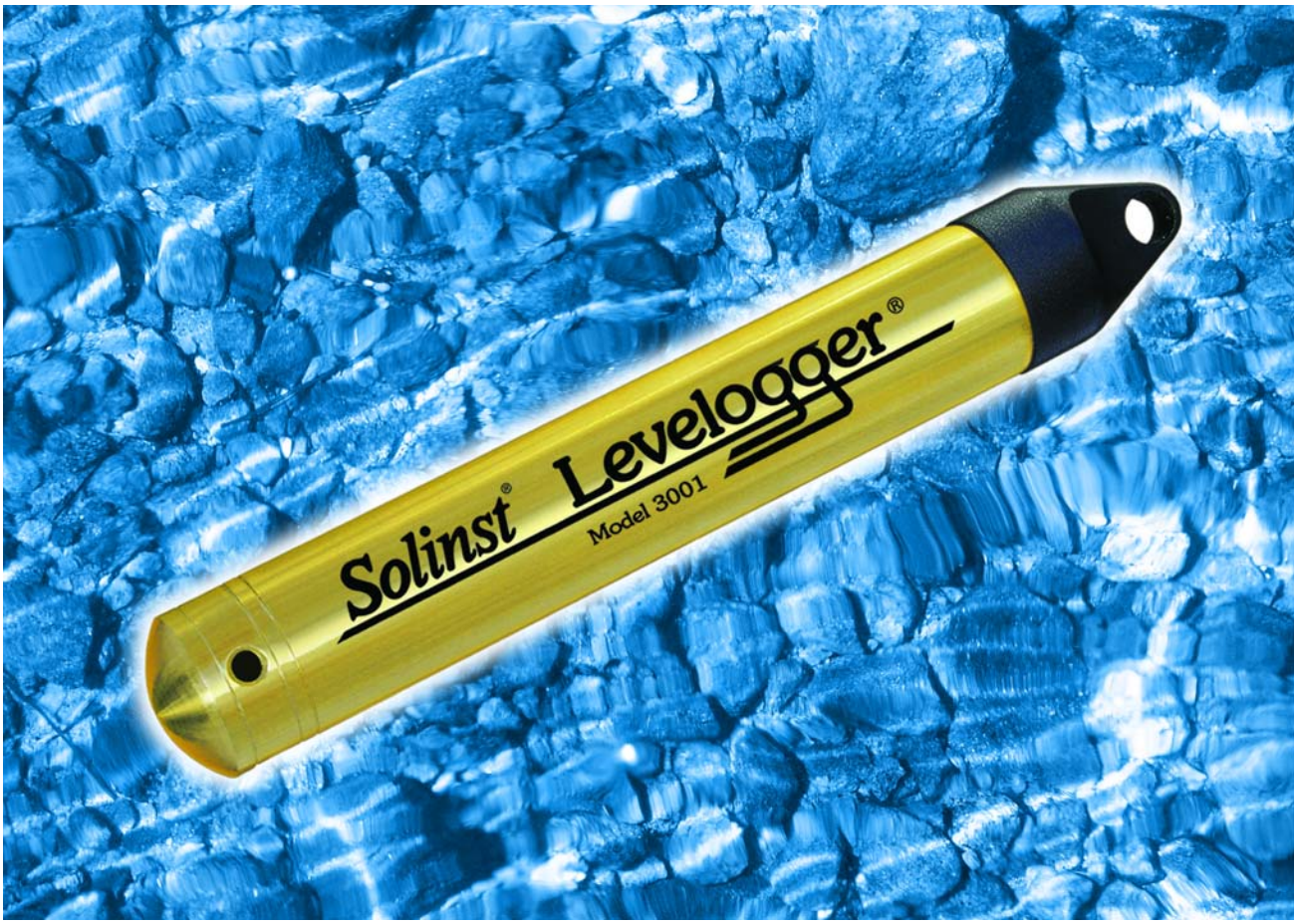


Levelogger Gold

Software Version 3
User Guide

November 7, 2006

Solinst®

Levelogger®
Model 3001

1 Introduction

This Instruction manual describes use of Levelogger Software Version 3, and installation, use and maintenance of the Levelogger in general. The Levelogger Software Version 3 is used to view existing logger settings, program new settings, launch logging sessions, monitor current readings, download and view data and export data. Levelogger 3 Software supports all types of Leveloggers including Levelogger Golds , Barologgers, LT, LTC and Rain Loggers.

This chapter also describes several important technical specifications of the Levelogger, its construction and design, factory and user calibration procedures, and the computer system requirements to operate the Levelogger software and communicate with the Levelogger.

The Levelogger is designed to measure groundwater and surface water levels and temperature. The Levelogger Gold and Barologger Gold replace the previous LT Leveloggers. The LTC Levelogger is still available to monitor electrical conductivity as well. Previous models included an "L" (level only) version and a very early unit with only the "Levelogger" designation. This was also a level only model. The Levelogger Gold measures both temperature and temperature compensated water levels more accurately than the older LT. The Barologger Gold uses internal mathematics based on air pressure rather than water pressure, to offer further accuracy. The LTC Levelogger measures temperature, temperature compensated water levels and electrical conductivity or specific conductance. Figure 1.1 outlines the specifications of the Leveloggers Gold. Figure 1.2 details specifications of the LTC Leveloggers. Leveloggers are programmed using either a desktop or laptop computer, or a Leveloader II. Computers connect to the Levelogger via an optical reader cable. The optical reader cable uses an infrared data reader/port connected to the Levelogger and an RS232 or USB Com Port to communicate information to and from the Levelogger and computer. See Section 6 for use of Leveloaders.

Levelogger Gold Specifications	
Level Sensor:	Piezoresistive Silicon in 316L Stainless Steel
Accuracy (Typical):	0.05% net FS
Accuracy (Max Error):	0.1% net FS
Stability of Readings:	Superior, low noise, 6 times better than previously
Resolution:	0.002 to 0.0006% FS
Normalization:	Automatic Temp Compensation
Temperature Sensor:	Platinum Resistance Temperature Detector
Temp. Sensor Accuracy:	± 0.05°C
Temp. Sensor Resolution:	0.003°C
Temp. Comp. Range:	-10 to +40°C
Response Time:	< 1 minute
Battery Life:	10 Years - based on one reading/min
Clock Accuracy:	± 1 minute /year
Operating Temperature:	-20°C to 80°C
Maximum # Readings:	40,000 of level and temperature
Memory:	Superior reliability EEPROM Slate, rollover and redundant backup of last 1200 readings
Communication:	Optical Infra-Red Interface, Serial at 9600 Baud, Conversion to RS232 or USB Computer Connection
Size:	7/8" x 6" (22 mm x 154 mm)
Weight:	6.3 oz (179 grams)
Backwards Compatibility:	Full
Corrosion Resistance:	Zirconium Nitride (ZrN) Coating
Other Wetted Materials:	316-L Stainless Steel, Delrin, Viton
Sampling Modes:	Linear, Event and User-Selectable with 30 separate line items
Measurement Rates:	0.5 sec to 99 hrs
Barometric Compensation:	Software Wizard and one Barologger in local area (approx. 20 miles/30 km) radius

Figure 1.1

Models	Full Scale (FS)	Water Fluctuation Range	Accuracy (typical)	Resolution
Barologger		Air Only	± 0.003 ft., 0.1 cm	0.002% FS
F15, M5	16.4 ft., 5 m	13.1 ft., 4 m	± 0.010 ft., 0.3 cm	0.001% FS
F30, M10	32.8 ft., 10 m	29.5 ft., 9 m	± 0.016 ft., 0.5 cm	0.0006% FS
F60, M20	65.6 ft., 20 m	62.3 ft., 19 m	± 0.032 ft., 1 cm	0.0006% FS
F100, M30	98.4 ft., 30 m	95.1 ft., 29 m	± 0.064 ft., 1.5 cm	0.0006% FS
F300, M100	328.1 ft., 100 m	325 ft., 99 m	± 0.164 ft., 5 cm	0.0006% FS

Figure 1.2

1.1 Level

The Levelogger Gold uses a high quality piezoresistive silicon pressure transducer packaged in 316L stainless steel housing. It gives high accuracy and high stability. The Levelogger body is coated with Zirconium Nitride (ZrN) to give corrosion resistance. All Leveloggers measure total or absolute pressure. When the Levelogger is operating in open air, it is recording barometric pressure and converting that pressure reading to its water level equivalent above the logger's pressure zero point of 950cm (31.17ft). When submerged, it is recording the combination of barometric pressure and water pressure. The Levelogger converts the total pressure reading to its corresponding water level equivalent. Actual water level is obtained by compensating for barometric pressure. The best method to compensate for barometric pressure is to employ a Barologger above the water level, somewhere on site, to obtain records of barometric pressure. The Levelogger Software includes a Barometric Compensation Wizard, which guides the user through the automated process of barometric compensation. Manual methods can be employed to determine the absolute water level using barometric records collected on-site or available from a local weather station (i.e. Airport). Water level readings from the Levelogger Gold, LT and LTC models are temperature-compensated.

1.1.1 Pressure Calibration

The Levelogger Gold is calibrated against a range of set reference points to an accuracy of 3 decimal places. The units of pressure are in pounds per square inch. The conversion factor for pounds per square inch relates to pressure as follows:

1 pound per square inch = 0.0689476 bar
= 0.703070 m
= 6.895 kPa
= 2.31 ft. H_20 @ 4°C.

During the calibration procedure, the Levelogger is fully submerged in a highly accurate water bath. The bath is set to 15°C and allowed to stabilize. The pressure is then calibrated to six separate pressure points covering the entire range of pressure for that particular Levelogger to check for any non-linearity. The process is repeated again at 35°C to check for temperature effects. Once done, the Levelogger is approved after all specifications for accuracy, precision, stability and hysteresis have been met.

1.2 Barologger

The Barologger Gold is designed for use in air only. It has a small range and firmware algorithms based on air pressure rather than water pressure. This makes the Barologger less accurate if used in water, but more accurate if used as intended, in air. Using a Barologger is the most accurate and convenient method of obtaining atmospheric pressure. When programmed with the same sampling parameters as the Leveloggers on site, a Barologger can avoid barometric data time lags and any errors introduced due to moisture buildup, kinking or damage to vented cable. The Barometric Compensation Wizard in the Levelogger Software simplifies the adjustment of the level measurements for barometric pressure changes, by using the synchronized data from all Leveloggers on site and the site Barologger.

1.3 Temperature

Levelogger Gold and LTC Leveloggers all record temperature compensated water level. Groundwater and surface water temperature measurements are particularly important in situations where temperatures may fluctuate significantly, and when temperature is used in determining liquid level, viscosity and hydraulic conductivity. temperature monitoring is vital in the calculation of certain temperature dependent contaminant reaction rates. A Platinum Resistance Temperature Detector is used to accurately compensate for temperature changes within the range of -10 to +40°C. The Leveloggers will record temperature in its thermal range of -20 to +80°C, but outside the range of -10 to +40°C compensation will be less accurate. Levelogger Golds react very quickly to changes in temperature (<1 minute) to give the highest accuracy.

1.4 Conductivity

The LTC provides the added feature of electrical conductivity measurement. conductivity measurement is particularly useful in monitoring saltwater intrusion, surface water infiltration and mixing, as well as the monitoring of certain pollutants and contaminant parameters. Conductivity is measured via a platinum 4-electrode sensor, which produces highly stable and consistent readings. The sensor is relatively insensitive to dirt and deposits, keeping maintenance to a minimum. Conductivity calibration is performed by using a liquid solution with a known conductivity value and the Calibration Wizard in the Levelogger Windows Software. Raw conductivity measurements can be converted to conductivity at 25°C, which is referred to as Specific Conductance. When programming the LTC the user can select either raw conductivity measurements or specific conductance.

1.4.1 Calibration of the Conductivity Sensor

The conductivity sensor of the Levelogger is a highly sensitive device requiring regular calibration by the user. The conductivity calibration frequency is dependent on the water quality of the Levelogger's monitoring environment. When monitoring in freshwater with good water quality, conductivity calibration may only be required once per year. On the other hand, conductivity calibration will be required more frequently when monitoring in polluted, salty, brackish, eutrophic or highly conductive water. To determine whether an LTC Levelogger should be recalibrated, test the unit in a solution with a known electrical conductivity value at a reference temperature. If that reference temperature is 25°C, set the LTC to record Specific Conductance in Channel 3: Conductivity, and observe the current reading by using the Current Measurement function. If this reading varies from the known Specific Conductance of the solution by greater than 1% of the Full Scale of Conductivity measurement, the unit should be recalibrated using the Conductivity Calibration Wizard procedure outlined in Section 5.7/8. Ensure that conductivity calibration is performed when the LTC is being set up for its initial use and after long periods of dry storage. If the LTC Levelogger has been dry stored for some time, allow the sensor to re-equilibrate by submerging in tap water for a minimum of 2 hours and up to 24 hours prior to re-calibration and reuse.

Levelogger LTC Technical Specifications	
Specifications	**LTC Levelogger**
Ranges	F100/C5, F100/C50, F330/C5, F330/C50 M30/C5, M30/C50, M100/C5, M100/C50
Max. No. of Readings	3 x 16,000
Measurements	Linear 0.5 sec to 99 hrs
Rates	Event-Based
Level Sensor	Ceramic Transducer
- Normalization	Auto Temp Compensation [to 1% Full Scale (FS) from -10°C to 40°C]
- Accuracy	0.1% FS (-10°C to 40°C)
- Water Level Fluctuation	F100/M30 = 95.12ft/29m
- Range (at sea level)	F330/M100 = 325ft/99m
- Resolution	F100/M30 = 0.03ft/1cm F330/M100 = 0.065ft/2cm
Temperature Sensor	Spreading Resistance Silicon
- Range	-20°C to 80°C
- Accuracy	0.1°C
- Resolution	0.01°C
Conductivity Sensor	4 Electrode Platinum
- Normalization	Temp. Compensation to give Specific Conductance (-10°C to 40°C)
- Accuracy	1% FS
- Range	0 - 5mS/cm; 1µS/cm
- Resolution	0 - 50mS/cm; 10µS/cm

Figure 1.3

1.5 Total Precipitation

The Solinst Rain Logger is designed to count the tips of an external tipping-bucket rain gauge within a user defined sample interval and output the total rainfall over that sample interval. The Rain Logger can store 24000 readings. The Rain Logger is designed to be compatible with the Solinst Levelogger series of products. The Rain Logger is programmed and data viewed and exported using the Levelogger Software from a PC, it can be communicated with using a Leveloader and can be integrated into an STS Telemetry System.

1.6 Backwards Compatibility

The Levelogger Gold and the Levelogger Gold Versions 3 Software upwards are backward compatible, with limitations. If a Levelogger Gold is to be used with the Leveloader I, Leveloader II, a Protocol Converter or an STS or RRL Telemetry System, the logger must be programmed with the old Levelogger Version 2 Software. Programming Levelogger Gold loggers using Version 2 Software limits the capabilities of the Gold unit, to be the same as the older stainless steel Levelogger units. If the user has a mix of Levelogger Gold and older units, they can use the Levelogger Gold Software to program and read all the loggers. They will get the accuracy and features inherent in the older stainless steel loggers, but will obtain the higher accuracy and enhanced features and functions of the Levelogger Gold loggers.

2 System Requirements

The minimal hardware and software requirements for software installation and operation are:

Hardware	Software
Memory: 32MB or more	OS: Windows 98, ME, 2000 or XP
Display: VGA: 800 x600 pixels, 256 colour	
Ports: USB or RS232 Serial Port	

Communication Port Setting for Levelogger Communications:

Bits per second	9600
Data bits	8
Stop bits	1
Flow control	None

3 Software Installation

- Place the Levelogger CD in the CD ROM drive or download the software from www.solinst.com/Downloads and save to hard drive.
- Open Windows Explorer and double click the setup.exe icon.
- At this point Windows will prompt you through the remainder of the installation process. Figure 3.1 shows the Levelogger Installation Wizard.
- Restart the computer after installation is completed. Default Directory is C:\Program Files\Solinst\Levelogger 3_0

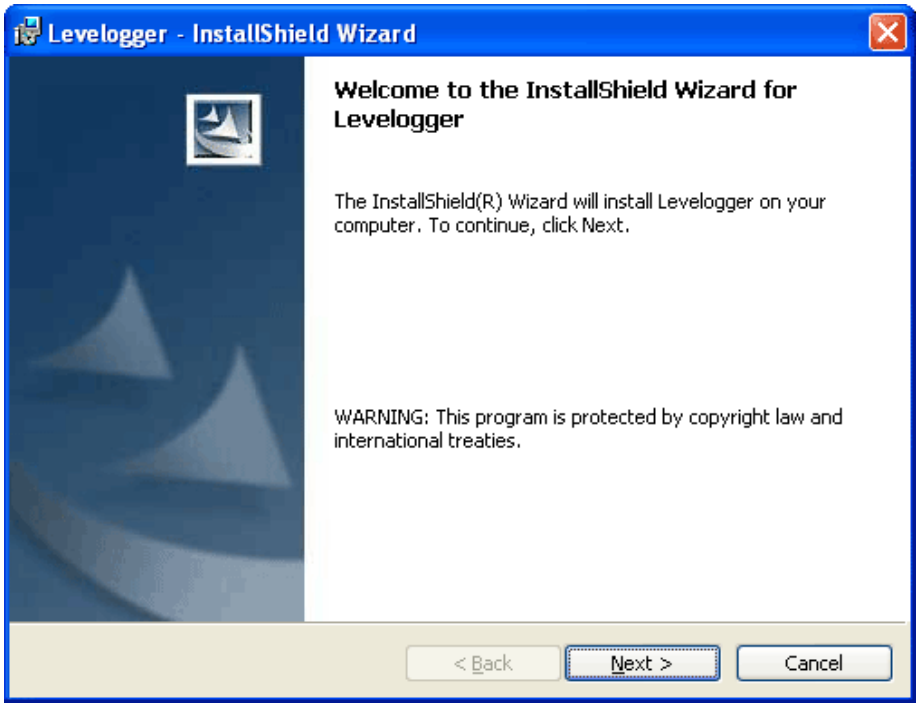


Figure 3-1 Software Installation Wizard

4 Startup, Configurations and Settings

Startup

To Start Levelogger 3, click the Levelogger 3 icon  , or click the Start button and select:

Programs > Solinst > Levelogger > Levelogger 3.0.

Communication Port Settings

Note that if using a USB port, plug in the USB cable before starting the Levelogger Software. Once the user starts the program, they can set up the parameters for the Software. Choose the Com Port Setting from the Configuration menu to set up the RS232 or USB communication port for the computer. Figure 4-1 shows the Application Setting Window.

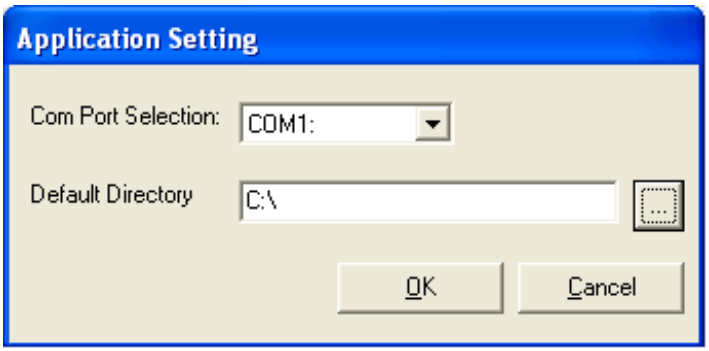


Figure 4-1 Application Setting Window

In the Com Port Selection field, select the communication port that is connected to the Levelogger by clicking the drop down list. The program automatically detects the available Com ports on your computer. If using an RS232 serial port (9-pin male DB9 Com port), identify the Com port number and select it in the Com Port Selection window.

Note that you may have to restart your computer after adding a new USB device, before that port will be detected by the Levelogger Software.

4.1 Communicating with a USB Port

USB port communication requires the installation of USB driver software and the setting up of a Virtual Com port. If communicating via a USB port, the user will either:

1) connect a Levelogger Optical Reader or PC Interface Cable to the USB port
2) use a USB to RS232 Adapter

If 1) during the installation of Levelogger V3 Software, the virtual com port driver will be installed automatically. The Levelogger Version 3 Software Installation Wizard also copies a folder to the Levelogger 3 folder containing all the Solinst USB drivers. When you plug in the Solinst USB device, check the com port designation.

Note:
Do not install generic drivers that Windows will locate.

Generic drivers are completely incompatible with Solinst USB devices.

If 2) Solinst strongly recommends the use of either Keyspan™ or IO Gear™ USB to RS232 Serial Adapters. These adapters have a sufficiently large buffer to accommodate the size of data bundle and bit transfer rate of the Levelogger. Follow the manufacturer's USB Driver and Com port setup installations found on the CD accompanying the adapter.

If you have installed another brand-name adapter, but cannot communicate with the Levelogger, in most cases the problem is that the adapter does not have a large enough internal memory buffer. The minimum buffer size should be 96 bytes.

4.2 Com Port Designation Set Up:

1) Click Start → Settings → Control Panel
2) Click Systems to open the System Properties
3) Click the Hardware tab and click "Device Manager"
4) Double Click the Ports Icon and select the "USB Serial Port"
5) Right click and select Properties
6) Click the "Port Settings" tab and click "Advanced"
7) Select the Com Port Number and click "OK"

4.3 Data Directory

The program will save data downloaded to the following default directory:

<C:\Program Files\Solinst\Levelogger3.0\Data> unless otherwise specified in the Default Directory field of the Application Settings Window.

After completing Application Settings, click the OK button to confirm and save the settings.

Levelogger V3 Software is based on 3 functional windows: Levelogger Settings, used to set up, start and stop the Levelogger, Data Control, used to download, view and compensate data and Real Time View, used to actively view data as it is being collected by the logger.

5 Levelogger Settings

After the user starts the Levelogger V3 Software, the Levelogger settings window will open.

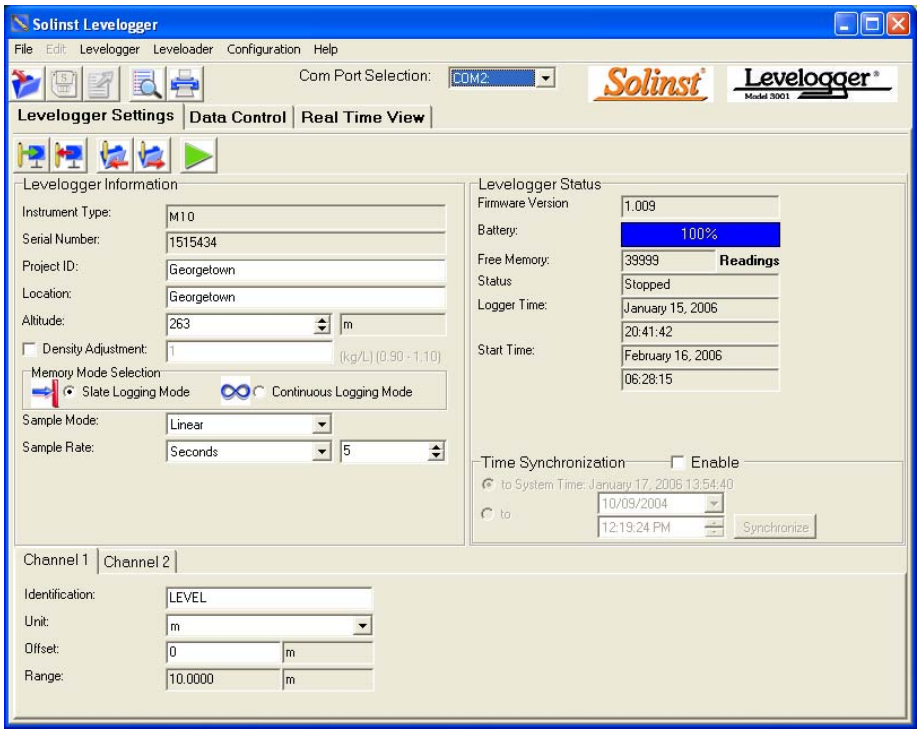


Figure 5-1 Levelogger Settings Window

Click the  button to retrieve the current settings from the connected Levelogger.

5.1 Levelogger Information Settings

The Levelogger Information Settings window includes Levelogger identification, Project ID and Location fields, sampling settings, altitude and fluid density input fields. The following is a description of each of the fields:

- **Project ID**, input your own Levelogger identification system. The Project ID is limited to 32 characters.
- **Location, input specific site / location information.** The location is limited to 32 characters.
- **Altitude** in feet or meters above sea level, at which the logger is actually deployed, is input in the altitude field. Water column equivalent pressure decreases with altitude at a rate of approximately 1.2:1000 in the lower atmosphere below 5000 m. You can compensate for this by entering an elevation between -1000 ft below sea level and 16,500 ft (or -300 m and 5000 m) above sea level. The readings will then be automatically compensated for elevation. The LTC and the L Levelogger (8.5") have a maximum altitude input of 8190 ft and previous LT versions 9750 ft (3000 m). See Section 10 for more information on how the Levelogger and Barologger adjust for altitude.

- **Density Adjustment** is used to adjust the range of the Levelogger based on the sample fluid density. The range for the density adjustment is from 0.9 kg/L to 1.1 kg/L. The range of the Levelogger after the density adjustment is based on the following formula.

  Actual Range ÷ Density = Corrected Range

  E.g. For F15 Monitoring Brackish Front in a Salt Water Intrusion Study

  16.40 ft ÷ 1.02 = 16.08 ft

  Uncheck the Density Adjustment field to disable the Density Adjustment function.

- **Sample Mode**, allows you to choose the sampling measurement type. Options are Linear, Event-based and Schedule (or Logarithmic in the older LT Leveloggers)

- **Memory Mode Selection** will be grayed-out if not in Linear Mode sampling. When using a Levelogger Gold in Linear Mode, there is a choice of Continuous Logging (wrap around) or Slate Logging. In Continuous Logging the new log is started at the end of any previous log and continues logging, eventually recording over the first logged data. As one of the download options is to 'Append Data', Continuous Logging can be a preferred choice when logging long-term. In Slate Logging the new log is also started at the end of any previous log, but will stop recording after 40,000 readings, so that the beginning of the current log will not be written over.

- **Linear** refers to a set time interval between collection of readings. Sample Rate can be any number from 0.5 seconds to 99 hours. The time unit and number of time unit intervals between each reading are set up in the Sample rate fields. The Levelogger Gold and Barologger Gold can store 40,000 readings of level and temperature. The LTC Leveloggers can store up to 16000 readings of level, temperature and conductivity. Previous LT Levelogger can store 24,000 readings.

- **Event-based Sample Collection** is the most memory efficient means of data collection. In Event mode, the Levelogger will activate every sampling interval defined in Sample rate and check if readings have changed by the selected percentage (0.1 - 25% of Full Scale) from the last recorded reading. For Levelogger Gold and LT Leveloggers, level is the selected parameter where change is monitored. For LTC Leveloggers, conductivity is the parameter that triggers the event-base sampling regime. The Levelogger will record a new reading only if the specified change in level has occurred. Note that the percentage of change for sample collection is set in the Percentage field beside the Sampling mode and that the threshold change is a percentage of the Levelogger's Full Scale for that particular parameter. An important reminder is that, although actual memory usage in stable water level conditions may be relatively small, battery power consumption is partially a function of the sample reading rate. Therefore, a small sample reading interval will consume battery power at a higher rate whether readings are

stored or not. In Event-based sampling mode, the Levelogger Gold has a total memory of 25,000 readings of level and temperature, the mini LT Levelogger (4.9 inches long) has a total memory capacity of 2 x 24,000 readings. The original LT Levelogger (8.5 inches long) will record 2 x 19000 readings in Event mode. LTC loggers will record 16000 readings in Event mode.

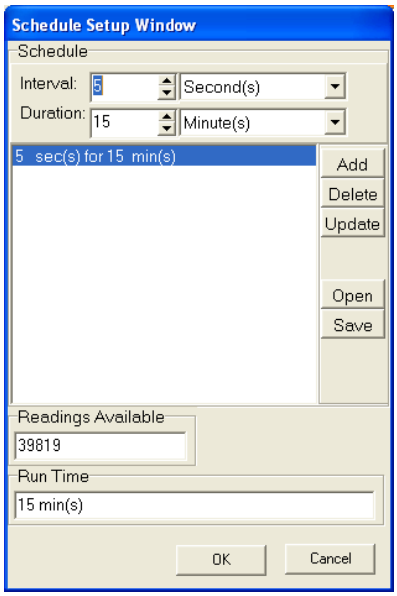


Figure 5-2 Levelogger Schedule Setup Window

- **Schedule Sampling** in the Levelogger Gold, replaces Logarithmic sampling in earlier version Leveloggers. Select Schedule and click the Edit button in the Logger Settings screen to bring up the Schedule Setup Window. Buttons allow adding and deleting of lines, updating, opening and saving of *.sci schedule files. The maximum number of line items in a schedule is 30, each with its own sampling interval of seconds, minutes or hours and duration of seconds, minutes, hours, days or weeks. Running totals of the number of readings still available, from the total possible 40,000, and the run time to date are shown. If the number of readings selected exceeds 40,000 an error message appears. Schedule sampling allows the user to select a logarithmic style sampling schedule adapted to the needs of each application.

- **Logarithmic Sampling** (available only on LT Leveloggers and previous Barologgers) offers a choice of three different sampling test periods with several levels of reading collection rates within each test period, based on a logarithmic spread of data collection intervals. The three Logarithmic sampling ranges are Log 25h, Log 6.5 day and Log 297 day sampling periods. Each log test starts with its most rapid sampling interval and uses a Step function approach in time to the longest logging interval at the end of the test. Figure 5.1 outlines how each Logarithmic sampling test period collects data over its entire sampling duration. In Logarithmic based sampling mode, the mini LT Levelogger (4.9 inches long) has a total memory capacity of 2 x 24,000 readings. The original LT Levelogger (8.5 inches long) will record 2 x 19000 readings in Log mode.

LT Levelogger Logarithmic sample collection regimes for short term (Log 25h), medium term (Log 6.5 day) and long term (Log 297 day) sampling periods.						
Time Interval	Log 25h		Log 6.5 day		Log 297 day	
	Sample Rate	# of Readings	Sample Rate	# of Readings	Sample Rate	# of Readings
0-10 min	0.5 sec	1200	1 sec	600	5 sec	120
10-100 min	1 sec	5400	5 sec	1080	20 sec	270
100-1550 min	5 sec	17400				
100-1000 min			10 sec	5400	1 min	900
1000-9460 min			30 sec	16920		
1000-10000 min					5 min	1800
10000-428200 min					20 min	20910
Reading Total	~25.8 hrs	24000	~157.7 hrs	24000	~297 days	24000

Figure 5-3 Logarithmic Sampling Test Period

5.2 Setting up Channel Information

In the lower portion of the Levelogger Settings window is the window for setting channel parameters. The software will detect the available channels when the Levelogger settings are read.

For Channel 1, "Level", you can set the following parameters:

- **Identification** describes the measurement parameter of the channel and has already been configured as 'level'. The level channel monitors water column equivalent pressure. The Identification field will be the data column heading and graph line name when viewing the data. The Identification is limited to 32 characters.
- **Units** refers to the channel's units of measurement. There are three units of measure available for the user to select: cm, m or ft. When the user changes the unit, the value of the range and altitude will change according to the Unit Conversion formula. Note that when a metric unit is used, the unit of altitude is meters. When feet are the level channel units, feet are the units of altitude.
- **Offset** refers to an offset correction, such as the distance between the tip of the Levelogger and the monitoring well cap or static water level. It is recommended that the value of 0.00 be used for offset as this keeps all subsequent readings relative to the tip of the Levelogger. The offset range for Levelogger Gold or Barologger Gold units is -3280 to 16400 ft or -1000 m to 5000 m. For other Levelogger versions (silver colored body), the offset field can accept numbers from –327 to +327 when level units are feet and the logger's level range is either 4.92, 16.40, 32.80, 65.60 or 98.40 ft. For units with range 3280 ft the offset field boundaries are -3270 to 3270. Similarly, for loggers configured in metric units of level and ranges of 1.500, 5.000, 10.000, 20.000 or 30.000 m, the offset field boundaries are – 30.30 to +30.30. For units with range 100.00 m the offset field boundaries are -327 to 327.

Note: Readings can be corrected or offset with respect to a specific reference elevation or datum for a much wider spectrum of numeric Offsets as part of the Data Compensation Wizard.

- **Range** refers to the full scale water fluctuation range capability of your particular Levelogger model. The full scale reading of any Levelogger unit is based on its metric range. Therefore, the Levelogger, which is available in F15 (M5), F30 (M10), F60 (M20), F100 (M30) and F300 (M100) ranges have actual water level ranges of 16.40 ft (5 meters), 32.80 ft (10 meters), 65.60 ft (20 meters), 98.40 ft (30 meters) and 328.0 ft (100 meters), respectively.

Channel 2: "Temperature", includes the following parameters: Identification and Units, Reference and Range

- The Temperature channel has been pre-configured by Solinst in °C and cannot be changed.

For Channel 3, "Conductivity" or ("Specific Conductance")

- For conductivity, the identification field allows you to choose the actual conductivity at the current temperature or select Specific Conductance measurement in which the conductivity reading is temperature compensated to the standard of 25 deg C.
  - The range of the second generation (black body) LTC is 80.00mS/cm and provides readings to the second decimal. By scrolling the range field to 30.000mS/cm, the user can obtain readings to the third decimal point. Please keep in mind that the maximum reading is determined by the range chosen, and regardless of range, the accuracy is ± the greater of 1% of reading or 10µS/cm.

5.3 Levelogger Status

The Levelogger Status Section of the Levelogger Settings Window shows the Firmware Version of the attached Levelogger. Levelogger Gold models will also show an accurate battery level and the number of free readings. LT Leveloggers will show an approximation of the battery level. The current date and time and the start date and time of all Leveloggers will be indicated.

5.4 Setting up the Levelogger Time

The 'Time Synchronization' section at the middle right of the Levelogger Settings window provides the controls for setting the Levelogger clock. The default setting in the Enable box is off, or unchecked. If you want to synchronize the Levelogger's clock, check the Enable box and select the time and click the synchronize button to set the time in the Levelogger. If you start the Levelogger without synchronizing the clock and the time difference between the Levelogger and the PC is more than 3 seconds, the software will give you a message asking "Do you want to synchronize the clock?". Click "Yes" to synchronize the clock. It can be very useful to synchronize the clocks of all the Leveloggers and Barologgers going to one site.

5.5 Program Levelogger Settings

At this point you have completed editing the settings for your logging session, click the button  to send all the settings to the Levelogger and the Levelogger will store all the new settings. Now that the logger has been programmed with your new settings, you can move on to Starting the logger.

5.6 Starting and Stopping the Levelogger

To begin logging, click the  button and the Start Levelogger dialog box will open.

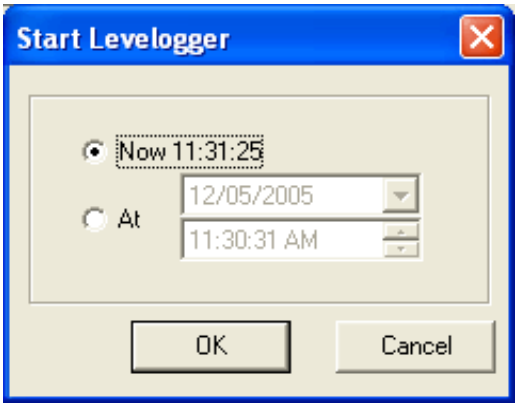
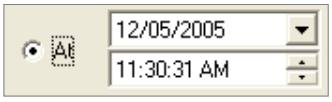


Figure 5-4 Start Levelogger Window

There are two ways to start logging. Choose "Now" to start logging immediately. The Status field in the Levelogger Status window will state: Started and will indicate the logger time and the Start time. Free memory indicates the number of readings remaining at the time of communication.

Choose 

to start the logging at a later date and/or time. This Start mode is referred to as Future Start in the Status field. After confirmation, the starting time is stored in the Levelogger and it will start collecting readings at the specified time. When the Future Start time is reached, the Status will change to Started.

After the Levelogger is started, it will begin collecting readings. The Start icon  will change to a Stop icon  .

The Levelogger can be stopped at any time before it reaches the maximum reading capacity. Starting begins a new recording session and clears previously stored data readings.

It is critical to note that LT and LTC Leveloggers log data in Slate mode, which means they will record data until stopped or their memory is full. When the memory fills, the logger will Stop recording. For this reason, it is important to determine, based on your start time and sampling rate, the date and time at which the memory will be full and the logger will stop recording. Levelogger Gold units record in Slate mode if Event or Schedule logging, but in Linear mode they can be set to Slate or to Continuous logging.

You can stop logging from the Levelogger Settings window, by clicking the Stop icon  .

5.7 Saving and Retrieving Default Settings

To store settings as defaults, click the  icon. It will store the settings of the Levelogger into an *.lls file as a series of defaults. The *.lls file will save the Project ID, Location, Sample Mode, Event Percent, Sample Rate, Altitude, Density, Channel ID, Unit and Offset.

To retrieve settings from defaults click the  icon from an *.lls file. This is particularly useful if programming several Leveloggers with similar identical settings. Keep in mind that Project ID and Location identification information will be identical and should be distinguished from logger to logger or monitoring point to point.

5.8 LTC (Stainless Steel) Calibration

L and LT Leveloggers and the Levelogger Gold do not require calibration. This section is only applicable to first generation Stainless Steel LTC Leveloggers. The first generation LTC had a length of 10.2 inches and a body comprised of Stainless Steel. See Section 5.8 for calibration of the second generation, black LTC, which has a 7-inch long body comprised of Zirconium Oxide. The conductivity sensor must be calibrated for reliable conductivity measurements. If the LTC Levelogger has not been in operation for some time, it is recommended that the unit undergo a brief acclimatization session. It is recommended that the LTC Levelogger be placed in tap water for 2 - 24 hours at a fixed sampling rate of 1 minute. Calibrate the LTC Levelogger for conductivity at the start of each new monitoring project or at a minimum each new monitoring season. Calibrating the LTC Levelogger again directly after the monitoring project or season will provide information on the degree of conductivity deviation during the project or season. If necessary, readings can be corrected for any conductivity deviation in a spreadsheet program after the data has been exported. The process of conductivity calibration is performed automatically by use of the Calibration wizard. The user need only place the LTC Levelogger in a specified calibration solution. Conductivity calibration solutions are available from Solinst or any laboratory supply outlet. The conductivity range of the LTC Levelogger determines the solution required:

- 5 µS/cm range requires a calibration solution of 5,000 µS/cm
- 50 µS/cm range requires a calibration solution of 12,880 µS/cm

The solution must be between 5 Deg C and 30 Deg C during actual calibration. Temperature should remain stable during the 10 - 20 seconds it takes to perform the calibration.

From within the Levelogger Settings window, start the calibration wizard by clicking the Calibration Wizard icon  .

The wizard will guide you through the calibration process. You can exit the wizard after any step to cancel the calibration session.

1. **Introduction.** This step is a reminder that the calibration exercise will overwrite all data currently in the LTC Levelogger and that the Levelogger must be connected with the computer during the entire calibration process. The logger must be stopped to calibrate.

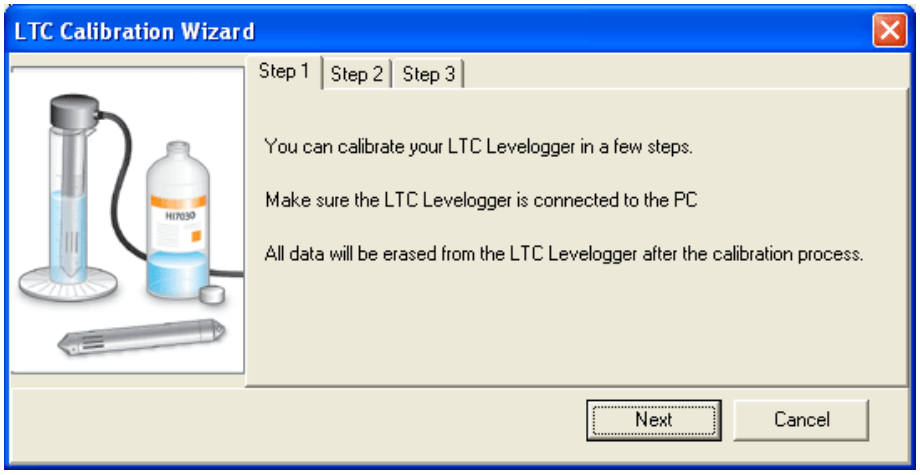


Figure 5-5 LTC Calibration Wizard Step 1

2. **Set-up.** The Levelogger Software detects the type of calibration solution required to calibrate the connected LTC Levelogger. Ensure the solution is ready. Start the calibration by selecting [Next].

Note: Ensure that the calibration solution covers the sensor cell grills and the logger is agitated to release entrapped air bubbles (~20ml required if using Solinst supplied test cylinder)

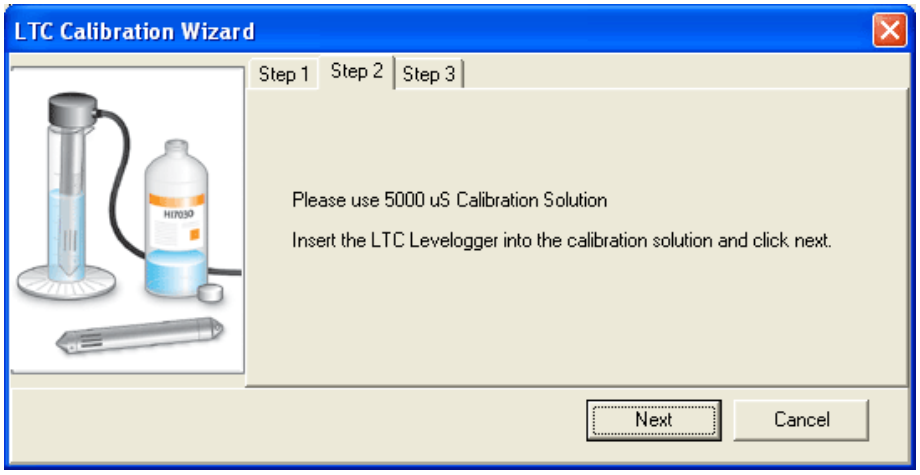


Figure 5-6 LTC Calibration Wizard Step 2

3. **Calibration.** In this step, the current sensor constant and solution temperature from the LTC Levelogger are stated. If the calibration failed, the LTC Levelogger is reset to its pre-calibration state. If the calibration succeeds, the new values are stored in the LTC Levelogger.

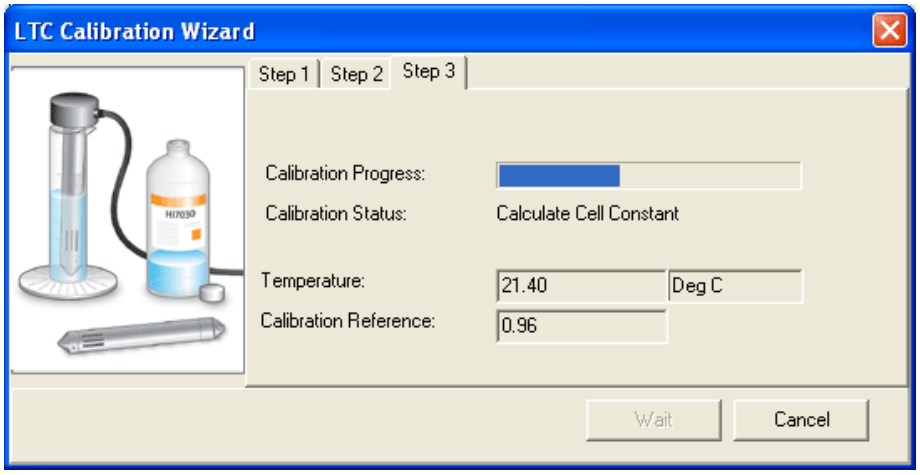


Figure 5-7 LTC Calibration Wizard Step 3

5.9 LTC (Black Zirconium Oxide) Calibration

Calibration of the second generation LTC, which has a 7-inch long body comprised of Zirconium Oxide is described in this section. The conductivity sensor must be calibrated for reliable conductivity measurements. If the LTC Levelogger has not been in operation for some time, it is recommended that the unit undergo a brief acclimatization session. It is recommended that the LTC Levelogger be placed in tap water for 2 - 24 hours at a fixed sampling rate of 1 minute. Calibrate the LTC Levelogger for conductivity at the start of each new monitoring project or at a minimum each new monitoring season. Calibrating the LTC Levelogger again directly after the monitoring project or season will provide information on the degree of conductivity deviation during the project or season. If necessary, readings can be corrected for any conductivity deviation in a spreadsheet program after the data has been exported. The process of conductivity calibration is performed automatically by use of the Calibration wizard. The user need only place the LTC Levelogger in a specified calibration solution. Conductivity calibration solutions are available from Solinst or any laboratory supply outlet. This LTC has an 80,000 µS/cm conductivity range and can be calibrated at up to 4 calibration standard points:

- 1413 µS/cm
- 5000 µS/cm
- 12,880 µS/cm and
- 80000 µS/cm

The solution(s) must be between 5 Deg C and 30 Deg C during actual calibration. Temperature should remain stable during the 10 - 20 second it takes to perform (each) the calibration.

From within the Levelogger Setting window, start the calibration wizard by clicking the Calibration Wizard icon  . The wizard will guide you through the calibration process.

You can exit the wizard after any step to cancel the calibration session. The logger must be stopped to calibrate.

1. **Introduction** This step is a reminder that the calibration exercise will overwrite all data currently in the LTC Levelogger and that the Levelogger must be connected with the computer during the entire calibration process.

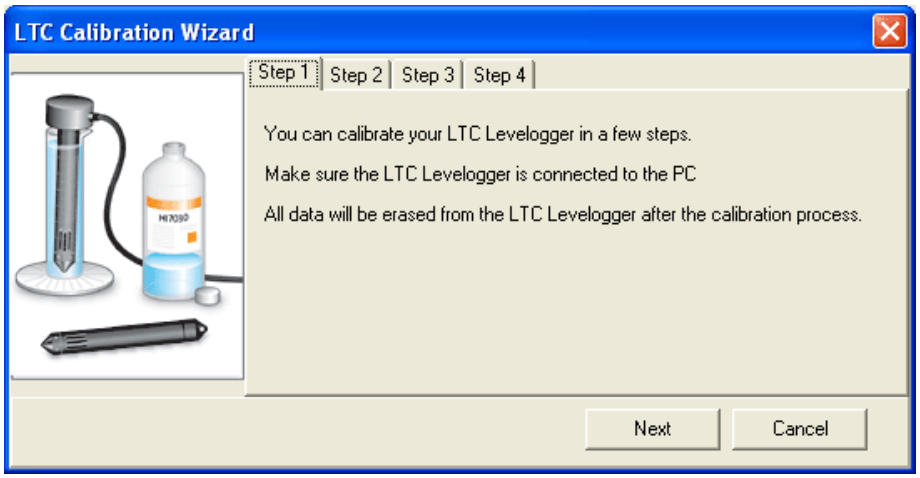


Figure 5-8 LTC Calibration Wizard Step 1

2. **Set-up** The Levelogger Software requires the user to choose the calibration solutions. Ensure the solution is ready in the calibration beaker or container. Start the calibration by selecting [Next].

Note: Ensure that the calibration solution covers the sensor cell grills and the logger is agitated to release entrapped air bubbles (~20ml required if using Solinst supplied test cylinder)

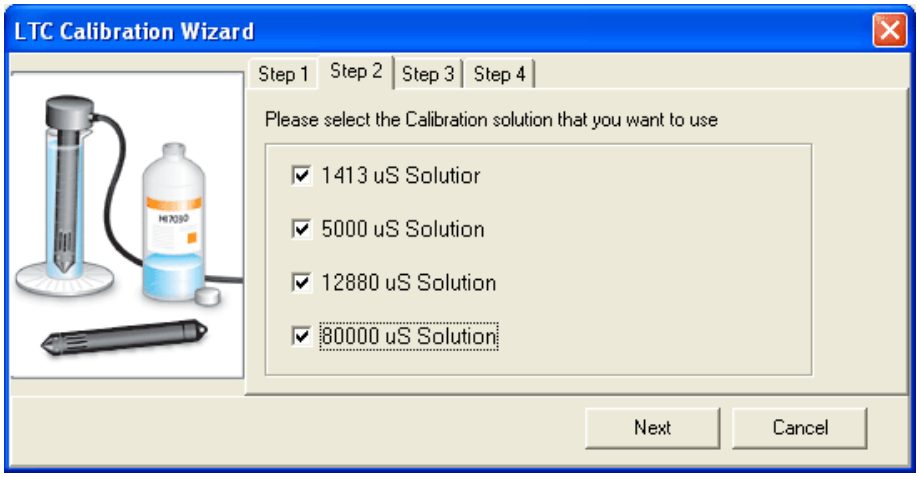


Figure 5-9 LTC Calibration Wizard Step 2

3. **LTC Levelogger rinsing process.** In this step, rinse the Levelogger. Use DI water to rinse the Levelogger first and the further rinse the Levelogger with the displayed calibration solution. Use fresh solution for calibration.

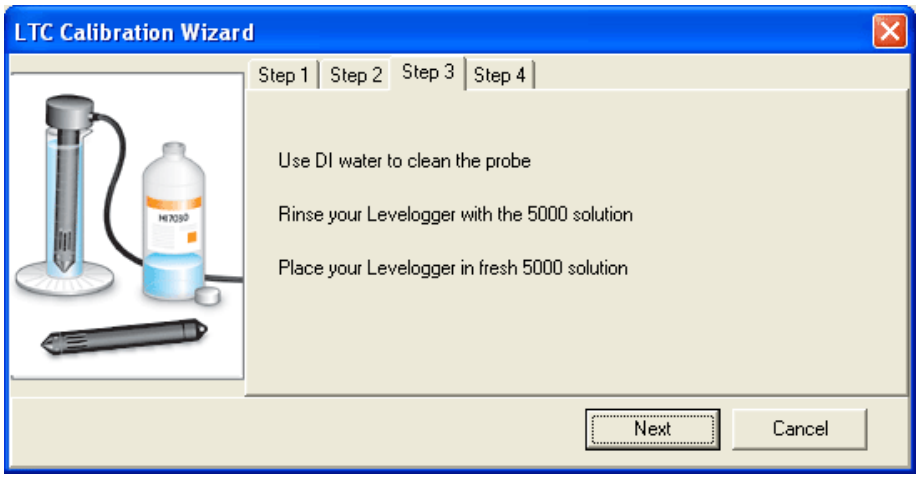


Figure 5-10 LTC Calibration Wizard Step 3
(example of window calibrating with 5000 µS/cm solution)

4. **Calibration.** In this step, the current sensor constant and solution temperature from the LTC Levelogger are stated. If the calibration for the specific solution succeeds, the software will go back to step 3 to continue the calibration with the other solution, if selected. If calibration with all the solutions is completed, the new values will be stored in the Levelogger. If the calibration failed, the LTC Levelogger is reset to its pre-calibration state.

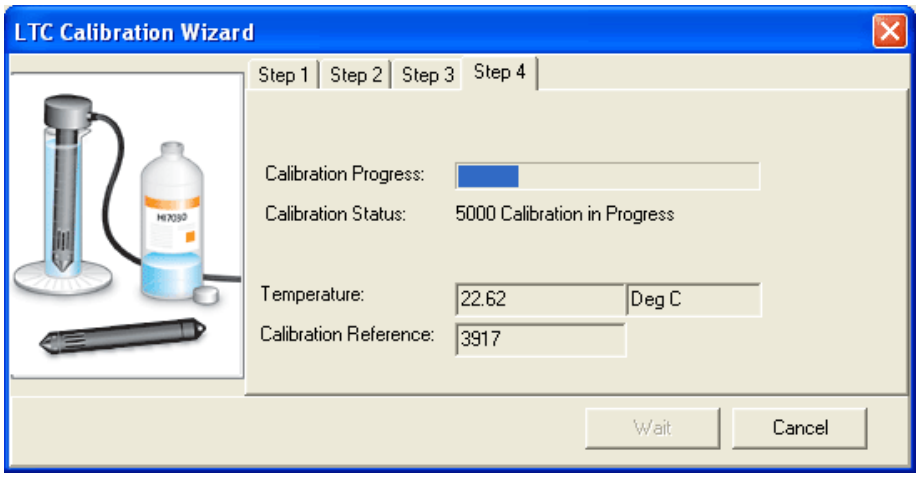


Figure 5-11 LTC Calibration Wizard Step 4

Figure 5-12 Solinst Rain Logger

Figure 5-13 The Levelogger PC Interface Cable (RS232)

Figure 5-14
The Tipping Bucket Rain Gauge Connector of the Rain Logger

5.10 Rain Logger

The Solinst Rain Logger (Fig 5-12) is designed to count the tips of an external tipping-bucket rain gauge within a user defined sample interval and output the total rainfall over that sample interval. The Rain Logger can store 24000 readings. The Rain Logger is designed to be compatible with the Solinst Levelogger series of products and is therefore programmed and data is viewed and exported using the Levelogger Software from a PC. It can be communicated with using a Leveloader and can be integrated into an STS Telemetry system.

The Rain Logger can be set up to log rainfall depth at intervals from 5 minutes to 90 minutes and also calculates and presents the maximum 5 minute rainfall intensity within the sampling interval. The Rain Logger is housed in a polycarbonate water-resistant housing. It should not be exposed to direct rainfall or submerged.

5.10.1 Rain Logger Communication Interface

The Rain Logger is compatible with Solinst Levelogger products. The Rain Logger is programmed and interrogated for data using Levelogger Software and is connected to a PC or Leveloader, handheld data transfer device, using the Leveloggers PC Interface Cable (Fig. 5 - 13). It is recommended that the PC Interface Cable be disconnected from the PC when not communicating with the Rain Logger to avoid potential activation of the Rain Logger when the serial port is initialized. The Rain Logger circuitry is electrically isolated from the serial port.

Rain Gauge Connector:

The rain gauge connected to the Rain Logger is supplied by the customer and is a reed-switch type gauge most commonly known as a tipping-bucket rain gauge. The rain gauge connector is 3-pin (Fig 5 -14) and connects to the 3-pin cable supplied with the Rain Logger. Longer cables up to 30m (100ft) can be supplied when the Logger is ordered. The connector cable has 3 wires, however only two, the blue and brown, wires are connected to the tipping bucket devise. As the tipping bucket is just an electrical circuit gate, it does not matter to which terminal on the tipping bucket the blue or brown wire is connected. There is no need for a ground or third wire since the Rain Logger is electrically isolated from any other system. Longer, exposed cables should be protected from rodents and vandalism by cable armoring or installation within electrical conduit.

5.10.2 Rain Logger Battery

The Rain Logger is powered by a standard 9V alkaline battery and should be replaced periodically. The Levelogger Software provides a reading of the approximate battery life remaining when connected to a Rain Logger. It is recommended that the battery be changed when remaining life falls below 40%.

The 9V battery is located inside the logger housing. To access the battery, loosen the 4 screws on the corners of the case with a standard screwdriver. The battery can be disconnected at any time but tipping events may be missed if battery change occurs during active rainfall or when a reading is being logged. If the Rain Logger is logging, the lamp on the front face of the Rain Logger will flash every minute. Wait until the lamp flashes and then exchange the old battery with a new one within 1 minute.

There is a clock battery inside the unit which is mounted to the printed circuit board. This battery powers the logger's internal clock and should last the lifetime of the logger.

5.10.3 Rain Logger Setup

The Rain Logger is programmed using the Logger Settings Window of the Levelogger Software. The appearance of the Logger Settings Window when in communication with a Rain Logger is shown in Fig 5-15.

Setting up and Starting a Rain Logger is a quick and simple process. Identify the logging session and location in the **Project ID** and **Location** fields. The **Sample Mode** for the Rain Logger is Linear. Input the **Sample Rate** from 5 to 90 minutes. Use a sample rate that is a multiple of 5, such as 5, 10, 15, 20, 30, 45, 60, etc. minutes.

Channel 1 will provide the total rainfall depth within the sample interval. It does so by multiplying the number of tips within the interval by the tipping bucket's calibration factor. The calibration factor is the amount of rainfall depth (mm, m, in or ft)/ tip. The calibration factor should be indicated on a label on the tipping bucket device or in the manufacturer's documentation. First choose the rainfall depth Unit and then input the **Range** from the following calculation:

Range = Calibration Factor x 30000

Eg. Range = 0.05" x 30000 = 1500

Or: Range = 0.25 mm x 30000 = 7500

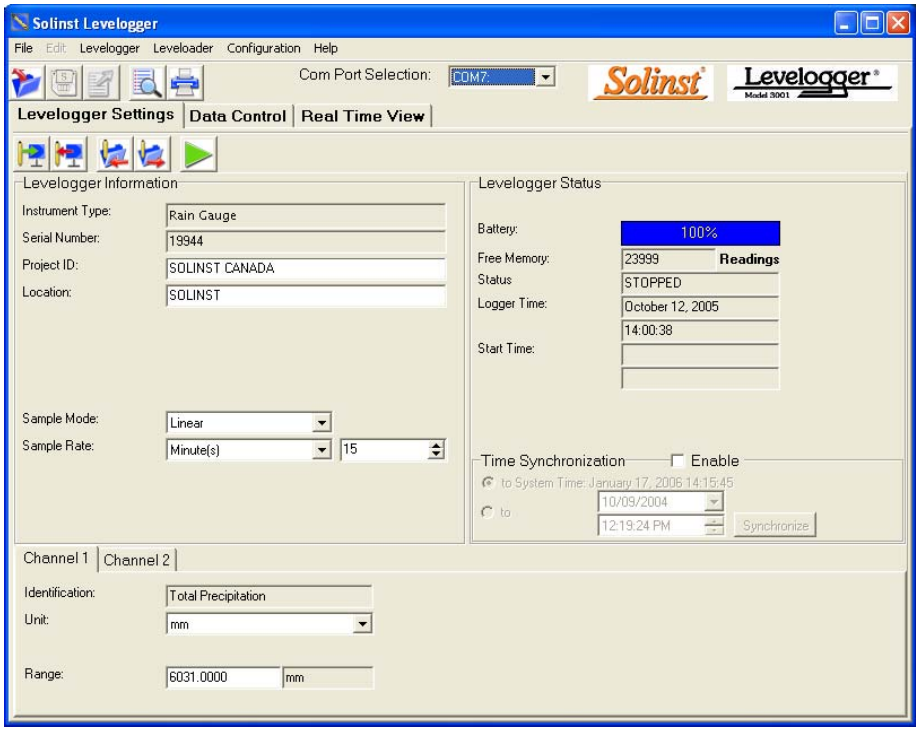


Figure 5-15 The Levelogger Settings Window of the Rain Logger.

Channel 2 does not require any setup or user input. The readings in channel 2 are of maximum 5 minute peak intensity within the sampling interval. This rainfall intensity value is derived by subdividing the sample interval into 5 minute sub-intervals and temporarily recording the number of tips in each 5 minute sub-interval. The Peak intensity reading is calculated by multiplying the number of tips in the 5 minute interval with the largest number of tips by 12 and presenting peak intensity/hr.

After the user has setup the Rain Logger, click the  button to start logging. A Message Box will pop up to ask for confirmation. When logging the logging lamp on the Rain Logger will flash every minute.

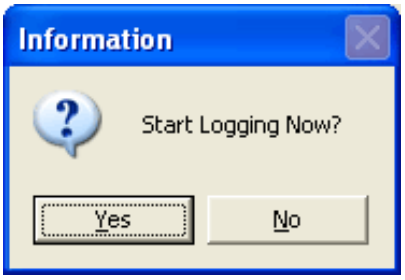


Figure 5-16
Rain Logger Start Logging Message Box

6 Data Control Window

Click the Data Control Tab from the Main Window, the Data Control window will appear. From the Data Control window, the user can download data from a Levelogger or Leveloader, display data in tabular or graphic form perform data compensations and export.

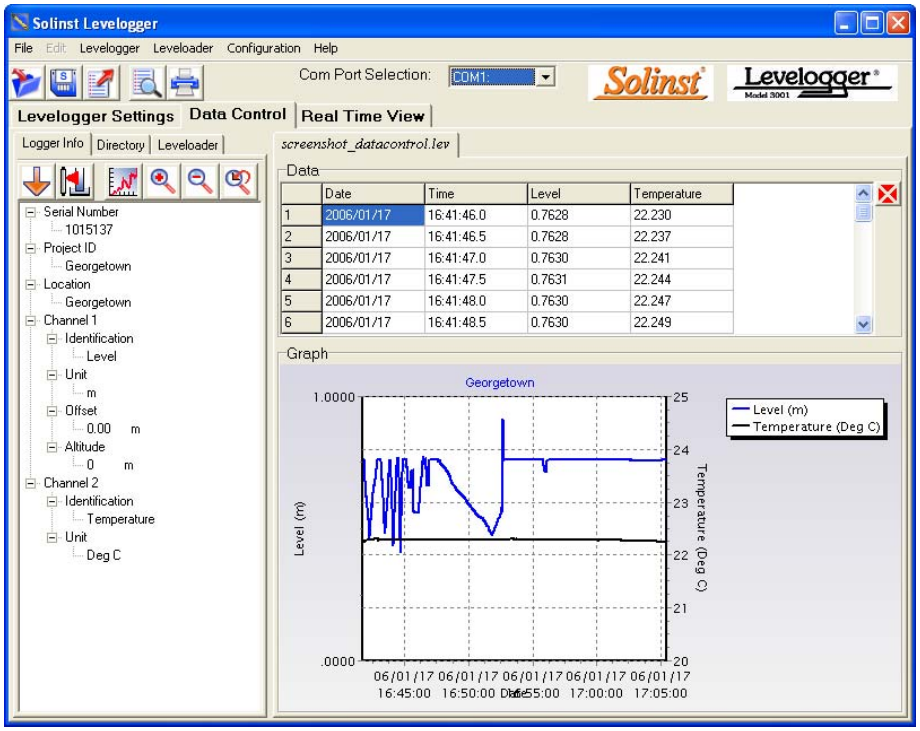


Figure 6-1 Data Control Window

Note:
The first thing you should do in this window is click one of the following tabs:

- Click the Logger Info tab to communicate with a Levelogger.
- Click the Leveloader tab to communicate with a Leveloader.
- Click the Directory tab to view the current file pathway or to open a specific file.

6.1 Downloading Options

Click the Download icon from the Data Control window to download data from the Levelogger. There are four options for downloading data. They are All Data, Append Data, Partial Download and Recover Previous Log. If the users select All Data, the program will download all the data from the current logging session of a Levelogger into a *.lev file. If the users select Append Data, the program will append the data in the opened*.lev file from the Levelogger. The opened *.lev file and the attached Levelogger should have the same serial number and start time, otherwise an error will occur.

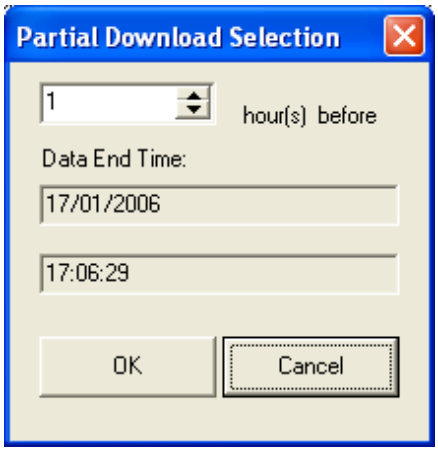


Figure 6-2 Partial Download Window

If the user selects Partial Download, a Partial Download Selection Window will open. The window shows the time stamp of the last reading in the logging session. The users can select the number of hours before the data end time. Once the users click OK, all the data within that time will be downloaded to a *.lev file.

If the user selects the Recover Previous Log, the software will try to recover the data from the previous log session and download the data to a *lev file.

Once the data is downloaded from a Levelogger, it is automatically saved in a temporary file.

Click the Save icon  to save the data in a specific *.lev file. The default directory for saved data is in the "Data" folder. However, the default directory for saved files can be changed by clicking the Configuration tab at the top of the program window, selecting 'Application Settings' and inputting or navigating to a different folder destination. If an error is experienced in saving your first data file such as depicted in Fig 6-3, you may not have file writing privileges to the default directory. It this case, create and set as the default file save folder, a new Levelogger data folder within the My Documents folder and attempt the file save procedure again.

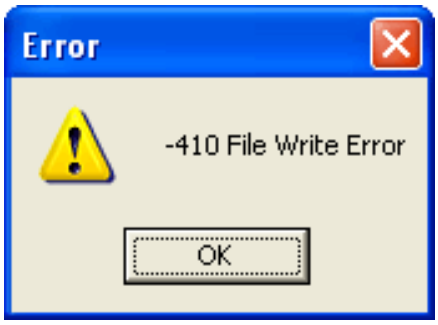


Figure 6-3 File Write Error Message

Click the File Open icon  to open a *.lev file. Multiple files can be opened at the same time and are available for viewing by clicking the File Name Tab on top of the data table. All the Levelogger settings and the channel information effective during data collection are shown on the left of the window. Click the Directory tab on the left of the window to show a directory list of the computer. Click on the *.lev file from the directory list to open a specific *.lev file. The Data Control window with the directory list is shown in Fig 6-4.

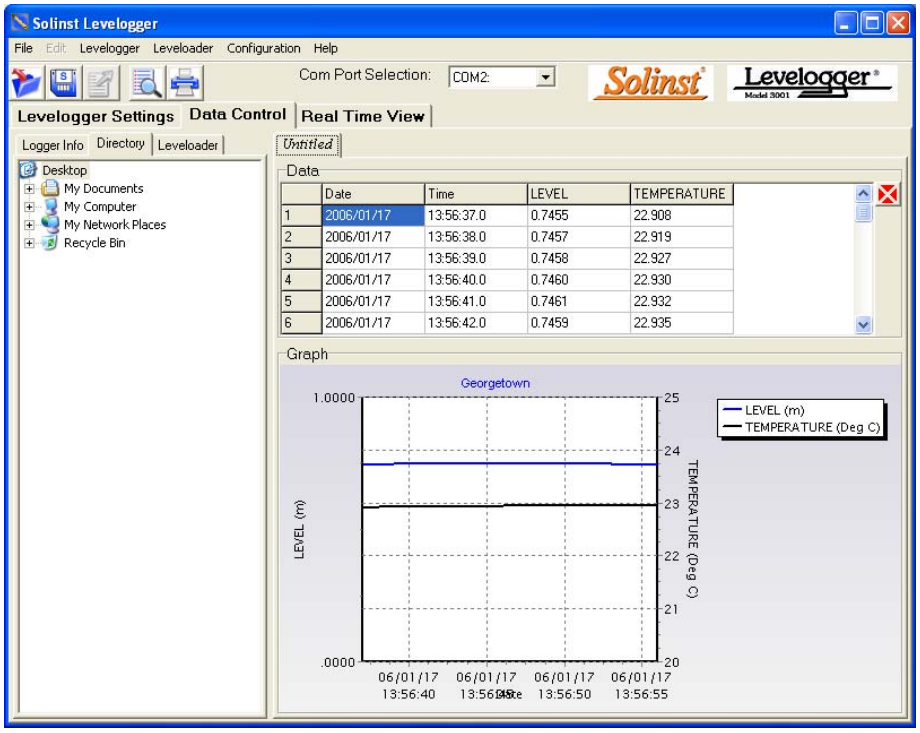


Figure 6-4 Data Control Window with Directory List

6.2 Graph Manipulation and Zoom Function

To perform the Zoom In function on the graph, click the  button.

To perform a Zoom Out function on the graph click the  button. Click the  button to undo all the zoom functions.

Click the Graph Option icon  to open the Graph Option Dialog. The Graph Dialog is shown in Figure 6-5.

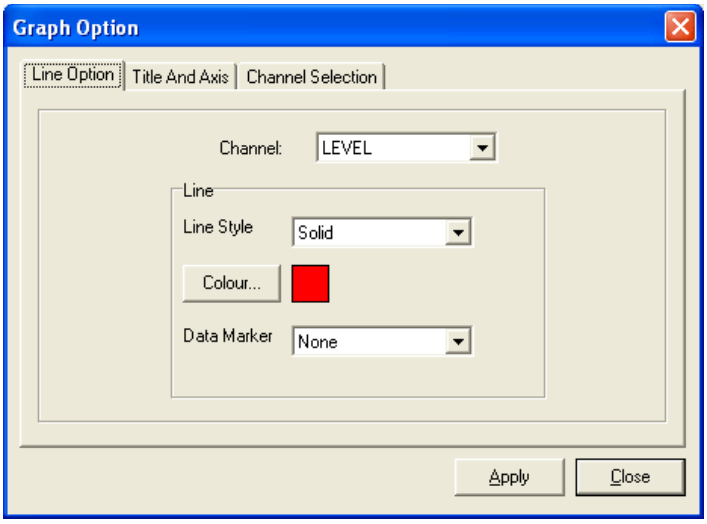


Figure 6-5 Line Option Window

The Line Option is used to adjust the style and color of the line in the graph for each channel. The user can also select the shape of the data marker or remove the data marker.

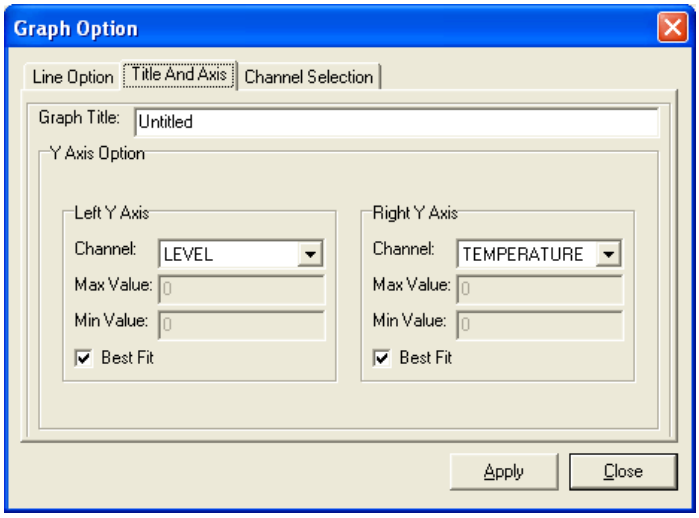


Figure 6-6 Title and Axis Window

The Title and Axis Option is used to enter the title of the graph and change the Y axis label or user selected scale. Check the Best Fit box to enable the software to determine the best fit scale. If the Best Fit box is not checked, the user has to enter a maximum and minimum value of the selected channel. The X axis is logging time.

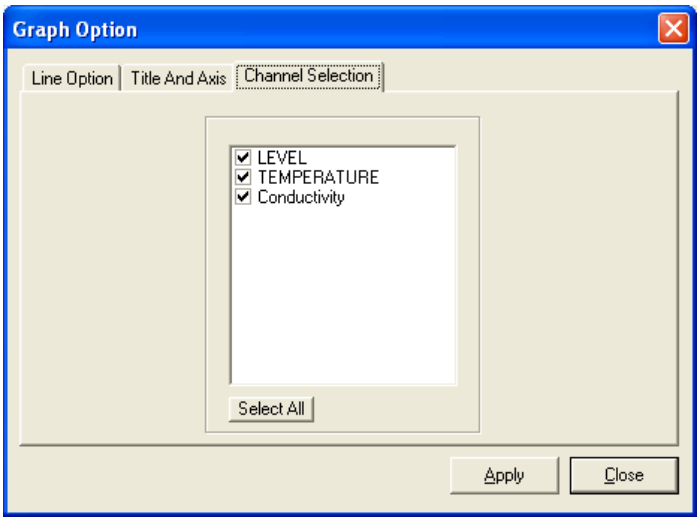


Figure 6-7 Channel Selection Window

The Channel Selection Option is used to control the visibility of each channel on the graph. A check mark beside the channel name indicates that the channel is visible on the graph. Click the Select All button to select all the channels.

6.3 Data Compensation

Click the Data Compensation icon  to open the Data Compensation Wizard. The Data Compensation Wizard is shown in Figure 6-8.

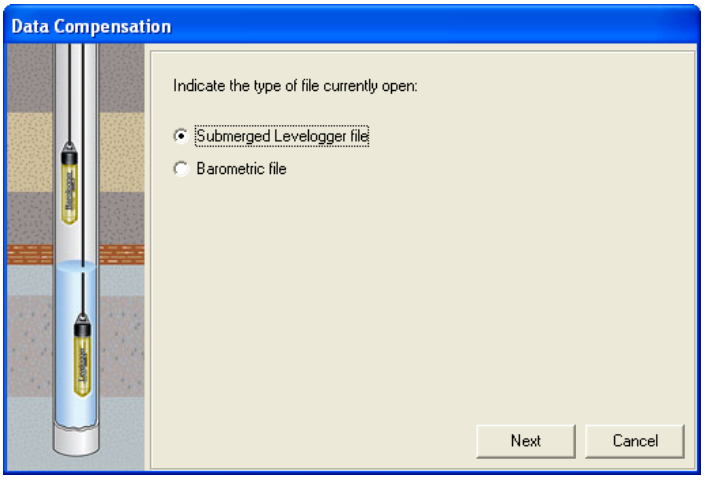


Figure 6-8 Data Compensation Window File Type Selection

In the first window of the wizard, the user identifies the currently opened file type. There are two file types: Barometric files (data that is retrieved from a Barologger) and Submerged Levelogger files (data that is retrieved from LT, LTC Levelogger or Levelogger Gold). After the selection of the file type, click Next and the Data Compensation selection window will open.

There are four data compensation options available: Barometric Compensation, Manual Data Adjustment, Density Adjustment and Barometric Efficiency.

- **Barometric Compensation** requires the Barometric file and the submerged Levelogger file and simply involves subtraction of the barometric reading from the Levelogger reading. If there is an inconsistency of the time stamp between the Barometric file and the Submerged Levelogger file, a linear approximation on the barometric data will be performed.

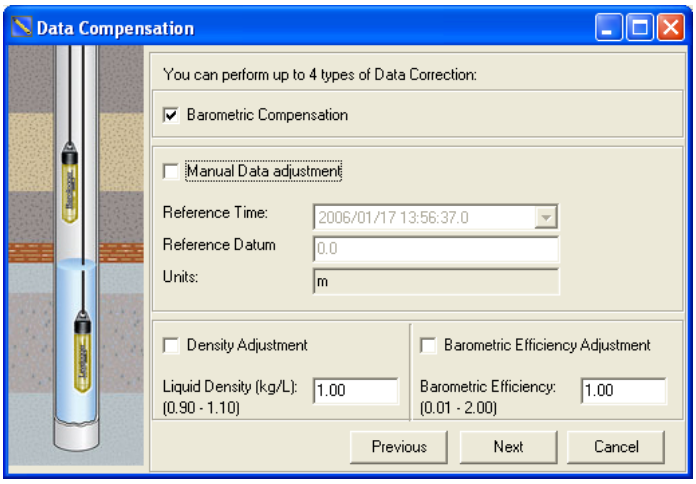


Figure 6-9 Data Compensation Window - Compensation Selection

- **Manual Data Adjustment** requires the user to select the Reference Time from the data file and enter the new reading in the Reference Datum to replace the original level reading of that selected Date/Time. The user can use this field to adjust the data by an offset value by inputting the Reference Datum value for that time when the offset is incorporated. Please note that the value input in Reference Datum field will become the actual finished data point at that date/time. Therefore, the program computes a correction factor to adjust the existing data value after the other requested compensations such as barometric or density compensations, are performed. This correction factor is then applied to all the data from that file after other compensations are performed.

- **Density Adjustment** corrects the range of the level channel in the data file based on a user input adjustment of fluid density. The adjustment formula is stated in section 5.1. The density range can be set from 0.90 to 1.10.

- **Barometric Efficiency Adjustment** is used to proportionally adjust Barologger data in relation to a particular Levelogger. Barometric efficiency is often expressed as a percentage or proportion. The input field is proportional and has a default value of 1.00. For more information about Barometric Efficiency, see Section 9.1.3. The barometric efficiency can be set from 0.01 to 3.00.

  The compensated data will be saved in a new *.lev file. The default file name will be the <Submerged Levelogger file name> with the word <compensated> added to the file name prefix. Alternatively, the user can name the compensated file. Do not change or delete the file extension.

Note:
If a Levelogger Gold is to be used with the Leveloader I or Leveloader II, the logger must be programmed with the old Levelogger Version 2 Software. Programming Levelogger Gold loggers using Version 2 Software limits the capabilities of the Gold unit to be the same as the older stainless steel Levelogger units.

6.4 Leveloader II

This section describes the setup and use of the Leveloader II. The Leveloader II is used to view existing logger settings, program new settings, launch logging sessions, download and view data and store multiple data files on one single handheld unit. The Leveloader II supports all types of Leveloggers including Gold, L, LT (including the previous Barologger, which is an LT with a small range), LTC and Rain Logger. The Leveloader II is designed to interface with a PC via Levelogger version 2 or greater software.

6.4.1 Leveloader II Hardware Description

Figure 6-10 below shows the hardware of the Leveloader II and the function of each part.

Figure 6-10 Leveloader II

6.4.2 Leveloader II Menu Description

Figure 6-11 shows the first four of six items in the main menu of the Leveloader II. The top of the screen shows the Leveloader II's battery level, current time and available memory.

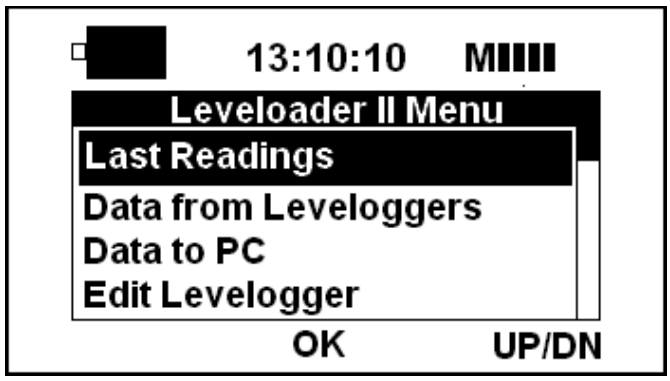


Figure 6-11 Leveloader II Main Menu

The battery gauge depicts the remaining life of the Leveloader II's 9V battery. Five battery levels can be displayed: full, high, medium, low and empty. When the battery icon is empty , replace the battery immediately.

The Leveloader II displays the current time. Time is displayed in 24 hour (hh:mm:ss) format. The Leveloader II's time can be set up manually within its Setup menu or automatically by synchronization with a PC from the Levelogger V3.0 Software. Refer to section 6.4.9 for further details.

The memory gauge depicts the amount of free space available in the Leveloader II's memory. There are five levels on the memory gauge, each depicted by a single bar. The total memory in the Leveloader II system is 2 Mb or 380,000 readings of level and temperature. The user can erase data by using the PC software or by removing the last log file from the Leveloader II Setup menu. Refer to section 6.4.9 for further details.

The bottom of the Figure 6-10 shows the functions of the push buttons. The function of the push buttons will vary under different menus.

There are six items in the Leveloader II main menu: Last Readings (Section 6.4.3), Data from Leveloggers (Section 6.4.4), Data to PC (Section 6.4.5), Edit Levelogger (Section 6.4.6), Leveloader Setup (Section 6.4.7) and Restart Levelogger (Section 6.4.8). Use the UP/DN buttons to scroll to these menus and press OK to enter the menu.

The Leveloader II is equipped with password access capability to prevent unauthorized access to critical Leveloader functions. No password is setup in the factory default configuration of the Leveloader II. The user can elect to configure the Leveloader II with password protection from the Levelogger V3.0 Software (see Section 6.4.9). Figure 6-12 shows the password protection screen. The Password screen only appears when password protection is activated and the user is attempting to edit Levelogger settings, erase data from the Leveloader or restart the Levelogger. No password is required to download/upload or view data. If password protection is activated, use the UP/DN buttons to chose letter/function. Press OK to insert a letter in the password. Use {PREV} and {NXT} to move the cursor in the password and {SUBMIT} when the password is complete. Click the Menu button to exit the Password screen. Note that the Levelogger must be stopped to edit settings.

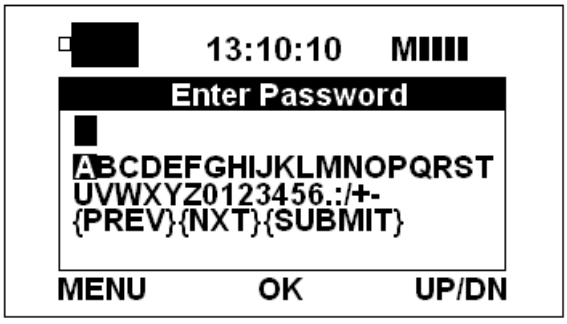


Figure 6-12 Enter Password Screen

6.4.3 Last Readings

When you select "Last Readings" from the main menu, the Leveloader II communicates with the attached Levelogger and retrieves its last logged reading set. The "Last Readings" screen (Figure 6-13) provides the logger serial number, remaining free memory and the last reading of all the channels of the attached Levelogger.

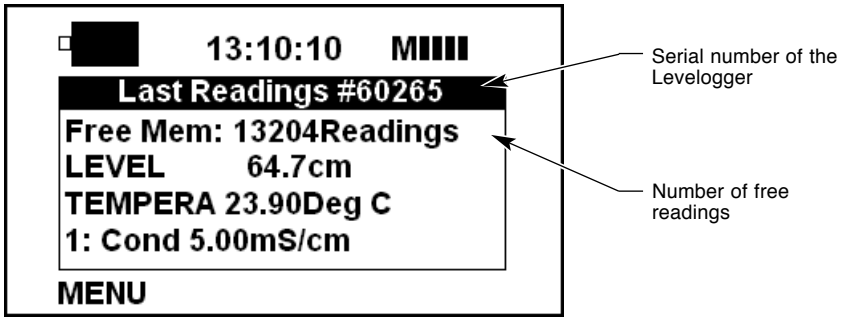


Figure 6-13 Last Readings Menu

6.4.4 Data from Leveloggers

When "Data from Leveloggers" is selected, the Leveloader II downloads the stored data from the attached Levelogger. The "Data from Leveloggers" screen (Figure 6-14) provides the logger's serial number, number of readings, the logger's battery level and a view of the data stored in the Levelogger. Use the up or down button to scroll through the Levelogger data.

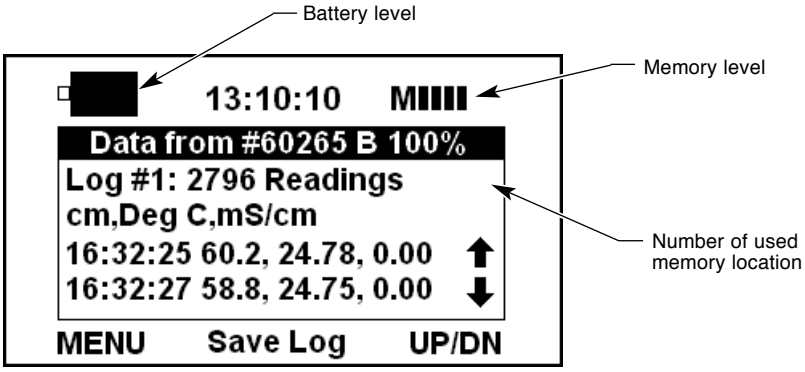


Figure 6-14 Data from Levelogger Menu

Note: To save the data to the Leveloader II, push the "Save Log" button in the middle bottom of the display. After the data has been saved in the Leveloader II memory, the Leveloader II will return to the main menu.

To save the data to the Leveloader II, push the "Save Log" button in the middle bottom of the display. After the data has been saved in the Leveloader II memory, the Leveloader II will return to the main menu.

6.4.5 Data to PC

The "Data to PC" screen (Figure 6-15) lists the number of log files stored in the Leveloader II. To upload data from the Leveloader II, connect the USB cable of the Leveloader II to the PC and open the Levelogger 3 Software. In the Levelogger 3 Software, click the Data Control tab and click the Leveloader tab. Inside the Leveloader window, click the download icon to commence data transfer from the Leveloader II to the PC. When in communication with the PC the Leveloader II's time can be synchronized and password set up. See Figure 6-15.

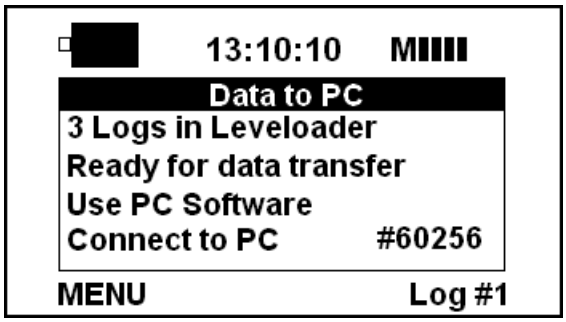


Figure 6-15 Data to PC menu

6.4.6 Edit Levelogger

The Leveloader II can adjust many of the Levelogger's settings. Figure 6-16 illustrates the Edit Levelogger menu. Settings that can be adjusted are Date/Time, Instrument No, Location, Sampling Rate, Sampling Type, Altitude and the logger status or started/stopped state. The Edit Levelogger menu displays the attached logger's settings. To adjust any setting, highlight it and click the Edit button.

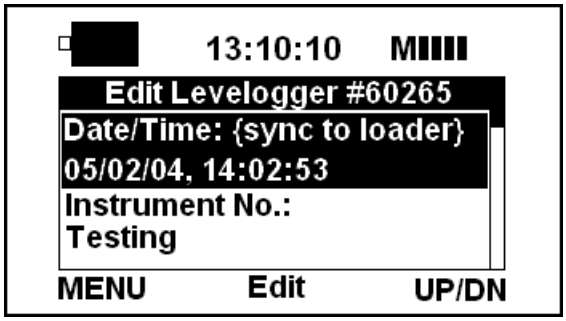


Figure 6-16 Edit Levelogger Menu

Edit Date/Time

This menu items is used to synchronize the date and time of the Levelogger to the Leveloader II by highlighting the Date/Time and clicking edit in the Edit Levelogger menu. Note that this edits the logger's time. The Leveloader II's time can be edited in Leveloader Setup.

Edit Instrument Number and Location

Figure 6-17 shows the Edit Instrument Number menu. The current Instrument Number is shown on top of the menu. To change the Instrument Number, highlight the character to modify by selecting {PREV} or {NXT}. Select a character from the list below and click "Edit" to modify the highlighted character. A line under the character indicates the current character. Select {SUBMIT} when editing of Instrument number is complete. The Leveloader II will send the new setting to the Levelogger. This type of operation is also used to modify the Location.

Click the Menu button prior to submitting to return to the Edit Levelogger menu and discard the changes.

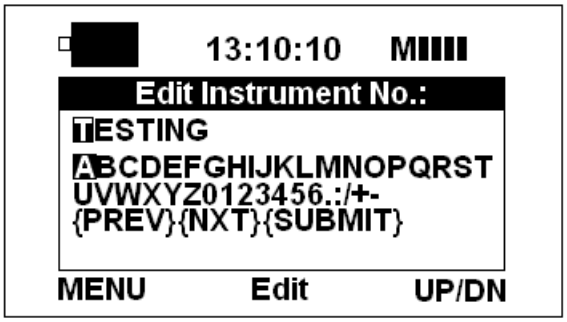


Figure 6-17 Edit Instrument Number Screen

Edit Sampling Type and Sampling Rate

The Edit Sampling Type menu is shown in Figure 6-18. Note that Sampling Types Fixed A, Fixed B and Fixed C do not have editable sampling rates, these sampling types have pre-configured sampling rates. In Event sampling type, the sampling rate defines how often the logger wakes up to detect whether it should log a reading.

The Edit Sampling Rate menu is shown in Figure 6-19. The current sampling rate is indicated in the Edit Sampling Rate menu. The following procedure is used to modify the sampling period:

1. Select unit (Seconds, Minutes and Hours) using UP/DN and click Edit.
2. Select duration (1 – 99) using UP/DN and click Edit.
3. When {SUBMIT} is highlighted, click Edit to confirm all the changes and the new setting will be sent to the Levelogger.

To cancel the operation, click MENU to return to the Edit Levelogger menu.

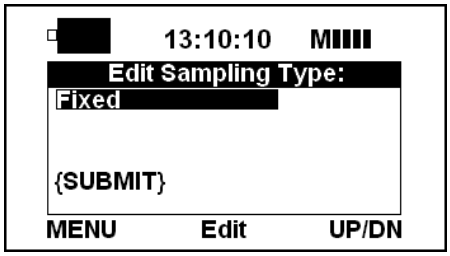


Figure 6-18 Edit Sampling type Screen

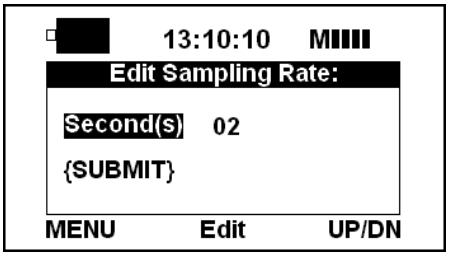


Figure 6-19 Edit Sampling rate Screen

Edit Altitude

The Edit Altitude operation is very similar in setup to the Edit Instrument Number operation. Only the numerical value of the altitude can be modified by using the Leveloader II. Enter the altitude and select {SUBMIT} to confirm the modification. The unit of altitude cannot be adjusted from the Leveloader II.

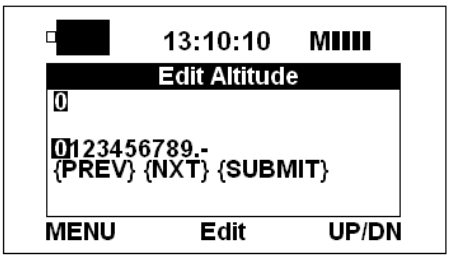


Figure 6-20 Edit Altitude Screen

6.4.7 Leveloader Setup

Leveloader Setup covers four functions: Time Setup, PC Communication Setup, Leveloader Information and Erase Last Log.

Time Setup

The Time Setup menu is used to adjust the date/time setup of the Leveloader II. Changes to date/time follow the same change or entry protocol as used to change other settings in the Leveloader II. Note date/time adjustment can be sent from the Levelogger 3 Software to the Leveloader II. Refer to section 6.3.13 for further detail. Figure 6-21 shows the Time Setup menu.

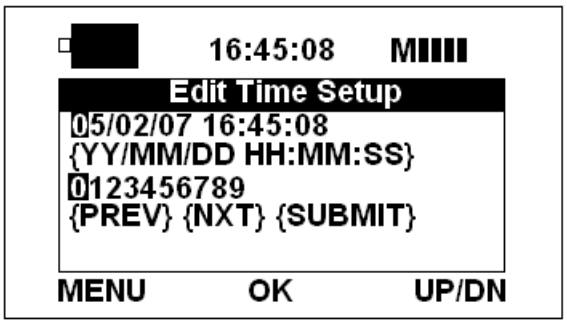


Figure 6-21 Time Setup Screen

The Date/Time format is YY/MM/DD HH:MM:SS. Change the date/time and select {SUBMIT} to confirm the changes. Click MENU to return to the previous menu and discard the changes.

PC Communication Setup

There are two PC communication speed settings for the Leveloader II. The "Levelogger 3 or greater" uses a 115200 baud rate for data communication and the "Other Levelogger Software" uses 9600 baud rate for data communication. "Levelogger 2 or greater" is compatible with Levelogger 2 and 3 Software. This is the default setting. "Other Levelogger Software" is compatible with all versions of the Levelogger Software but you should expect the data transmission rate to be slower under this setting and downloads one log file at a time.

Leveloader Information

The Leveloader Information shows the firmware version number, memory capacity and Solinst website address.

Erase Last Log

Erase Last log erases the latest log file stored in the Leveloader II. Use this feature to free up Leveloader II memory space. When Erase Last Log is selected, a warning message requests confirmation of erasure function.

6.4.8 Restart Levelogger

In the Restart Levelogger menu, the user can choose to start logging immediately or to setup future start time. If Future Start Logging is selected, enter the future start time. Leveloggers must be stopped to be restarted, therefore if the Levelogger is running when the Restart Levelogger item is selected, the Leveloader II will prompt the user to stop logging. To stop the Levelogger from a Leveloader II, press BOTH the UP and DOWN arrow buttons simultaneously. Be sure to save data from the Levelogger before restarting.

6.4.9 Levelogger V3 Software and Leveloader II

Refer to the Levelogger version 3 Software Manual Sections 3 and 4 for installation and general operational instructions. Ensure the Com Port selection is for Leveloader II USB port and the Leveloader II USB drivers are installed as per Section 4.2. The Leveloader window is opened by clicking the Leveloader tab on the left side of the Data Control window. The Leveloader II window enables all communications between the PC and the Leveloader II. All the log files stored in the Leveloader II can be downloaded to the PC when the download button  is clicked. The Leveloader Window is shown in Fig 6-22.

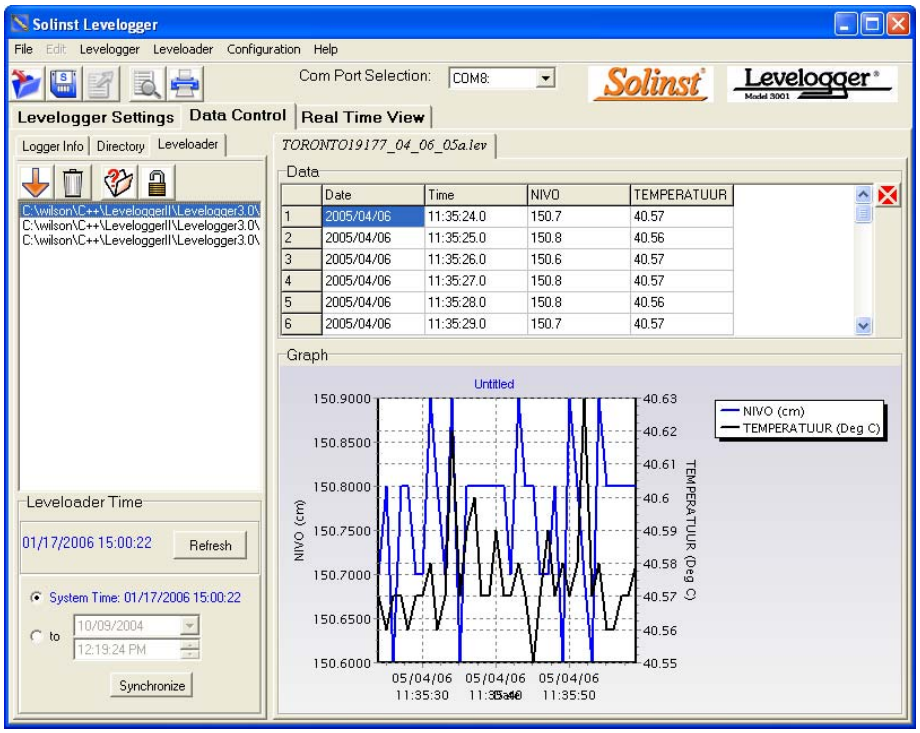


Figure 6-22 Leveloader Window

Download Data

Before data is downloaded, the automatic file name format should be setup. Click the  button at the top of the left window to setup the Data file name format. Figure 6-23 shows the Set Data File Name Window. The Levelogger II Software will name each file transferred from the Leveloader II to the PC according to the file name format. When saved to the PC, the file can be renamed by the user if desired.

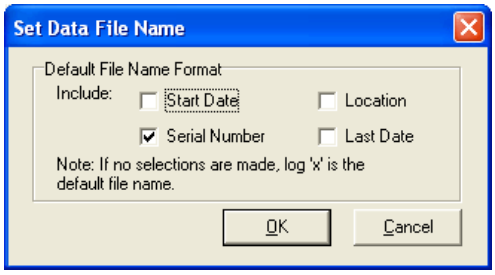


Figure 6-23 Set Data File Name Window

In the Set Data File Name Window, the user can select the file's Start date, Location, Serial Number and/or Last reading date to compose the downloaded file name. The file name format sequence is : [Location] and/or [Serial Number] and/or [Start Date] and/or [Last Date]. If no file format field is clicked, the file will be given the Log Number it had in the Leveloader II. Click OK to confirm the data file name format.

After setting up the Data File Name format, turn the Leveloader II ON and scroll to "Data to PC" mode, and select it. When the Leveloader II is in the "Data to PC" screen and is connected to the PC USB port with the proper Com Port selected, click the Download All button  or choose Select from the Leveloader pull-down menu to download specific files. A pop-up window directs the user to browse to the data destination folder and the download process will begin when the OK button is clicked. The Levelogger 3 Software incorporates a Data folder. It is recommended that data files from the Leveloader II be saved in the Data folder. Figure 6.24 shows the Download Process of the Leveloader II.

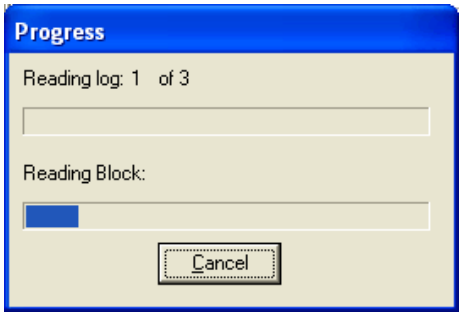


Figure 6-24 Data transfer progress window

Once the download has concluded, the file name(s) of the saved data will be listed in a File Selection list in the left window of the Data Control screen. Select the file from the File Selection list to open the file.

If the user wishes only to download selected files from the Leveloader II, click the Download button and click "Select …" from the pull-down menu. A dialog box will open displaying the log files in the Leveloader II memory. Choose the file(s) to download and click OK to start the download process.

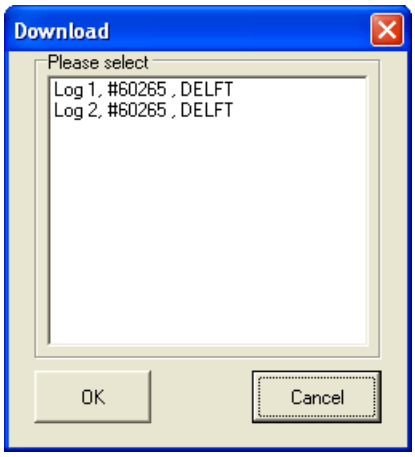


Figure 6-25 Log File Selection Window

Erase Data

To erase all the data from the Leveloader II, turn ON the Leveloader II and scroll to "Data to PC" select this item. While the Leveloader is in Data to PC mode click the Erase button or choose "Erase" from the Leveloader pull-down menu in the Levelogger 3 Software. A warning will pop up to confirm data erasure. Click YES to Erase or NO to avoid data erasure. When all data has been erased, a window will pop up that reads, "Data Erase Completed", click OK. The first line on the Leveloader II screen will become "0 Logs in Leveloader".

Password Protection Setup

Password protection is a new feature available only with the Leveloader II. To set up a password, make sure the Leveloader II is in Data to PC mode and click the  button on the PC software to open the password set up dialog box.

Figure 6-26 Leveloader Password Setup Window

To set up a new password:

1. Enter the old password in the top text box.
2. Make sure the check box is checked.
3. Enter the new password in the middle and the bottom text box.
4. Click OK to send the new password to the Leveloader II.

If the process is successful, you should see a message "password updated".

To disable a password:

1. Enter the old password in the top text box.
2. Uncheck the check box.
3. Click OK.

If the process is successful, you should see a message "password updated".

Clock Synchronization

Clock synchronization enables the Leveloader II to be synchronized to the PC time or an alternate user defined time. To synchronize, first ensure the Leveloader is in Data to PC mode. To synchronize to the PC system, select the "System Time" option in the Leveloader window of the Data Control screen and click the Synchronize button. To set up another time, select "to" in the time setup sub-window, enter the Date/Time and click the Synchronize button.

Note:
If a Levelogger Gold is to be used with the Leveloader I or Leveloader II, the logger must be programmed with the old Levelogger Version 2 Software. Programming Levelogger Gold loggers using Version 2 software limits the capabilities of the Gold unit to be the same as the older stainless steel Levelogger units.

6.5 Leveloader I

The Leveloader I Window is opened by clicking the Leveloader tab below the left side window and is used to set up the Leveloader and to download the log files stored in the Leveloader to the PC. All the log files stored in the Leveloader can be downloaded to the PC when the download button is clicked. The data will not append to old files. The Leveloader Window is shown in Fig 6-27.

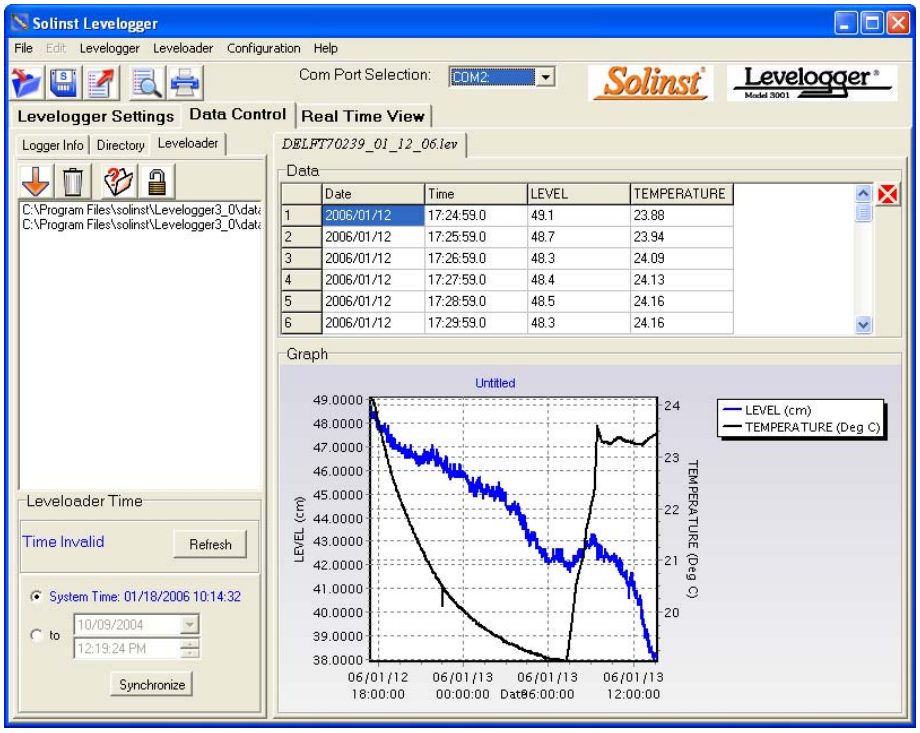


Figure 6-27 Leveloader Window

Before data is downloaded, the output file name format should be setup.

Click the button at the top of the left window to set up the output file name format. Figure 6-28 shows the Output Files Setting Window.

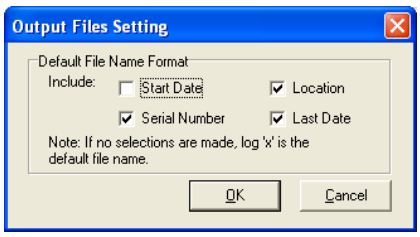


Figure 6-28 Output Files Setting Window

In the Set Data File Name Window, the user can select the file's Start date, Location, Serial Number and/or Last date to compose the downloaded file name. The file name format is : [Location][Serial Number][Start Date][Last Date]. If no file format field is clicked, the file will be given the Log Number it had in the Leveloader. Click OK to confirm the file name format.

After setting up the Output File Name, turn the Leveloader ON and scroll to "Data to PC" mode, and select it. When the "Wait Wait" message is showing on the Leveloader screen and the Leveloader is connected to the PC com port, click the Download All button  or choose Download from the Leveloader pull-down menu to download selected logs. A pop-up window to allow the user to select the destination folder and the download process will begin when the OK button is clicked. Figure 6-30 shows the Download Process of the Leveloader.

Once the download is completed, the file name(s) of the saved data will be listed on the left of the Windows. The user can choose the file from the File Selection list to open the file.

To erase all the data from the Leveloader, turn on the Leveloader, scroll to "Data to PC" mode, push SELECT twice. "Wait Wait" will be displayed on the Leveloader screen. While "Wait Wait" is displayed, click the Erase button  or choose "Erase" from the Leveloader pull-down menu. A warning will pop up to confirm data erasure click YES to Erase or NO to avoid data erasure. When all data has been erased, a window will pop up that reads, "Data Erase Completed", click OK. "Done push SEL" will appear on the Leveloader screen.

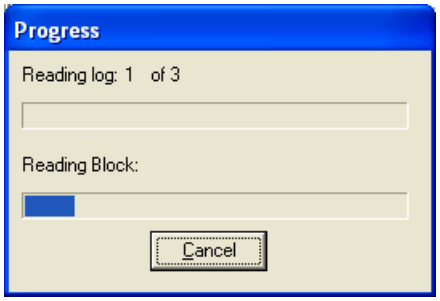


Figure 6-29 Data transfer progress window

7 Real Time View Window

Click the Real Time View Tab from the Main Window and the Current Readings Window will appear (Fig 7-1). The purpose of this window is to provide on-screen measurement as data is being recorded by the connected logger. The data is displayed in tabular and graphical format. All the channel information and Levelogger settings are displayed in the bottom left window.

First select a Non-Logged View Rate (middle left). This rate can be set independently of the logging period of the Levelogger and does not interfere with any logging taking place in the Levelogger itself. Real Time View readings can be displayed as a graph or in tabular format. If one channel is not required, it can be removed by unchecking the check box to the right of the data display. If not displayed, it is not being recorded. Real Time View readings are being recorded within the Levelogger Software and prior to closing the window, they can be saved by exporting the data into a *.csv file, by choosing the file export option.

To start the current readings, click the Start  icon. Immediately the readings will be displayed.

To take a reading at any specific time, click the 

button and that reading will be added to the displayed data. To turn the Real Time View monitoring off, decide if you want to save the data as described above, and simply click the Real Time View Tab or the Levelogger Settings Tab.

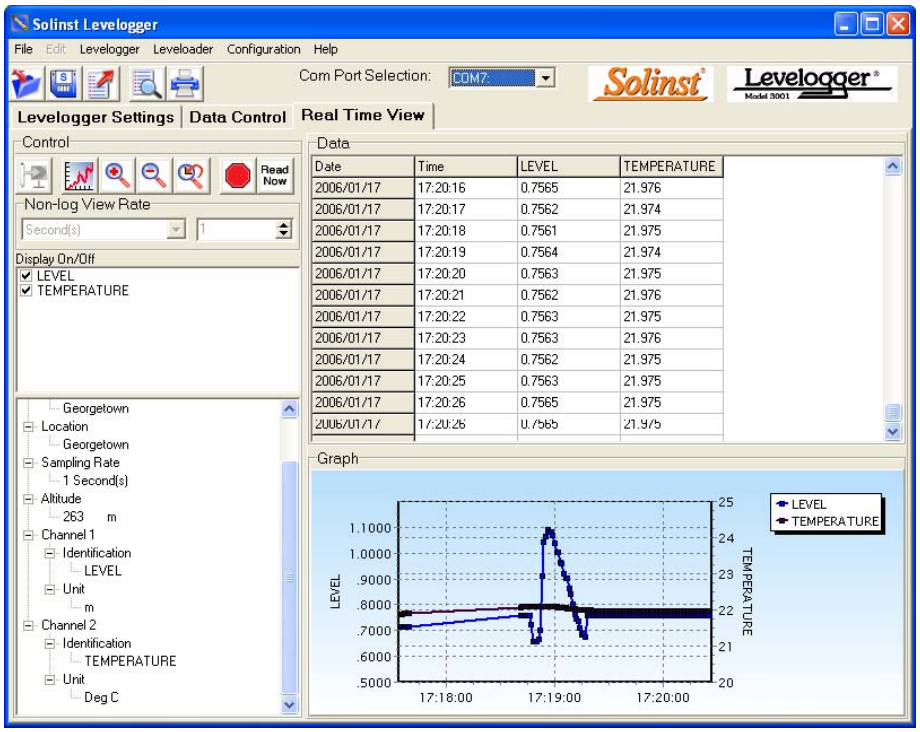


Figure 7-1 Real Time View Window

8 File Export and Print Function

Data can be exported in *.csv (comma separated value) file format by clicking File > Export > Data. The *.csv file format is supported and can be imported by most spreadsheet programs. Also, the data graph can be exported to a *.bmp file or a *.wmf file by clicking File > Export > Graph.

The Logger Settings, data table and data graph can be printed. Click the print preview icon  to open the print preview window. Figure 8-1 shows the print preview of the Logger Settings. The Levelogger Settings are always on the first page of the document. The data graph is on the second page of the document and the rest of the document is data table.

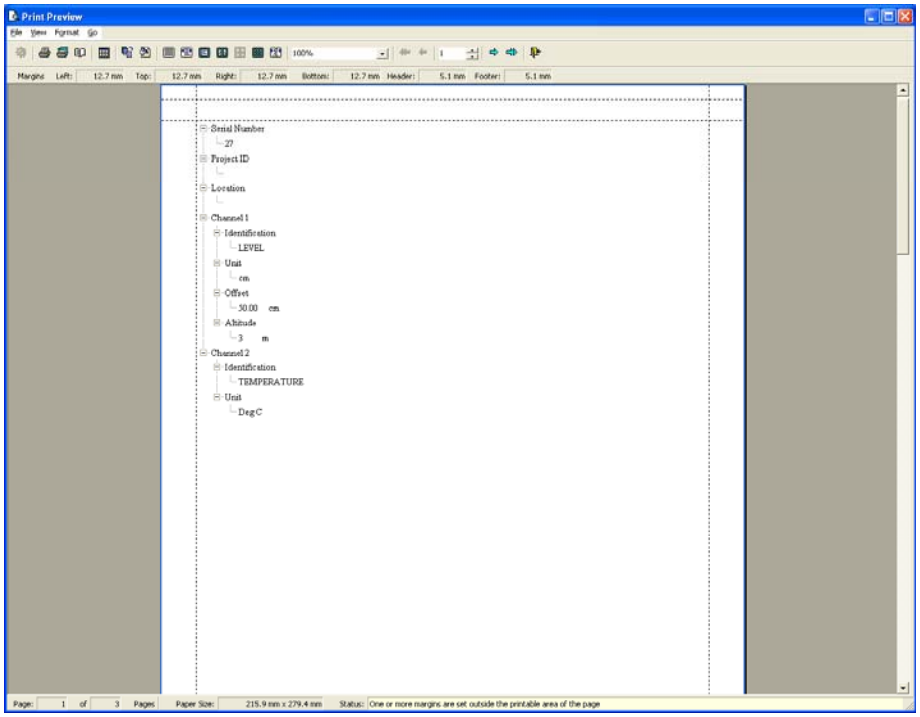


Figure 8-1 Print Preview Window

Click the print icon  to open the print dialog and print the document.

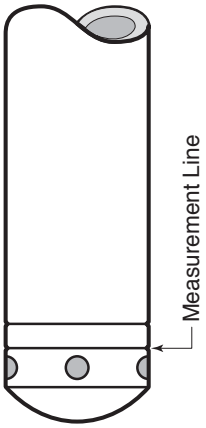


Figure 9-1
Levelogger Transducer
Measurement Line and Dimension

Note:
When using Direct Read Cables, the following maximum lengths apply to the cable according to which PC Interface Cable is to be used:

- USB PC Interface Cable: 1,000' (300m)
- RS232 PC Interface Cable: 500' (150m)
- RS232 PC Interface Booster: 1650' (500m)

9 Installation and Maintenance of Leveloggers

9.1 Installation

Many options exist for installation of the Levelogger, but essentially these installation methods can be classified into two broad categories: free suspended or fixed installations.

1. In free suspended installations, the Levelogger is hung via suspension wire or Direct Read Cable from the well cap, or some fixed tie-off location, at the well head.
2. In fixed installations the Levelogger is fixed in place by a compression fitting, a clamping mechanism or simple metal straps.

Prior to commencing the discussion of installation techniques several general points related to Levelogger installation should be made. First, it is recommended that the Levelogger be installed in a vertical orientation. However, inclined or horizontal installation is acceptable. The level sensor in the Levelogger is indicated by the machined line about the body of the logger just above the pressure access holes. The pressure transducer is oriented in a plane normal to the long axis of the body and detects pressure directed along the plane of the long axis (Fig 9-1). In vertical orientations, the sensor detects pressure above the pressure transducer line, where as in non-vertical orientations, the pressure zero point is proportional to the angle of inclination.

Care should be taken to avoid dropping the Levelogger against a hard surface. Further, the pressure transducer can be damaged if the logger is over-pressurized by submergence greater than its level range. The Levelogger is warranted to pressures up to 150% of its full scale level range.

Other important considerations when installing the Levelogger in pressurized or intermittently pressurized locations such as pressure vessels, pressurized pipes, pulse flow conditions, drop structures or near hydraulics works, is to keep in mind the potential effect of water or steam hammer and hydraulic jump. Water hammer is caused by an abrupt alteration of flow direction resulting in pressure surges. Steam hammer occurs when steam enters a cold pipe partially filled with water. The hammer effect has the potential to significantly increase hydraulic pressure possibly exposing the pressure sensor to pressures beyond its maximum rating. Hydraulic jump is a phenomenon that occurs when water is “lifted” or “ramped” by velocity or flow obstructions. Hydraulic jump causes turbulence and creates non-representative head conditions in the water column. Care should be taken to avoid logger installation at points susceptible to hydraulic jump.

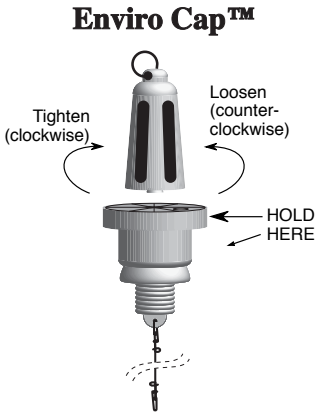


Figure 9-2
Locking, tamper-proof Enviro-Cap Step 1

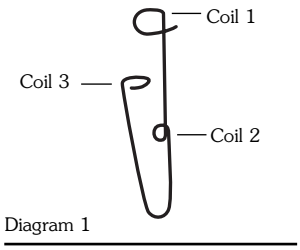


Diagram 1

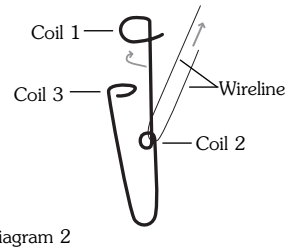


Diagram 2

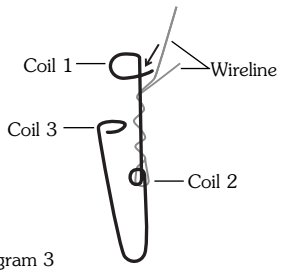


Diagram 3

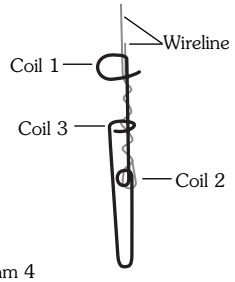


Diagram 4

Figure 9-3 Wireline Hook Installation

9.1.1 Free Suspended Installations

Suspension Wire Installation

Solinst supplies stainless steel suspension wire assemblies including SS stranded wire and hooks available in a variety of lengths from 50 ft (15 m) to +500 ft (+150 m). Solinst also supplies a specially designed, tamper-proof, vented, locking well cap known as the Enviro-Cap™ from which the Levelogger can be suspended.

This type of installation is applicable to both submerged and barometric record applications. Follow these steps to install the Levelogger using stranded cabling and hooks:

1. Loop the cable through the coil 2 of the hook assembly, then wind the looped strands several times around the hook shaft and pass through coil 1.
2. Pass coil 3 through the Enviro-Cap™ eyelet or Levelogger/Barologger eyelet and snap coil 3 to the hook shaft.
3. If the Enviro-Cap™ is not used then some secure tie-off point should be used or installed.
4. If installing a Barologger, ensure the suspension level is above the highest expected water level.
5. When retrieving data and/or reprogramming the Levelogger, extract it from the monitoring location, unthread the installation cap, interrogate and re-suspend the unit rechecking the security of the wireline clamps each time.

Direct Read Cable Assembly Installation

The Direct Read Cable system is composed of the ordered length of Direct Read Cable, the Direct Read Wellhead and the PC Interface Cable. The Direct Read cable threads to the Levelogger, while the socket at the opposite end of the Direct Read Cable fits into the specially designed Direct Read Wellhead. The PC Interface Cable connects to the Direct Read socket at surface and to the RS232 port on the PC (Fig. 9-4). While use of the Direct Read Wellhead is recommended and convenient, it is optional as long as a satisfactorily secure alternative tie-off point is found for the Direct Read Cable. Follow these steps to install a Direct Read Cable Assembly to the Levelogger:

1. Remove the installation cap from the Levelogger, align and connect the optical socket (two glass 'eyes' using the alignment pin) of the Direct Read cable to the Levelogger by threading the coupling onto the Levelogger tightly.
2. The Levelogger and optical socket will fit through the hole in the Direct Read wellhead. Use the eyelet at the bottom of the wellhead to securely tie-off the cable and logger. Do not suspend the logger and cable from the surface socket.
3. Remove the protective cap from the non-optical socket at the wellhead end of the Direct Read cable, seat the socket in the Direct Read Wellhead and align and thread it to the round socket of the PC Interface Cable.

Figure 9-4
Direct Read Assembly Components

4. Connect the 9 pin RS232 socket of the PC Interface Cable to the RS232 Com Port on your PC.
5. The plugged hole in the wellhead can be removed to provide an access port for a water level meter probe.

9.1.2 Fixed Installations

Open Channel Installations

Open channel flow is flow defined as gravity flow in any stream, canal, ditch, flume, or partially full pipe or tunnel not under pressure. It is different from closed channel flow in which the closed channel is full and under pressure. This section provides installation and monitoring advice in such open channels as natural streams and engineered conduits such as concrete channels as well as installation recommendations in monitoring water level in flow control structures such as weirs, flumes, pipes and orifice discharge devices.

To ensure the integrity of monitoring data, it is vital to choose the monitoring location with care. In natural channels, choose a location on the stream where the flow is least turbulent without surcharging, yet representative of the immediately upstream reach of the channel in slope and bottom surface roughness. In streams or channels with deep or rapid flow, or of uneven or slippery bottom materials, take extra care for your personal safety in installing equipment. Do not install equipment by attaching to structures that may interfere with debris flow, threaten the stability of flow at that location or the security of the equipment. When possible, install the Levelogger in a stilling well device. The stilling well will protect the logger from floating debris and rock saltation as well as dampen the effects of surface waves or turbulence. If a stilling well cannot be used and the logger must be affixed to an anchor structure instream such as a concrete slab or large stable boulder, consider protecting the logger from floating debris and rock saltation by placing it inside a short perforated section of protective 1" dia. pipe. Avoid monitoring in the vicinity of flow obstacles that can cause hydraulic jump. In pipes, the logger should be located at least 2 – 4 pipe diameters down- and upstream of pipe turns, junctions, inlets, outlets, turbulent joints or valves. Place the logger upstream of zones potentially subject to surcharging. Always bear in mind that the logger does not have to be at the deepest point in the stream or at the bottom of the pipe, it need only be located in the safest location within the stream/pipe profile just below the lowest anticipated water line. In this case use an offset value or the Reference Datum adjustment to compensate the data for the level offset.

This Section discusses flow in open channels determined by one of the following methods: Area-Velocity, Slope-Hydraulic radius and Hydraulic structure(s).

Using the **Area-Velocity method** the Levelogger provides readings of the head of water above the pressure transducer. The practitioner will use the water depth to determine the cross-sectional area of water, then the water velocity to ultimately derive flow:

Flow = Area x Velocity

The cross-sectional area of water in natural channels is most commonly determined by surveying the shape of the channel bottom at the monitoring station. In circular pipes the wetted area can be determined by using a section of a circle equation and in other engineered channels, by determining the channel geometry. Either water head will be related to area by using and equation, where head is the only variable, or the Head: Area information is compiled in a Look-up table. The water velocity can be determined in a number of ways, by estimation taking into account the channel geometry, area and surface roughness, by spot measurement in which the stream is velocity profiled both vertically and across its cross-sectional area to develop a rating curve, or by deployment of a logging velocity meter that can accurately characterize the velocity over the cross-sectional area. Together the area multiplied by average velocity to derive flow.

In the **Slope-Hydraulic radius method**, techniques like the Manning formula or variations such as Lanfear and Coll or Chezcy's equations are used to estimate flow based on changes to the cross sectional area and wetted perimeter. The cross sectional area and wetted perimeter must be predetermined and are proportional to head. The Manning formula:

$$Q = \frac{KAR^{\frac{2}{3}} S^{\frac{1}{2}}}{n}$$

Where:
- Q = Flow rate
- K = Constant dependent on units used
- A = Cross sectional area of low
- R = Hydraulic radius (cross sectional area divided by the wetted perimeter)
- S = Slope of the hydraulic gradient
- n = Manning's roughness coefficient

Hydraulic structures are among the most common and reliable means of measuring flow. Four types of hydraulic structures and the methods used to measure them are discussed here: weirs, flumes, pipes and orifice discharge devices.

Installation at Weirs

Weirs are very common and reliable flow control and measurement structures. A wide variety of weir types have been designed and their flow characterized in discharge equations. The most common weirs are sharp-crested rectangular, V-notch, trapezoidal (Cipolletti) and compound weirs combining elements of two or more of these types. Other special weir configurations are designed to create a specific type of relationship between head and flow rate. The Sutro weir creates a hydraulic condition where discharge is directly proportional to head. The approximate linear weir creates a hydraulic condition where the head: discharge relationship is linear. Other weirs such as the Poebing and Approximate exponential weir have an exponential relationship between head and discharge. However, no weir design is more common and better understood than the rectangular, V-notch or trapezoidal configurations.

From a monitoring point of view it is extremely important to place the pressure transducer at the appropriate location at the weir. Figure 9-5 illustrates the appropriate location of the pressure transducer upstream of the weir crest and the draw-down zone.

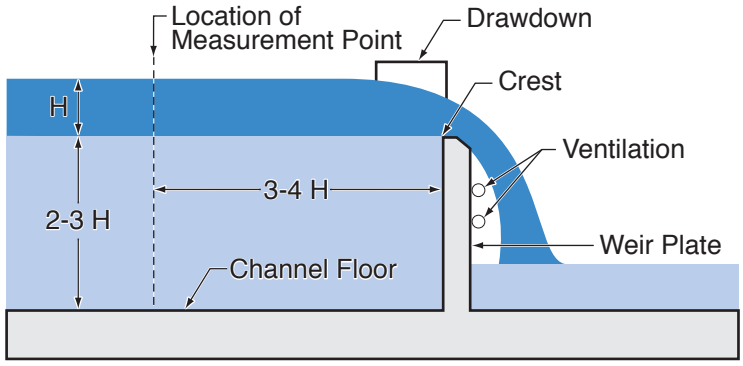


Figure 9-5 Sharp Crested Weir

The formuli for the three most common weir designs are:

V-Notch: $Q = KH^{2.5}$

Rectangular:

a. Suppressed (no end contractions) : $Q = KLH^{1.5}$

b. Contracted (with end contractions): $Q = K(L - 0.2H)\,H^{1.5}$

Trapezoidal or Cipolletti: $Q = KLH^{1.5}$

Where:

Q = Flow rate

H = Head on the weir

L = Crest length of the weir

K = Constant dependent on units

K values for V-notch weirs for metric of US Customary units vary with the V-notch angle and can be found in hydraulic texts. K values for the sharp-crested rectangular weirs and the Cipolletti weir, in which the slope of the trapezoid is 4:1, are provided in Table 9-1

	CFS	GPM	MGD	L/s	m^3/hr
Unit of **L** & **H**	ft	ft	ft	m	m
K suppressed & contracted	3.33	1495	2.152	1838	6618
K Cipolletti trapezoidal	3.37	1511	2.176	1859	6692
K California pipe method	8.69	3900	5.62	4680	16900

Table 9-1 K Constant Values for Rectangular Wiers

Installation in Flumes

After weirs, flumes are the most common hydraulic control structures and use flow restriction followed by flow expansion so that flow rate may be determined by head measurement at a specific point in the flume. In general flumes are used where weirs are not feasible due to inadequate channel slope or channel space footprint restrictions. Flumes are grouped into one of three categories based on the Froude number of flow set up by the flume. The Froude number is the ratio Inertia : Gravity. If the Froude number is unity, the flume flow is considered critical. When the Froude number is less than unity, sub-critical (gravity predominates) and when greater than unity, supercritical (inertia predominates). Most flumes are designed for critical or supercritical flow. Critical flow flumes typically use width reduction to set up the critical flow conditions. Supercritical flow flumes utilize a sloping bed, bed drop and or width reduction to create supercritical conditions from the converging section, through the throat to the diverging section. The most common flume types are Parshall, Trapezoidal, Palmer-Bowlus, Leopold-Lagco, USDA Soil Conservation Service HS, H and HL flumes as well as Cutthroat, British rectangular and San Dimas flumes.

As in weirs, the head measuring point(s) in flumes is very specific. Figure 9-6 illustrates the recommended upstream free flow head monitoring point for a Parshall flume. This point is defined as upstream of the start of the throat, 2/3 the total length of the converging section. The head vs flow rate equation for free flow via a Parshall flume is:

$$Q = KH^n$$

Where:
- Q = Flow rate
- H = Head measured at point 2/3 A
- n = Constant power, dependent on throat width
- K = Constant dependent on throat width and units

The Parshall flume is characterized as supercritical by width reduction and drop in bed. An alternative head measurement is in the throat upstream of the zone of submerged flow. Care must be taken when using head measurement in the throat that backwater or surcharging effects in the diverging section during periods of higher flow do not reach the throat monitoring point.

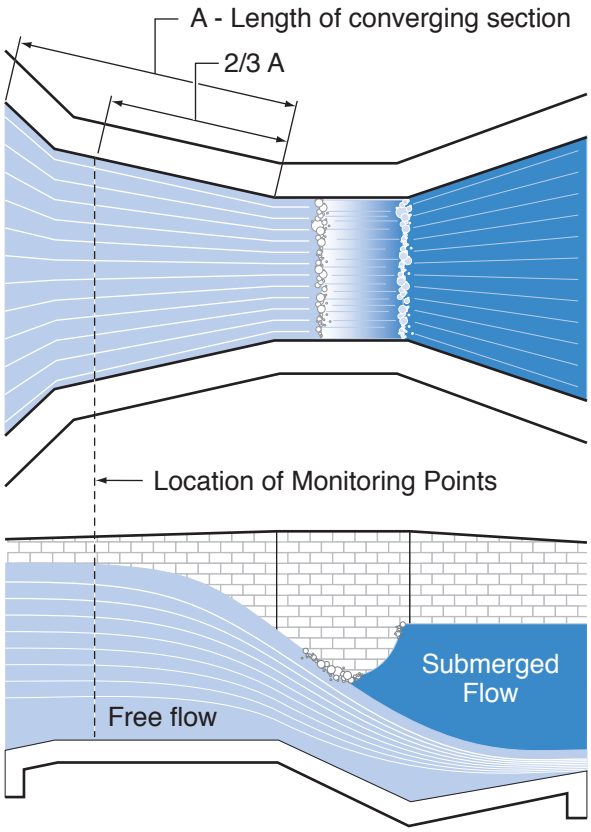


Figure 9-6 Parshall Flume

The California Pipe Method

The California pipe method of flow measurement is for use with circular pipe, partially filled and horizontal for at least 6 pipe diameters prior to pipe discharge into air. Water should not enter the horizontal section at an excessive rate and if flows create near pipe-full conditions, a vent hole should be installed several pipe diameters upstream of the outfall. To determine pipe discharge using head at the outfall the California pipe method may be written as:

$$Q = Kd^{0.6} H^{1.88}$$

Where:
- Q = Flow rate
- H = Head of liquid at pipe outlet
- d = Pipe diameter
- K = Constant dependent on units

Orifice Discharge Monitoring

Discharge through orifices such as in a Hickenbottom perforated riser is a common water detention and flow control approach. The Hickenbottom device typically uses a series of circular holes drilled both around the circumference and along the vertical length of a section of riser pipe connected via an elbow joint to a lateral discharge pipe. Hickenbottom devices are commonly used to detain stormwater in ponds, wetlands, ditches, swales or depressions at the Hickenbottom riser to reduce downstream erosion and prolong the settling period for suspended solids prior to discharge thereby improving water quality. Hickenbottom devices enable the practitioner to derive discharge rate by head measurement outside the structure. Discharge from a Hickenbottom structure can be calculated as the iteration of individual single orifice discharge equations. A typical orifice equation is derived from Bernoulli's equation and can be written as follows for metric units:

$$Q = CA(2gh)^{0.5}$$

Where:
- Q = Orifice discharge in m^3/sec
- C = The discharge coefficient ($C_cC_v \approx 0.647$), where C_c, the coefficient of contraction, for a sharp-edged orifice is ≈ 0.66 and C_v, the coefficient of velocity through the orifice is ≈ 0.98.
- A = Orifice area in m^2
- g = Acceleration due to gravity ($9.81\ m/sec^2$)
- h = Head in m of water above the orifice

Artesian Monitoring

Monitoring of artesian conditions in which the piezometric surface is above ground surface or more particularly above the top of well casing elevation using Leveloggers can be quite straight forward. Three artesian scenarios are discussed: a) continuous artesian conditions where i) freezing is not a concern, ii) or where freezing is a concern and b) intermittently artesian conditions.

Continuous artesian conditions infer that the piezometric surface never drops below the level the ground surface or particularly the top of casing elevation and the casing is sealed with a sealed wellhead. In this case, where freezing is not a concern, the Levelogger need only be installed in the wellhead itself by means of a large compression fitting as illustrated in Figure 9-7. Solinst can supply a 7/8" nylon compression fitting for this purpose. First, a 7/8" NPT hole is tapped into the wellhead, then the base of the compression fitting is threaded into the hole and the threads sealed. The collar and ferrule are slid on the Levelogger just above the transducer measurement line (collar below ferrule), the logger inserted in the base and the nut slide down over the body of the logger. The nut is tightened and threads sealed to form a hydraulic seal against the body of the Levelogger leaving the upper portion of the Levelogger and cap exposed above the compression fitting. The user can communicate with the logger simply by removing the logger cap and attaching the Optical reader. Ensure that the logger and sealed wellhead are enclosed within an outer protective well cap or enclosure.

Figure 9-7
7/8" Nylon Compression Fitting

When freezing is a concern in a continuous artesian well, the well is typically sealed below the frost line with a packer. Again, Solinst can build specially adapted mechanical packers for this purpose. The special packer is typically built on 1 – 2" PVC pipe that extends from below the frost line to the wellhead and is actuated at the wellhead by turning a threaded tube that runs within the pipe. Direct Read cable for communication with the Levelogger is built into the packer. The Direct read cable runs through the threaded tube and sealed by use of a small compression fitting that tightens onto the Direct Read cable. When installing the Levelogger is threaded to the Direct Read cable and the Levelogger and packer assembly lowered into the well. When in place, the packer is actuated, the well sealed and standing water in the well above the packer is evacuated.

Intermittently artesian conditions imply that the peizometric surface fluctuates above and below ground surface or particularly the top of casing elevation. The methods described above can be used in intermittently artesian conditions. However, a third option exists in that whereby the 7/8" nylon compression fitting described above can be slid nut first, ferrule above collar, over the optical connector and length of the Direct Read cable and tightened to the underside of the surface connector. The Levelogger attached to the Optical connector and cable can be inserted through a 7/8" NPT hole tapped into the sealed wellhead as described above and the threaded base of the fitting threaded into the tapped hole in the sealed wellhead. One caveat to this installation is that we recommend an eyelet be installed on the underside of the sealed wellhead and the Direct Read cable be suspended from the eyelet instead of suspending free from the surface connector.

When conducting artesian monitoring with Leveloggers a number of considerations must be kept in mind. First, ensure that the maximum hydraulic pressure the Levelogger will encounter within the well at its installation point will not exceed the hydraulic range of the logger. Second, artesian conditions do not preclude the necessity for barometric compensation of Levelogger data. Artesian conditions are caused by aquacludes forming confined aquifers. Confined aquifers, while not acted on by barometric pressure to the same extent as unconfined aquifers, are typically subject to barometric pressure at some barometric efficiency (See Section 9.1.4). Finally, bear in mind that the total pressure and subsequent water column equivalent depth measured by the Levelogger after barometric compensation may not represent the actual water level within the artesian well. Sealed intermittent artesian wells can be pressurized when artesian, but can also be de-pressurized when non artesian. The Levelogger's reading after barometric compensation represent the height of the piezometric surface.

Vacuum/ Vapor Monitoring

Vacuum/Vapor monitoring is conducted to determine the explosive potential of the vadose zone, to assess the volatilization rate of hydrocarbon contaminants or to determine hydrocarbon Vapor chemical concentrations. Vacuum monitoring is usually conducted by first installing pressure transducers such as the Levelogger in monitoring wells and then shutting-in or sealing those wells to the atmosphere with pressure sealed wellheads. Air is pumped out from an extraction well amongst the cluster or matrix of monitoring wells, theoretically dropping air pressure in the vicinity of the extraction well. For short-term tests in which data is not required during the extraction event, the Leveloggers can be programmed and simply suspended from hooks or eyelets on the

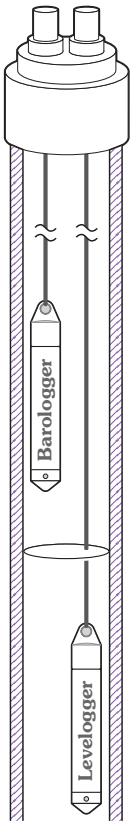


Figure 9-8 Levelogger and Barologger in Well

underside of the sealed wellheads, the test run and the data collected at the end of the test by extraction and downloading of the loggers. However, if ongoing data from the Leveloggers is required during the extraction event, the loggers must be installed in a manner similar to the artesian monitoring scenarios described in Section 9.1.2. Leveloggers or Barologgers can be used to monitor the drop in pressure. However, if using Barologgers in the well headspace ensure that adequate range exists above net barometric pressure to monitor the anticipated drop in pressure. See Section 9.1.3 to extend the Barologgers virtual hydraulic range if required.

9.1.3 Barologger Installation

The Barologger is a Levelogger with a small range of 4.92 ft (1.5 m) adequate to monitor the fluctuations that occur in barometric pressure. The Barologger's readings are used to barometrically compensate Levelogger readings. Typically, Barologger readings range from 1 – 3.3 ft (30 – 100 cm) when the Barologger is programmed with its operating altitude. Failure to input the correct altitude with result in incorrect readings and may cause the pressure transducer to go out of range. It is strongly recommended that the altitude input be accurate to ≤10 m. When the Barologger is programmed at its operating altitude, its readings can be used to directly compensate for barometric pressure, the readings of any Levelogger programmed at the Levelogger's operating altitude. As a rule or thumb, a Barologger can be used to compensate all the Leveloggers in a 20 mile (30 km) radius.

To monitor barometric pressure correctly, the Barologger should never be submerged. In well installations, it is recommended that the Barologger be suspended in one of the monitored wells above the high water point (Figure 9-8). For best reading accuracy, the Barologger should be installed in a similar thermal environment to that of the Levelogger. In groundwater wells, the Barologger should be suspended beyond the frost line and deep enough to avoid large temperature fluctuations. In surface water applications, the Barologger is best deployed in a dry well – a well embedded in the bottom of the water body, but sealed at the base from water entry and vented to the atmosphere. If a dry well cannot be installed, the Barologger can be installed on a float in the stilling well. Further information on the Barologger and barometric pressure can be found in Section 10.

Barologger Use in Hydraulic Environments

Mini Barologgers will be more accurate in water as they have a full scale range of 4.92 ft (150 cm) and the logger measures actual depth of water column adjusted to its elevation setting. Barometric pressure readings in the Barologger typically range between 1 and 3.3 ft (30 ~ 100 cm), when set at the actual installation elevation. This implies that the water column equivalent fluctuation in barometric pressure is about 2.3 ft or 70 cm. When clients want to use the Barologger for hydraulic monitoring, they should attempt to maximize the portion of the Barologgers range above the barometric component for this purpose. If the altitude is programmed at the elevation of the logger above sea level, this will be the section of range from 3.3 - 4.92 ft or ~100 to 150 cm or about 1.6 ft total flux span. However, if we program the logger to an elevation 1000 ft lower than actual we can increase the effective portion of the range available for hydraulic readings by 1 ft from about 1.6 ft to 2.6 ft of span.

Note: The Barologger Gold should not be used to monitor water, as the internal mathematics are based on air pressure rather than water pressure.

The actual weight of a column of water decreases with increasing elevation at a rate of approximately 1 ft/1000 ft or 1 m/1000 m. Thus a 3 ft column of water at sea level weighs more than that same column of water at 1000 ft. As the Barologger converts the weight or pressure into a depth of water column, the loggers use the elevation field to compute the water column equivalent depth for that particular elevation. In this case, we want the Barologger to record water column equivalent barometric pressure from 0 - 2.3 ft (0 - 70 cm) instead of 1 - 3.3 ft (30 - ~100 cm), which will leave the 2.3 - 4.92 ft (70 - 150 cm) portion of the full scale range available for hydraulic monitoring. A safety factor of 0.12 ft. is recommended to accommodate high barometric pressure, therefore, a 2.5 ft. safe hydraulic monitoring range results. This adjustment in how the logger computes pressure is performed by simply programming the logger for an elevation 1000 ft (300 m) lower than actual. The minimum and maximum numeric elevations that the Barologger can be programmed for are -1000 ft (-300 m) and 9750 ft (3000 m), respectively.

Barometric Efficiency

The influence of barometric pressure on a groundwater surface can follow three scenarios. In confined aquifers with capillary or vadose head space, increased atmospheric pressure can tighten the pore spaces in the overlying soil and produce a capillary effect as the water level rises in response to having nowhere else to go but up. Second, some deeper aquifer systems can be quite barometrically isolated from the relatively small change in level that barometric influences can produce. The third scenario occurs in an unconfined aquifer, with high barometric efficiency, in which a barometric pressure change results in an equivalent or highly proportional drop or rise in groundwater pressure. In essence, depending on the aquifer type and depth, increased barometric pressure can result in either increased, static or decreased water levels. Barometric efficiency, the relationship of a barometric change on groundwater pressure, in confined aquifers generally ranges from 20 to 75%, whereas in unconfined aquifers the efficiency can range from 80 - 100%.

A second important element of Barometric efficiency is time lag – the time differential between a unit change in barometric at the surface to the time of transmission of that change to the aquifer. Calculating general barometric efficiency should not be done on a single barometric event, but rather on a statistically significant number of events. As a result, it may take a month or more of submerged Levelogger and Barologger data to determine barometric efficiency and time lag. As Barometric pressure fluctuates over time in excess of 60 cm water column equivalent pressure and as barometric efficiency can be such an important factor in accurately monitoring groundwater levels, it is vital that barometric compensation of the Levelogger data be performed.

Barometric efficiency and time lag cannot be determined with vented pressure transducers in which barometric efficiency is assumed to be 100% no time lag. The inherent error these assumptions can cause in the incumbent data can be quite significant. The absolute pressure method used in the Levelogger and Barologger provide the user with the data necessary to determine barometric efficiency. If a barometric efficiency value has been determined from the Levelogger and Barologger data, that value can be applied to Barologger data in the Compensation Wizard. Application of this feature can produce net groundwater level data of an accuracy that cannot be produced by vented transducers.

Wells puncturing an aquifer have a negligible to non-existent effect on directly transmitting barometric changes to the larger aquifer. Barometric pressure is transmitted through overlying layers. To obtain the best and most accurate long term water level readings from Leveloggers, the user must first understand how the Levelogger calculates a depth of water above the transducer and second whether barometric efficiency should be considered in barometric compensation.

9.1.4 Installation in Extreme Thermal and Marine Environments

Freezing or High Temperature Conditions

Levelogger installation at submerged depths that may be at risk of freezing during the monitoring session is not recommended without taking adequate precautions to avoid transducer damage. When water freezes it expands approximately 9% by volume. 9% expansion can equate to extreme pressure as demonstrated in Example 9.1. Therefore, solid freezing has the potential to damage the pressure transducer, which is rated to withstand up to 150% of its depth fluctuation range. Pressures beyond this threshold may damage the transducer. With certain precautions, the Levelogger can be used in freezing liquid environments. If monitoring shallow water bodies or groundwater zones susceptible to freezing, the easiest way to avoid transducer damage is to lower the transducer to a point in the water column below the frost line or ice formation depth. In water bodies such as shallow streams, wetlands or ponds where freezing may penetrate to the bottom, install the Levelogger in a vented stilling well imbedded into the bottom of the water body beyond the frost line. In cases where the above noted precautions cannot be taken and the Levelogger must be installed in the freezing zone, it is recommended that the logger be placed inside two elongated silicon, rubber or latex balloons, the balloons be filled with a non-toxic, non-corrosive anti-freeze solution and sealed (Figure 9-9). Place the balloons in a section of perforated, 1.25" (30 mm) ID pipe and install the logger in the monitored water. The antifreeze solution will protect the Levelogger from ice expansion at the pressure transducer, yet transmit any pressure fluctuations that occur. Please note that a similar installation protection can be used when the Levelogger is monitoring liquids which are incompatible with its wetted materials. The operating temperature range for Leveloggers is -20° - 80°C (-4° - 180°F). At the opposite end of the thermal scale, exposing the Levelogger to temperatures beyond 80°C may damage the thermistor and otherwise affect the Levelogger.

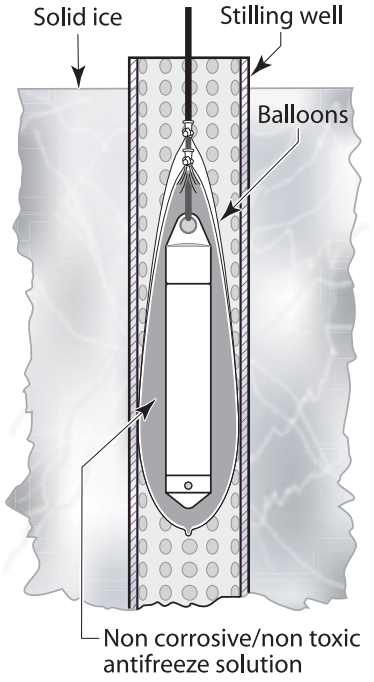


Figure 9-9
Installation in Freezing Liquid

Example 9.1 Solid Freezing Effects

The pressure exerted by the physical expansion or ice crystallization process on a retaining or enclosing contact surface is related to the temperature gradient over which the process occurs. For example, liquid freezing at -22ºC, can create expansion pressures of 22 kg/cm2 or 313 psi or the equivalent of 721ft or 220m water column depth.

Marine or Brackish Installations

When installing the Levelogger in salt or brackish water or in a liquid having a specific gravity (density) different than fresh water, the density difference is compensated for by checking the Density Adjustment checkbox in the Levelogger Settings window and inputting the density of the monitored fluid. See Section 5.1 for details in compensating the Levelogger for fluid density differences.

The second generation ceramic body LTC Levelogger can be used for monitoring in salt or brackish water. However, continuous use of the first generation stainless steel body LTC Levelogger or LT Levelogger in salt or brackish water is not recommended, as the salt or other pollutants may cause pitting which can lead to perforation of the Levelogger's casing. To minimize this effect, regularly lift the Levelogger from the liquid; within seconds a thin protective layer will be formed by oxidation. Again, this precaution applies to the first generation stainless steel LTC and the LT Levelogger. If using an LT Levelogger in a continuous salt/brackish monitoring scenario, the stainless steel body of the logger can be protected in a manner similar to the freezing protection method described in Section 9.1.4. The LT can be placed in balloons and the balloons filled with non-corrosive/ non-toxic fluid. As pressure changes, the fluid encasing the loggers will transmit the pressure differential to the logger's pressure transducer. Care must be taken in the selection of the balloon material or filling fluid such that the balloon material prevents diffusion of salts across the concentration gradient or that the filling fluid is comprised of polymeric molecules too large to diffuse out of the balloon material. The second generation LTC has a ceramic body which is highly resistant to corrosion in salt water environments and can monitor in salt or brackish water without any corrosion concerns. To ensure accurate measurement, the conductivity sensor should be in close proximity to any zone of active flow in the groundwater monitoring well or near the screened ports of a stilling well.

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9.2 Levelogger Maintenance

Levelogger maintenance consists of cleaning the outside stainless steel casing, the circulation holes and the optical infrared eyes. The required frequency of cleaning is dependent on several aspects of the monitored water quality. In freshwater with good to excellent water quality, the Levelogger cleaning requirements will be very minimal; amounting to a seasonal or even annual maintenance inspection. In most cases cleaning can be accomplished by rinsing the Levelogger and using mild, non-residual, non-abrasive household cleaners using a very soft-plastic, bristled, pipe-cleaner type brush. Do not insert any object through the circulation holes at the sensor end of the Levelogger. In some cases simple cleaners are insufficient to properly clean the Levelogger. Several commonly occurring water conditions require specific maintenance methods, these include hard water, high suspended solids loading, biological or chemical fouling and salt or brackish water conditions.

Hard water monitoring can result in the precipitation of calcium and magnesium deposits on the pressure transducer as well as other components of the Levelogger. These deposits can be safely dissolved using a diluted solution (typically ≤ 10% strength) of acetic or phosphoric acid. Commercially available products for dissolving hard water scaling are also available and can be used if designed for household use. Some industrial strength hard water scaling removers are much higher strength and are not recommended for cleaning the Levelogger.

High suspended solids load may block the circulation ports or clog the internal pressure cell of the Levelogger. The potential clogging effect of solids deposition can be minimized by placing the Levelogger in zones of flow. To remove solids build up, rinse the Levelogger under a low flow of tap water until particles have been washed away.

Bacteriological or chemical fouling can be an important consideration in many ground and surface water monitoring projects. Sessile bacteria will often utilize installed instrumentation as an attachment substrate. Chemical deposit can be the result of electrical charge differential between the instrumentation of the monitored liquid or the result of biological or algal activity. Both forms of fouling can result in difficult to remove deposits on the Levelogger transducer, the conductivity wires and the Levelogger casing. To remove fouling use a diluted (≤ 10%) solution of sulfuric acid. Persistent material may require soaking for several hours.

The LTC Levelogger can be used for temporary monitoring in **salt** or **brackish water**. Continuous use of the LTC Levelogger in salt or brackish water is not recommended, as the salt or other pollutants may damage the Levelogger's casing or its pressure sensor. To minimize this effect, regularly lift the Levelogger from the liquid; within seconds a thin protective layer will be formed by oxidation. To ensure accurate measurement, the conductivity sensor should be in close proximity to any zone of active flow in the groundwater monitoring well or near the screened ports of a stilling well. When completed salt or brackish water monitoring, ensure the Levelogger is thoroughly rinsed with tap or deionized water to prevent salt deposits forming on any Levelogger components as the water evaporates. Monitoring with the LTC Levelogger in polluted, salty, brackish or highly conductive environments will result in an

increased conductivity sensor calibration requirement. See Sections 5.7-5.8 for more information on how best to determine whether the conductivity sensor requires recalibration. The second generation LTC has a ceramic body which is highly resistant to corrosion in salt water environments and can monitor in salt or brackish water without any corrosion concerns.

When being **stored for extended periods**, it is recommended that the Levelogger be placed in the protective foam shipping sleeve in a dry location where the temperature will not exceed the operating temperatures of -20° -80°C. It is also recommended that the logger be programmed to log at a 24 hour (1 reading/day) frequency. This logging rate will not cause appreciable battery drain, yet will exercise the transducer and electronics and actually prevent battery discharge. Ensure the installation cap or direct read cable optical connector are connected to the logger during storage.

10 Manual Barometric Compensation

This section describes how to perform manual barometric compensation on Levelogger data files when a Barologger was not dedicated as a barometric recorder. This section describes available sources of barometric record, conversion factors for common barometric units to water column equivalent and how to perform the compensation in spreadsheet formats using available barometric information. Finally, this section describes the most accurate and representative methods of obtaining barometric data and performing barometric compensation on submerged Levelogger data.

For short term tests during which the barometric pressure varies insignificantly, the collection of continuous barometric data may be unnecessary. In this event, take a reading from an open air exposed Levelogger prior to running the short term test and record this level. This level represents the barometric pressure. Similarly, at the end of your test, take another barometric reading and record this measurement. After the submerged Levelogger data has been exported to a spreadsheet program compensate your submerged Levelogger data files for barometric pressure. If no appreciable change in barometric reading occurred, you may write in the first cell of a new column a simple calculation that subtracts the water column equivalent of your barometric reading from the submerged data file, then copy and paste this calculation to all the cells in that new column. The new column will represent the barometrically compensated liquid level.

Barometric data can be collected on site using a recording barometer or from a local weather station. If setting up the barometer, set the recording interval to that of the Levelogger sampling interval or some multiple of the Levelogger interval. To compensate submerged Levelogger data using barometric data collected from an on site barometric logger or a nearby weather station several steps must be taken:

1. Export both the Levelogger data file and the barometric file to a spreadsheet.
2. In the spreadsheet, convert the barometric data column from its barometric measurement units (typically atm, mm Hg, psi, mb or kPa) to feet or meters of water column equivalent using the conversion factors in Table 10-1.

Table 10-1		
Common barometric units to water column equivalent conversions		
Barometric unit	**Water column equivalent (ft)**	**Water column equivalent (m)**
1 psi	2.3108	0.7043
1 atm	33.959	10.351
1 kPa	0.3352	0.1022
1 mm - Hg	0.04469	0.01362
1 in - Hg	1.1330	0.3453
1 mb	0.03352	0.01022

Table 10-1 Common Barometric Units to Water column Equivalent Conversions

3. Then write another calculation in another column to subtract the Levelogger's pressure zero point offset value from the converted barometric data. The Levelogger's zero point offset is 31.17 ft (9.5 m) of water column less an altitude correction. 31.17 ft (9.5 m) is the lowest expected barometric pressure at mean sea level. As elevation increases above mean sea level, the lowest expected barometric pressure decreases at a rate of approximately 1.21/1000 ft or m (altitude/826) of altitude. Therefore the Leveloggers barometric pressure offset at 1500 ft elevation will be:

(Zero Point Offset at ∅MSL) – (Altitude Correction) =
(Elevation-Corrected Zero Point Offset)
(31.17) – (1500/826) = 29.35 ft

The Levelogger Gold automatically adjusts to this elevation-corrected zero point offset when the altitude is input into the programming setup accurately. The altitude used to calculate the altitude correction MUST be the altitude input in the altitude field of the Levelogger setup. Therefore, if the altitude at time of the above Levelogger setup was uncertain and an altitude value of 1200 ft was input in the altitude field, then 1200 ft must be used to calculate the elevation-corrected zero point offset. The elevation-corrected zero point offset is subtracted from the barometric pressure expressed in water column equivalent to determine the amount of barometric pressure the Levelogger is recording above its elevation-corrected barometric pressure zero offset.

For previous Levelogger versions use an altitude correction of 1:1000.

4. This net barometric pressure expressed as water column equivalent is the amount of barometric pressure the Levelogger is currently sensing. This value is then subtracted from the Levelogger submerged data file. Example 10.1 provide a case study of how manual barometric compensation is performed.

EXAMPLE 10.1

A Levelogger Gold is monitoring at 1625 m (5332 ft) AMSL in Colorado. A recording barometer is also logging at the same sample interval in barometric units of psi. If we examine how to perform manual barometric compensation on Levelogger Gold data from a particular reading time, we will understand how to perform the manual barometric compensation process. The Levelogger's altitude field was set at the accurate elevation of 1625 m and the level reading at the start of submerged data collection was 10.25 ft. The barometric data reading at that time was 12.18 psia which converts to a water column equivalent of 28.15 ft.

The Levelogger's elevation-corrected barometric pressure offset value was:

31.17 ft – (5332/826) ft = 24.715 ft

This value is subtracted from the recording barometer's reading to obtain the amount of barometric pressure the Levelogger is sensing:

28.15 ft – 24.715 ft = 3.43 ft

Therefore, at the time of these readings the Levelogger's level reading was being influenced by 3.43 ft of effective barometric pressure. The actual water level above the Levelogger therefore is the total level measurement it records less the effective barometric pressure it sensed:

10.25 ft – 3.43 ft = Actual Water Level

= 6.81 ft of Water Level

When analyzing barometric data it is important to keep in mind that storm events commonly reduce total atmospheric pressure by about 1.7% from pre-existing high pressure conditions. 1.7% converts to approximately 0.6 ft or 0.2 m of water level equivalent barometric fluctuation.

The most accurate and reliable method of obtaining representative barometric compensation of level readings is to employ an accurate surface barometric recorder (ie. the Barologger). The traditional convention has been to use a vent tube reaching from the surface to the transducer. This vent tube terminates behind the transducer diaphragm, theoretically filtering barometric effects on level readings from total pressure. After much experience with erroneous barometric compensation due to crimped, damp, wet and cut tubing, unacceptably slow response to small barometric change and many situations where barometric compensation was not required, we decided vented tubing did not offer the level of integrity in barometric compensation our clients deserved. A recording barometer does and will provide the data necessary to access barometric compensation requirements.

Vented tubing has been used in the past for several reasons. One it was a cheap, low tech method of balancing out the effect of barometric pressure on a monitored water surface. Second, when the tubing is cared for, inspected and tested for failure regularly, it responds reasonably well to steep barometric gradients such as when a large scale atmospheric front moves across the surface. The seldom discussed problem is that the response time to the much more common incremental barometric change is unacceptable. The vented tubing often leaked or its connection to the pressure probe leaked, causing the transducer to fail and experience irreparable damage. Some manufacturers, recognizing the inherent inferiority of passive venting, have adopted a method of automatic vent tube testing whereby a small vacuum pump at the surface

constantly clears the vent of water and in some cases provides a warning when the integrity of the tubing has been compromised. This elaborate method of making a cumbersome technology work, requires significant battery power to operate. The use of a Barologger as an on-site barometer or the use of local weather station barometric data is less expensive and provides more reliable results than the real hidden costs associated with the use of vented cable technology to provide barometric compensation.

11 Diagnostics Utility

The Levelogger Gold Diagnostics Utility can be used for troubleshooting the Levelogger Gold and obtaining information about that Levelogger that can assist the Solinst Technical Support representative to identify and fix any problems you may encounter with your Levelogger Gold.

The utility can be used to read Levelogger information, run a self-test, do a Memory Dump and create reports.

11.1 Read Levelogger Information

The 'Read Levelogger Information' function reads the following information from the Levelogger:

1. Model Number
2. Serial Number
3. Firmware Version
4. Battery Voltage
5. Charge Level
6. Current Temperature Reading
7. Current Level Reading

This information can be used to identify firmware, battery and/or temperature/pressure sensor problems. To execute this function simply click the 'Read Levelogger Info' button.

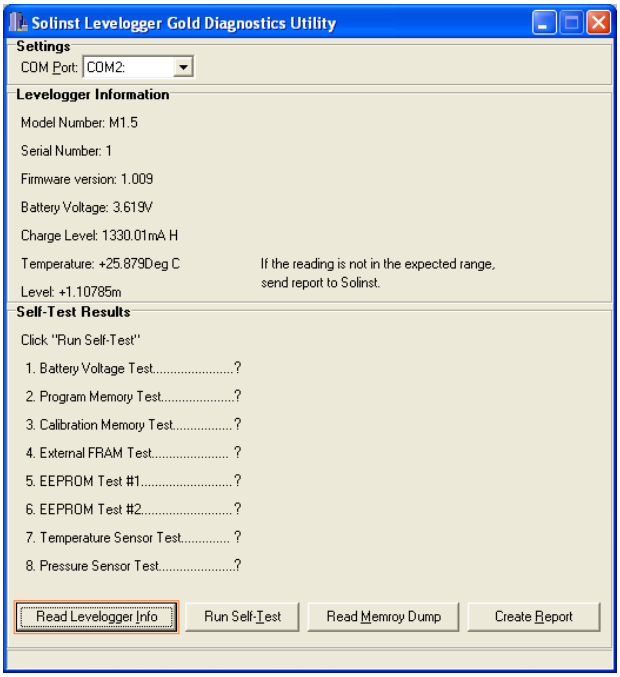

Figure 11-1 Read Logger Info

11.2 Run Self-Test

The 'Run Self-Test' function performs a series of self-tests on the Levelogger to check for problems with the battery, memory, and pressure/temperature sensors. If any of these tests fail then a report should be created and sent to Solinst Technical Support.

To execute this function simply click the 'Run Self-Test' button.

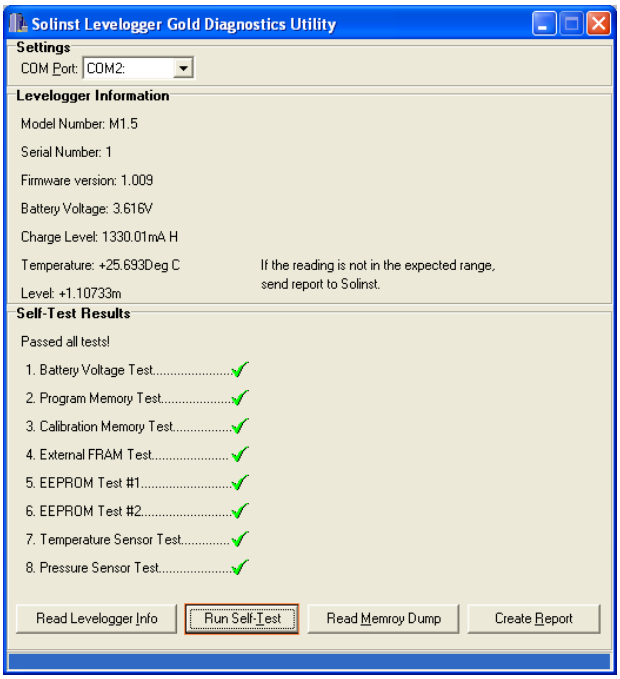

Figure 11-2 Run Self Test

Note:
It is recommended that, before attempting to use this function, you use the 'Create Report' function to send a report to the Solinst Technical Support.

11.3 Read Memory Dump

This function is used as a last resort if the problem still cannot be resolved after performing the above steps. It creates a complete dump of the Levelogger's memory, which can then be sent to Solinst Technical Support for analyzing.

To execute this function simply click the 'Read Memory Dump' button.

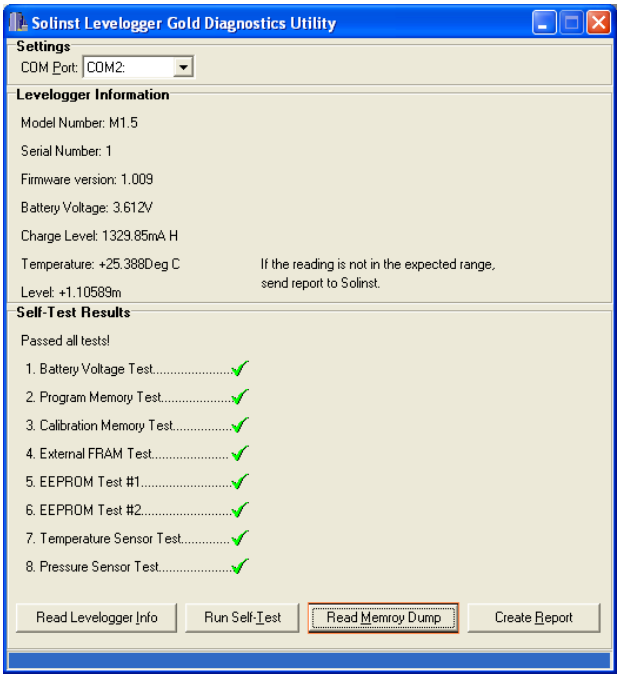

Figure 11-3 Read Memory Dump

11.4 Create Report

This function simply creates a text file containing the information obtained from steps 1 and 2. When you click the 'Create Report' button, a window will pop up asking you to fill out your company information. Simply fill this out and the resulting report can be sent to Solinst Technical Support for troubleshooting.

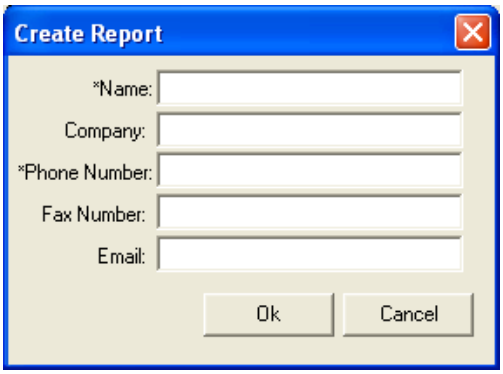

Figure 11-4 Customer Info Input Window

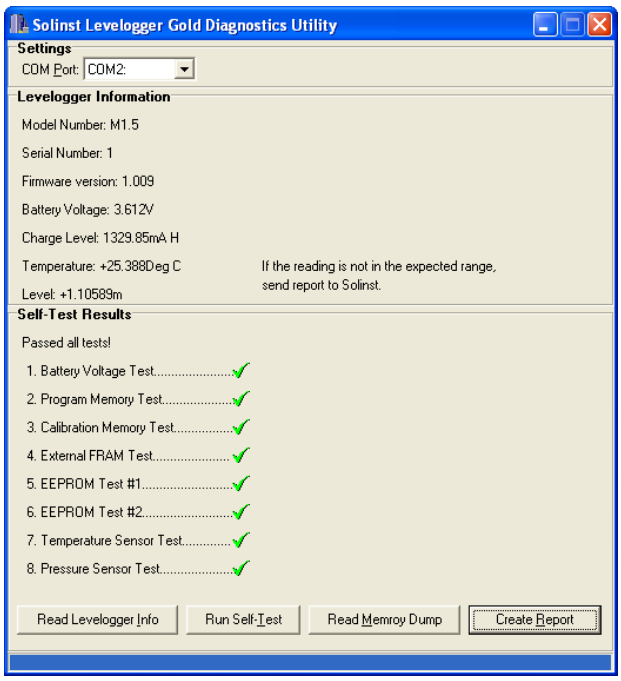

Figure 11-5 Create Report

Note:
It is important that the communication between the PC and the Levelogger is not interrupted during a firmware/calibration upload so please make sure to close any other running programs, including screen savers, and do not disconnect the Levelogger before the upload is finished.

12 Firmware Uploader Utility

The Firmware Uploader Utility can be used to upload new firmware files into a Levelogger Gold. The firmware file can be obtained from http://www.solinst.com/Downloads/.

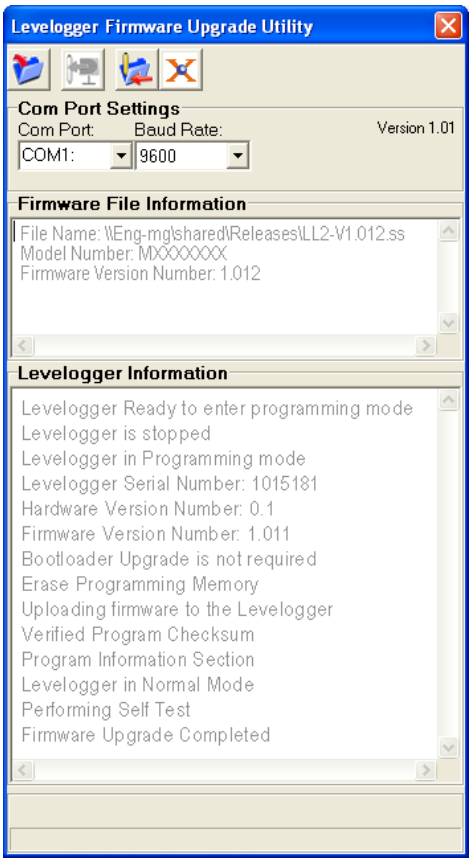

Figure 12-1 Firmware Update Utility Window

To upload new firmware to a Levelogger Gold, follow these steps:

1. Open the Solinst Firmware Update Utility (LLGfirmwareUpdate.exe), which is located in the 'Utility' folder in the Levelogger 3 folder and pick the Com Port to which the Levelogger is connected. Make sure the Baud Rate is set to 9600.
2. Click the leftmost 'Open' button  , which should open a file dialog asking for the firmware file (*.ssf) to upload. Navigate to the directory where the firmware file is located then click on the file and click 'Open'.
3. Check the 'Firmware File Information' box to make sure that the opened file is the right one.
4. Click the 'Upload Firmware' button  , which is the second button from the left, to start the firmware upload process.

5. If a communication error occurs and is indicated in the Levelogger Information Window (Fig.11-1) either before the "Verified Program Checksum" message or after the "Program Information Section", then restart the upgrade process.
6. If, however, a communication error occurs between the "Verified Program Checksum" and the "Program Information Section" messages, then please contact Solinst. You will need to give the Levelogger Serial Number and explain the exact positioning of the error message.

13 Trouble Shooting

13.1 Problems During Installation of Levelogger Gold Software

"Class not Registered" or "DLL not found" or "Access violation"

1. You may not have Administrator Rights to install the software in the Windows NT/Windows 2000/Windows XP environment.

   - Ask your System Administrator for assistance.
2. Some files got corrupted during installation of the Levelogger software. Use "Add/Remove Programs" to uninstall then re-install Levelogger software.

13.2 Error During Software Uninstall Process

The "Add/Remove Program" cannot locate the Levelogger Gold <setup.exe> file of the software or the link between the software and the "Add/Remove Program" is damaged.

The record in the Registry Table must be removed:

1. Ask your System Administrator to remove this.
2. Refer to the following link from Microsoft Website for instructions: http://support.microsoft.com/default.aspx?scid=kb;en-us;247501

Note: Solinst recommends Keyspan or IO Gear. For problems with converters from other manufacturers, please contact the manufacturer.)

13.3 Problems During Installation of RS232 to USB Converter

Unable to install the RS232/USB converter from Keyspan or IO Gear

1. After plugging in the RS232/USB Converter, a Hardware Installation Wizard will open. Follow the instruction from the Wizard and make sure to select the RS232/USB Converter Driver from the Keyspan or IO Gear Installation CD.
2. If the Hardware Installation Wizard does not open after plugging in the RS232/USB Converter, follow the steps below to open the Hardware Installation Wizard:

   a. Select Control Panels

   b. Double click on System

   c. Select the Device Manager Tab

   d. Double click on Other devices

   e. Right click on USB Serial Converter

   f. Select Update Driver …

13.4 Data Has Been Erased Accidentally

If Levelogger Gold has been restarted and old data has not been saved, go to Download Options and choose Data Recovery. It downloads the immediately previous log.

13.5 Error Messages During Use of Software

"Communication Time Out" or "Communication Error" or "The Command that is sent to the Levelogger Gold is not defined"

1. Try communicating with another Levelogger Gold, Optical Reader or Direct Read Cable. The communication cable, Optical Reader or Levelogger Gold may be damaged.
2. Clean the optical "*eyes*" on the Levelogger and the cable, with a soft cloth.
3. Check that the communication cable is connected to the same Com Port that is chosen in the upper middle of the Main Window of the Levelogger software.
4. Check the Com port settings. They should be as follows:
   - Bits per second: 9600
   - Data bits: 8
   - Parity: None
   - Stop bits: 1
   - Flow control: None
     (This may have been set to Xon/Xoff – change it to None, Select [OK] and back out of this pathway.)

   The route to view your Com port settings is as follows:

   a. Select Control Panels

   b. Double click on System

   c. Select the Device Manager Tab

   d. Double click on Ports

   e. Double click on Communications Port(s)

   f. Choose the Port Settings Tab
5. Try using a different computer, to see if this is the cause of the problem.
6. If using a laptop (especially in conjunction with a Direct Read Cable) your Com Port may not be powered adequately to receive/transmit data. Try using a desktop computer to test this, or contact Solinst to obtain a PC Interface Booster Cable.
7. If problem persists, contact Solinst.

"Port Cannot Open"

1. Ensure the correct Com Port is selected in the upper middle of the Main Window of the Levelogger Gold software.
2. Check if some other software is using the same Com Port in the background. Shut that software down or choose another Com Port if available. Such background software may be anti-virus software or PDA software.
3. Make sure your Com Port has been enabled:
   a. Select Control Panels
   b. Double click on System
   c. Select the Device Manager Tab
   d. Double click on Ports
   e. Double click on Communications Port(s)
   f. Choose General
   g. Uncheck "Disable in this hardware profile box"
4. If you are using a virtual Com Port, like a USB optical reader or USB/RS232 converter, refer to the "Problems During Installation of RS232 to USB Converter" section to make sure they are installed properly.

"File Create Error" and "File Write Error"

1. If you do not have file-writing privileges to the Levelogger Gold default data folder, change the folder as follows: in the Levelogger Gold software, click "Configuration" then "Application Settings". Under "Default Directory", enter a new destination folder, to which you have file writing privileges, e.g. "My Documents". Follow the same procedure if you have the same problem when you export the data file in csv format.
2. Ask your System Administrator for assistance.

"File Open Error" and "File Read Error"

1. Shut down or disable any other software that is active and using the same file.
2. In Notepad or Wordpad, open the <*.lev> or <*.lls> file to check for corruptions in the file. How are the Levelogger files ended?
3. If problems persist contact Solinst for assistance.

"Time Span Error, some data cannot be compensated"

1. Find another barometric data file that has the same time stamp as the Levelogger.
2. Perform the compensation (a simple subtraction) in a spreadsheet program for any missing time stamps.

"A different type of Levelogger is detected"

Replace the Levelogger currently in the Optical Reader with the one that was previously being worked on, and complete the operation.

"The selected file is not a barometer"

Select a Barologger for the compensation process.

"Data Corrupted"

Contact Solinst for assistance. Use Levelogger Gold Diagnostic Utility to do a memory dump and sent the dump file to Solinst for further analysis.

"Internal Error"

Contact Solinst for assistance.

"Fail to append data - A different Levelogger has been detected!" or "Fail to append data - A different start time has been detected!" or "Fail to append data - New data is not available in the Levelogger!"

The Levelogger software can only append data to a file that has the same serial number and start time as the connected Levelogger. Find the correct file, or use "All Data" to download the complete file.

"Only Levelogger Gold supports this function"

The "Append Data", "Partial Download" and "Data Recovery" functions are only supported by the Levelogger Gold loggers, not previous version Leveloggers.

"Schedule cannot be empty"

When using the "Schedule" sampling option in a Levelogger Gold, the schedule must contain at least one item.

"Readings in schedule exceed the maximum"

The number of readings in a schedule should not result in more than 40,000 individual readings.