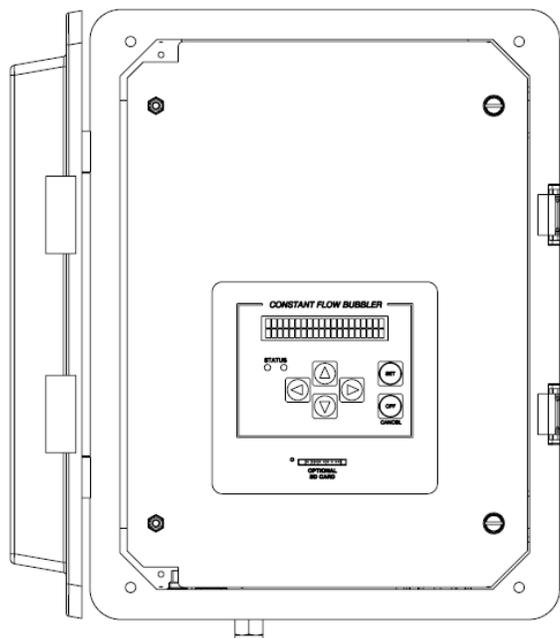




Accubar[®]

Constant Flow Bubble Gauge/Recorder

56-0133



OPERATIONS & MAINTENANCE MANUAL

Part No. 8800-1167
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Introduction

The Sutron Accubar® Continuous Flow (CF) Bubble Gauge/Recorder (part number 56-0133-25-1) is a self-contained, precision device for measuring water levels. The device combines into a single package a pump, tank, manifold, control board, front panel (display and keypad), Accubar sensor, SDI-12 and RS232 interfaces, and enclosure for the purpose of measuring water levels using long established bubble gauge principles.

The Accubar CF Bubble is ideally suited for making water level measurements in rivers, streams, reservoirs, tidal, oceans and industrial areas.

The Bubbler is both a logger and a sensor. It is capable of operating standalone, or connected to another logger. In addition, the Bubbler can be used in conjunction with another water level pressure sensor.

The log inside Bubbler is capable of holding more than 300 000 readings, and allows the recording of status and water level data. The Bubbler has an SDI-12 interface as well as RS232/RS485 so it can provide data to data loggers or communications equipment.

A front panel allows the user to setup the operating parameters, monitor performance, perform tests, and examine the log.

The RS232 port supports a simple command line mode compatible with HyperTerminal and other communications programs. It allows full access to setup, status and data of the Bubbler. The interface makes it easy to connect the Bubbler to a modem or radio.

Features

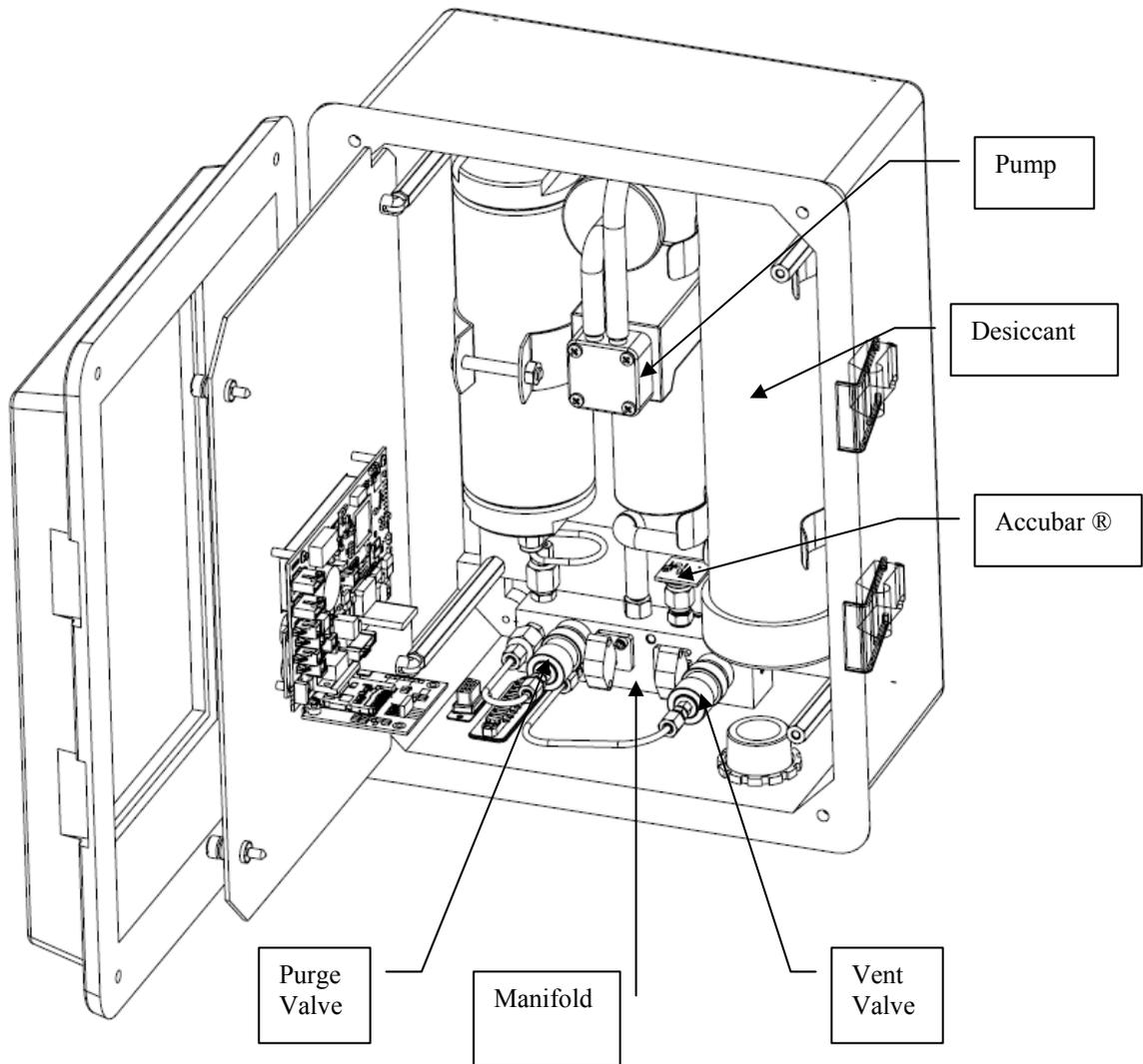
- Self-contained needing only external power and outlet tubing
- Long-life desiccant (up to 1 year depending on local humidity and user set flow rate)
- User-settable bubble rate for varied field conditions
- Built-in, precision Accubar® sensor with auto-zero for even higher accuracy
- Accuracy 0-25ft 0.02%FSO, 26-50 ft. 0.05% reading.
- User-configured averaging to filter out waves.
- User-settable auto purge to keep the outlet clear of debris
- User-settable measurement and logging
- Built-in Flash log for 300,000 readings
- Stand-alone operation or operation with other loggers/communications via SDI-12, RS232 and RS485.
- Swing-out panel for easy maintenance.
- Front panel allows full access to setup, status and data
- Provides redundant data storage when connected to a logger

Unpacking

Remove the Bubbler from the shipping container and visually inspect the unit for signs of damage during shipment. Report any such damage to the factory immediately to ensure a prompt response and resolution. Retain one shipping container in the event a factory return is necessary.

Please note that if a return is required, a return material authorization (RMA) number is required. To get this RMA number, call the Sutron Customer Service Department at 703 406 2800.

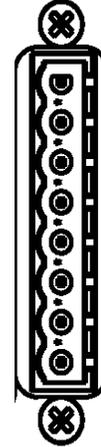
Mechanical Features



Cabling

Terminal Block

Terminal Block	Description	Notes
1	Earth	Earth
2	DATA	SDI-12
3	+12V	SDI-12 (not sufficient to power the Bubbler)
4	GND	SDI-12
5	RS485 A	RS485 A
6	RS485 B	RS485 B
7	+12V	Power 12V (4 amps)
8	GND	Power Ground



Power Connections

The CF Bubbler requires external +12V power to operate. The most common power source for the Bubbler is a lead-acid battery. **Connect the battery to pins 7 and 8 of the external terminal strip.** Use wire that is at least 20 gauge and no longer than 5 feet. If you need longer wires to the battery, use a lower gauge wire. Make sure the power connections (7 and 8) go straight to the battery.

When using the CF Bubbler with a Satlink or other telemetry device, be sure to still connect the battery directly to the Bubbler's power connections. *The Bubbler cannot be fully powered via SDI-12.*

Note: you cannot connect the power to switched or protected voltages on most data loggers because the Bubbler uses too much power (around 4 amps at 12V) when it runs the pump.

For details on Bubbler [battery voltage](#) please refer to page 21.

SDI-12 Connections

The SDI-12 interface has only 3 connections – GND, +12V and Data. Wire these connections directly to the SDI-12 connections on a compatible data recorder or to another SDI-12 device. The sensor is shipped to respond to SDI-12 address 0. The section [SDI-12 Sensor Operation](#) has more details.

Note, if you are operating standalone, you do not need anything connected to the SDI-12 connections.

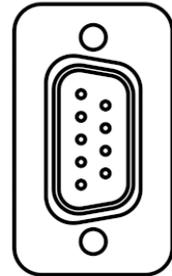
The Bubbler *cannot* be powered via SDI-12.

DB9 Connector

The Bubbler comes with a DB9F connector for connection to RS-232 devices. The DB9F can be connected to the serial port on most PCs using a straight cable. A null modem adapter is needed to connect to most PDAs and [modems](#). There is a [command line interface](#) that allows communication via RS-232 (page 33).

The following table shows the pin assignments in the DB9F connector.

DB9F Pin	Name	Notes
1	N/C	No Connection
2	RXD	Data from CF Bubbler
3	TXD	Data to the CF Bubbler
4	DTR	Signal to the CF Bubbler
5	Ground	
6	N/C	No Connection
7	RTS	Request to Send, signal to the CF Bubbler
8	CTS	Clear to Send, signal from the CF Bubbler
9	VOUT	Jumper selectable for 5V or VBAT (100ma max)



Quick Install

- Vertically [mount the enclosure](#)
- [Insert the tubing](#) into the water
- [Provide power](#)
- Do a [leak test](#)
- [Purge](#) the line
- Customize settings:
 - Setup the [bubble rate](#)
 - Change station name
 - [Set the water level](#)
 - Set [level units](#)
 - Change [automeasure](#) schedule

For [complete installation details](#), please turn to page 39.

Standalone Quick Install

The Bubbler starts measuring and collecting data as soon as it is powered up. By default, the Bubbler will measure and log water level every 15 minutes; each reading is averaged for 10 seconds. All of these settings and more can be changed – please [refer to page 17](#) to learn more about how the unit measures.

Quick Install with a Logger

Bubbler can be connected to other devices via either SDI-12, RS-485 and RS232.

- For SDI-12 operation, connect the three wire interface to the properly labeled pins on the Bubbler and setup the logger to periodically collect data from the sensor. The first parameter of the M! command will provide the water level. For more details on SDI-12, please refer to the [SDI-12 Sensor Operation](#) section of the manual.
- If connecting using the RS232 port, the data can be polled from the Bubbler, or it can be automatically output by the Bubbler. Setup the connected device (which may be a logger, a modem, or even a direct connection to a PC running HyperTerminal) for 115200 baud, 8 data bits, no parity (the baud rate can be changed via the front panel [Setup > Other Settings > Baud Rate](#)).
 - To poll for data, have the connected device issue a carriage return, wait for prompt, issue the ASCII command “!MEAS” followed by a carriage return, and capture the returned data. The first data item returned is the water level.
 - To capture data, setup the Bubbler for *auto output* via the front panel [Setup->Other Settings->Auto Output](#). Once setup, the Bubbler will periodically output the water level in ASCII.

Please refer to the section [RS232 Command Line Interface](#) on page 33 for more details.

Redundant Data Collection

- Connect the Bubbler via SDI-12 to a logger and setup the logger to get data from the Bubbler.
- Provide a power supply to the Bubbler (via the Battery connector).
- With this setup, if the logger malfunctions, the Bubbler will keep on collecting data.

Setup and Operation

Principles of Bubbler Operation

The Accubar CF Bubble is ideally suited for making water level measurements in rivers, streams, reservoirs, tidal, oceans and industrial areas.

A bubble gauge operates by generating pressure in a line sufficient to produce bubbles out the end of tube placed in the water. When the rate of bubbles is sufficiently small, the pressure in the line is static so that the pressure at the orifice is the same as the pressure at the other end of the tube in the instrument itself. A sensor can then measure the pressure without having to install the sensor in the water.

Pressure Maintenance

Since air is always leaving the tank, the system will need to periodically operate the pump, just to keep the differential pressure within limits. As the water level rises, the differential pressure will be reduced and the pump is operated to restore the differential pressure to proper limits. As the water level goes down, there is no need to operate the pump because surplus air (pressure) simply escapes through the line.

Bubble Rate

The bubble rate is the measure of the amount of air going down the orifice line per unit of time. The Sutron Bubbler supports two units for bubble rate: Bubbles per minute (BPM) and Standard Cubic Centimeters per Minute (SCCM). The higher the bubble rate, the more air will flow down the line.

The Bubbler rate can be configured by the user: use [Station Setup > Bubbler Setup > Bubble Rate](#), SDI -12 [XBF](#), or [BUBBLE RATE](#) command line.

The correct bubble rate is station dependent.

- **Sites measuring a deeper water level will require a higher bubble rate.**

If the bubble rate is too low, the Bubbler will not be able to overcome the pressure exerted by the water onto the air in the orifice line. This will result in no bubbles going out and an erroneous water level reading.

A rapidly rising water level will not be immediately detected by the Bubbler. If a fast reaction time to water level changes is required, a higher bubble rate will be needed.

- **Sites with rapidly changing water levels will require a higher bubble rate.**

The higher the bubble rate, the more power the Bubbler will require.

The bubble rate for a site with slowly changing levels is typically 60 bubbles per minute out of a 1/8 ID tube. This corresponds to a flow of about 7.5 standard cubic centimeters per minute (SCCM). The main device in the CF bubbler that governs the flow is a flow restrictor installed in the manifold. This flow restrictor is designed to give a specific flow based on the differential pressure it sees. For example, if there is a differential of 5 PSI across the restrictor, the flow will be 6 SCCM. At 10 PSI, the flow will be 12 SCCM. The way the bubbler maintains the flow at the desired value is to monitor this differential pressure and increase the pressure when it falls out of limit. The bubbler does this by turning on a pump to add pressure to a tank.

Note: the setting of the bubble rate is identical to how the bubble rate is set in conoflo type bubble gauges that have been used for many years.

Pump Run Time

The Bubbler tracks the cumulative pump on time. That is the total amount of time that the pump has been running. It is possible to reset the pump run time.

To view the pump run time, go to [Diagnostic > Pump Run Time](#), or. To reset the pump run time, press SET when viewing it via front panel, or type *DIAGNOSTIC 0* via command line.

Bubbler Internal Sensors

The Bubbler uses several internal sensors to maintain pressure. There is a tank sensor, which measures the air pressure inside the tank, and a restrictor sensor, which measures the pressure drop across the internal restrictor.

Tank pressure can be found on the top level of the front panel menu. Both restrictor and tank pressure can be seen on the [Diagnostic](#) menu, via [SDI-12 M8](#) and via [INTERNAL](#) command.

Purge

The purpose of the purge is to clear the orifice line of any obstructions, such as dirt and silt.

Purging turns on the pump and builds to *purge pressure* (default 50 PSI) and then opens the restrictor bypass valve to force the pressurized air to the outlet. The pump will continue to run for *purge duration*, turn off, and allow the pressure to bleed out the line.

To change purge pressure and duration, go to [Station Setup > Bubbler Setup](#), or type *PURGE PRESSURE* and *PURGE DURATION* via command line.

To start a purge, use [Diagnostic > Purge](#), [SDI-12 M9](#), [PURGE NOW](#) command line.

During a purge, the Accubar will not be able to measure water level. This is because the pressure in the orifice line is not caused by the water, but by the Bubbler itself. You may see missing Accubar data or data marked 'Reading old' during a purge.

AutoPurge

A purge may be done automatically by the Bubbler. It can be done periodically, whenever the Bubbler detects a blockage, and whenever initiated by the user.

If you would like for the Bubbler to periodically purge, enable *AutoPurge* ([Station Setup > Bubbler Setup > AutoPurge Enable](#) or type *AUTOPURGE ENABLE*). To tell the Bubbler how often to purge, use the *AutoPurge Interval* setting.

Blockage Detection

Blockage detection refers to the Bubbler's ability to automatically detect when the orifice line is blocked and initiate a purge, thus cleaning the line of the blockage. For example, if the line fills up with sand or silt, it could prevent the water level sensor from properly measuring the water level. The Bubbler can detect that condition and automatically purge the line of obstruction.

When the orifice line is blocked, the pressure inside the line will build up. Initially, the Bubbler will think that the water level is rising and compensate by increasing the tank pressure. If this continues, the pressure in the line will increase to its upper limit and the system will stop pumping in order not to overpressure. To prevent this scenario, make sure to enable Bubbler's *blockage detection*.

If you would like for the Bubbler to automatically detect blockage and purge, enable *Blockage Detection* ([Station Setup > Bubbler Setup > Blockage Detection](#) or type *BLOCKAGE DETECTION*). Also setup *Blocked Flow* and *Blocked Pressure*.

This is the algorithm that detects blockage: if the pressure across the Bubbler's internal restrictor pressure sensor is less than the user set *blocked flow*, and if the pressure in the orifice line is greater than *blocked pressure*, a blockage has occurred.

What this means is that if that the pressure inside the line (*blocked pressure*) is very high and the air flow through the line (*blocked flow*) is very low, the line is blocked.

Set *blocked pressure* to a value that is higher than the highest pressure that can be caused by the water level being measured. If the *blocked pressure* is set too high, the system may never reach that pressure because the system tries not to overpressure (it will not operate the pump if the pressure is too high).

Set *blocked flow* to a small value like 2PSI (which roughly corresponds to 2SCCM). The flow sensor is accurate to +/- 1PSI, and minimum flow is 5PSI (about 5SCCM). A small value indicates that not enough air is flowing through the line.

For example, if *blocked pressure* is 15PSI and *blocked flow* is 2PSI, a purge will occur if the pressure in the orifice line is greater than 15PSI and the flow is less 2PSI.

Please note that neither AutoPurge nor Blockage Detection can cause a purge more frequently than once an hour.

Leak Test

Leaks inside the Bubbler can be a source of inaccuracy and/or excessive pumping and use of desiccant. To check for leaks, you must cap the outlet or orifice and run the built-in leak test.

Sutron provides a cap with each unit that can be used to cap the outlet for the leak test. When the leak test completes, the system will display a status indicating whether the unit has passed or failed the leak test along with a score.

To start a leak test, use [Diagnostic > Leak Test](#), or [LEAK TEST](#) via command line.

Starting the Bubbler

The Bubbler starts operating as soon as power is applied. The display will turn on. If an Accubar is installed, measurement will commence and the front panel will be updated with a water level reading. While the bubbler is operating, the status LED will flash occasionally to let you know that the bubbler is operational.

Green LED	flashes every five seconds to indicate the Bubbler is operating normally
Red LED	flashes if the Bubbler has encountered a problem

Accubar Pressure Sensor

The Accubar is a pressure sensor inside the Bubbler. It is used to measure the pressure in the orifice line. That pressure can be translated into a water level reading.

The true reading made by the Accubar is a differential pressure – the pressure difference between atmospheric pressure and pressure in the orifice line. The Accubar is a vented sensor.

Each Accubar sensor is calibrated independently of the Bubbler. On each Accubar there is a sensor, an analog to digital converter, and a secure chip containing the calibration data. Every Accubar has a unique sensor ID.

To view the Accubar ID, use [Diagnostic > Accubar ID](#), [SDI-12 XAI](#), or [DIAGNOSTIC](#) via command line.

The Accubar is a plug and play part, meaning that it can be easily replaced without disturbing the rest of the Bubbler system.

Disabling the Accubar and water level measurements can only be accomplished by physically disconnecting the sensor from the board. Before you disconnect the Accubar, please consider the fact that the Accubar is a very low power device that does not interfere with the pressure maintenance of the Bubbler. Plus, the Accubar will provide water level data which may be of use if the external sensor fails.

Autozero

Even though the Accubar sensor is very accurate and stable, it still exhibits a small amount of drift in the "zero". A sensor's accuracy depends completely on the stability of the zero and span. Any error in the zero becomes an error in the final water level. Even though sensors are calibrated at the factory for zero, they all drift and introduce error into the water level. The CF Bubbler Accubar features an autozero ability that eliminates the errors due to a drift in zero resulting in more accurate water level readings.

The Bubbler will automatically autozero the Accubar every 15 minutes. The autozero will take approximately half a minute to complete. During this time, the sensor is vented to the atmosphere so that both sides of the sensor are at identical atmospheric pressure. If you have setup the Bubbler to measure more often than every 30 seconds, you may see missing data or data marked 'Reading old' every 15 minutes – this is due to the autozero.

Autozeroing can be disabled by [enabling the external sensor](#) (page 20).

To view the Accubar autozero, use SDI-12 [V](#), or [DIAGNOSTIC](#) via command line.

Measuring Water Level

The Bubbler uses the Accubar sensor to measure water level. If no Accubar is installed, the water level will not be measured. The water level is the first reading shown on the [front panel](#) when the station is powered up.

The Accubar is a pressure sensor. It will measure the difference between the pressure in the orifice line and atmospheric pressure. Water level is computed from that pressure difference.

The Bubbler will take multiple Accubar samples and compute an averaged water level from them. If there is a problem when measuring, the quality of the water level will be bad. A bad quality is indicated with a [“?” after the reading](#) if using the front panel. The [command line interface](#) will say 'error', and SDI-12 will indicate an [invalid reading](#).

It is normal to see bad quality right after power up, while the Bubbler is still computing the first reading. However, if it occurs at other times, it is most likely due to failure of the Accubar sensor. In this case the Accubar sensor will need to be [replaced](#) (see page 44).

To see the water level, use the first menu shown on the [front panel](#); Via command line, use the [MEAS](#) command. Via SDI-12, use the [M command](#).

Measurement Name

The reading made by the Bubbler is that of water level. This manual refers to the reading as 'water level' There is a setting called *measurement name* that allows the user to name the reading something else, such as 'stage'.

Measurement name can be viewed and changed via [Station Setup > Accubar Setup](#) or via the [MEASUREMENT NAME](#) command line.

Setting Water Level

When the Bubbler is first installed, it will display an absolute water level based on the water pressure. The user will then typically read the current water level off a staff gauge and then set this level into the Bubbler.

To set the water level via front panel, power up the Bubbler, wait for it to show a water level reading, and then press SET. Enter the correct water level and press set again. It is also possible to use SDI-12 [XS command](#) and command line [LEVEL](#) to set the water level.

Field Calibration Offset

$$\text{Water Level} = \text{Accubar reading in chosen units} + \text{field calibration offset}$$

The field calibration offset can be viewed and changed via [Station Setup > Accubar Setup](#), via SDI-12 [XE](#), or via [FIELD CAL OFFSET](#) command.

Level Units

Bubbler can report water level readings in feet, PSI, kPa, centimeters, meters, millimeters, or user units.

$$\text{Water Level} = \text{Accubar reading in chosen units} + \text{field calibration offset}$$

To change level units, use [Station Setup > Accubar Setup > Level Units](#), SDI-12 [XUP](#), or [LEVEL UNITS](#) command.

User units are defined using the fields User slope and user offset. If user units are chosen:

$$\text{Water Level} = (\text{Accubar reading in PSI} * \text{user slope}) + \text{user offset} + \text{field calibration offset}$$

To change user slope and offset, use [Station Setup > Accubar Setup > User Slope](#), SDI-12 [XUU](#), or [USER SLOPE](#) and [USER OFFSET](#) commands.

Right Digits

The number of digits shown after the decimal place is referred to as the right digits. If you would like the water level to read 10.12 rather than 10.12345, please set the right digits to 2.

To change right digits, use [Station Setup > Accubar Setup > Right Digits](#), SDI-12 [XUP](#), or [RIGHT DIGITS](#) command.

Temperature

The Accubar sensor has an internal temperature sensor. Please keep in mind that this is the temperature inside the Bubbler which is not the same as the temperature outside. The temperature is displayed in user's choice of Celsius or Fahrenheit.

To view Accubar temperature, use [Diagnostic > Accubar w/o offset](#), SDI-12 [M6](#), or use the [MEAS](#) command. To change Accubar temperature units, use [Station Setup > Accubar Setup](#), SDI-12 [XUT](#), or [TEMP UNITS](#) command.

Automeasure

Automeasure refers to the Bubbler's ability to automatically measure and log water level data. The user can determine when this will occur by changing the *automeasure interval and time*. Automeasure may not be turned off.

Automeasure time and interval determine when the Bubbler measures and logs data.

- *E.g. Automeasure time 00:00:00 interval 00:10:00*
 - 00:10:00 data measured and logged
 - 00:20:00 data measured and logged
 - 00:30:00 data measured and logged
 - and every ten minutes afterwards...
- *E.g. Automeasure time 00:00:30 interval 00:05:00*
 - 00:00:30 data measured and logged
 - 00:05:30 data measured and logged
 - 00:10:30 data measured and logged
 - and every five minutes afterwards...

To change automeasure interval and time, use [Station Setup > Accubar Setup](#), or `AUTOMEASURE INTERVAL` and `ATUOMEASURE TIME` commands.

The last measurement made by automeasure is called [last automeasured](#)– please see page 18.

Operating Mode

There are two operating modes: normal and continuous:

- In **normal mode**, Bubbler spends its time in low power mode until it is time to measure. Once the measurement is complete, Bubbler goes back to low power mode. This is the most commonly used mode and is recommended unless the Bubbler will be measuring very frequently.
- In the **continuous mode**, Bubbler is constantly collecting data. When it is time to measure, Bubbler will use the previously collected data to instantly come up with a water level reading. Bubbler does not go into low power in continuous mode. The continuous mode adds about 10 mA to the quiescent power consumption compared with 0.25mA in the normal mode.

These examples illustrate the difference between continuous and normal modes:

Normal mode with 10 second averaging:

1. 12:00:00 measure command is received (via SDI-12, front panel, RS232, or automeasure)
2. 12:00:00 sensors are powered on and measurement starts
3. 12:00:11 measurement completes with data collected between 12:00:00 and 12:00:10
4. 12:00:11 sensors are powered down

Continuous mode with 10 second averaging (sensors are powered on all the time):

1. 12:00:00 measure command is received (via SDI-12, front panel, RS232, or automeasure)
2. 12:00:00 measurement completes with data collected from 11:59:50 to 12:00:00

Desired Effect	Appropriate Mode
Low power consumption	Normal mode
Low power consumption and immediately ready data	Normal mode, use last measured readings (page 18)
Immediately ready and current data	Continuous mode
Very frequent measurements (every 15 seconds or less)	Continuous mode

Operating mode can be changed via front panel [Station Setup > Accubar Setup](#), via SDI-12 [XOM](#) and via `OPERATING MODE` command line

Averaging Time

Every time the Bubbler measures it will collect samples for a user defined period in order to produce a water level reading: this time period is called the averaging time. The setup variable *avg time* controls the averaging time. It is not possible to specify a number of samples, only the averaging time.

Averaging time can be changed via front panel [Station Setup > Accubar Setup](#), via SDI-12 [XT](#), and via [AVG TIME](#) command line.

Last Automeasured

Water level measurements made by the Bubbler are not instantaneous; how long they take depends on [averaging time](#) (page 17). When a logger is communicating with the Bubbler, it can ask the Bubbler to make a new measurement. However, the logger then has to wait for the Bubbler to complete the measurement.

If the user desires data that is instantly available, the Bubbler provides last measured data. The Bubbler automatically measures based on the [automeasure](#) interval (see page 17) . That data can be retrieved as the last measured data.

For example, if Bubbler is setup to automeasure every 10 minutes, with an averaging time of 10 seconds:

- 12:00:00 to 12:00:10 Bubbler measures water level
- 12:01:00 logger asks for last measured data; Bubbler immediately returns 12:00:10 data
- 12:10:00 to 12:10:10 Bubbler measures water level
- 12:11:00 logger asks for last measured data; Bubbler immediately returns 12:10:10 data

If the user desires data that is both immediately available and current, [continuous mode](#) (page 17) is the way to go.

Last measured data can be accessed via [SDI-12 M2](#) and via [LAST](#) command.

Logging

A secure flash chip in the Bubbler provides a logging capacity of more than 300,000 entries. Data will *not* be lost if power is removed. Once the log is full, the oldest data will be overwritten.

Each log entry consists of

- date and time (with a second resolution)
- name (e.g. Water Level)
- measurement reading (optional)
- measurement quality and units (optional)

Here are several examples of log entries:

- Water Level,10/11/2006,10:00:00,3.08,feet,
- Setup Change,10/10/2006,16:22:33,
- Reset Powerup,11/09/2006,15:52:17,1,

Minimally, Bubbler will log water level and various events. The user can decide how often to log water level (via [automeasure settings](#) see page 17).

There is not a means of erasing data from the log.

Events

Occasionally, the Bubbler will log events. Events are used to help troubleshoot the data.

The following actions will cause the Bubbler to log an event:

- Setup change (whenever any setting is changed)
- Log download (whenever the log is downloaded)
- Display On and Display off (whenever the user wakes the unit up by pressing a button)
- Command line enter (whenever the user connects via the RS232 port)
- Reset (log contains reset type and count)
- Errors (such as low battery and sensor failure)
- Before cal and after cal (logged whenever the user sets the water level to record the water level before and after the calibration)
- Log in events (if [password](#) is enabled), including failure to log in.

Downloading the Log

To logged data may be accessed via the front panel, via the RS-232 interface, and via an [SD card](#). SDI-12 does not provide access to the log

The log can be examined via the front panel (the [Logged Data](#) menu), or downloaded via command line (using the [LOG](#) command).

When downloading the log, the whole log or only parts of it can be downloaded. In addition, the Bubbler remembers the last log download and will allow downloads ‘since last download’, which means that the only parts of the log downloaded are those that have not been previously downloaded.

Logged Measurement Time

Measurements are not instant. Once initiated, a Bubbler measurement will take the user defined [averaging time](#) plus some overhead to complete. For example, a measurement that starts at 12:00:00, with an averaging time of 10 seconds will complete at about 12:00:11. That measurement will be logged with 12:00:00 as the timestamp. **The timestamp of the logged measurement is the time the measurement was started.**

Log Daily Values

The Bubbler can log diagnostic information at 23:59:59 each day. That information consists of [battery voltage](#), battery under load, [tank pressure](#), [pump run time](#), and Accubar [autozero](#)

Control of the log daily values setting: ([Station Setup > Other Setup > Log Daily Values](#), [LOG DAILY VALUES](#) command).

SD Card Interface

The Bubbler supports SD card usage for downloading logged data and setup changes. An SD card is a portable media storage that is widely available on the commercial market. MMC cards may also be used with the Bubbler.

SD Card Log Download

To download the log using an SD card, simply plug the card in.

- If the front panel is off when the card is plugged in, an automatic log download will start in 10 seconds. The automatic download will download since last download.
- If the display is on when the card is plugged in, the download log menu will appear. Navigate the menus and choose the appropriate [log download type](#).

There is a red LED that will light up while the SD card is in use. Please do not remove the card when it is in use.

Automatic Log Backup

If an SD card is left plugged in, the unit will perform an automatic backup of the log to the SD card. All the user needs to do is leave the SD card plugged in, and the Bubbler will periodically download the log and save it to a file on the SD card.

With an SD card left plugged in, four hours after the user stops using the display, and every four hours afterwards, the unit will download the logged data and append it to a file. Once the file exceeds about 2MB, a new file will be started. The backup will work until the SD card gets full, at which point it stops downloading.

When visiting the station for maintenance to retrieve the log, it is only necessary to remove the card that was left plugged in.

Setup and SD Cards

It is possible to save the current setup to an SD card. [SD Card Operations > Write Bubbler Setup to Card](#).

A setup saved to the SD card can be transferred to a PC using an SD card reader. A setup file can be edited using a text editor on a PC (such as Notepad). Once settings are changed, the file can be saved to the SD card and sent to the Bubbler, changing the Bubbler's setup.

Setup files on an SD card can be sent to the Bubbler using the [SD Card Operations > Read Bubbler Setup From Card](#) menu.

Setup

The Bubbler's setup is stored in secure memory, meaning it will not be lost if power is removed (for any time period). The setup of the Bubbler is broken into sections: Bubbler Setup, Accubar Setup, and Other Setup. All setup can be changed through any interface: [SDI-12](#), [front panel](#) or [RS232 command line](#).

Setting the setup to defaults will reset all the settings to factory defaults. Access is provided via [Station Setup > Other Setup > Default Setup](#), SDI-12 [XFD](#), and SETUP DEFAULTS command.

The whole setup may be saved to file using the [command line interface](#) or using an [SD card](#). A setup file can be edited using a text editor on a PC (such as Notepad). Once settings are changed, the file can be sent to the Bubbler via the [command line interface](#) or via an [SD card](#).

Connecting Bubbler to a Logger

The Bubbler will measure on its own schedule regardless of whether it is connected to another logger. This ensures redundancy of logged data. If the connected logger malfunctions, the Bubbler will keep collecting data.

The digital SDI-12 interface allows for a standardized connection to a logger. Please note that SDI-12 cannot provide power to the Bubbler – make sure to use the [proper power connection](#) (page 9). For full details on SDI-12, please refer to [the section](#) on page **Error! Bookmark not defined.**

The Bubbler can be attached to a telemetry device, such as a [modem](#), via its [RS232 port](#). Bubbler allows full access to status, setup and data via the RS232 port, using the command line interface detailed on page 33). Loggers that do not support SDI-12 should interface via the RS232 port.

To ensure that the logs of the Bubbler and the attached logger match (as far as water level goes), make sure that the [automeasure time and interval](#) of the Bubbler are the same as the measurement time and interval of the logger.

Ensure that the time of the Bubbler and logger match by [changing the time](#) of either one (page 21).

Satlink and Bubbler

When connecting a Bubbler to a Satlink, use the SDI-12 connection. Setup Satlink for an SDI-12 measurement (please see the Satlink manual for details). Make sure that Satlink measurement time and interval match the Bubbler's [automeasure time and interval](#).

Satlink will automatically synchronize the Bubbler's clock via SDI-12. This will happen as soon as Satlink is started; Satlink will then periodically ensure that Bubbler and Satlink clocks are in sync.

Connecting an External Sensor

A different pressure sensor may be used in conjunction with the Bubbler. In this scenario, the Bubbler provides the pressure required to keep the bubbles flowing down the orifice line, and the external sensor measures the pressure in the orifice.

Tell the Bubbler that an external sensor is present via [Station Setup > Accubar Setup > External Sensor](#), or via EXTERNAL SENSOR command.

Enabling the external sensor will disable Accubar [autozero](#); otherwise, the external sensor will see a pressure of 0 every time the autozero is performed.

Bubbler Time

Bubbler time can be viewed and set via the front panel [top level menu](#), via the SDI-12 [XDT command](#), or by using the [TIME](#) command line.

Bubbler sports an RTC (real time clock) backed by an internal battery. The RTC keep ticking even if the main battery to the Bubbler is removed. The RTC will, at worst case, drift ± 2 minutes per month (0 to +50C). The lifetime of the RTC battery is about 5 years.

Battery Voltage

Bubbler must be powered via the power connector, or via both for redundant power (see page 9 for [connection details](#)).

When reporting battery voltage, Bubbler will report the two voltages: battery voltage when the pump is off, and battery voltage when the pump is on (also called battery voltage under load). Battery voltage can be read from the [front panel](#), SDI-12 [M1](#), or [BATT](#) command.

The Bubbler can log the battery voltage once a day – please see the section about [logging daily values](#) on page 19.

Cut-off Voltage

Before the Bubbler turns on the pump, it will check the battery voltage. If that battery voltage is less than 10.0V, the operation will be aborted, (and an error recorded). Likewise, while the pump is running, if the battery voltage drops below 8.0V, the operation will be aborted.

Every time an Accubar measurement is made, the battery voltage is checked. If the voltage is less than 10.0V, the measurement will proceed, but the result will be marked with a battery low flag.

The red LED will come on whenever the battery voltage is less than required, indicating that the battery should be changed.

Password

You can enable password protection by configuring a password. If password protection is enabled, the user is allowed view setup and data. However, no changes to setup will be allowed until a password is entered. A password prompt will automatically appear whenever a setup change is attempted.

Via front panel, go to [Station Setup->Other Setup->Password](#). Press set and enter a password. Press set again and the password will be enabled.

Using the command line, type "PASSWORD = XXX" to set password to XXX. Type "PASSWORD =" to disable password usage.

To disable the password, enter a blank password.

Logging out is accomplished by turning off the display, by typing EXIT in the command line, or by powering down the unit.

SDI-12 is unaffected by password protection.

If you forget the password and want to clear it, reset the unit and press and hold the DOWN key. You must keep the key pressed until you see the message “Password Cleared” appear on the front panel.

Front Panel Interface

The Bubbler features a two line LCD interface, six buttons and two LEDs. The front panel interface can be used to setup the station, examine it's status, view the current measurements, and view logged data.

Navigating the Menu

The menu has a tree structure, like directories in an operating system.

1. The [Bubbler menu tree](#) (page 24) can be navigated with the arrow keys. Press ▲ (UP) and ▼ (DOWN) to browse the menu items that are on the same level. On certain menus, press ► (RIGHT) to enter a sub menu, and ◀ (LEFT) to go up to the parent menu.
2. Some menu items offer a means to change setup. To change a value press SET. The prompt will change and a flashing cursor will appear. You can then use the arrow keys to select a different value.
3. Once you have the desired value on the display, press SET again to make the change permanent or to cancel a change, press the OFF/CANCEL button.
4. In the case where there are only two possible values for a setting, pressing SET will flip-flop between the values and the change is made immediately.

Front panel key functions

- a. RIGHT will navigate to a sub-menu (assuming there is one).
- b. LEFT will go back to the parent menu.
- c. UP and DOWN will navigate among the menus on the same level.
- d. SET starts a change or confirms an action.
- e. CANCEL cancels a change or action. The CANCEL key is also labeled OFF.
- f. CANCEL also goes back levels.
- g. Hold CANCEL to go to the top of the menu.
- h. Hold UP or DOWN to change contrast setting.
- i. Hold SET turn on backlight

Turning Display On/Off

The Bubbler will continue to measure and log data as long as a good battery is connected. The display turns off automatically after 5 minutes of inactivity in order to conserve power. The display can be turned on at any time by pressing any key.

To turn off the display, press the OFF/CANCEL button. You may need to press it several times to exit out of some menus first. Holding the OFF/ CANCEL button in any menu will turn off the display.

Backlight

The display is equipped with a backlight to assist in viewing in many different lighting conditions. To turn on the backlight, press and hold the SET button until the backlight turns on. The backlight will turn off automatically when the display is turned off.

Contrast

If it becomes difficult to read the display, you may need to adjust the contrast. To set the contrast, press and hold the UP or DOWN arrow buttons until you see the CONTRAST prompt and keep holding the button until the display is readable. If the display becomes too dark or too light, press the opposite arrow key to reverse the contrast. Once the display is readable, release the arrow, and this setting will be stored for the next time the display is turned on.

Viewing Current Data

When the display is turned on, the last measured water level will display. The Bubbler will then initiate a new measurement and display the results as soon as the measurement completes (which is based on [averaging time](#)). As long as the water level menu is displayed, live readings will be continuously made

Understanding the “?” indicator.

If the Bubbler display a “?” after a value if there is a question about the [quality of the data](#). It is normal to see the ? right after power up, while the Bubbler is still computing the first readings. However, if it occurs at other times, it is most likely due to failure of the Accubar sensor. In this case the Accubar sensor will need to be [replaced](#) (see page 44).

If there are errors, the message ‘Hardware Error’ will be displayed when the front panel is turned on. In that case, you may press RIGHT for details. You may then press SET to clear the errors.

Front Panel Menu Tree

- Errors (only show if errors are present)
 - Hardware error details
 - [Accubar Water Level](#) (live) and time of reading -- Press set to calibrate
 - [Tank Pressure](#) (live)
 - [Battery Voltage](#) (live)
 - [GPS*](#) (when Garmin GPS is enabled)
 - GPS Status
 - GPS Time of Last Sync
 - Local Time Offset
- [Logged Data](#)
 - Logged Water Level
 - Logged Events
 - All Logged Data
- Station Setup
 - [Bubbler Setup](#)
 - [Bubble Rate](#)
 - [Bubble Units](#)
 - [AutoPurge Enable](#)
 - [AutoPurge Interval](#)
 - [Purge Pressure](#)
 - [Purge Length](#)
 - [Blockage Detection](#)
 - [Blocked Flow](#)
 - [Blocked Pressure](#)
 - Accubar Setup
 - [Automeasure Interval](#)
 - [Automeasure Time](#)
 - [Operating Mode \(Normal | Continuous\)](#)
 - [Averaging Time](#)
 - [Level Units](#)
 - [Level Right Digits](#)
 - [Temperature Units](#)
 - [User Slope \(user units only\)*](#)
 - [User Offset \(user units only\)*](#)
 - [External Sensor](#)
 - [Field Calibration Offset](#)
 - [Measurement Name](#)
 - Other Setup
 - Station Name
 - [Password](#)
 - [Default Setup](#)
 - [Baud Rate](#) (for RS232)
 - [Auto Output](#)
 - [SDI-12 Address](#)
 - [Log Daily Values](#)
- [SD Card Operations](#)
 - [Download Log](#)
 - [Read Setup From SD Card](#)
 - [Write Setup to SD Card](#)
 - Format SD Card
- Diagnostics
 - [Purge](#)
 - [Last Purge Results](#)
 - [Leak Test](#)

[Last Leak Test Results](#)

[Accubar Pressure Without Field Calibration Offset and Accubar Temperature](#)

[Tank and Restrictor Pressure](#)

[Pump Run Time](#)

[Accubar ID](#)

Software Version

Station Name and Time

SDI-12 Sensor Operation

The CF Bubble Gauge can function as an SDI-12 Sensor. This allows the CF Bubbler to connect to another data logger or transmitter to provide the data when requested. If you are not using the Bubbler with another data recorder or transmitter, you can skip this section.

For details on [SDI-12 wiring](#), please refer to page 9.

The most common SDI-12 command used with the Bubbler is the “M” measure command followed by the “D0” command. The “M” command requests the Bubbler to make a measurement and the “D0” command gets the data. While there are a lot of other commands available, most users will simply use the M, D0 commands.

The remainder of this section documents all the SDI-12 commands supported by the Bubbler. Note that most any setting that can be changed from the front panel, can also be changed via SDI-12.

SDI-12 Reference

The Bubbler will respond to all standard SDI-12 commands. To use the SDI-12 commands you must have a data logger or interface that supports the SDI-12 standard. More details on the SDI-12 interface can be found at <http://www.sdi-12.org>.

The Bubbler is compliant with SDI-12 Specifications version 1.3, with the exception of being able to abort measurements. If a measurement command is issued to the Bubbler, the Bubbler will proceed to measure. If the measurement is aborted (by issuing an SDI-12 break), the Bubbler will not issue a service request after it completes the measurement. However, the Bubbler will not abort the measurement. After the measurement abort is issued, other commands may be issued to the Bubbler, and the Bubbler will respond to them properly.

The general form of an SDI-12 command is:

aC!<CR><LF>

where a is the sensor address 0-9,A-Z,a-z,*, ?. (Addresses * and ? will address any sensor, regardless of its address.)

C is the command and ! is the last character of the command.

Note on validity: Some SDI-12 water level readings will return a validity flag.

The **validity** can be

- 0 - valid
- 1 - sensor failure
- 2 - reading old (returned data is from a previous reading)

Why would the reading be old? The Bubbler may have been doing a purge or an autozero which prevents the Accubar sensor from measuring.

The standard SDI commands are as follows

	Name	Command(s)	Response	Example/Notes
	Acknowledge Active	a!	A	
I	Send Identification	a!	a13 SUTRON 1.0 CFBBLRssssssV1.03 Where 1.0 is the board revision, ssssss is the Accubar ® serial number and V1.03 is	

	Name	Command(s)	Response	Example/Notes
			the software revision	
A	Change Address	aAb!	B	Changes address to b
?	Address Query	?!	A	
M MC C CC	Measure Accubar water level	aM! aD0!	Attn a + level (pg 15) + units (see XUP pg 29) +level validity (pg 26)	Returns the water level in user specified units.
M1 MC1 C1 CC1	Measure water level in PSI (does not apply field calibration offset) and battery voltage	aM1! aD0!	Attn a + level (pg 15) in PSI + temperature (pg 16) in Celsius + battery voltage (pg 21) + battery under load (pg 21) +level validity (pg 26)	Diagnostic command used to see the unmodified Accubar reading, Accubar temperature, current battery voltage, and battery voltage under load (during pump on)
M2 MC2 C2 CC2	Get last automeasured Accubar water level.	aM2! aD0!	Attn a + level (pg 15) + units (see XUP pg 29) +age +level validity (pg 26)	Retrieves the last measured water level during an automeasure. Age is the number of seconds since the reading was made.
M6 MC6 C6 CC6	Measure Accubar water level and temperature	aM6! aD0!	Attn a + temperature (pg 16) + temperature units (pg 29) + level (pg 15) +level units (see XUP pg 29) +level validity (pg 26)	The temperature and water level are provided in user chosen units.
M8 MC8 C8 CC8	Measure Bubbler internal sensors	aM8! aD0!	Attn a + restrictor pressure (pg 13) + tank pressure (pg 13) + temperature (pg 13) + validity (pg 26)	The provided readings are of the Bubbler's internal sensors. Measurements are in units of PSI and C.
M9 MC9 C9 CC9 R9	Purge Now	aM9! 0D0!	Attn a +duration +pumptime +success	This command requests a purge be done now. The response to the M command will tell how long the purge will last. The data provided is the result of the last purge: duration is how long the purge took in seconds, pump time is how long the pump was on during the purge in seconds, and success is zero if the purge completed successfully.
V	Verification	aV!	A +error count	Diagnostic results tell the total number of errors (0 if

	Name	Command(s)	Response	Example/Notes
			+total reset count + Accubar autozero +restrictor autozero	there are no errors), the total number of resets, the results of the Accubar autozero, and the restrictor autozero.

	Name	Command(s)	Response	Example/Notes
X?	Request unknown address	<u>*X?!</u>	<u>A</u> Address of the sensor	This command causes the Bubble to identify itself.
XAD	Set SDI-12 address	<u>aXADnAn!</u> n the new SDI-12 address, repeated twice	<u>a0011</u> no response if the addresses do not match	Note: a D0 command issued after will return the new address.
XAI	View extended Accubar identification	<u>aXAI!</u>	<u>aIIccccccmmmmmmvvvxx xxxx</u> II SDI version (1.3) cccccc is " SUTRON " mmmmm sensor model vvv hardware version xxxxxx Accubar Sensor ID	
XE	Set field calibration offset (pg 16)	<u>aXEdu!</u> d is the new field calibration in the units indicated by u.	<u>attt1</u> where ttt indicates the command will be complete in ttt seconds and 1 indicates one value can be collected.	0XE+0+0 (will set the field calibration offset to 0) 0XE+5+3 (will set the field calibration offset to 5cm) Note: a D0 command issued after XE is complete will display the new offset in the current units (as set by the XUP command).
XS	Set water level (pg 15)	<u>aXSdu!</u> d is the desired water level and in the units indicated by u. The Bubbler will adjust the field calibration offset to ensure the reading matches the value entered.	<u>attt1</u> where ttt indicates the command will be complete in ttt seconds and 1 indicates one value can be collected.	Example: 0XS+7.87+0 (sensor is at 7.87 feet, adjust offset to ensure this reading) Note: a D0 command issued after XS is complete will display the new offset in the current units (as set by the XUP command).
XOM	Set/display operating mode (pg 17)	<u>aXOM+m!</u> m is optional. Omit m to read the current mode, include it to change the mode. m = 0, normal	<u>attt1</u> where ttt indicates the command will be complete in ttt seconds and 1 indicates one value can be collected.	Example: 0XOM+0! (puts device into normal mode) Note: a D0 command issued after XS is complete will display

	Name	Command(s)	Response	Example/Notes
		mode, measure only when data is requested m = 1, continuous mode, measure continuously and provide data when requested.		the operating mode.
XT	Set/display averaging time (pg 17)	<u>aXT+t!</u> t is optional. Omit t to read the current value, include it to change. t = averaging time in seconds (0 to 900 seconds)	<u>attt1</u> where ttt indicates the command will be complete in ttt seconds and 1 indicates one value can be collected.	Example: 0XT+10! (sets the averaging time to 10 seconds) Note: A D0 command issued after will return the averaging time.
XUP	Set/display level units & level right digits (pg 16)	<u>aXUP+n+d!</u> Both n and d are optional. Include them if you want to change the values. n = 0 feet n = 1 PSI n = 2 kPa n = 3 cm n = 4 m n = 5 mm n = 9 user units d = number of places right of the decimal	<u>attt2</u> where ttt indicates the command will be complete in ttt seconds and 2 indicates two values can be collected.	Example: 0XUP+1+2! select PSI with 2 right digits Note: a D0 command issued after the XUP will return the value of the units that are selected and the number of digits right of the decimal point.
XUT	Set/display temperature units (pg 16)	<u>aXUTn!</u> n is an optional parameter. Include it only if you want to change the value. n = 0 for Celsius, n = 1 for Fahrenheit	<u>attt1</u> where ttt indicates the command will be complete in ttt seconds and 1 indicates one value can be collected.	Example: 0XUT1! (set temperature units to F) Note: a D0 command issued after the XUT will return the value of the units that are selected.
XUU	Set/display user units (pg 16)	<u>aXUUso!</u> Both s and o are optional. Include them if you want to change the values. where s is the pressure scale factor and o is the offset,	<u>attt2</u> where ttt indicates the command will be complete in ttt seconds and 2 indicates two values can be collected.	Example: 0XUU+27.63+0 (27.63 inches per psi) Note: a D0 command issued after XUU will return the scale and offset.

	Name	Command(s)	Response	Example/Notes
		User output = (psi)*scale + offset		Note: Be sure that the units of pressure (XUP) are set to user units (9).
XFD	Set factory defaults (pg 19)	<u>aXFD!</u>	<u>a0011</u> indicating that the command will take 1 second and 1 value can be collected.	Note: a D0 command issued after the XFD command will return the operating mode.
XBF	Set/display bubble rate and units (pg 12)	<u>aXBF+r+u</u> Both r and u are optional. Include them only if you want to change the values. r is the bubble rate and u is the bubble units (u=0 bubbles/minute, u=1 SCCM)	<u>attt2</u> where ttt indicates the command will be complete in ttt seconds and 2 indicates two values can be collected.	0XBF+50+0 50 bubbles/minute Note: a D0 command issued after command will return the bubble rate and units.
XOP	Set/display auto output (pg 34)	<u>aXOP+a!</u> a is optional. Include it to change the value. a = 0 disable output a = 1 enable output	<u>a0011</u> indicating that the command will take 1 second and 1 value can be collected.	Note: a D0 command issued after command will return the auto serial output.
XDT	Set/display date and time (pg 21)	<u>aXDT!</u> this command reads the current time <u>aXDTYYYY/MM/DD HH:MM:SS!</u> a is address XDT is the command to set the date and time YYYY is the year MM is the month (01 to 12) DD is the day of the month (01 to 31) HH is the hour (military time 0 to 23) MM is the minutes SS is the seconds	<u>aYYYY/MM/DD HH:MM:SS+q+g</u> a is address YYYY is the year MM is the month (01 to 12) DD is the day of the month (01 to 31) HH is the hour (military time 0 to 23) MM is the minutes SS is the seconds q is a single digit that indicates the quality of the time. 0 means the time is invalid. 1 can mean that time was set since bootup (if no GPS is present), or that the time has been synced to the GPS in the last 12 hours (if a GPS is present). g is a single digit that indicates the presence of the GPS. 0 means no GPS is present, 1 means that a GPS is present.	Example set date time command: 0XDT2005/09/01 13:15:00! Sets the date to the 1st of September2005, and the time to 1:15:00 PM.
XXS	Generic set/display setup command	See below for details	See below for details	See below for details

XXS Generic change Bubbler setup command.

This command is used to make changes to all setup data in the unit. It is used in the following manner:

XXS+s+n+v1+v2+v3+...+vx where

s is the setup identifier and must be equal to 1

n is the setup variable to start making changes at.

v1 is the new value to write for the first variable

v2 is the value to write for the next variable

The setup variables are accessed using their order in the software meta variable map as seen in the following table. The values than can be used for any of the variables can be seen in the Bubbler Settings and Accubar Settings sections.

1. Bubble Units
2. Bubble Rate
3. AutoPurge Enable
4. AutoPurge Interval
5. Station Name
6. Purge pressure
7. Purge length
8. Blockage detection
9. Blocked flow
10. Blocked pressure
11. Automeasure Interval
12. Automeasure Time
13. Operating Mode
14. Averaging Time
15. Level Units
16. Temperature Units
17. Level Right Digits
18. User Slope
19. User Offset
20. External Sensor
21. Auto Output
22. Field Calibration Offset
23. Log Daily Values
24. Measurement Name
25. Garmin GPS Enable
26. GPS Local Time Offset

An example command to change the bubble units to BPM is:

XXS+1+1+0

You can also change bubble units to BPM and bubble rate to 22.5 together in the same command by typing:

XXS+1+1+0+22.5

To read a setup value, issue command XXS+1+n!, where n is the setup variable whose value you are interested in. For example, to read the current bubble rate, issue command XXS+1+2! and follow it up with a D0! command. The reply to D0 will have the bubble rate.

Any settings that allow for a negative value can be set using a '-' as a delimiter, such as changing the user offset.

XXS+1+20-5.5 would change the offset to -5.5

Changing the station name can use either a '+' or '-' delimiter and may contain spaces:

XXS+1+5+New Name+20
to 20.

would change the station name to “New Name”, and the Purge Pressure

RS232 Command Line Interface

The RS232 interface provides a simple way to connect the Bubbler to PCs, modems and other communications devices. [Details on the DB9 connector](#) are on page 10.

Microsoft Windows usually comes with a program called HyperTerminal. It can be found by going to the Windows start menu, Programs, Accessories, Communications.

By default the RS232 interface operates at 115200 Baud, no parity, 8 data bits, 1 stop bit. Handshaking is recommended. The RTS line (pin 7 RS232) must be asserted for communication to work. Asserting RTS wakes up the Bubbler. Please allow at least half a second between asserting RTS and starting communication (automatically done by HyperTerminal).

If connecting to a PC, use a standard DB9 serial cable. If connecting to a [modem](#) or a logger, you are likely to need a null modem adapter.

To start command line mode, send carriage return or line feed (or both). If using HyperTerminal or a similar program, simply press ENTER. Bubbler will respond with a prompt >

Once in command line mode, type "HELP" to get a list of supported commands.

Changing the baud rate can be done via the front panel: [Station Setup > Other Settings > Baud Rate](#), or via the command line by typing "BAUD RATE". The default baud rate is 115200.

Machine to Machine Communication

All commands may be preceded with an !. If they are, a concise reply meant for machine to machine interaction is returned. Commands would be preceded by an ! if they were sent by an Xpert or some such computer.

Viewing Water Level

To initiate a new [water level measurement](#), type [MEAS](#). To see the [last automeasured](#) water level, including details, type [LAST](#). The output by the Bubbler will look like this:

```
Accubar Reading
  Water Level 7.01 feet
  Internal Temp 23.38 C
Internal Sensors
  Restrictor Pressure 31.259 PSI
  Tank Pressure 31.263 PSI
```

For a concise version, try !LAST or !MEAS;

```
7.01, 23.38
31.259, 31.263,
```

Downloading the Log

The Bubbler will save the water level in its flash memory each time a measurement is made. This data is then available to download to via the RS232 port. The command "LOG" command will start a Y-Modem transfer of the log to the connected device. For details on [logged data](#), please see page 18.

There are optional parameters that alter what data is downloaded:

"LOG" with no parameters will download since last.

"LOG ALL" gets whole log.

“LOG X” gets X last days ("LOG 3" gets last 3 days worth of data)
“LOG timeStart” gets data since provided date
“LOG timeStart timeEnd” gets data between provided dates
time can be YYYY/MM/DD HH:MM:SS or YYYY/MM/DD or HH:MM:SS
e.g. "LOG 12:00:00 13:00:00"
e.g. "LOG 2006/01/20 12:00:00 2006/01/21 12:00:00"
“LOG HELP” Shows details on how to use the download command.

Auto Output

When the Bubbler has *auto output* mode enabled (via front panel, [Station Setup>Other Settings>Auto Output](#), command line AUTO OUTPUT), it will automatically send data out on the RS232 port. The data will come out at whatever *baud rate* is setup (via front panel, [Station Setup>Other Settings>Baud Rate](#), command line BAUD RATE). If connected via HyperTerminal, and if command line mode is active, type EXIT to leave command line mode and to capture the auto output.

The data auto output is the water level. It is output as fast as it is measured (which depends on user settings), once a second at most. The data is ASCII. This is an example of the output:

46.3
46.3
46.4
46.4

RS232 Command Reference

Documentation Legend:

+ If any command **is followed by +**, it means that as long as the command starts with the indicated word, it will be accepted.

E.g. MEAS + means that typing “MEAS”, “MEASURE”, or “MEASXXX” will all have the same effect.

0 **If a 0 follows** a listed command, it means that the command can optionally be followed by the character 0.

E.g. “DIAG” will show the system diagnostic status. “DIAG 0” will first show current status and then clear the status.

! NOTE:

All commands may be preceded with an !. If they are, a concise reply meant for machine to machine interaction is returned. Commands would be preceded by an ! if they were sent by an Xpert or some such computer.

E.g. “MEAS” will show

Accubar reading
Pressure 6.41 feet
Internal Temp 23.91 C

“!MEAS” will show

6.41, 23.91

NOTE:

No **individual setup commands** are documented here. Every setup variable can be viewed by typing its name.

E.g. “BUBBLE RATE” will show the current rate.

Every setup variable can be changed by typing its name = new value.

E.g. “BUBBLE RATE = 15” will set the current rate to 15 (of whatever units are currently chosen).

List of commands

ACCUBAR +

Initiates, waits for, and shows the results of [Accubar readings](#).

AUTOZERO +
Shows the results of the last [autozero](#) (for both Accubar and restrictor). If AUTOZERO NOW is typed a new autozero is initiated.

BATT +
Shows the current [battery reading](#) and the last reading during pump on.

DIAG + 0
Shows system diagnostics, including system resets, [autozero](#) results, [Accubar sensor ID](#), and pump run time. If followed by 0, it will clear system resets.

DOWNLOAD
See [LOG](#)

EXIT
Quits command line.

HELP
Brings up the help (lists commands).

HI
System replies with "Hello"

INTERNAL
Initiates, waits for, and shows the results of [Bubbler internal sensor](#) measurements.

LAST +
Shows the [last automeasured](#) reading.

LEAK TEST
Shows the results of the last [leak test](#). If LEAK TEST NOW is typed, Bubbler starts a leak test, shows user the pressures as the leak test runs, and shows the leak test results once the test is complete.

LOG
This command is used to download the [log](#). It can be followed by optional parameters indicating what part of the log to download.
LOG with no parameters will download since last.
"LOG ALL" gets whole log.
"LOG X" gets X last days ("LOG 3" gets last 3 days worth of data)
"LOG timeStart" gets data since provided date
"LOG timeStart timeEnd" gets data between provided dates
time can be YYYY/MM/DD HH:MM:SS or YYYY/MM/DD or HH:MM:SS
e.g. "LOG 12:00:00 13:00:00"
e.g. "LOG 2006/01/20 12:00:00 2006/01/21 12:00:00"

LEVEL = 14.5
[Sets the water level](#) to 14.5 (of whatever units are currently chosen). User can choose any number, not just 14.5. Please see the section Setting Water Level on page 15.

MEAS +
Initiates, waits for, and shows the results of sensor measurements. That includes [Accubar readings](#) as well as [Bubbler internal sensor](#).

PASSWORD

PUMP +
If typed without any parameters, the current state of the pump (on or off) is shown, along with the [pump run time](#) in days.
If "PUMP ON" is typed the pump will turn on and stay on for up to three minutes at which point the control will shut it off. No provisions exist for protecting the Accubar sensor from excessive pressure.
If "PUMP OFF" is typed, the pump will turn off.
If followed by a number (floating point expressed in seconds), the pump will turn on for that amount of time. E.g. "PUMP 2.5" will have the pump turn on, stay on for 2.5 seconds and then turn off.

REBOOT
Does a software resets of the system.

RESETS + 0

Shows system diagnostics, including system resets. If followed by 0, it will clear system diagnostic status.

RESTRICTOR +

Shows the reading of only the [internal restrictor sensor](#).

SETUP

If provided without any other parameters, it lists all setup details. That includes each setup variable and its current value.

Can be followed by a setup variable name and a new value for that variable.

E.g. "CHANGE STATION NAME = SUTRON"

If SETUP DEFAULT is issued, it will reset the entire setup to defaults.

STATUS 0

Shows system status including time, boot time, battery readings, last measurements, current internal sensor readings, and any hardware errors that may exist. If followed by 0, it clears the hardware errors.

TANK +

Initiates, waits for, and shows only the [internal tank sensor](#) reading.

TIME

Shows the current [system date and time](#). If followed by a new time, it changes the system time.

UPG +

Initiates a system software upgrade. It needs to be followed by the YModem transfer of an .upg file specific to the product. Both the main application and the bootloader are upgraded this way (but each needs its own .upg file). Check www.sutron.com for software upgrades.

VER +

Shows the current software version, including build date and time and the bootloader version.

List of setup variables

Type SETUP to get a list of the whole setup. Every setup variable can be viewed by typing its name.

E.g. "STATION NAME" will show the current station name.

Every setup variable can be changed by typing its name = new value.

E.g. "STATION NAME = SUTRON" will set the station name to "SUTRON".

[AUTO OUTPUT](#)
[AUTOMEASURE INTERVAL](#)
[AUTOMEASURE TIME](#)
[AUTOPURGE ENABLE](#)
[AUTOPURGE INTERVAL](#)
[AVG TIME](#)
[BLOCKAGE DETECTION](#)
[BLOCKED FLOW](#)
[BLOCKED PRESSURE](#)
[BUBBLE RATE](#)
[BUBBLE UNITS](#)
[EXTERNAL SENSOR](#)
[FIELD CAL OFFSET](#)
[LEVEL RIGHT DIGITS](#)
[LEVEL UNITS](#)
[LOG DAILY VALUES](#)
[MEASUREMENT NAME](#)
[OPERATING MODE](#)
[PURGE LENGTH](#)
[PURGE PRESSURE](#)
STATION NAME
[TEMP UNITS](#)
[USER OFFSET](#)
[USER SLOPE](#)

Setup Transfer via Hyperterminal

It is possible to capture a Bubbler's setup and save it to file. Using HyperTerminal, establish [RS232 connection](#) first. Once you are able to talk to the Bubbler, use HyperTerminal's Transfer menu and select Capture Text. Then type !SETUP on the command line. The Bubbler will stream out its entire setup and it will be saved in the file selected. Make sure to tell HyperTerminal to stop text capture after getting the setup in the file. Alternatively, a setup file can be saved to [SD card](#).

Once the setup is saved to file, feel free to edit the file, changing any of the settings. To send a setup file to the Bubbler, HyperTerminal will need to be properly configured to delay after sending every line. To do so, user HyperTerminal's **File, Properties** menu. Click on the **Settings** tab and click the **ASCII Setup** button. Change the **Line delay to 1000 milliseconds** and change the **Character delay to 5 milliseconds**. If these changes are not made, HyperTerminal will send the file too fast for the Bubbler to capture any but the first few settings. Once the changes are made, choose HyperTerminal's Transfer menu and click **Send Text File**. Select the file with the saved setup. You will see the transfer take place on HyperTerminal's main window. Bubbler will report which settings have been changed.

Connecting a Modem

It is possible to connect a modem to the Bubbler, allowing for remote access to the station. Use the [RS232](#) port to connect the modem. Most modems will need a null modem adapter between the modem and the Bubbler.

The modem will need to be configured before it can be used. Please make sure to test out the modem-Bubbler connection before deploying them in the field. The following modem settings must be configured:

- **Autoanswer: enable** (otherwise a connection will never be established)
- **Connect timeout: enable** (otherwise the modem will keep the Bubbler awake, increasing power consumption)
- **Command echo: disable** (otherwise the modem and the Bubbler will forever talk to each other, preventing further connections and increasing power consumption)
- **Telnet mode: enable** (this is required only if using a modem over TCP/IP – if not enabled, log downloads may fail, especially if using HyperTerminal)
- **RTS: enable** (this is likely on by default – the Bubbler will not notice the modem unless RTS is on)
- **Carrier Detect: always on** (also know as LSD Action, DCD, and CD)
- **Baud rate, parity, etc:** set this up to match the [settings of the Bubbler](#) (Bubbler defaults are 115200 Baud, no parity, 8 data bits, 1 stop bit)

Xpert-Xlite Modem 8080-0005

Sutron manufactures a modem (Xpert-Xlite Modem part number 8080-0005) that is suitable for use with the Bubbler. When connecting this modem, make sure to set the modem's internal jumper for external power AND for either 5V or 12V depending on which you provide. A null modem is needed between the Bubbler and the modem. The default settings from Sutron for the modem will work. If the settings have been changed, issue these commands to the modem:

```
AT&F
ATS0=1
ATE0Q1&D0&W
```

This is what the commands mean:

```
AT&F set to factory defaults
S0=1 answer on first ring
E0 don't echo characters
Q1 don't send result codes
&D0 ignore DTR
&W save settings into profile.
```

Raven Modem

A Raven modem allows you to access the bubbler through the internet. The Raven should be ordered with a fixed IP address. Using that IP address, you will be able to use HyperTerminal or other TCP/IP aware communications programs to use the command line interface of the Bubbler. Make sure to place a null modem adapter between the Raven and the Bubbler.

The Raven modem must be configured as follows:

Device Port	3001
Configure Serial Port	115200,8N1
Command Echo	0
TCP Auto Answer	2
TCP Connect Timeout	30
TCP Idle Timeout	2
Telnet Echo Mode	0
UDP Auto Answer	2

You can connect the Raven to the same battery powering the Bubbler; however, remember that it will increase the power consumption (both when the modem is idle and when it is connected). As a result, you will need to make sure your battery is large enough to provide the power needed by the station.

Installation

Mount the enclosure

The Bubbler is designed to mount vertically against a wall or other surface. In this configuration, the orifice line connection points down. Do not simply place the bubbler on a bench or table top. The vertical mounting helps prevent any moisture from forming inside the bubbler tubing. If not mounted vertically, the Accubar sensor will be negatively affected.

The Bubbler mounts to a panel or surface through four holes that are accessible in the corners of the fiberglass enclosure

Tubing/Orifice Installation:

The Bubbler OUTLET pressure fitting accommodates an 3/8" OD tubing that will run down into the water. The 3/8" tubing provided by Sutron can be installed directly on the ground, buried in the ground or in a conduit. When running the tube to the water, try to ensure that the line is run with a continuous downward slope. If there are low points in the line and moisture collects there, you may get erroneous readings. For the greatest accuracy, the maximum length of orifice line to use with the Bubbler is 500 ft. The following table shows the expected pressure drop in 1/8" I.D. tubing due to movement of air through tubes 500 ft and longer:

Feet of tubing	Flow Rate in CC/min	Pressure error in ft H2O
500	5	0.025
500	15	0.075
1000	5	0.05
1000	15	0.15
2000	5	0.10
2000	15	0.30

The tube should be fitted with a suitable orifice in the water. The orifice should be firmly attached a wall, rock or weight so it doesn't move.

The orifice should be installed in water that is relatively still and free from currents. If there are currents in the area of the orifice, the currents will cause a shift in the pressure reading.

The tube is connected to the Bubbler using a Swagelok fitting. They can be assembled in three simple steps.

Step 1

Insert the tubing into the Swagelok tube fitting. Make sure that the tubing rests firmly on the shoulder of the fitting and that the nut is finger tight.

Step 2

Before tightening the Swagelok nut, scribe the nut at the 6 o'clock position.

Step 3. Hold the fitting body steady with a backup wrench and tighten the nut 1 ¼ turns. Watch the scribe mark make one complete revolution and continues to the 9 o'clock position.

Once the Swagelok fitting has been installed, it can be disconnected and retightened many times. To retighten:

1. insert the tubing with the pre-Swaged ferrule into the fitting body until the front ferrule seats.
2. tighten the nut by hand.

3. tighten with a wrench about ½ turn.

Electrical connections:

Refer to Chapter 3 on Cabling for a description of the electrical connections.

Bubbler Setup

Most sites will need, at a minimum, the following settings during installation. The settings can be entered using either the front panel or RS232 port.

Station name
Bubble rate
Desired units and right digits
Automeasure time and interval

Other settings are used as needed for a specific site.

Check for Leaks

Leaks inside the Bubbler can be a source of inaccuracy and/or excessive pumping and use of desiccant. To check for leaks, you must cap the outlet or orifice and run the built-in leak test routine. Sutron provides a cap with each unit that can be used to cap the outlet for the leak test. When the leak test completes, the system will display a status indicating whether the unit has passed or failed the leak test along with a score.

Purge Line

After connecting the outlet line to the bubbler, issue the [purge](#) command. The command turns on the pump and builds pressure to a user set pressure (default 50 PSI) and then opens the restrictor bypass valve to force the pressurized air to the outlet. The pump will continue to run for a user set period (default 30 seconds) and then turn off the pump and allow the pressure to bleed out the line.

Calibration

The Bubbler undergoes a rigorous screening and testing at the factory before they are shipped to ensure that they meet their accuracy specifications over temperature and that they are stable both in zero and span and will continue to be accurate over time. Any drift in the zero of the unit is automatically removed automatically (when autozero is enabled). The span drift of the Bubbler in the field is typically less than 0.01% per six months. This is a small fraction of the stated accuracy of the Bubbler. The stated accuracy of the Bubbler at its full scale reading is 0.1% of reading, although typically it is much better. Even though it would typically take over 5 years for the Bubbler to drift as much as 0.1%, it is recommended that the Bubbler, like all precision measurement instruments, be calibrated annually. See additional details in the [maintenance section](#) on page 44 of the manual.

Hostile Conditions

(from the IOC Manual on Sea Level Measurement and Interpretation: Volume II – Emerging Technologies)

Effect of Waves

Surface waves will produce a rapid cyclic change in pressure in a bubbler system. The error so produced is dependent on wave amplitude in the following relations

$$E = \frac{V}{A} \frac{S}{P_0}$$

where E = error
 V = total system volume
 A = horizontal cross sectional area of pressure point
 S = pressure amplitude of short period wave
 P_o = water head pressure at outlet below trough of a wave

Effect of Currents

Areas of strong currents should be avoided when siting bubbler measuring systems. The presence of a pressure point in the tidal current will distort the velocity field, so that the pressure sensed cannot be interpreted simply as the undisturbed hydrostatic pressure. Depending on whether the bleed hole faces into or away from the current the measured pressure will be greater or less than the hydrostatic pressure. If a pressure point has to be fixed in strong currents it should be positioned so that the bleed hole is tangential to the main current flow to minimize the error

Density Variations

Since the water levels measured by pressure systems are a function of the water pressure at the pressure point outlet, variations in the water density can lead to errors in both bubblers and direct reading systems. Such density variations are most pronounced at sites situated close to or on river estuaries. If an estuarine site must be used, specific gravity measurements should be taken and corrections applied.

Troubleshooting and Maintenance

Troubleshooting

The following checklist will help in troubleshooting problems:

Problem	Possible Cause
No data	Faulty wiring – check all wiring and terminations
	No power – check fuse in the data recorder and power at sensor. There is no fuse in the sensor itself.
	Wrong address requested -- make sure the data recorder is set up to request data at the proper address
	Wrong address set in sensor -- use the identify command to make sure the sensor is responding to the proper address, if not double check the SDI-12 address using the front panel.
	Command or address is wrong case – all Bubbler commands are capital letters, make sure address is proper case and commands are upper case.
Garbled data	Multiple sensors set to the same address -- check address settings of all SDI sensors. Remove all other sensors from the recorder and add them one at a time.
	Command issued to a wild card address (* or ?). Remove all other sensors from the recorder and try again.
Erroneous data	Wrong units selected -- use the M command and look at the units field. Verify that the desired units are selected.
	High unstable readings when bubbler is utilized – Unit has not been configured for use at the site. Use the XPC and XPT commands as described in Chapter 6 – Installation to configure the unit for the site.
	High unstable readings when bubbler is utilized – Water in the orifice line. Use 0XPR+240! To purge line for four minutes.
	Low readings when bubbler is utilized – Check for leaks in the system by using the XPL command.
	Erroneous offset entered -- display the field calibration offset using the M3 command and verify it. Re-calibrate the offset.
	Erroneous user scale and offset entered – display the user scale and offset using the M3 command and verify.

Maintenance

The Bubbler is designed to operate for extended periods with very little or no maintenance required. If a site visit is needed for any reason, it is a good idea to perform a routine maintenance check of the encoder. Some easy to follow guidelines are listed below.

1. Check the desiccant at each visit (every 3 months). If the desiccant is more than ½ pink, replace with fresh desiccant. The new desiccant will be blue. See the section [desiccant life](#) on page 43 for more information on how long the desiccant will last.
2. Perform a visual inspection of the unit. Note any abnormalities such as external oxidation, rust.

3. Check the wiring to make sure it is not corroded, frayed, or loose.
4. Examine pump runtime. Verify runtime is reasonable (less than 5 min/day at 5SCCM). The purge and leak tests may help determine the cause of the excessive runtime.
5. Run a purge to verify the pump and internal tubing are intact. If the purge fails to reach the desired pressure, check the tubing from the outlet of the pump (red barb) to the check valve (at top of pump).
6. Run a leak test if possible to verify there are no internal leaks.
7. Download the data and events. Examine the log for any abnormal readings or events.

Desiccant Life

The following table shows the desiccant life a function of flow rate and humidity. For example, at a setting of 5 SCCM, no purges, the desiccant will last for 12.2 months at an area of 50% average humidity and 30C average temperature. The desiccant will last 11.3 months if there are 60 second purges once a week.

Desiccant Life calculation			Life in Months for Drierite based on Flow (SCCM) -- no purges			
Humidity %	Temp - C	Vapor gm/m3	Flow (SCCM)			
			5	10	15	20
50	25	11.5	16.2	8.1	5.4	4.0
50	30	15.2	12.2	6.1	4.1	3.1
50	35	19.8	9.4	4.7	3.1	2.3
75	25	17.3	10.7	5.4	3.6	2.7
75	30	22.9	8.1	4.1	2.7	2.0
75	35	29.8	6.2	3.1	2.1	1.6
90	25	20.8	8.9	4.5	3.0	2.2
90	30	27.4	6.8	3.4	2.3	1.7
90	35	35.8	5.2	2.6	1.7	1.3

			Life in Months for Drierite based on Flow (SCCM) - 60 sec purge 1/week			
Humidity %	Temp - C	Vapor gm/m3	Flow (SCCM)			
			5	10	15	20
50	25	11.5	14.9	7.8	5.2	4.0
50	30	15.2	11.3	5.9	4.0	3.0
50	35	19.8	8.7	4.5	3.0	2.3
75	25	17.3	9.9	5.2	3.5	2.6
75	30	22.9	7.5	3.9	2.6	2.0
75	35	29.8	5.8	3.0	2.0	1.5
90	25	20.8	8.2	4.3	2.9	2.2
90	30	27.4	6.3	3.3	2.2	1.7
90	35	35.8	4.8	2.5	1.7	1.3

Desiccant has a capacity of 44.6 grams water
Purge assumes flow of 5 litres/minute
Vapor densities from hyperphysics web site

Factory Calibration

The initial factory calibration of the Accubar pressure sensor typically includes over 1000 different pressure temperature points that cover the complete temperature range from -40 to +60 degrees C and cover the complete pressure range from 0 to 25 PSI for the 5600-0133-25. This ensures that the Bubbler meets the specifications over the complete pressure and temperature range. A calibration verification encompasses nearly 200 points over the complete temperature and pressure range. The Bubbler Accubar sensor can be sent back to the factory for a complete re-calibration over temperature or a simpler calibration check. Since the calibration data is stored in the small sensor module, you can freely swap or interchange Accubar sensors into different BUBBLERS. Sutron recommends an annual check of the Accubar calibration.

Accubar Replacement

The Accubar can be easily replaced. After acquiring a new sensor from Sutron, power down the Bubbler, open the front panel, unplug and remove the old Accubar and replace it with the new Accubar.

FIRMWARE Upgrade

Sutron's CF Bubbler has been designed using the most modern techniques such that at any time the system firmware may be upgraded while it is in the field preventing the need to ever return a unit to the factory for firmware upgrades. The factory may offer new features or bug fixes that may only be accessed through firmware upgrades. The techniques below will illustrate how to install the upgraded firmware into the unit.

Methods for upgrade:

There are several possible methods to use to upgrade the software in the unit. The first step in all methods is to download from the Sutron web site the program upgrade file, such as 'v1_24mainBubbler1265.upg', found at <http://www.sutron.com/downloads/software.htm>. Select the CF Bubbler and download the UPG file to a temporary folder or desktop location where it may be accessed at a later time.

Method 1: Using 'UPGRADE' command using HyperTerminal:

Open and run HyperTerminal on a PC. Set the properties to:

Baud Rate: 115200
Bits: 8
Parity: None
Stop Bits: 1

- Start with the unit powered up and running.
- Connect DB-9 serial cable and establish communications by typing 'enter'. (connect port)
- Once the prompt is found, type 'UPGRADE' or 'UPG'.
- Now the system is waiting for HyperTerminal to send the file.
- An upper case "C" will repeat every 2 seconds or so over the serial port. Select 'Send File' and choose 'Y-Modem' and then select the upgrade file name previously stored on the computer.
- Once the download is completed, the system will reboot.
- Type the command 'Ver' to confirm that the upgrade was successful

Method 2: Using HyperTerminal and 'Escape' key:

Open and run HyperTerminal on a PC. Set the properties to:

Baud Rate: 115200
Bits: 8
Parity: None
Stop Bits: 1

- Start with the unit powered DOWN.
- Open the serial port with HyperTerminal.
- Power up the unit simultaneously while holding the 'Escape' key on the keyboard of the computer running HyperTerminal. Release the escape key once the unit has powered up.
- An upper case "C" will repeat every 2 seconds or so over the serial port. At this time, use 'Send File' and choose 'Y-Modem' and then select the upgrade file name previously stored on the computer.
- Once the download is completed, the system will reboot.
- Type the command 'Ver' to confirm that the upgrade was successful.

GPS

It is possible to use a GPS to provide the Bubbler with an accurate, self setting clock. Bubbler can be connected to a Garmin GPS 16HVS. Bubbler needs to have software **version 1.24** or newer to support GPS.

Timekeeping

When equipped with a GPS, the Bubbler will keep UTC time. UTC (Universal Coordinated Time) is an internationally accept time standard. UTC will differ from the local time by a number of hours. The user can setup the Bubbler so that it keeps local time by changing the variable Local Time Offset. To get EST, set the local time offset to -5 hours.

If a Sutron Satlink (versions 6.17 and newer) is connected to the Bubbler via SDI-12 (in addition to the Garmin GPS), note that Satlink will set the clock of the Bubbler once per day. **Please ensure that Satlink's local time offset is equal to that of the Bubbler.**

An Bubbler equipped with a GPS will provide a timing accuracy of ± 1 second.

GPS Installation and Setup

When first installing the GPS, make sure the GPS is positioned so that it has a clear view of the sky. Make sure to connect the GPS to the Bubbler via RS232. Sutron provides a custom RJ45 to RS232 connector for this purpose (the diagram for the connector is on page 48).

After connecting the two devices, go the **Station Setup** menu on the front panel of the Bubbler. Find the entry called *Garmin GPS* and press set to enable the GPS. Then go back to the top of the menu, and hit the down button until the **GPS status menu** is shown. If the Bubbler is communicating with the GPS, the menu will say

GPS initializing. If the GPS has acquired a time fix, the Bubbler will show *GPS functioning*.

Pressing right in the GPS status menu will provide more details.

If the GPS has locked on satellites and is providing accurate time, the menu will show a message such as

GPS has valid time
5 satellites used in time fix

Pressing down from the detailed status menu will show the **last GPS time sync**. The time show is the time when the GPS last had a time fix. If it has been more than 12 hours since the last valid time fix, the GPS is not working properly and may need to be repositioned (please see page 47).

The next entry in the menu is **local time offset**. The user can setup the Bubbler so that it keeps local time by changing the variable Local Time Offset. To get EST, set the local time offset to -5 hours.

When installing, it is recommended that the user wait until the GPS has valid time before leaving the station. If the GPS does not acquire the time in ten minutes, the GPS should be repositioned so that it has a better view of the sky.

Keep in mind that whenever the display is turned on, Bubbler will power up the GPS. This helps with GPS positioning. As long as the display is on, the Bubbler will provide power the GPS, allowing it to track satellites. When the display is off, the Bubbler will power the GPS once an hour for up to 15 minutes.

GPS Positioning

If the Bubbler is reporting that the **GPS cannot get a time fix**, it means that the GPS is unable to get a clear view of the sky. It could also be the case that the GPS is picking up interference. The best solution is to reposition the GPS. The GPS needs to have a **clear view of the sky** in order to properly function.

Place the GPS antenna in the most open space possible. Do not place it directly under anything nor directly beside something. Always attempt to achieve a "full sky" view with the antenna.

Place the GPS antenna high up on a pedestal or in a protected location. Flat surfaces may tend to cover with ice and snow more so than elevated locations. Keep away from areas where birds may nest. Placement is very important and great care should be taken in selecting the location.

GPS Operation

Once every hour, the Bubbler will wake up the GPS. Once the GPS has acquired a time fix (should not take more than 40 seconds), the Bubbler will set its clock and put the GPS in low power mode. Powering the GPS once an hour provides the optimal power consumption.

In addition, whenever the display is turned on, Bubbler will power up the GPS. This allows the user to see whether the GPS can acquire a time fix and helps in positioning the antenna.

GPS Errors

If the GPS is either not communicating with the Bubbler or if the GPS cannot acquire a time fix, the Bubbler will blink the red LED to indicate that there is a problem. In addition, the Bubbler will show a message describing the problem on the front panel. Once a day, the Bubbler will write an event to the log indicating that it has GPS problems.

The Bubbler reporting "**No GPS Detected**" can indicate that the connector between the GPS and Bubbler is bad (please refer to the section on the connector on page 48) or that the Bubbler does not have its jumpers set properly (please see the section on page 47 about Jumpers)

If the **GPS cannot get a time fix**, please see the section on GPS Positioning on page 47.

If the Bubbler reports "**GPS Comm Failure**", it means the Bubbler is detecting data on the RS232 line, but that the data is incomprehensible. It could indicate that the GPS has been improperly configured. If possible, try using a different GPS module.

If a faulty GPS is connect to the Bubbler, of it the GSP is not connected to the Bubbler, the Bubbler will take a full minute before deciding it cannot talk to the GPS. Ensure that the Bubbler is given enough time to talk to the GPS before leaving the station.

Jumpers

There is a jumper inside the Bubbler that ensures that the Bubbler provides 12 Volts on RS232 which the Garmin GPS requires in order to function. **If the Bubbler is reporting "No GPS Detected"**, it may be the case that the jumper is not properly setup.

To setup the jumper, the case must be opened. Once the case is open, the jumper is easily accessible. The Jumper in question is J19, and is located next to the RS232 connector. Place a connector on jumper J19 so that it connects 12v to the middle pin (pins 1 and 2)

In addition to J19, there is another jumper needs to be properly configured in order for the unit to provide power to the GPS. However, this jumper is properly setup at the factory and it is unlikely to be the cause of the problem. The jumper in question is J16 (located next to J19). It should have a connector across pins 2 and 3 or have no connector at all.

RJ45 to RS232 Connector

A custom connector is required to get the Sutron and the Garmin GPS together. The connector bridges the RJ45 on the Garmin GPS to the RS232 on the Sutron unit. The table below provides the wiring diagram for the connector.

Note: The colors on the Garmin GPS RJ45 **do not match** the colors of the RJ45 to RS232 converter.

Rj45 pin Garmin plug color	RJ45 to Rs232 converter	RS232 on Sutron unit	Function	comments
1 Red	Blue	9	Power	8 to 40V for 16HVS
2 Black	Orange	5	Ground	
3 Yellow	Black	8 CTS	Remote power on/off	On if <0.3V, Off if open circuit
4 Blue	Red	2	Port 1 Data in	NMEA input to GPS
5 White	Green	3	Port 1 Data out	NMEA output from GPS
6 Gray	Yellow	no connect	PPS	1Hz
7 Green	Brown	no connect	Port 2 Data in	RTCM output
8 Violet	White	no connect	Port 2 Data out	reserved

Appendix A – Specifications for the Bubbler

56-0133-25-1 BUBBLER

Electrical

Power Required	8-16VDC
Average Power	<100 mW for a 3 second measurement every 15 minutes, no purge. <350 mW for 120 second measurement every 5 minutes with 30 second purge every hour.
Pump on current	4 Amp max, 2.5 Amp typical
Quiescent current	<1 mA
Outputs	SDI-12, RS232, RS485

Pneumatic

Pressure Range	0-25 psi
Accuracy	0-25ft 0.02%FSO 26-50 ft. 0.05% reading.
Resolution	0.0001 psi
Purge Pressure	>=50 psi.
Bubble Rate	Set by user
Compressor Type	Piston and cylinder compressor

Mechanical

Enclosure	NEMA-4 Fiberglass
Dimensions	12" x 15" x 7.5"
Pressure Outlet	3/8" Tube fitting

Environmental

Temperature	-25°C to +60°C optional -40°C to +60°C
Humidity	0-95% Non-condensing

Ordering Information

Part Number	Description
56-0133-25-1	Accubar Constant Flow Bubble Gauge, 25 PSI max

Appendix B– Sutron Customer Service Policy

CUSTOMER SERVICE POLICY

Dear Customer:

Thank you for making the important decision to purchase Sutron equipment. All Sutron equipment is manufactured and tested to the highest quality standards as set by Sutron's Quality Assurance Department. Our Customer Service Representatives have years of experience with equipment, systems, and services. They are electronic technicians with field and applications experience, not just with a technical background.

Customer Phone Support

Customer Service Representatives routinely handle a wide variety of questions every day. If questions arise, please feel free to contact me or one of the Customer Service Representatives. We are available from 8:00 am to 5:00 pm Monday through Friday and will be happy to take your call.

We can answer most sensor and interface questions on the first call. If we cannot quickly answer a question on an interface, we will work with you until we find a solution.

Sometimes a problem is application related. Although we pride ourselves on handling 95% of application related questions over the phone, we maintain constant contact with our Integrated Systems Division and Engineering Division for additional assistance.

Introductory Training

Training is an important part of the Sutron Customer Service philosophy. The Sutron training policy is simple---If you buy Sutron equipment, you get Sutron training! Without the proper training, you cannot take advantage of the benefits and advantages that Sutron equipment provides. We often supply on-site introductory training at your facility for no charge. You provide the classroom, students, equipment, and coffee---we'll provide the instructor.

On-Site Visits

Of course not all problems can be fixed over the phone. Sometimes a customer needs an on-site technician to identify site related problems or troubleshoot a network. Sutron can provide these services at a reasonable cost. Call for details. If you would like to learn more about Sutron products email sales@sutron.com

Thanks again for your order,

Paul Delisi
Customer Service Manager
Sutron Corporation

Appendix C– Commercial Warranty

SUTRON MANUFACTURED EQUIPMENT

THE SUTRON CORPORATION WARRANTS that the equipment manufactured by its manufacturing division shall conform to applicable specifications and shall remain free from defects in workmanship and material for a period ending two years from the date of shipment from Sutron's plant.

Sutron's obligation under this Warranty shall be limited to repair at the factory (21300 Ridgetop Circle, Sterling, VA 20166), or at its option, replacement of defective product. In no event shall Sutron be responsible for incidental or consequential damages, whether or not foreseeable or whether or not Sutron has knowledge of the possibility of such damages. This warranty shall not apply to products that have been damaged through negligence, accident, misuse, or acts of nature such as floods, fires, earthquakes, lightning strikes, etc.

Sutron's liability, whether in contract or in tort, arising out of warranties or representations, instructions or defects from any cause, shall be limited exclusively to repair or replacement parts under the aforesaid conditions.

Sutron requires the return of the defective electronic products or parts to the factory to establish claim under this warranty. The customer shall prepay transportation charges to the factory. Sutron shall pay transportation for the return of the repaired equipment to the customer when the validity of the damage claim has been established. Otherwise, Sutron will prepay shipment and bill the customer. All shipments shall be accomplished by best-way surface freight. Sutron shall in no event assume any responsibility for repairs or alterations made other than by Sutron. Any products repaired or replaced under this warranty will be warranted for the balance of the warranty period or for a period of 90 days from the repair shipment date, whichever is greater. Products repaired at cost will be warranted for 90 days from the date of shipment.

NON-SUTRON MANUFACTURED EQUIPMENT

The above Warranty applies only to products manufactured by Sutron. Equipment provided, but not manufactured by Sutron, is warranted and will be repaired to the extent of and according to the current terms and conditions of the respective equipment manufacturers.

REPAIR AND RETURN POLICY

Sutron maintains a repair department at the factory, 21300 Ridgetop Circle, Sterling, VA 20166. Turn around time normally ranges from 10-30 days after Sutron receives equipment for repair. **Call Customer Service at (703) 406-2800 for a Return Material Authorization (RMA) number.** Return the defective equipment to the factory, transportation charges paid.

EXTENDED WARRANTY AND ON-SITE MAINTENANCE

Extended warranty and on-site maintenance contracts are available. Price quotations may be obtained from Sutron customer service representatives.

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