (e.g. pH) at which the relay turns on, i.e. the set-point. Press Enter to accept this value.

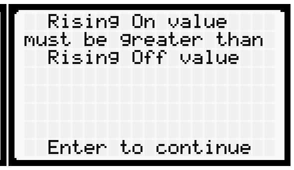


3. Enter the value of the set-point at which the relay turns off. Press Enter to accept this value. As explained above the off-value must be lower than the on value.

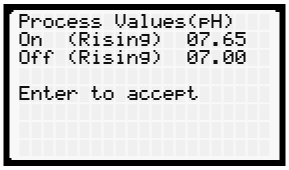


4. If you choose an off-value that is higher than the set-point the following warning message appears.





5. Confirm by pressing Enter.



6.1.1.2 Falling Process

The configuration process is identical to rising process (section 6.1.1.1) except that the on setpoint must be lower than the off setpoint. As stated above, a relay cannot be set for a rising process AND a falling process. If you previously set a relay for a rising process and you set it again for a falling process, then the rising process mode automatically turns off.

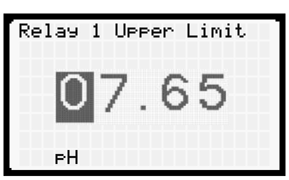
6.1.1.3 Range Alarm

The Range Alarm mode setting is used—as the name implies—typically as an alarm which is activated if the process value is either **outside** a specified range or **inside** it. In most applications it will be used for out-of-range process values. When the relay is normally open (NO) the range alarm is out-of-range. When the relay is normally closed (NC) the range alarm is in-range.

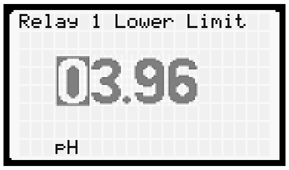
Unlike rising or falling processes there are no "off" set-points. To prevent an excessively frequent cycling of the relay consider configuring Relay Off Delay (Section 6.1.3)

1. Select Range Alarm.

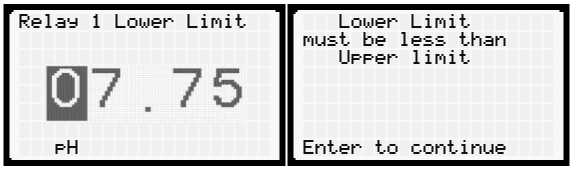
2. Enter the value of the upper set-point. Press Enter to accept this value.



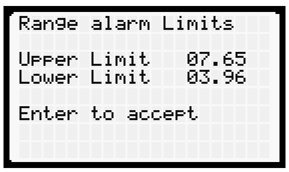
3. Enter the value of the lower set-point. Press Enter to accept this value. The lower value must be lower than the upper value.



4. If your lower value is higher than your lower value the following warning message appears.



5. Confirm by pressing Enter.



6.1.2 Cycle On/Off

The cycle on/off parameter is very useful for preventing overshoot of a process controlling action—usually the dispensing of a chemical. If the response time of the process to the added chemical is slow compared to the rate at which the chemical is being introduced, then the process variable will overshoot its target (as described in Section 6.1.1 for a rising process).

Choosing set-points for activating and deactivating the relay is a first line defense against overshoot. The cycle on/off feature is a second line defense. As Figure 6-1 shows, the duty cycle is expressed as the duration over which the relay is activated divided by the total time of the complete on-off cycle. If the relay is on for 10 seconds and off for 30 seconds, then the complete cycle is 40 seconds and the duty cycle is 25%. The slower the response time of the process to the added chemical (or other process control mechanism) the lower the duty cycle or time-on should be.

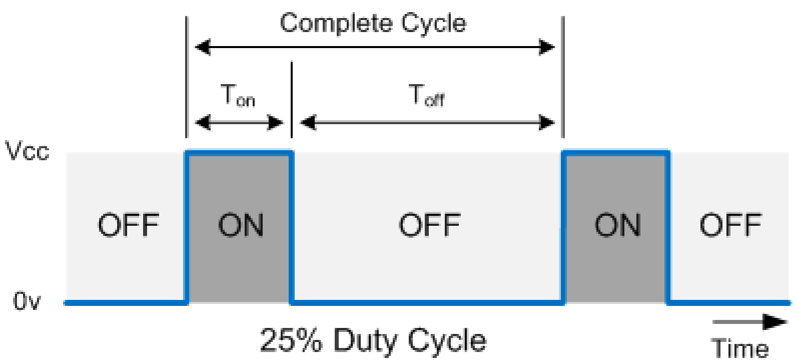
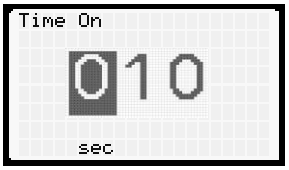


Figure 6-1 Duty cycle with the On cycle being ¼ of the complete cycle. An example of a duty cycle expressed in seconds is 10 seconds on and 30 seconds off.

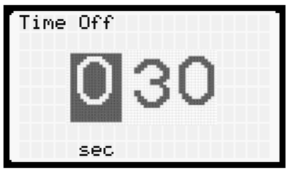
6.1.2.1 Configuring Cycle

The controller ships with cycle on/off deactivated.

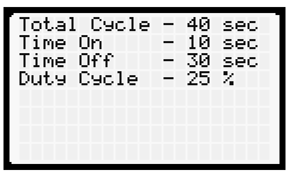
1. Select On.
2. Enter the value for the amount of time, in seconds, the relay is on (activated). Press Enter to accept this value.



3. Enter the value for the amount of time, in seconds, the relay is off (deactivated). Press Enter to accept this value.



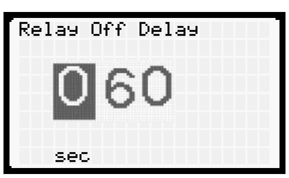
4. Press Enter to confirm the displayed value or cancel by pressing Back



6.1.3 Relay Off Delay

There are instances in which a process value can initially spike upon addition of a chemical. An example is acid that is dispensed very close to a pH sensor such that, when the acid is first dispensed the probe pH drops precipitously and then rises as the acid is mixed. This is the opposite of a problem that occurs if the probe is far from the injection point such that there is a long delay in the change in pH and that calls for cycle on/cycle off control. Placing the sensor in the correct position would preempt the need for a relay delay but, for systems that are not easily modified, this option is a good solution.

1. Select On.
2. Enter the value for Relay Off Delay, the amount of time the relay is off (deactivated), in seconds. Press Enter to accept this value.

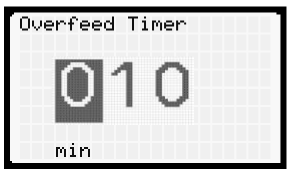


6.1.4 Overfeed Timer

If a probe malfunctions it is possible for a relay to activate and stay permanently activated. Using the above example of a relay connected to an acid dispenser: The relay is programmed to activate at 9 and deactivate at 8. If the probe failed and remained stuck at pH 8 or higher, then the chemical pump that dispenses the acid would operate until it emptied out the entire container of acid. Perhaps worse is that the actual pH of the process would drop to a dangerously low level and cause serious damage to the processing equipment.

The overfeed timer option prevents this. By specifying the maximum amount of time that a relay can remain activated, the damage caused by a faulty probe signal is contained. Although this feature is turned off by default, we strongly recommend always setting this option.

1. Select On.
2. Enter the value for the maximum time, in minutes, the relay can remain activated.



3. Press Enter to accept this value.

6.1.5 Override

This simple control manually forces the relay on or off. It can be used as a switch to turn the process control function off and on and is normally used for either testing or emergency purposes.

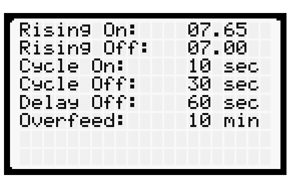
Auto: Disable override so that the relay behaves as set up.

On: Activate the relay.

Off: Deactivate the relay.

6.1.6 Summary

The Summary menu item lists only configured relay parameters described in this section



Press Back or Enter to continue.

6.2 4-20 mA Output – Channel 1

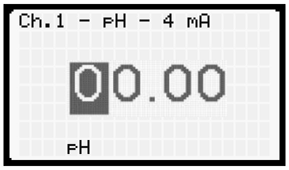
The AM-2250 and AM-2251 host two 4-20 mA outputs. Output #1 emanates from the main circuit board (pins 1 and 2 of the sensor connector). Output #2 emanates from the power board and is thus not available in the AM-2250TX.

Channel 1 output always transmits the process variable and can be configured for PID control. Channel 2 output can be configured for process or temperature in pH, ORP or conductivity mode. For flow mode channel 2 can transmit total flow.

For either output the 4 mA and 20 mA values can be set to any value. Customizing the range maximizes the accuracy of the 4-20 mA signal.

6.2.1 Configuring Channel 1 Output

1. Enter the value of the process variable that corresponds to 4 mA.

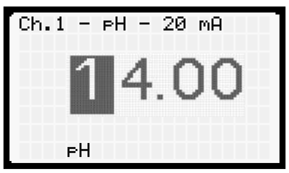


    a. The default value is 0 for pH, conductivity and flow.

    b. For an ORP sensor the default value is -1000 mV.

    Adjust the 4 mA value to the lowest value you expect to observe. If, for instance, you are monitoring the pH of a process that never falls below 3 then change the 4 mA value to 3.

2. Enter the value of the process variable that corresponds to 20 mA. This is usually the highest value you expect to observe. Its default value depends on the setup parameters for the probe.



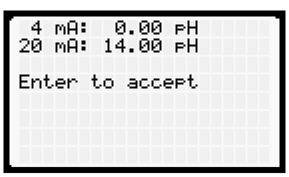
    a. For a pH probe it's 14.

    b. For an ORP probe it is +1000 mV.

    c. For a conductivity probe it is the upper limit for the cell constant chosen. For instance, a probe with a cell constant of 10 will create a default 20 mA value of 50 mS/cm.

    You may adjust the 20 mA value to correspond to the highest value you expect to observe. If, for instance, you are monitoring the pH of a process that never rises below 10 then change the 20 mA value to be pH10.

3. The next screen summarizes your choice of 4 and 20 mA values



4. Press Enter to accept this value or Back to start over

Note that the 4 mA value can be higher than the 20 mA value. This simply reverses the direction of the 4-20 mA signal as the process variable changes.

6.2.2 Proportional Control

Some pumps, especially metering pumps, can be controlled by a continuously variable 4-20 mA input from a transmitter. This type of control is called **proportional control** because the magnitude of the current output is proportional to the difference between the set-point of the process value and the actual process value, aka the **error**.

Take the case of the process whose pH naturally rises and is controlled by dispensing acid (see Figure 6-2 below). For control by a relay described in Section 6.1.1 the relay-on pH value was set at 9.0 (red line) and the relay-off value was set at pH 8.0 (green line). The process would thus cycle between pH 8.0 and 9.0. Although this is the most common way to control, it is not the most efficient one. In the example below the pH reaches 9.0, which starts the acid pump at maximum output. The acid takes time to dose and mix and, as a result, the pH value decreases gradually. As it approaches pH 8.0 the pump is still working at maximum output and results in chemical overdose (yellow area). This effect could be minimized by using the Cycle and Relay Off Delay features, described in sections 6.1.2 and 6.1.3.

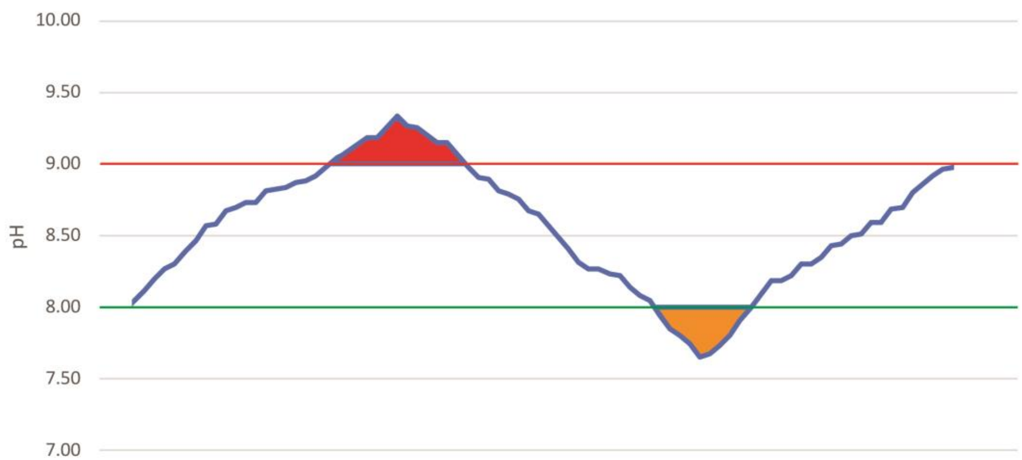


Figure 6-2 Example of pH control using relay.

Proportional control ensures that the process value reaches the set-point in the most time efficient manner. Using the pH example above: The pH set-point is 9.0. As the pH rises above 9.0 the error increases and the corresponding current output increase proportionally. At 9.01 the output might be 4.01 mA. At 12.0 the output might be 20 mA. The chemical pump therefore changes it delivery rate according to the difference between the process value and set-point.

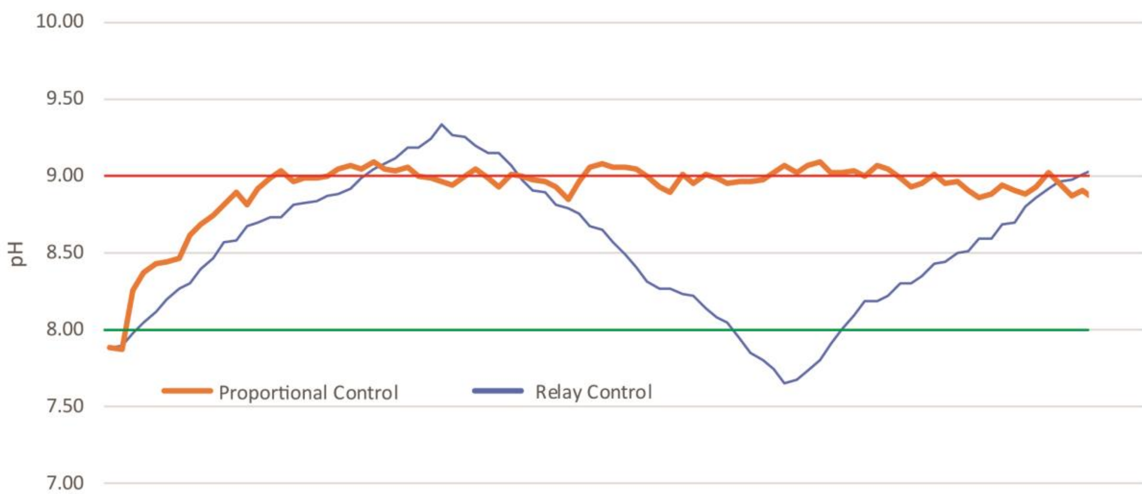
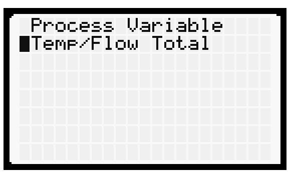


Figure 6-3 Example of proportional control

Note: The proportional control can only use one dispensing device (either acid or base). If process can naturally vary both directions consider using second 4-20 mA output or a pair of relays.

6.3 4-20 mA Output – Channel 2 (AM-2250 and AM-2251)

The same instructions listed above apply to Channel 2. This channel can be set to transmit the process value, temperature or flow total.



The default 4-20 mA output for temperature is for the range 0 to 100 °C. The 4 and 20 mA values can be any value between -20°C and 120°C can be used.

6.4 PID Control

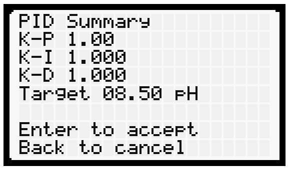
PID is only available on Channel 1 output. PID control extends proportional control to include two additional terms. PID stands for Proportional-Integral-Derivative which are defined as follows:

- **Proportional**. This component of the current output is proportional to the error, e(t), as described in the previous section.
- **Integral**. This component of the current output is proportional to the integral of the error. This is roughly equivalent to the sum of the error going back in time.
- **Derivative**. This component of the current output is proportional to the instantaneous change in error.

You can choose one to three of the three components for P, PI, PD or PID control. Leaving out one of the three terms requires setting the desired coefficient for that that term to zero.

To set up PID control requires setting values for the three coefficients to the three terms:

1. Turn PID control On.
2. Set the value for K_P. Press Enter to accept it.
3. Set the value for K_I. Press Enter to accept it.
4. Set the value for K_D. Press Enter to accept it.
5. Set the value for the PID target, which is the desired value of the parameter (in the example above, 8.5).
6. Confirm PID summary screen by pressing Enter.

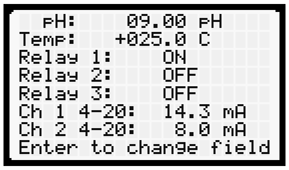


Setting up PID control takes considerable skill and should not be done by "amateurs." Choosing the wrong PID parameters can cause a process to overshoot wildly and never reach equilibrium.

6.5 Manual Test

Manual Test allows you to ensure that the outputs operate as intended without requiring the probe to deliver the actual output needed to test a relay or 4-20 mA output. For instance, if you set a relay for a rising process that activates when the pH reaches 9.0 you might test it by immersing it in pH 9.1 solution and verifying that the relay activates. Manual testing enables this test to be done without the solution. Simply dial in the pH value to 9.0 and observe the state of the relay on the screen. Temperature values can also be simulated: Press Enter to change from process to temperature.

The Manual Test screen also displays both 4-20 mA values. In the example below Relay 1 was set to activate at pH 9.0. Relays 2 or 3 were either set to activate at a higher pH, a falling process below 9.0 or were not turned on at all. The Channel 1 4-20 mA corresponding to pH 9.0 is 14.3 mA (based on the 4-20 range corresponding to 0 to 14). The 4-20 Channel 2 mA corresponds to the temperature (Based on the 4-20 range corresponding to 0 to 100C).



Note: Manual Test cannot simulate Relay Cycle, Relay Off Delay, Overfeed, PID.

7 Operation

7.1 Run Mode

Press Run from just about any menu to set controller in operation mode. The screen for “Run” mode shown on Figure 7-1 below. Note that AM-2250TX does not have a backlit display. Since there are no relays available, the relay status indicators are not displayed.

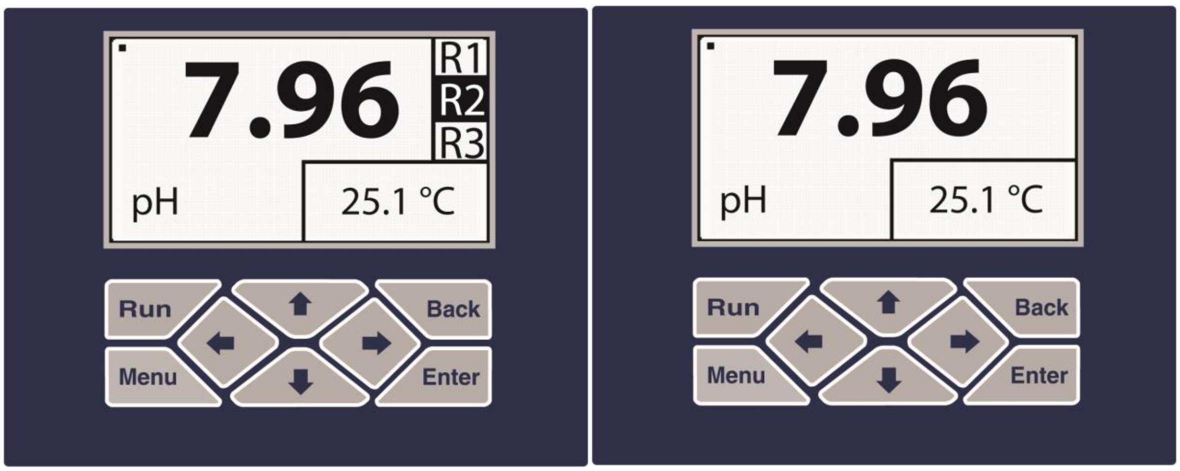


Figure 7-1 AM-2250 or AM-2251 on the left and AM-2250TX on the right in "run" mode

7.2 Display Features

The screen refreshes every second. A blinking dot in the top left corner indicates that measurements are occurring. The blinking dot also confirms that the controller is operating even though the process and temperature values may be so stable that they appear to be “frozen.” (if the process value changes too frequently consider increasing “Damping” (section 9.2).

The process value is displayed in the middle. The font size and number of decimal points are set to minimize user error. The temperature reading is displayed in the bottom right corner in user selected units. All units of measure will contain one decimal point. The AM-2250 and AM-2251 controllers also display relays indicators on the right side: if a relay has not been activated an empty box is displayed, as shown for R1 and R3 in Figure 7-1 above. If a relay has been activated the box appears solid, as shown for R2 on Figure 7-1.

7.3 Maintenance

To perform a calibration or change the probe configuration press the Menu button.

As soon as main menu appears on the screen the controller automatically activates “Hold” mode. While you are in menu screen:

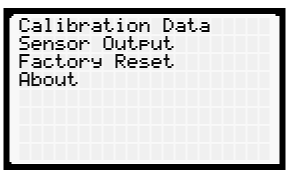
- Process and temperature measurements are paused.
- Activated relays are deactivated.
- 4-20 output(s) freeze on the last reported value.

Placing relays on hold during calibration is essential as calibration standards might activate their target (usually a pump). If, however, a relay must be kept activated during calibration/maintenance time activate Override (described in section 6.1.5)

AM-2250TX transmitter can deactivate 4-20 mA output in order to dramatically reduce power consumption. This may be useful for low power (battery) applications where only local display is required. To deactivate 4-20 mA CH1 press simultaneously ← and →. Pressing the same button combination again would reactivate output. This can also be used for loop troubleshooting and diagnostics.

8 Diagnostics

The Diagnostics menu has four options.



8.1 Calibration Data

This menu has one screen, which displays the results of the latest calibration.

- **pH**: Number of calibration points (2 or 3), slope, offset, efficiency and calibration temperature.
- **ORP**: Offset and calibration temperature.
- **Conductivity**: Number of calibration points (1 – 16), measured cell constant, calibration temperature and temperature coefficient.
- **Flow**: K-factor.
- **DO:** DO slope and calibration temperature.

8.2 Sensor Output

This Diagnostic screen displays the raw signal coming from a probe. It is invaluable for diagnosing probe problems.

- **pH**. A pH probe outputs a voltage. The temperature element (if present) outputs a resistance. For diagnosing a problematic pH probe the voltage output should be (7.0 – pH) x 59 mV within about about 50 mV. A smaller value indicates a low efficiency, which may be ameliorated by cleaning the electrode, changing the reference solution or changing the salt bridge. If the probe output does not change upon changing from one calibration solution to another then the probe is dead.

The resistance of the temperature element should be close to the nominal resistance, which is usually either 300 or 1000 Ω. A resistance reading far removed from its nominal value is indicative of a defective element or the improper selection of the element

- **ORP**. An ORP probe also outputs a voltage. The temperature element (if present) outputs a resistance. Unlike a pH probe the ORP value is not temperature compensated.

  The resistance of the temperature element should be close to the nominal resistance, which, depending on the element is usually 300 or 1000 Ω. A resistance reading far removed from its nominal value is indicative of a defective element.

- **Conductivity**. A conductivity sensor measures resistance (which is inversely proportional to conductance). The temperature element outputs resistance as well.

  The resistance of the temperature element should be close to the nominal resistance, which, depending on the element is usually 1000 Ω or 3000 Ω. A resistance reading far removed from its nominal value is indicative of a defective element.

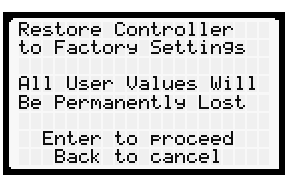
- **Flow**. A paddle-wheel or magnetic flow meter outputs a pulse train. The raw output is the pulse frequency. There is no temperature measurement.

- **DO**. The Clark-style probe outputs a tiny current produced by the reduction of oxygen at the cathode. The raw signal is measured in nanoamps (nA). The atmospheric pressure converts the signal to a D.O. value in %-saturation whereas the temperature and salinity values convert the current to concentration units of ppm (mg/l).

  The resistance of the temperature element should be close to the nominal resistance, which is 1000 Ω or 10 kΩ. A resistance reading far removed from its nominal value is indicative of a defective element.

8.3 Factory Reset

This feature restores the 2250 unit to its factory default state. It resets all user calibrations, 4-20 outputs and relay setpoints values.



There is also a hardware reset that can be performed. While powering unit press and hold Back button until logo appears on the screen. Then release Back button – the unit will start fresh, i.e. all calibration and output user values will be erased.

8.4 About

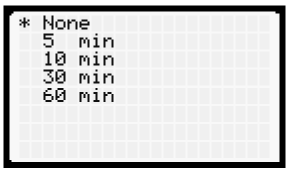
This feature displays the current firmware version and its release date. If you experience issues with your AM-2250 analyzer you will want to know the firmware version running before contacting us.

9 Preferences

The Preferences menu has three options that only affect the user experience.

9.1 Auto Return

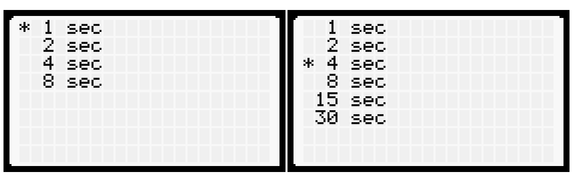
This feature allows you to return the 2250 to Run mode if you walk away from the 2250 while exercising a menu item. The choices are:



If you choose “None” then the menu which was active when you left will be active indefinitely. If you choose one of the other options, e.g. 10 min, then the screen will revert to the run screen after 10 minutes of inactivity. This feature is invaluable if the 2250 is transmitting data to a PLC or SCADA. While a menu item is being exercised the controller ceases to send data, which can cause an undue alarm or relay at the PLC or SCADA.

9.2 Damping

Signal averaging, aka “damping,” smooths fluctuating process values—both on the display and on the 4-20 mA output. which dampens fluctuating values. The options are shown here:



The signal averaging is a rolling average. For example, if damping is set to 4 seconds, then each process value data point equals the average of the preceding four points. The default value is 1 or 4 seconds.

9.3 Backlight (AM-2250 and AM-2251)

This option allows you to change the brightness level of the LCD screen. It is useful for matching the screen brightness to the ambient brightness. For darkened interiors, turning down the brightness helps prevent eye strain. Adjustment is done by pressing the ↑ or ↓ buttons while in that menu screen. Press Enter to confirm or Back to cancel.