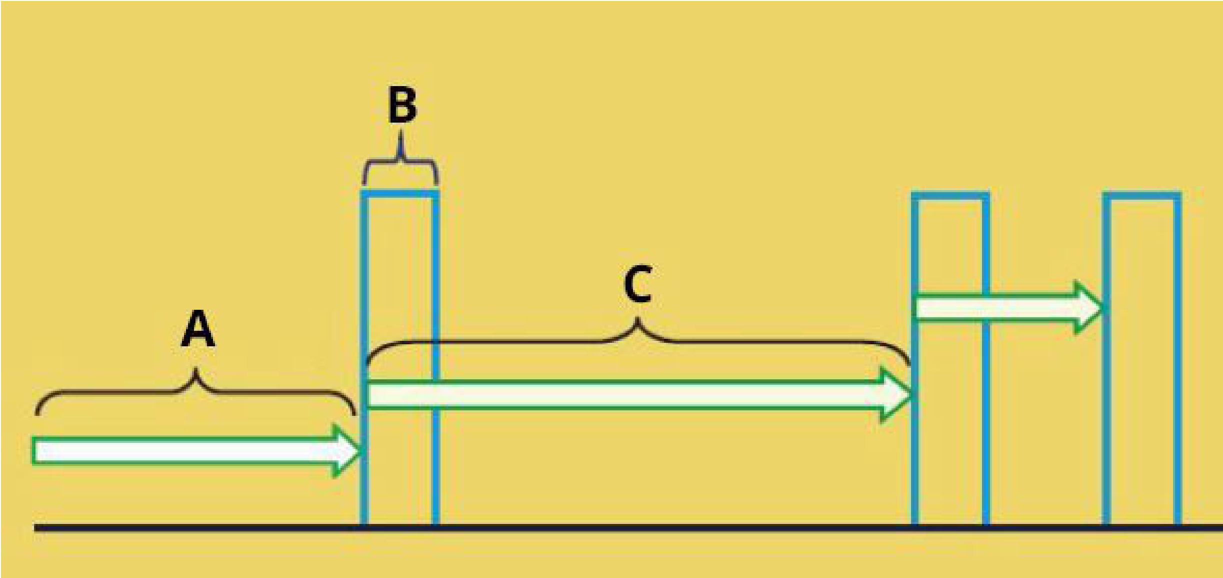
Figure 9-4: Totalizer Alarm Operation



A. X-volume accumulated
B. Relay on time
C. X-volume accumulated
D. Time

9.4.2 Set up Totalizer Based Relay Activation

Access Totalizer Timers by pressing **ENTER/MENU** from the main screen and then **Program** → **Relays** → **Configure Relay**. From the ***main relay programming*** screen, program this feature as follows:

Procedure

1. Relay: Assign a relay by highlighting the desired relay 1-4 and press **ENTER/ MENU**.
2. Type: Select Totalizer timer as the relay type and press **ENTER/MENU**.
3. Assign: Assign Pulse flow S1 (Sensor 1) or S2 (Sensor 2) as the measurement input and press **ENTER/MENU**.
4. Active relay after: Enter accumulated volume (XX.XXXX) and units of measurement:
    - gal
    - thousand gal
    - million Gal
    - trillion Gal
5. On time: Enter the time in minutes (X.X min) for the relay to remain energized. The assigned measurement value will be on hold during this time.
6. Normal state: Set the normal alarm condition as Open or Closed and press **ENTER/ MENU**. Program the normal state to define the desired alarm default state to normally open or normally closed upon power up.

Table 9-3: Defaults and Programmable Limits

Relay function	Limits and selections	Default
Totalizer Based Timer	NA	NA
Activate relay after	0 to 99.9990	10
units	Gal, Liters, cuft, m3 accumulated	E3gal (x1000 gal) accumulated
On time	0 to 999.9 min	0 min
Normal state	Close/Open	Open

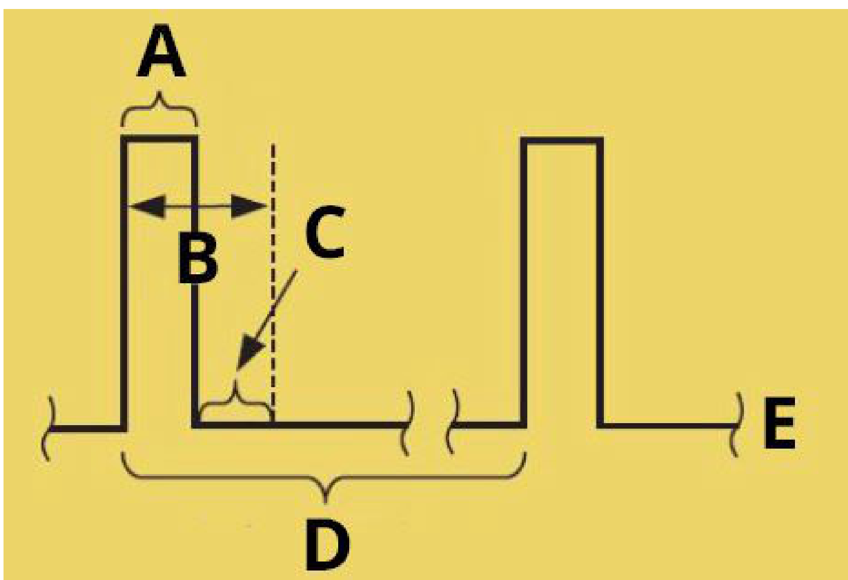
9.4.3 Interval timer

Description

The interval timer may be used for periodic sensor cleaning or periodic process adjustment. The cycle begins at the Interval time when the switch is turned on. When the Interval time has expired, the transmitter activates hold mode on the assigned measurement and the relay is energized for the On time period.

A schematic of the Interval timer operation is shown:

Figure 9-5: Interval Timer Alarm Operation



A. *On time*
B. *Hold*
C. *Recovery time*
D. *Interval time*
E. *Time*

Set up interval timer

Access Interval timer by pressing **ENTER/MENU** from the main screen and then **Program** → **Relays** → **Configure Relay**.

From the ***main relay programming*** screen, program this feature as follows:

Procedure

1. Relay: Assign a relay by highlighting the desired relay 1-4 and press **ENTER/MENU**.
2. Type: Select Interval timer as the relay type and press **ENTER/MENU**.
3. Interval time: Enter the time in hours (XX.X hours) between complete interval cycles.
4. On time: Enter the time in minutes (X.X min) for the relay to remain energized. The assigned measurement value will be on hold during this time.
5. Recovery time: Enter the time in minutes (XX min) before the process is restored and live measurements can resume.
6. Hold while active[1]: Select which sensors outputs should be on hold (S1, S2, or both) during the Interval timer activation time. Press **ENTER/MENU**.
7. Select **NEXT**. Press **ENTER/MENU** to advance to the next setup screen.
8. Normal state: Set the normal alarm condition as Open or Closed and press **ENTER/ MENU**. Program the normal state to define the desired alarm default state to normally open or normally closed upon power up.

Table 9-4: Defaults and Programmable Limits

Relay function	Limits and selections	Default
Interval timer	NA	NA
Interval time	0 to 999.9 hr	24.0 hr
On time	0 to 999.9 sec	10 sec
Recovery time	0 to 999 sec	60 sec
Hold while active	0 to 999 sec	0 sec
Normal state	Sensor 1, Sensor 1, both	Sensor 1

9.4.4 Date and time activation

Description

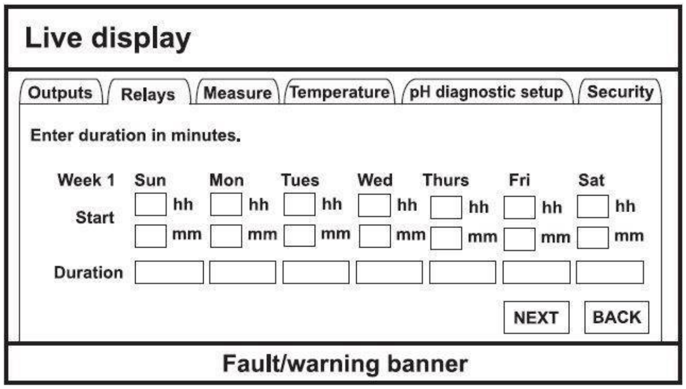
This relay feature allows programming of 1 to 4 relays to activate on an assigned day of the week and time of day or night for an assigned interval. They function like sprinkler timers. The programmable timeframe cycle is two weeks.

An example application for Date and Time Activation is daily chlorine dosing in seawater-cooled condensers.

The ***Date and Time relay setup*** screen is shown:

(1) *Rosemount 56 units with software ver. 2.1X and greater allow override of interval timer to ensure that all relays and outputs are held if desired.*

Figure 9-6: Date and Time Alarm Operation



Set up Date and Time

Access Date and Time timer by pressing **ENTER/MENU** from the main screen and then **Program → Relays → Configure Relay**.

NOTICE

Date and Time timer operation depends on accurate setup of the internal real time clock. Emerson recommends continuous powered operation of the Rosemount 56 Transmitter to preserve programmed Date and Time timer clock settings.

From the ***main relay programming*** screen, program this feature as follows:

Procedure

1. Relay: Assign a relay by highlighting the desired relay 1-4 and press **ENTER/ MENU**.
2. Type: Select Date and Time timer as the relay type and press **ENTER/MENU**.
3. Select **NEXT**. Press **ENTER/MENU** to advance to the next setup screen.
   The Week 1 calendar will appear.
4. Program the start relay activate time by entering day(s) of week, hour(s) of day, and minutes for each hour. Enter the duration of time in minutes (XX min) for relay activation.

   Up to four relays can be simultaneously energized for any programmed times.
5. Select **NEXT**. Press **ENTER/MENU** to advance to the next setup screen.
   The Week 2 calendar will appear.
6. Repeat the programming entries for Week 2 in the same manner as Week 1.

   Up to four relays can be simultaneously energized for any programmed times.

10 Calibration

10.1 Introduction to calibration

Calibration is the process of adjusting or standardizing the transmitter to a lab test or a calibrated laboratory instrument, or standardizing to some known reference (such as a commercial buffer). The auto-recognition feature of the transmitter will enable the appropriate calibration screens to allow calibration for any single sensor configuration or dual sensor configuration of the transmitter. Completion of Quick Start upon first power up enables live measurements, but does not ensure accurate readings in the lab or in process. Perform calibration with each attached sensor to ensure accurate, repeatable readings.

This section covers the following programming and configuration functions:

1. Auto buffer cal for pH
2. Manual buffer cal for pH
3. Set calibration stabilization criteria for pH
4. Standardization calibration (1-point) for pH, ORP, and Redox
5. Entering the cell constant of a conductivity sensor
6. Calibrating the sensor in a conductivity standard Conductivity Cal
7. Calibrating the transmitter to a laboratory instrument
8. Zeroing an chlorine, oxygen, or ozone sensor
9. Calibrating an oxygen sensor in air
10. Calibrating the sensor to a sample of known concentration
11. Enter a manual reference temperature for temperature compensation of the process measurement.

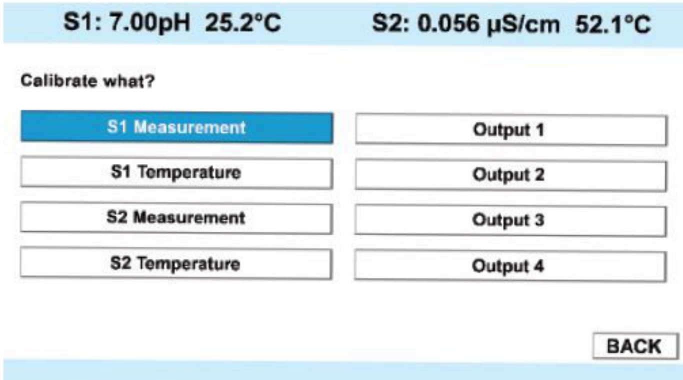
10.2 pH calibration

New sensors must be calibrated before use. Regular recalibration is also necessary. Use auto calibration instead of manual calibration. Auto calibration avoids common pitfalls and reduces errors. The transmitter recognizes the buffers and uses temperature-corrected pH values in the calibration. Once the transmitter successfully completes the calibration, it calculates and displays the calibration slope and offset. The slope is reported as the slope at 77 °F (25 °C).

To calibrate the pH loop with a connected pH sensor, access the ***Calibration*** screen by pressing **ENTER/MENU** from the main screen, select S1 or S2 Measurement, and press **ENTER/MENU**. Press **INFO** at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

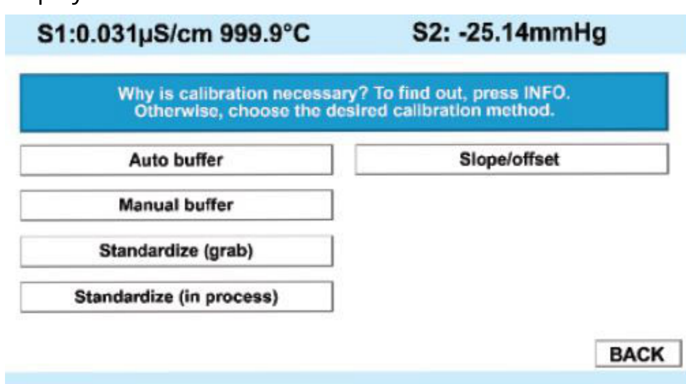
The following calibration routines are covered:

1. Auto Calibration - pH 2 point buffer calibration with auto buffer recognition
2. Manual Calibration - pH 2 point buffer calibration with manual buffer value entry
3. Standardization - pH 1 point buffer calibration with manual buffer value entry
4. Entering A Known Slope Value - pH Slope calibration with manual entry of known slope value



Procedure

1. To Auto Calibrate the pH loop using 2 point buffer calibration with auto buffer recognition, select Auto Buffer and follow the step-by-step procedures displayed on-screen.
2. To Manual Calibrate the pH loop using 2 point buffer calibration with manual buffer value entry, select Manual Buffer and follow the step-by-step procedures displayed on-screen.
3. To Standardize Calibrate the pH loop using 1 point buffer calibration with manual buffer value entry, select Standardize and follow the step-by-step procedures displayed on-screen.
4. To Calibrate the pH loop using with manual entry of a Known Slope Value and Reference offset value, select Slope/Offset and follow the step-by-step procedures displayed on-screen.



10.3 ORP calibration

For process control, it is often important to make the measured ORP agree with the ORP of a standard solution. During calibration, the measured ORP is made equal to the ORP of a standard solution at a single point.

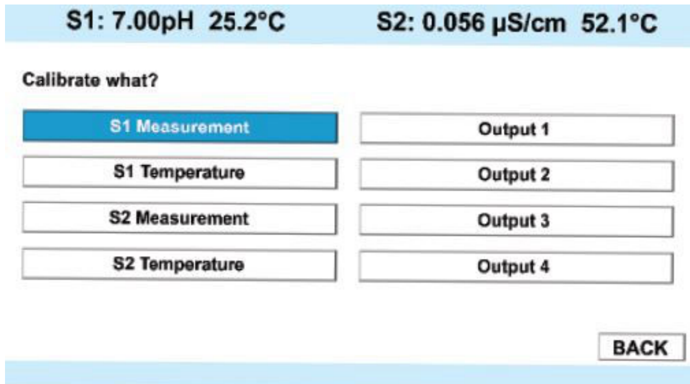
Procedure

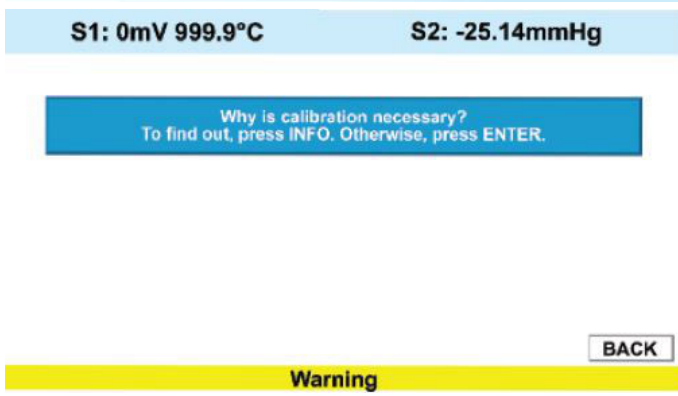
1. To calibrate the ORP loop with a connected ORP sensor, access the ***Calibration*** screen by pressing **ENTER/MEN**U from the main screen.
2. Select S1 or S2 Measurement, and press **ENTER/MENU**.

Press **INFO** at any time to learn more about this pr ear with detailed instructions and information.

3. The following calibration routine is covered:

   To Standardize the ORP loop using 1 point buffer calibration with manual buffer value entry, follow the step-by-step procedures displayed on-screen.





10.4 Contacting conductivity calibration

New conductivity sensors rarely need calibration. The cell constant printed on the label is sufficiently accurate for most applications.

Calibrating an in-service conductivity sensor

After a conductivity sensor has been in service for a period of time, recalibration may be necessary. There are three ways to calibrate a sensor:

- Use a standard instrument and sensor to measure the conductivity of the process stream. It is not necessary to remove the sensor from the process piping. The temperature correction used by the standard instrument may not exactly match the temperature correction used by the transmitter. To avoid errors, turn off temperature correction in both the transmitter and the standard instrument.
- Place the sensor in a solution of known conductivity and make the transmitter reading match the conductivity of the standard solution. Use this method if the sensor can be easily removed from the process piping and a standard is available. Be careful using standard solutions having conductivity less than 100 µS/cm. Low conductivity standards are highly susceptible to atmospheric contamination. Avoid calibrating sensors with 0.01/cm cell constants against conductivity standards having conductivity greater

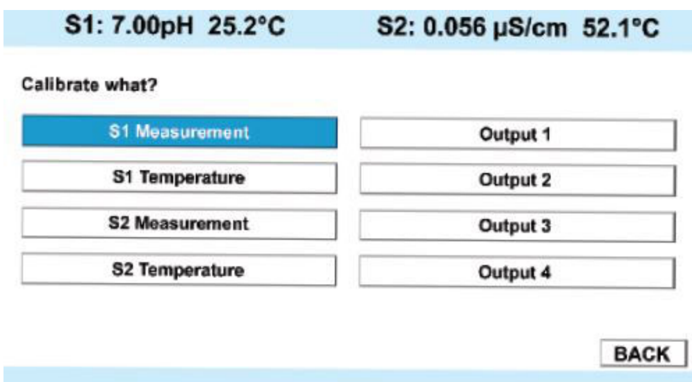
than 100 µS/cm. The resistance of these solutions may be too low for an accurate measurement. Calibrate sensors with 0.01/cm cell constant using method c.

- To calibrate a 0.01/cm sensor, check it against a standard instrument and 0.01/ cm sensor while both sensors are measuring water having a conductivity between 5 and 10 µS/cm. To avoid drift caused by absorption of atmospheric carbon dioxide, saturate the sample with air before making the measurements. To ensure adequate flow past the sensor during calibration, take the sample downstream from the sensor. For best results, use a flow-through standard cell. If the process temperature is much different from ambient, keep connecting lines short and insulate the flow cell.

To calibrate the conductivity loop with a connected contacting conductivity sensor, access the ***Calibration*** screen by pressing **ENTER/MENU** from the main screen, select S1 or S2 Measurement, and press **ENTER/MENU**. Press **INFO** at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

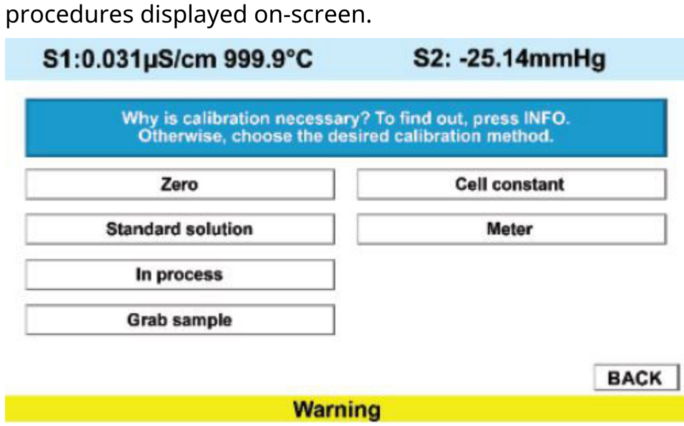
The following calibration routines are covered:

1. Zero Cal Zero: the transmitter with the sensor attached.
2. In Process Cal: Standardize the sensor to a known conductivity.
3. Cell K: 1.00000/cm Enter the cell Constant for the sensor.
4. Meter Cal: Calibrate the transmitter to a lab conductivity instrument.
5. Cal Factor: 0.95000/cm Enter the Cal Factor for 4-Electrode sensors from the sensor tag.



Procedure

1. To Zero Calibrate the transmitter with the sensor attached, follow the step-by-step procedures displayed on-screen.



2. To perform an In-Process Calibration of the conductivity loop by Standardizing the sensor to a known conductivity, follow the step-by-step procedures displayed on-screen.
3. To calibrate the conductivity loop by entering a Cell constant, enter the cell Constant for the sensor and follow the step-by-step procedures displayed onscreen.
4. To Meter Cal Calibrate the transmitter to a lab conductivity instrument, follow the step-by-step procedures displayed on-screen.
5. To enter the Cal Factor to support calibration of a 4-Electrode sensors, enter the Cal Factor for the 4-Electrode sensors from the sensor tag and follow the step-by-step procedures displayed on-screen.

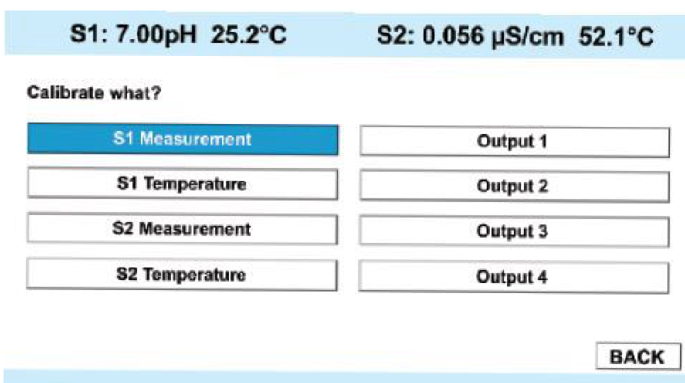
10.5 Toroidal conductivity calibration

Calibration is the process of adjusting or standardizing the transmitter to a lab test or a calibrated laboratory instrument, or standardizing to some known reference (such as a conductivity standard). This section contains procedures for the first time use and for routine calibration of the Rosemount 56 transmitter.

To calibrate the conductivity loop with a connected contacting conductivity sensor, access the ***Calibration*** screen by pressing **ENTER/MENU** from the main screen. Select S1 or S2 Measurement and press **ENTER/MENU**. Press **INFO** at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

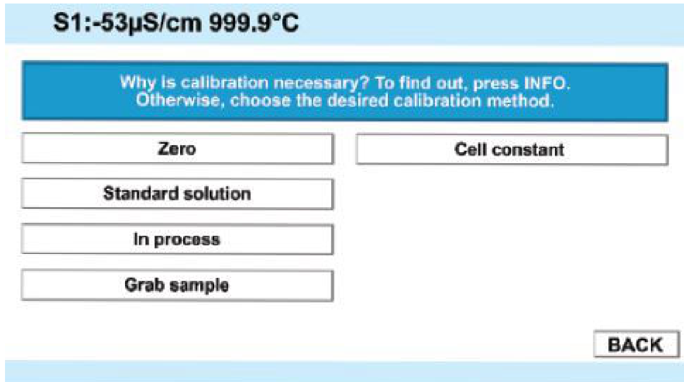
The following calibration routines are covered:

1. Zero Cal: Zero the transmitter with the sensor attached.
2. In Process Cal: Standardize the sensor to a known conductivity.
3. Cell K: 1.00000/cm Enter the cell Constant for the sensor from sensor tag.



Procedure

1. To Zero Calibrate the transmitter with the sensor attached, follow the step-by-step procedures displayed on-screen.
2. To perform an In-Process Calibration of the conductivity loop by standardizing the sensor to a known conductivity, follow the step-by-step procedures displayed on-screen.
3. To calibrate the conductivity loop by entering a Cell constant, enter the cell Constant for the sensor and follow the step-by-step procedures displayed on-screen.



10.6 Chlorine calibration

With a chlorine measurement board and the appropriate sensor, the Rosemount 56 can measure any of four variants of chlorine:

- Free Chlorine
- Total Chlorine
- Monochloramine
- pH-independent Free Chlorine

The section describes how to calibrate any compatible amperometric chlorine sensor. The following calibration routines are covered in the family of supported chlorine sensors:

- Air Cal
- Zero Cal
- In Process Cal

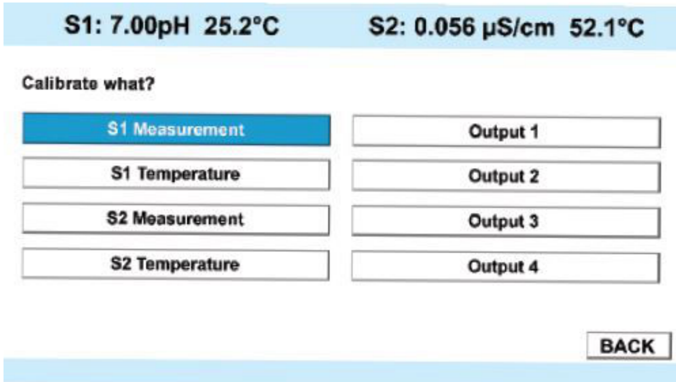
10.6.1 Free chlorine calibration

A free chlorine sensor generates a current directly proportional to the concentration of free chlorine in the sample. Calibrating the sensor requires exposing it to a solution containing no chlorine (zero standard) and to a solution containing a known amount of chlorine (full-scale standard). The zero calibration is necessary because chlorine sensors, even when no chlorine is in the sample, generate a small current called the residual current. The transmitter compensates for the residual current by subtracting it from the measured current before converting the result to a chlorine value. New sensors require zeroing before being placed in service, and sensors should be zeroed whenever the electrolyte solution is replaced.

To calibrate the chlorine sensor, access the ***Calibration*** screen by pressing **ENTER/ MENU** from the main screen. Select S1 or S2 Measurement and press **ENTER/ MENU**. Press **INFO** at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

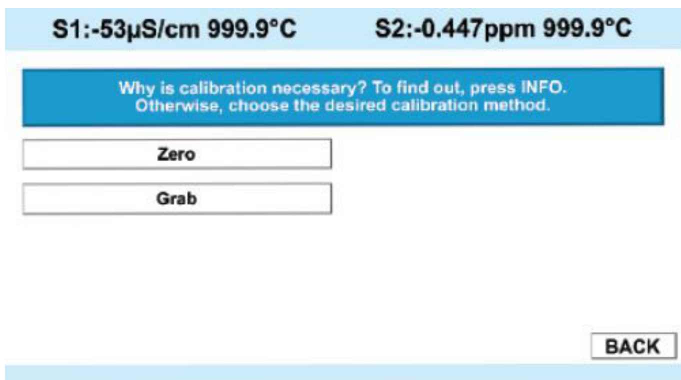
The following calibration routines are covered:

1. Zero Cal :Zeroing the sensor in solution with zero free chlorine.
2. Grab Cal: Standardizing to a sample of known free chlorine concentration.



Procedure

1. To Zero Calibrate the transmitter with the sensor attached, follow the step-by-step procedures displayed on-screen.
2. To perform a Grab Calibration by Standardizing the sensor, follow the step-by-step procedures displayed on-screen.



10.6.2 Total chlorine calibration

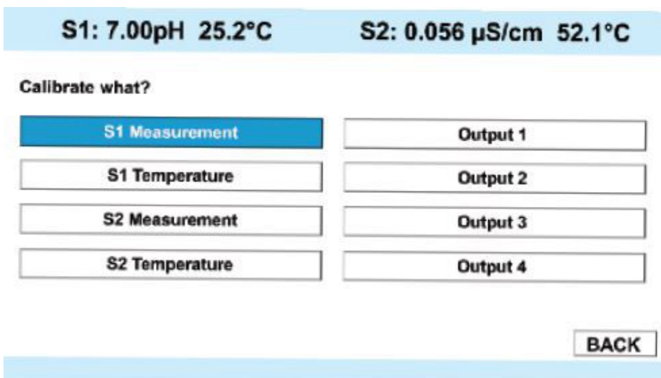
Total chlorine is the sum of free and combined chlorine. The continuous determination of total chlorine requires two steps. First, the sample flows into a conditioning system (TCL) where a pump continuously adds acetic acid and potassium iodide to the sample. The acid lowers the pH, which allows total chlorine in the sample to quantitatively oxidize the iodide in the reagent to iodine. In the second step, the treated sample flows to the sensor. The sensor is a membrane-covered amperometric sensor, whose output is proportional to the concentration of iodine.

Because the concentration of iodine is proportional to the concentration of total chlorine, the transmitter can be calibrated to read total chlorine. Because the sensor really measures iodine, calibrating the sensor requires exposing it to a solution containing no iodine (zero standard) and to a solution containing a known amount of iodine (full-scale standard). The Zero calibration is necessary because the sensor, even when no iodine is present, generates a small current called the residual current. The transmitter compensates for the residual current by subtracting it from the measured current before converting the result to a total chlorine value. New sensors require zeroing before being placed in service, and sensors should be zeroed whenever the electrolyte solution is replaced. The best zero standard is deionized water. The purpose of the In Process Calibration is to establish the slope of the calibration curve. Because stable total chlorine standards do not exist, the sensor must be calibrated against a test run on a grab sample of the process liquid. Several manufacturers offer portable test kits for this purpose.

To calibrate the chlorine sensor, access the ***Calibration*** screen by pressing **ENTER/ MENU** from the main screen. Select S1 or S2 Measurement and press **ENTER/MENU**. Press **INFO** at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

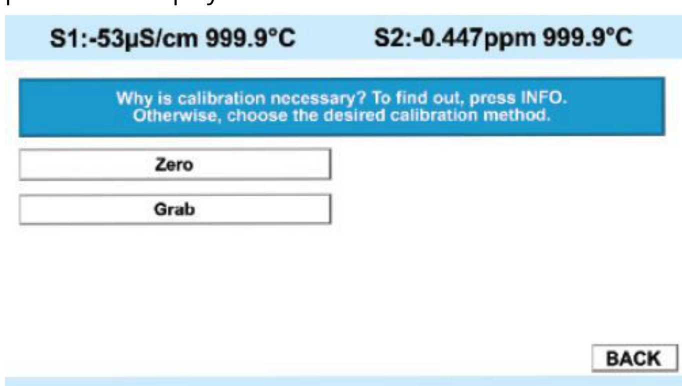
The following calibration routines are covered:

1. Zero Cal: Zeroing the sensor in solution with zero total chlorine.
2. Grab Cal: Standardizing to a sample of known total chlorine concentration.



Procedure

1. To Zero Calibrate the transmitter with the sensor attached, follow the step-by-step procedures displayed on-screen.
2. To perform a Grab Calibration by Standardizing the sensor, follow the step-by-step procedures displayed on-screen.



10.6.3 Monochloramine calibration

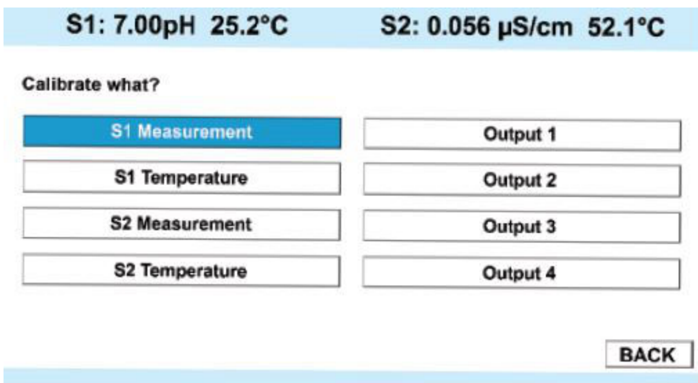
A monochloramine sensor generates a current directly proportional to the concentration of monochloramine in the sample. Calibrating the sensor requires exposing it to a solution containing no monochloramine (zero standard) and to a solution containing a known amount of monochloramine (full-scale standard). The Zero calibration is necessary because monochloramine sensors, even when no monochloramine is in the sample, generate a small current called the residual or zero current. The transmitter compensates for the residual current by subtracting it from the measured current before converting the result to a monochloramine value. New sensors require zeroing before being placed in service, and sensors should be zeroed whenever the electrolyte solution is replaced. The best zero standard is deionized water.

The purpose of the In Process calibration is to establish the slope of the calibration curve. Because stable monochloramine standards do not exist, the sensor must be calibrated against a test run on a grab sample of the process liquid. Several manufacturers offer portable test kits for this purpose.

To calibrate the chlorine sensor, access the ***Calibration*** screen by pressing **ENTER/ MENU** from the main screen. Select S1 or S2 Measurement and press **ENTER/ MENU**. Press **INFO** at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

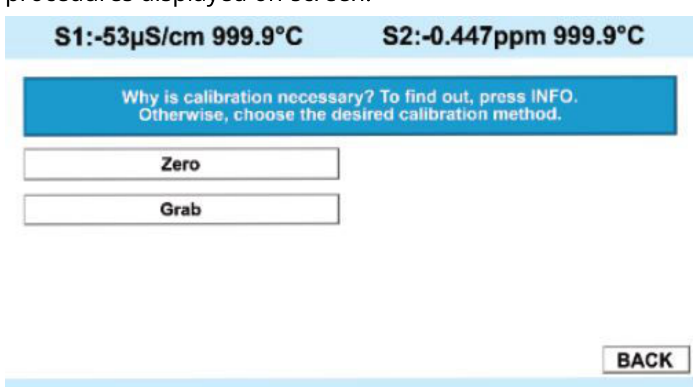
The following calibration routines are covered:

1. Zero Cal: Zeroing the sensor in solution with zero total chlorine.
2. Grab Cal: Standardizing to a sample of known monochloramine concentration.



Procedure

1. To Zero Calibrate the transmitter with the sensor attached, follow the step-by-step procedures displayed on-screen.
2. To perform a Grab Calibration by Standardizing the sensor, follow the step-by-step procedures displayed on-screen.



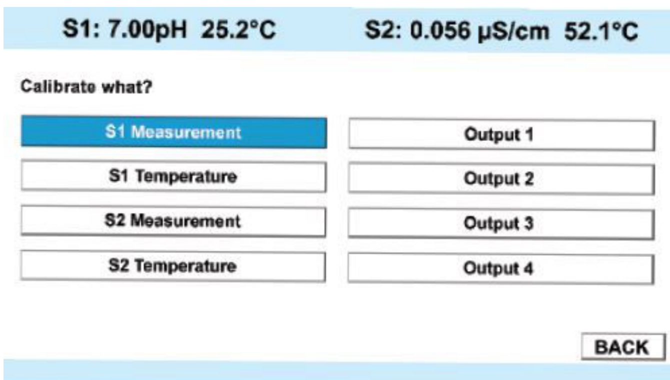
10.6.4 pH-Independent free chlorine measurement

A free chlorine sensor generates a current directly proportional to the concentration of free chlorine in the sample. Calibrating the sensor requires exposing it to a solution containing no chlorine (zero standard) and to a solution containing a known amount of chlorine (full-scale standard). The zero calibration is necessary because chlorine sensors, even when no chlorine is in the sample, generate a small current called the residual current. The analyzer compensates for the residual current by subtracting it from the measured current before converting the result to a chlorine value. New sensors require zeroing before being placed in service, and sensors should be zeroed whenever the electrolyte solution is replaced.

To calibrate the chlorine sensor, access the Calibration screen by pressing **ENTER/ MENU** from the main screen, select S1 or S2 Measurement and press **ENTER/MENU**. Press **INFO** at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

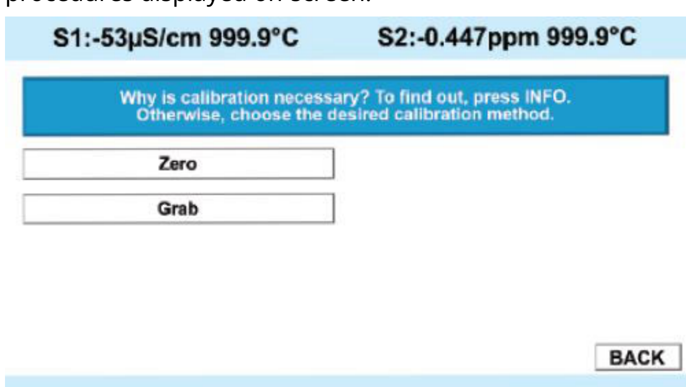
The following calibration routines are covered:

1. Zero Cal Zeroing the sensor in solution with zero total chlorine
2. Grab Cal Standardizing to a sample of known chlorine concentration



Procedure

1. To Zero Calibrate the analyzer with the sensor attached, follow the step-by-step procedures displayed on-screen.
2. To perform a Grab Calibration by Standardizing the sensor, follow the step-by-step procedures displayed on-screen.



10.6.5 Oxygen calibration

Oxygen sensors generate a current directly proportional to the concentration of dissolved oxygen in the sample. Calibrating the sensor requires exposing it to a solution containing no oxygen (zero standard) and to a solution containing a known amount of oxygen (full-scale standard). The Zero Calibration is necessary because oxygen sensors, even when no oxygen is present in the sample, generate a small current called the residual current. The transmitter compensates for the residual current by subtracting it from the measured current before converting the result to a dissolved oxygen value.

New sensors require zeroing before being placed in service, and sensors should be zeroed whenever the electrolyte solution is replaced. The recommended zero standard is 5 percent sodium sulfite in water, although oxygen-free nitrogen can also be used. The Rosemount 499ATrDO sensor, used for the determination of trace (ppb) oxygen levels, has very low residual current and does not normally require zeroing. The residual current in the 499ATrDO sensor is equivalent to less than 0.5 ppb oxygen. The purpose of the In Process Calibration is to establish the slope of the calibration curve. Because the solubility of atmospheric oxygen in water as a function of temperature and barometric pressure is well known, the natural choice for a full-scale standard is air-saturated water.

However, air-saturated water is difficult to prepare and use, so the universal practice is to use air for calibration. From the point of view of the oxygen sensor, air and air-saturated water are identical. The equivalence comes about because the sensor really measures the chemical potential of oxygen. Chemical potential is the force that causes oxygen molecules to diffuse from the sample into the sensor where they can be measured. It is also the force that causes oxygen molecules in air to dissolve in water and to continue to dissolve until the water is saturated with oxygen.

Once the water is saturated, the chemical potential of oxygen in the two phases (air and water) is the same. Oxygen sensors generate a current directly proportional to the rate at which oxygen molecules diffuse through a membrane stretched over the end of the sensor. The diffusion rate depends on the difference in chemical potential between oxygen in the sensor and oxygen in the sample.

An electrochemical reaction, which destroys any oxygen molecules entering the sensor, keeps the concentration (and the chemical potential) of oxygen inside the sensor equal to zero. Therefore, the chemical potential of oxygen in the sample alone determines the diffusion rate and the sensor current. When the sensor is calibrated, the chemical potential of oxygen in the standard determines the sensor current. Whether the sensor is calibrated in air or air-saturated water is immaterial.

The chemical potential of oxygen is the same in either phase. Normally, to make the calculation of solubility in common units (like ppm dissolved oxygen [DO]) simpler, it is convenient to use water-saturated air for calibration. Automatic air calibration is standard. Simply expose the sensor to water-saturated air.

The transmitter monitors the sensor current. When the current is stable, the transmitter stores the current and measures the temperature using a temperature element inside the oxygen sensor. The user must enter the barometric pressure. From the temperature the transmitter calculates the saturation vapor pressure of water.

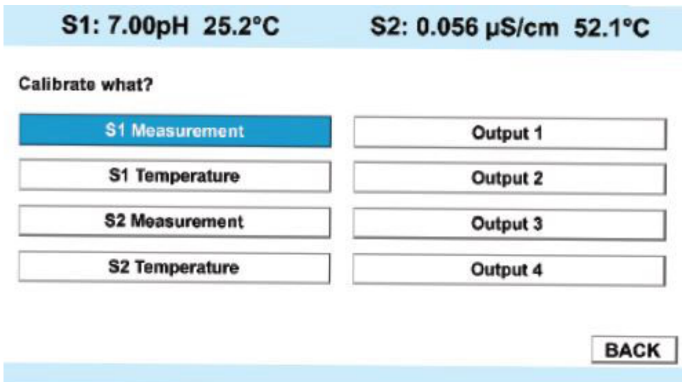
Next, it calculates the pressure of dry air by subtracting the vapor pressure from the barometric pressure. Using the fact that dry air always contains 20.95 percent oxygen, the transmitter calculates the partial pressure of oxygen. Once the transmitter knows the partial pressure of oxygen, it uses the Bunsen coefficient to calculate the equilibrium solubility of atmospheric oxygen in water at the prevailing temperature. At 25 °C and 760 mmHg, the equilibrium solubility is 8.24 ppm.

Often, it is too difficult or messy to remove the sensor from the process liquid for calibration. In this case, the sensor can be calibrated against a measurement made with a portable laboratory instrument. The laboratory instrument typically uses a membrane-covered amperometric sensor that has been calibrated against water-saturated air.

To calibrate the oxygen sensor, access the ***Calibration*** screen by pressing **ENTER/ MENU** from the main screen. Select S1 or S2 Measurement and press **ENTER/MENU**. Press **INFO** at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

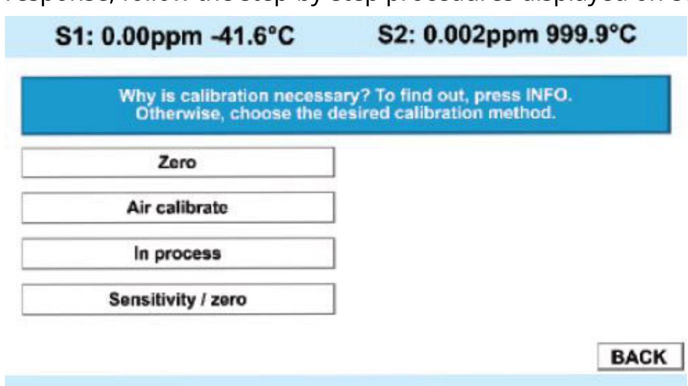
The following calibration routines are covered:

1. Zero Cal: Zeroing the sensor in a medium with zero oxygen.
2. Air Cal: Calibrating the sensor in a water-saturated air sample.
3. In Process Cal: Standardizing to a sample of known oxygen concentration.
4. Sen@ 25 °C: 2500 μA/ppm Entering a known slope value for sensor response.



Procedure

1. Zero Calibrate the transmitter with the sensor attached; follow the step-by-step procedures displayed on-screen.
2. To Air Cal Calibrating the sensor in a water-saturated air sample, follow the step-by-step procedures displayed on-screen.
3. To perform an In-Process Calibration by Standardizing the sensor, follow the step-by-step procedures displayed on-screen.
4. To calibrate the oxygen sensor by manually. Entering a known slope value for sensor response, follow the step-by-step procedures displayed on-screen.



10.6.6 Ozone calibration

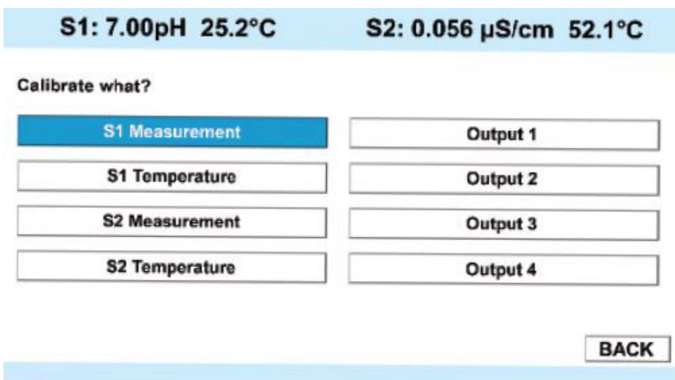
An ozone sensor generates a current directly proportional to the concentration of ozone in the sample. Calibrating the sensor requires exposing it to a solution containing no ozone (zero standard) and to a solution containing a known amount of ozone (full-scale standard). The Zero Calibration is necessary because ozone sensors, even when no ozone is in the sample, generate a small current called the residual or zero current. The analyzer compensates for the residual current by subtracting it from the measured current before converting the result to an ozone value.

New sensors require zeroing before being placed in service, and sensors should be zeroed whenever the electrolyte solution is replaced. The best zero standard is deionized water. The purpose of the In Process Calibration is to establish the slope of the calibration curve. Because stable ozone standards do not exist, the sensor must be calibrated against a test run on a grab sample of the process liquid. Several manufacturers offer portable test kits for this purpose.

To calibrate the ozone sensor, access the ***Calibration*** screen by pressing **ENTER/MENU** from the main screen. Select S1 or S2 Measurement and press **ENTER/MENU**. Press **INFO** at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

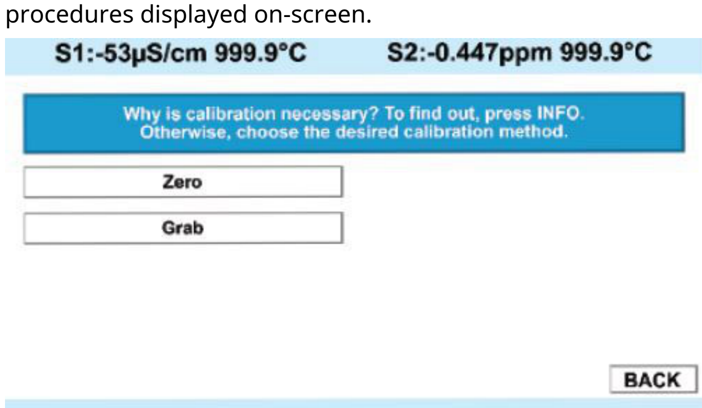
The following calibration routines are covered:

1. Zero Cal: Zeroing the sensor in solution with zero total chlorine.
2. Grab Cal: Standardizing to a sample of known ozone concentration.



Procedure

1. To Zero Calibrate the analyzer with the sensor attached, follow the step-by-step procedures displayed on-screen.
2. To perform a Grab Calibration by Standardizing the sensor, follow the step-by-step procedures displayed on-screen.



10.6.7 Calibrating temperature

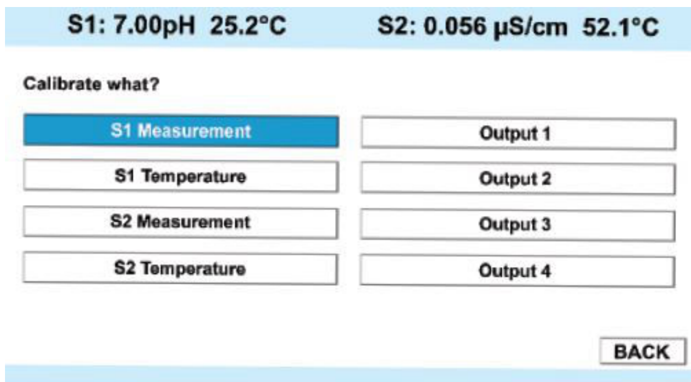
Most liquid analytical measurements require temperature compensation (except ORP). The Rosemount 56 performs temperature compensation automatically by applying internal temperature correction algorithms. Temperature correction can also be turned off. If temperature correction is off, the transmitter uses the manual temperature entered by the user in all temperature correction calculations.

To calibrate temperature, access the ***Calibration*** screen by pressing **ENTER/MENU** from the main screen. Select S1 or S2 Temperature and press **ENTER/MENU**. Press **INFO** at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

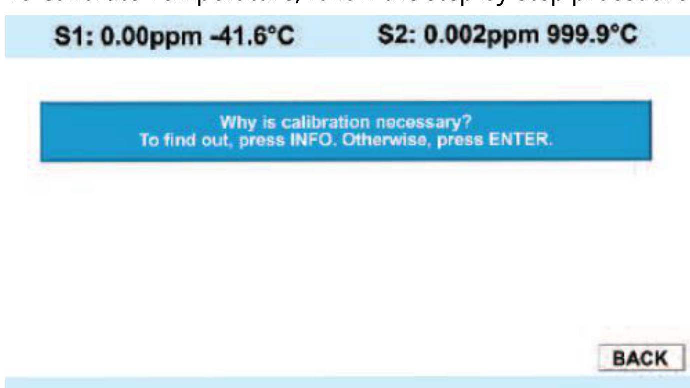
The following calibration routine is covered:

Procedure

1. Temperature with manual temperature entry:



2. To Calibrate Temperature, follow the step-by-step procedures displayed on-screen.



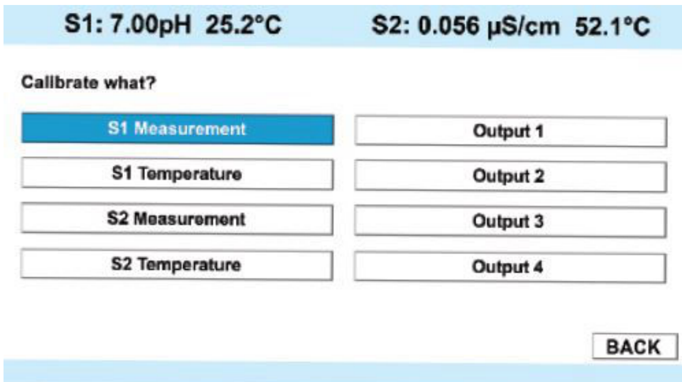
10.6.8 Turbidity

This section describes how to calibrate the turbidity sensor against a user-prepared standard as a 2-point calibration with deionized water, against a 20 NTU user-prepared standard as a single point calibration, and against a grab sample using a reference turbidimeter.

To calibrate the turbidity sensor, access the ***Calibration*** screen by pressing **ENTER/MENU** from the main screen. Select S1 or S2 Measurement and press **ENTER/MENU**. Press **INFO** at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

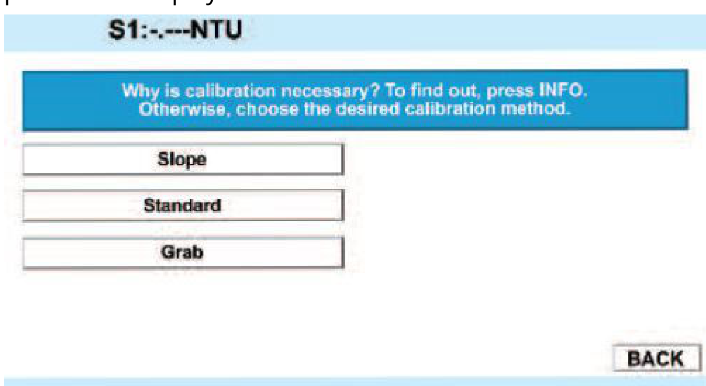
The following calibration routine is covered:

1. Slope Calibration: Slope cal with pure water and a standard of known turbidity.
2. Standardize Calibration: Standardizing the sensor to a known turbidity.
3. Grab Calibration: Standardizing the sensor to a known turbidity based on a reference turbidimeter.



Procedure

1. To calibrate the turbidity loop using Slope Calibration with pure water and a standard of known turbidity, follow the step-by-step procedures displayed on-screen.
2. To calibrate the turbidity loop using Standardize Calibration by Standardizing the sensor to a known turbidity, follow the step-by-step procedures displayed on-screen.
3. To calibrate the turbidity loop using Grab Calibration by Standardizing the sensor to a known turbidity based on a reference turbidimeter, follow the step-by-step procedures displayed on-screen.



10.6.9 Pulse flow

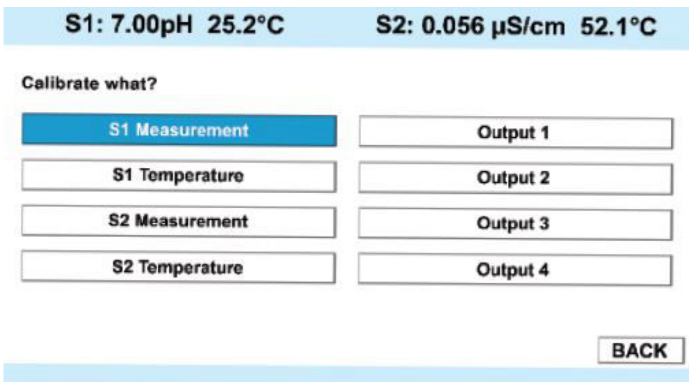
A variety of pulse flow sensors can be wired to the Flow signal input board to measure flow volume, total volume, and flow difference (if 2 Flow signal boards are installed). The

Rosemount 56 Flow signal board will support flow sensors that are self-driven (powered by the rotation of the impeller paddle-wheel).

To calibrate the pulse flow sensor, access the ***Calibration*** screen by pressing **ENTER/MENU** from the main screen. Select S1 or S2 Measurement and press **ENTER/MENU**. Press **INFO** at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

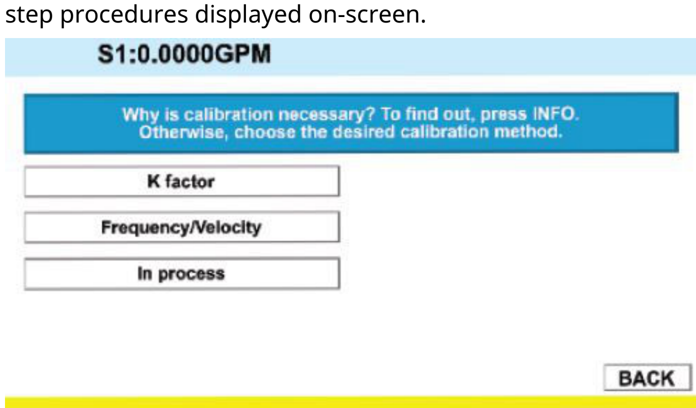
The following calibration routine is covered:

1. K Factor: A constant value representing pulses/Gal of flow.
2. Frequency/Velocity & Pipe Alternate cal method: Requires manual entry of frequency (Hz) per velocity and Pipe diameter used.
3. In process Calibration based on known volume per unit of time
4. Totalizer Control User settings to stop, restart and reset total volume meter



Procedure

1. To enter a K Factor constant value representing pulses/Gal of flow, follow the step-by-step procedures displayed on-screen.
2. To calibrate pulse flow Frequency/Velocity & Pipe as an alternate cal method, follow the step-by-step procedures displayed on-screen.
3. To perform In-process Calibration the pulse flow sensor based on known volume per unit of time, follow the step-by-step procedures displayed on-screen.
4. To stop, restart, and reset Totalizer Control total volume meter, follow the step-by-step procedures displayed on-screen.



11 HART® communications

11.1 Introduction to HART® communication

The Rosemount 56 can communicate with a HART host using HART Revision 5 or HART Revision 7. The revision of HART used by the Rosemount 56 can be selected using the keypad/display or a HART master such as AMS or the Field Communicator. The default version of HART is Revision 5. Since some HART hosts cannot accommodate HART 7, the choice of HART Revision should be based on the capabilities of the host, and should be chosen as a first step in configuration.

When HART 5 is chosen, the Device Revision of the 56 is Device Revision 1; when HART 7 is chosen, the Device Revision is Revision 2 or higher for later revisions of the 56. The Device Revision of the DD (Device Driver) and install files for AMS and DeltaV used should be the same as the Device Revision of the Rosemount 56.

HART 5 Device Identification (56 Revision 1):

Manufacturer Name:	Rosemount
Model Name:	Rosemount 56
Manufacturer ID:	46 (0x2E)
Device Type Code:	86 (0x0056)
HART Protocol Revision:	5.1
Device Revision:	1
Capabilities:	Supports all signal boards except the turbidity and flow/4-20mA input signal boards.

HART 7 Device Identification (56 Revision 2):

Manufacturer Name:	Rosemount
Model Name:	Rosemount 56
Manufacturer ID:	46 (0x2E)
Device Type Code:	11862 (0x2E56)
HART Protocol Revision:	7.1
Device Revision:	2
Capabilities:	Supports all signal boards.

HART 7 Device Identification (56 Revision 3):

Manufacturer Name:	Rosemount
Model Name:	Rosemount 56
Manufacturer ID:	46 (0x2E)
Device Type Code:	11862 (0x2E56)
HART Protocol Revision:	7.1
Device Revision:	3
Capabilities:	Supports all signal boards and the complete set of parameters for standardized PID with PID transport time feature and TPC control.

11.2 Physical installation and configuration

11.2.1 HART® wiring and output configuration

HART communication is superimposed on Analog Output 1 for all of the measurements and parameters of the Rosemount 56. The 4-20 mA current of Analog Output 1 can be configured by the keypad display to be powered by the 56 (Output 1 power: Internal), or by an external 24 Vdc power supply, or an input/output (I/O) that provides power (Output 1 power: External).

11.2.2 HART® multidrop (Bus) configuration

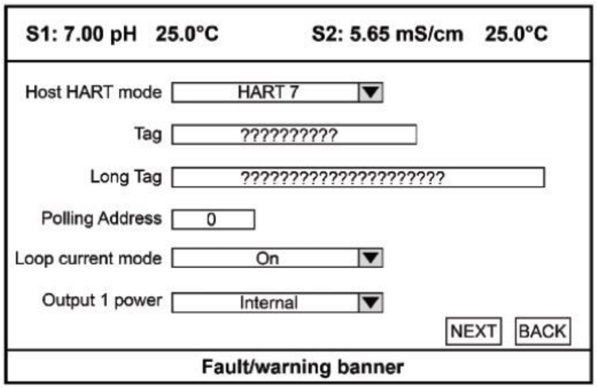
The HART Polling Address should be left at its default value of 0, unless the Rosemount 56 is used in a Multidrop configuration with up to 14 other transmitters. When the Polling Address is greater than 0, the 4-20 mA output is held at 4 mA or below and does not change in response to changes in the measurement in HART 5.

In HART 7, Loop Current Mode should be set to On to hold the current output to a minimum value. In both HART 5 and HART 7, Output Power should be set to External so that an external 24 Vdc power supply can be used to power the multidrop bus.

11.2.3 HART® configuration

To access the ***HART Configuration*** screens, press the **HART** button in the ***Main Menu***. The following controls are available:

Figure 11-1: *HART Configuration Screen* 1: Basic Definitions



- Host HART mode – Toggles between HART version 5 and HART version 7. If the HART host being used can accommodate HART 7, choose HART 7 due to its larger feature set. If the host can only use HART 5, then choose HART 5.

  Note
  If the Rosemount 56 is connected to a HART host and the HART version is changed, the host will likely detect the transmitter as a new transmitter with a different device revision number.

- Tag – The traditional 8 character HART tag number
- Long tag – HART tag number of up to 32 characters (HART 7 only).
- Polling address – Choose **0** unless Multidrop is being used. If Multidrop is being used, each transmitter should have its own polling address of from 1 to 15.
- Loop current mode – Set Output 1 current to a minimum value for multidrop applications (HART 7 only).
- Output 1 Power – Select **Internal** to power Output 1 with the 56. Select **External** to power the current loop with an external power supply, such as a host I/O that provides power (source) to the transmitter (sink).

HART Configuration Screen 2 Basic Definitions

- Burst command:
  — Cmd 1 – Bursts the Primary Value
  — Cmd 2 – Bursts Loop Current + % of range of the Primary Value
  — Cmd 3 – Bursts Dynamic Variables (Primary Variable, Secondary Variable, Tertiary Variable, and Quaternary Variable) + Loop Current
  — Cmd 9 – Bursts up to 8 Device Variables with time stamp and status (HART 7 only) Cmd 33 – Bursts 4 Device Variables
  — Cmd 48 – Bursts Additional Transmitter Status Bits (HART 7 only)
  — Cmd 93 – Bursts Trend Data (HART 7 only)

- Find device cmd – Setting Find Device to **On**, enables the 56 to be indentified by the host. The transmitter returns identity information including device type, revision level, and device ID.
- Response preambles – Preambles synchronize the receiver to the incoming data. Response preambles are the number of bytes of preambles (2 to 20) sent by the 56 at the start of a response packet.

11.3 Measurements available via HART®

A number of live measurements are made available by HART in addition to the main measurements, such as pH or Conductivity. All of these measurements are called Device Variables, which can be mapped to the Dynamic Variables PV, SV, TV, and QV for regular reading by the typical HART host.

The Rosemount 56 assigns the Dynamic Variables Primary Variable, Secondary Variable, Tertiary Variable, and Quaternary Variable (PV, SV, TV, and QV) to Analog Outputs 1, 2, 3, and 4 respectively. Conversely, measurements assigned to Outputs 1 through 4, will automatically be assigned to PV through QV.

Each measurement board will have its own set of Device Variables, based on the secondary measurements used in making the main measurement. HART® and Device Variables shows the Device Variable for the each sensor boards

11.4 Diagnostics available via HART®

11.4.1 Status information – Device status bits

Bit 0 Primary Variable out of Limits:

This bit is set when PV is out of its limits.

Bit 1 Non-primary Variable out of Limits:

This bit is set when non PV is out of its limits.

Bit 2 Loop Current Saturated:

This bit is set when the Analog Output 1 current is less than 1.0 mA or greater than 22.0 mA and the Device Status Bytes bit 3 is not set.

Bit 3 Loop Current Fixed:

This bit is set when Analog Output 1 does not follow the process. This bit is cleared when Analog Output 1 follows the process.

Bit 4 More Status Available:

The “more status available” bit will be set when the device status condition occurs (i.e. bit goes from 0 to 1) on at least one of the Additional Transmitter Status bits are set.

Bit 5 Cold Start:

This bit is set when a Master Reset is performed either by Command 42, or a power cycle. This bit is cleared after the first response or burst. In the case of a burst, the first burst always goes to the primary master.

Configuration Changed:

This bit is set when the last bytes of an EEPROM writing sequence is completed. Since EEPROM writes are delayed until after the response, the immediate acknowledgement will not have the bit set, however, after the EEPROM write completes, the bit will be set. This bit applies to all EEPROM writes whether or not they apply directly to the configuration of the instrument or not. This bit is cleared when Command 38 is executed.

Field Device Malfunction:

This bit is set when any of the following conditions is true, and cleared when all of the following conditions are false:

1. There is at least one main board fault.
2. There is at least one Sensor 1 fault.
3. There is at least one Sensor 2 fault.

11.4.2 Status information – Extended device status bits (HART® 7 only)

Bit 0

Maintenance Required:

Any calibration error will set this bit. Any calibration for either Sensor 1 or Sensor 2 that fails will set this bit. This bit gets cleared if all device variables are calibrated successfully.

This bit is set to indicate that, while the device has not malfunctioned, the Field Device requires maintenance.

Bit 1

Device Variable Alert:

This bit will get set when at least one of device status byte of all the valid Device Variables does not equal to "good and not limited" (i.e. the higher 4 bits not equal to 0x1100).

This bit is set if any Device Variable is in an Alarm or Warning State. The host should identify the Device Variable(s) causing this to be set using the Device Variable Status indicators.

Bit 3

Critical Power Failures:

This bit will always be cleared on the Rosemount 56.

11.4.3 Additional transmitter status (Command 48)

Additional Transmitter Status provides diagnostic status bits specific to the condition of sensors, sensor boards, and the main board of the Rosemount 56. Calibration errors and notification of events, such as calibration in progress and relay activation are also indicated by status bits. HART® Status Bits shows these bits organized according to the main board or applicable sensor board.

11.5 HART® hosts

A HART host can access live measurements, as well as diagnostic messages and provide a tool for configuring the measurement and calibrating the Rosemount 56. The AMS

Intelligent Device Manager and the Field Communicator are two examples further explained in the next two sections.

11.5.1 AMS Intelligent Device Manager

The AMS Device Intelligent Device Manager is member of the AMS Suite of asset management applications, which provides tools for configuration, calibration, diagnosing, and documenting transmitters and valves. The following AMS windows are examples of these functions:

Figure 11-2: Main Measurement and Overall Status: Overview Screen

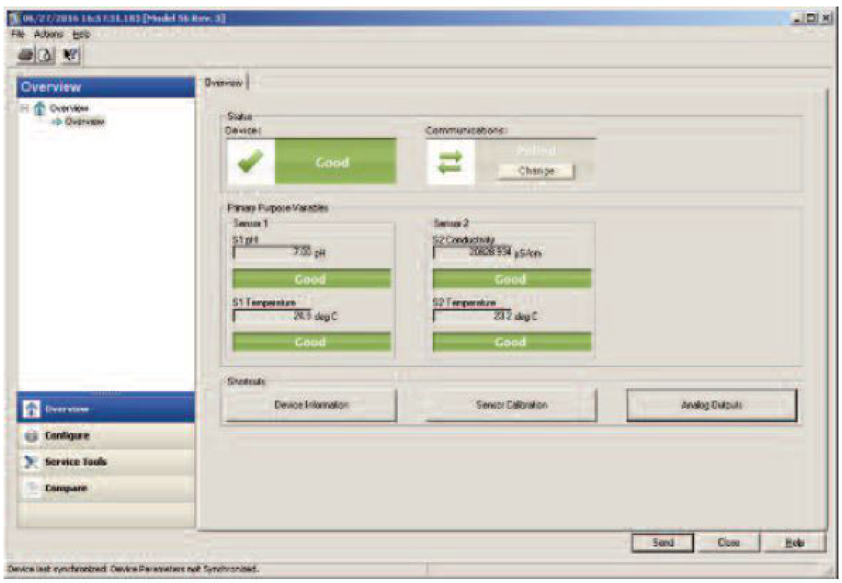


Figure 11-3: Device Variables and Dynamic Variables

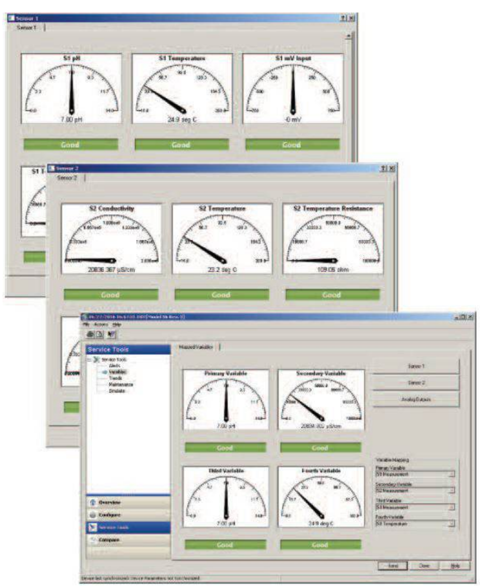


Figure 11-4: Diagnostic Messages (Additional Transmitter Status)

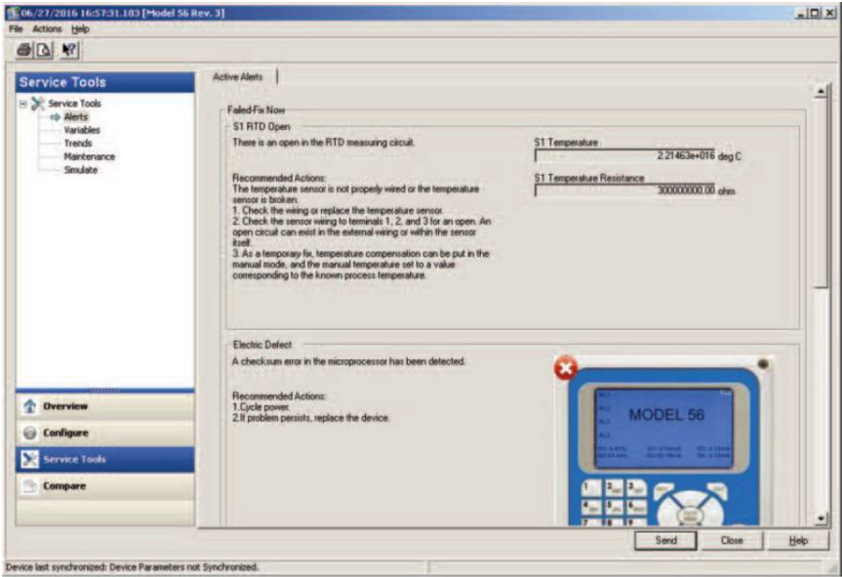


Figure 11-5: Configure Screen

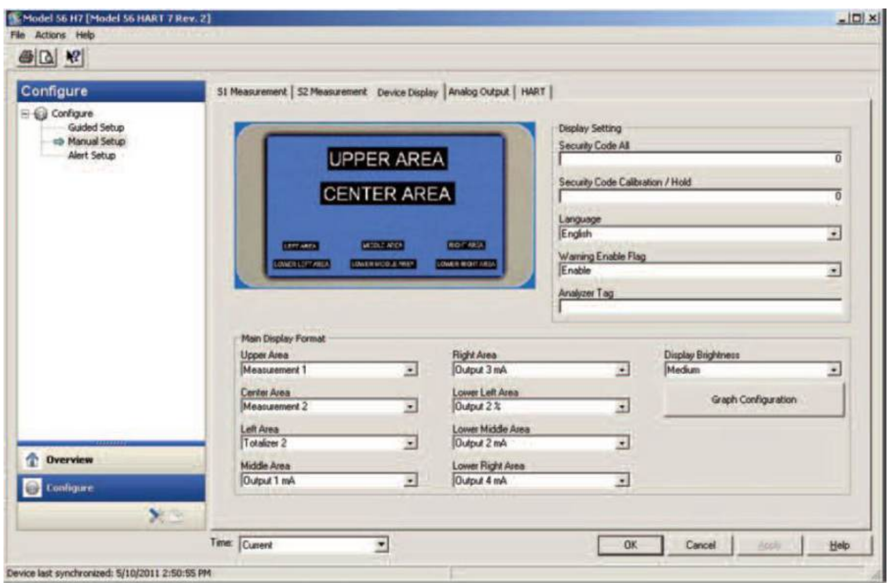
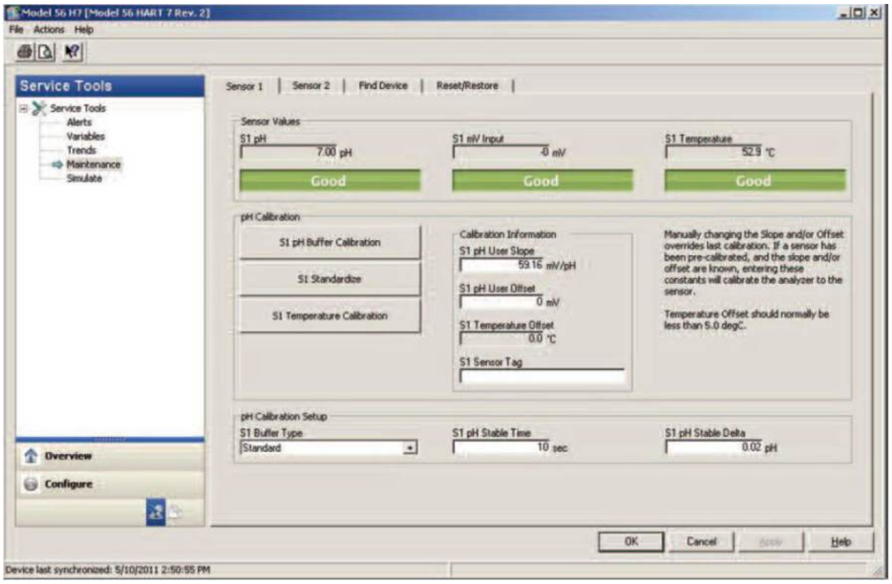


Figure 11-6: Maintenance



11.5.2 Field Communicator

HART® (and Fieldbus) devices can be access in the field using the Field Communicator, which provides the same basic functionality as the AMS Intelligent Device Manager. Asset management information can be uploaded into the AMS database from the Field Communicator for a common database for asset management data. The Field Communicator uses a color menu driven display.

11.6 Wireless communication

The Rosemount 56 can communicate by *Wireless*HART® using the Smart Wireless THUM Adapter™ and the Emerson Wireless 1410 Gateway. All the information available with the wired device can be accessed wirelessly, making it possible to have the measurements and benefits of HART® communication in locations where running cable would be difficult or prohibitively expensive.

Although HART 5 or HART 7 can burst the Dynamic Variables Primary Variable, Secondary Variable, Tertiary Variable, and Quaternary Variable (PV, SV, TV, and QV), HART 7 should be used with the THUM because up to 8 Device Variables can be continually burst using Command 9.

11.7 Field Device Specification (FDS)

For more details on the implementation of HART® in the Rosemount 56 and its command structure, the Field Device Specification for the relevant Device Revision should be consulted. They can be downloaded from Emerson.com/global.

12 PROFIBUS® communications

12.1 General

The 56 can communicate using PROFIBUS® DP-V1 if you purchase a 56 with a PROFIBUS communication board installed (model code 56-PC-02-DP), or by adding a PROFIBUS communications board to the standard 56 with HART® communications.

The standard HART 56 Transmitter can be converted to PROFIBUS DP by adding a PROFIBUS board. There are two different PROFIBUS boards for the 56, which must be chosen to be compatible with the main board software version of the 56.

- If the 56 software version begins with a 2 (2.XX), PROFIBUS board PN 24285-02 should be chosen.
- If the 56 software version begins with a 1 (1.XX), PROFIBUS board PN 24285-01 should be chosen.

A 56 with PROFIBUS communications retains all the analog and discrete functionality of the standard HART 56 transmitter. The four 4 to 20 mA analog outputs can be configured as analog outputs or PID control outputs.

The four discrete relay outputs can be configured for concentration control (high/ low alarms with or without a delay timer), event based activation, timer based activation, or TPC (Duty Cycle/ Pulse Width Modulation) control.

12.2 PROFIBUS® features

As outlined in the Device Description Data Field (GSD), the 56 has the following PROFIBUS DP-V1 identification and capabilities:

Identification:

GSD Revision: 5

Vendor Name: Rosemount

Model Name: MODEL 56 PROFIBUS

DP Revision: V1.00

Identification Number: 0x10AA

Hardware Release: V1.00

Software Release: V1.00

Implementation Type: VPC3+C

Device: DP-V1 Slave

Baud Rates Supported:

All PROFIBUS DP baud rates are supported, from 9.6 kbps to 12 Mbps.

Additional Capabilities:

- The 56 PROFIBUS board supports the automatic transmission rate recognition. It automatically sets its baud rate to the transmission rate of the PROFIBUS network, specified by the master.

- The DP device supports the function Set_Slave_Add for setting the slave address via the PROFIBUS. The slave address for the 56 can be set automatically or manually by the PROFIBUS master. The DP device supports DP-V0 cyclic services and Identification and Maintenance (I & M) function: - I&M 0
- The Minimum Slave Interval is 100 sec minimum interval between two poll cycles.

56 Modules

The 56 is a multiparameter device, which supports a number of combinations of two analytical measurements, and four relays which can be configured for a number of discrete functions. As a result, the 56 is defined as a modular station, to allow it to cover these measurements, relay status, and associated information. The 56 has 36 modules available, and 33 can be inserted into the device. They include:

- The two main measurements, their units, and the measurement
- The temperature measurements from each board and their units
- Dual conductivity measurements: conductivity ration, percent passage, and percent rejection
- Dual flow board measurements: flow recovery, flow difference, and flow unit
- Alarm relays (four possible): their type, state, logic assignment and simulate status Details of the module are in PROFIBUS® communications.

56 Device Diagnostics

A number of diagnostic bits are provided via PROFIBUS, which cover the fault and warning messages for the 56 main board, signal boards, and measurements. They are organized as follows:

Table 12-1: Device Diagnostic Bits

Diagnostic bits(1)	Bit description
16	Change in diagnostic data
24-27	Main board faults
33-38	Main board warnings
40-57	Signal board 1 and measurement faults
72-89	Signal board 2 and measurement faults
104-121	Signal board 1 and measurement warnings
136-153	Signal board 2 and measurement warnings

(1) Bit position after the header byte.

12.3 PROFIBUS® communications

12.3.1 Configuring the 56 for PROFIBUS® communications

Baud Rates

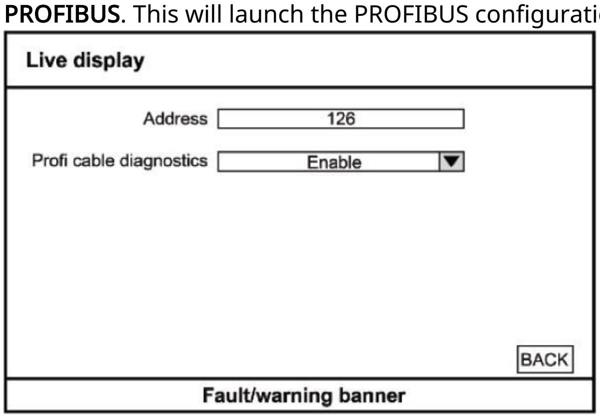
The 56 supports all the baud rates of PROFIBUS DP as shown in Table 12-2. Since the 56 supports transmission rate recognition, it will recognize the baud rate used on the network, and set its own baud rate to match the network's rate.

Table 12-2: Baud Rates Supported

Baud rate	Maximum Response Time for Responders (unit is bit time)
9.6 kbps	60
19.2 kbps	60
45.45 kbps	60
93.75 kbps	60
187.5 kbps	60
500 kbps	100
1.5 Mbps	150
3 Mbps	250
6 Mbps	450
12 Mbps	800

Slave address

The 56 supports the set slave address function, which makes it possible for the PROFIBUS master to set the slave address of the 56. Some PROFIBUS masters cannot set slave addresses, and the slave addresses have to be set in each slave device. If this is case, the slave address can be set in the 56 by pressing the **ENTER/MENU** key and selecting **DP: PROFIBUS**. This will launch the PROFIBUS configuration window:



- The PROFIBUS address is writeable up to a value of 126.
- At the same time the slave address is being set, PROFIBUS cable diagnostics should be enabled. These diagnostics provide a useful tool for troubleshooting cable connection problems.

12.3.2 PROFIBUS® faults and warnings

Faults

The 56 displays the following hardware faults associated with problems related to the PROFIBUS board and its connection to the main board:

Recommended actions

1. PROFIBUS board mismatch - The revision of the installed PROFIBUS board is not compatible with the main board of the transmitter. Note the revisions of the PROFIBUS board and the main board of the transmitter and contact the factory.

2. Self-test failed - At power up, the PROFIBUS board conducts several internal self tests. At least one of them failed.
    a. Try to reset the transmitter by cycling the power.
    b. Replace the PROFIBUS board.
3. Internal communication failed - The main board detects the PROFIBUS board, but the PROFIBUS board is not communicating with the main board.
    a. Try to reset the transmitter by cycling the power.
    b. Check the interconnecting cable between the PROFIBUS and main board.
    c. Replace the PROFIBUS board.

Warnings

Cause

Warnings related to cable problems and software compatibility are also displayed, if PROFIBUS cable diagnostics are enabled:

Recommended actions

1. Cable shorted or open - No PROFIBUS cable is connected, or the A and B leads of the cable are shorted.
2. Check PROFIBUS Cable - The A and B leads in the PROFIBUS cable may be reversed. If standard PROFIBUS cable is used, the green lead should be wired to Position A and the red lead to Position B. The bus may not have a terminator, or it may not be turned on. Check to see that a terminator is present and turned on.
3. PROFIBUS function limited - The PROFIBUS board has new features that the main board software does not support. If one or more new features are not supported, the minor revision number of the PROFIBUS board will be greater than the minor revision number of the main board. Replace the main board.

    Details on these faults and warnings are accessed like any other fault or warning in the 56: Press the **INFO** key and then select **Faults – fix now** or **Warnings – fix soon**.

LED diagnostics

Cause

The PROFIBUS board itself displays diagnostic information via an LED, which is located on the upper right side of an installed board:

Recommended actions

1. Slow blink – No cable is present or the connection is shorted
2. Slow, even blinking – Reversed A and B cable connection
3. Quick flashing – PROFIBUS message detected
4. 1 second blinking – Self-test failure
5. Off – No power or a defective or missing ribbon cable

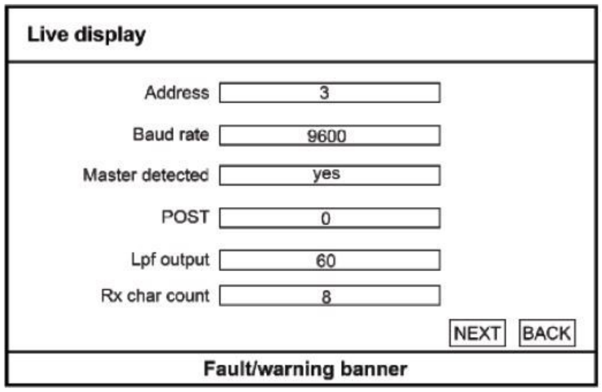
Diagnostic information

Cause

The 56 provides diagnostic information on PROFIBUS communications. To access the ***Live Display*** window:

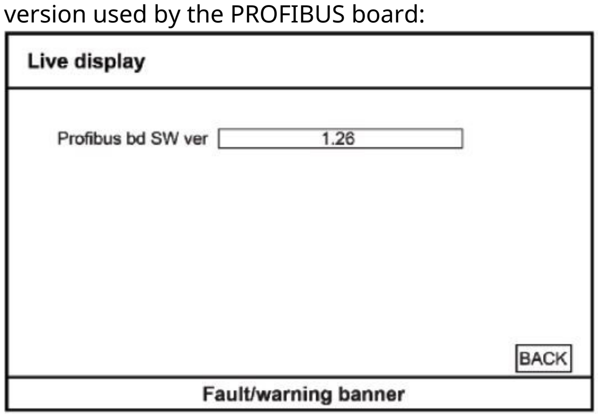
Recommended actions

1. Press the ***INFO*** key.
2. Select ***PROFIBUS information***.



- Address – Displays the address being used by the 56 on the network
- Baud rate – The baud rate of the 56 and the network
- Master detected – If the master is not detected, the host and transmitter are not communicating. Check wiring connections, make sure the addresses match, and try changing the baud rate.
- POST, Lpf output, Rx character count – POST is the power-on self test. POST and the remaining parameters on this window are used as factory diagnostics only.

Pressing the **NEXT** button brings up the final diagnostic parameter, the software version used by the PROFIBUS board:



12.4 Data transmission

General

The 56 uses RS-485 communication technology for transmission. When messages are transmitted on PROFIBUS networks, for word transfer (more than one byte), the high byte is transferred first, followed by the low byte (Big-Endian/Motorola format).

56 modules

The details of measurement modules and relay modules are shown in Table 12-3.

12.4.1 Measurement modules

Table 12-3: Measurement Modules

Module	Module name	Data type	Size bytes	Identifiers
	Signal Input Board 1			
1	PV1 value	float	4	0x41,0x83,0x01
2	PV1 Unit	uint	2	0x41,0x81,0x02
3	PV1 Type	uchar	1	0x41,0x80,0x03
4	Temperature1	float	4	0x41,0x83,0x04
5	Temperature1 Unit	uint	2	0x41,0x81,0x05
	Signal Input Board 2			
6	PV2 Value	float	4	0x41,0x83,0x06
7	PV2 Unit	uint	2	0x41,0x81,0x07
8	PV2 Type	uchar	1	0x41,0x80,0x08
9	Temperature 2	float	4	0x41,0x83,0x09
10	Temperature 2 Unit	uint	2	0x41,0x81,0x0A
	Dual Conductivity Input Boards			
11	Conductivity Ratio	float	4	0x41,0x83,0x0B
12	% Passage	float	4	0x41,0x83,0x0C
13	% Rejection	float	4	0x41,0x83,0x0D
	Dual Flow Input Boards			
14	Flow Recovery	float	4	0x41,0x83,0x0E
15	Flow Difference	float	4	0x41,0x83,0x0F
16	Flow Unit	uint	2	0x41,0x81,0x10

Table 12-4: Measurement Unit Codes and Units

Unit code	Unit	Unit code	Unit	Unit code	Unit
1001	°C	1212	µA	1364	GPH
1002	°F	1213	nA	1423	ppm
1034	m3	1243	mV	1424	ppb

Table 12-4: Measurement Unit Codes and Units *(continued)*

Unit code	Unit	Unit code	Unit	Unit code	Unit
1038	L	1274	pH	1425	ppth
1043	ft3	1281	Ohm	1521	ppb-ppm
1048	Gallon	1282	Gohm	1522	ug//L-mg/L
1059	h	1283	Mohm	1523	None
1060	d	1284	Kohm	1524	% Oxygen in Gas
1061	m.sec	1289	mS	1525	ppm Oxygen in Gas
1067	ft/sec	1290	µS	1526	NTU
1105	g/L	1295	Ohm-cm	1527	FTU
1133	kPa	1302	mS/cm	1528	FNU
1137	bar	1342	%	1551	S/cm
1138	mbar	1349	m3/hour	1552	µS/cm
1140	atm	1352	L/min	1555	M Ohm-cm
1155	in Hg	1353	L/hour	1556	k Ohm-cm
1157	mm Hg	1357	cu ft./min	1558	mg/L
1190	kwatt	1358	cu ft./hour	1559	µg/L
1211	mA	1363	GPM	1560	% Saturation

Table 12-5: Measurement (Primary Variable [PV] 1 and PV 2) Types

Types	Measurement	Types	Measurement
0	Unknown	14	Custom concentration
1	pH	15	Total dissolve solids
2	ORP	16	Salinity
3	Redox	17	Oxygen
4	Ammonia	18	Ozone
5	Fluoride	19	Free chlorine
6	Custom ISE	20	pH independent free
7	Conductivity	21	Chlorine total chlorine
8	Resistivity	22	Chloramine
9	NaOH	23	Flow
10	HCl	24	mA input
11	Low Range H_2SO_4	25	Turbidity
12	High Range H_2SO_4	26	Total suspended solids
13	NaCl	-	-

Measurement modules provide the PV value for each signal board, the PV unit (Table 12-3), and the PV type (Table 12-4).

12.4.2 Relay modules

Table 12-6: Measurement Modules

Module	Module name	Data type	Size bytes	Identifiers
	Relay 1		1	
17	Alarm1 Type	uchar	1	0x41,0x80,0x11
18	Alarm1 State	uchar	1	0x41,0x80,0x12
19	Alarm1 Logic	uchar	1	0x41,0x80,0x13
20	Alarm1 Assignment	uchar	1	0x41,0x80,0x14
21	Alarm1 Simulate Status	uchar	1	0x41,0x80,0x15
	Relay 2			
22	Alarm2 Type	uchar	1	0x41,0x80,0x16
23	Alarm2 State	uchar	1	0x41,0x80,0x17
24	Alarm2 Logic	uchar	1	0x41,0x80,0x18
25	Alarm2 Assignment	uchar	1	0x41,0x80,0x19
26	Alarm2 Simulate Status	uchar	1	0x41,0x80,0x1A
	Relay 3			
27	Alarm3 Type	uchar	1	0x41,0x80,0x1B
28	Alarm3 State	uchar	1	0x41,0x80,0x1C
29	Alarm3 Logic	uchar	1	0x41,0x80,0x1D
30	Alarm3 Assignment	uchar	1	0x41,0x80,0x1E
31	Alarm3 Simulate Status	uchar	1	0x41,0x80,0x1F
	Relay 4			
32	Alarm4 Type	uchar	1	0x41,0x80,0x20
33	Alarm4 State	uchar	1	0x41,0x80,0x21
34	Alarm4 Logic	uchar	1	0x41,0x80,0x22
35	Alarm4 Assignment	uchar	1	0x41,0x80,0x23
36	Alarm4 Simulate Status	uchar	1	0x41,0x80,0x24

Table 12-7: Alarm Types

Alarm type code	Alarm type
0	Set Point Alarm
1	Interval Timer
2	TPC (Duty Cycle)
3	Bleed Alarm
4	Feed Alarm
5	Setpoint Alarm + Delay Timer
6	Date and Time Timer
7	Totalizer Timer

Table 12-7: Alarm Types *(continued)*

Alarm type code	Alarm type
8	Fault Alarm
9	No Alarm Assigned to Relay

Table 12-8: Alarm States

0	Off
1	On

Table 12-9: Alarm Logic

Code	Logic
0	High Alarm
1	Low Alarm
2	USP Alarm (Contacting Conductivity only)

Table 12-10: Alarm Simulation

Code	State
0	Off
1	De-Energize
2	Energize

Table 12-11: Alarm Assignment Codes

Sensor 1	Sensor 2	Variable assigned
1	41	Process variable
2	42	Temperature
4	44	Amperometric sensor current
7	47	Millivolt input
9	49	Glass electrode impedance
11	51	Reference electrode impedance
14	54	Raw conductivity
15	55	Raw resistivity
16	56	Turbidity
18	58	Flow velocity
19	59	Totalized flow
33	73	Free ions

Dual Sensor and Main Board Assignments	
0	Main board temperature
201	Conductivity ratio