



STATIC WATER LEVEL MEASUREMENT



# WELL SOUNDER WS2010 / WS2010 PRO USER MANUAL

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## PRODUCT OVERVIEW



The Well Sounder 2010 PRO is a simple to use self-contained portable acoustic ranging instrument designed specifically to find the distance through a well casing or sounding tube to the water surface. However, it also can be used to measure any closed pipe, straight or crooked.

The product consists of a control unit and a probe. The control unit contains the driver electronics, processor, display, keypad and 6 AA batteries. Internal non-volatile memory is included to record system settings, calibration data, and log data. A real-time clock/calendar is also included to time stamp the recorded log data. The RS232 port can be set to output data to a remote device or used as a bidirectional communications interface to a computer for remote programming or data download. A power jack allows the unit to be run from an optional AC adapter or battery pack. An optional flow meter can also be connected, read and recorded by the data logger.

The 2010 PRO version offers enhanced features in addition to those above, such as a USB port for easy connection to a computer for downloading log data, and greatly expanded memory. Log data on the 2010 PRO is separated into easy to identify windows compatible files sorted by well ID. The PRO version also offers enhanced power save functions such as Auto-off and the ability to provide an alarm output, a 0-5 volt analog voltages as well as a 4-20 ma current loop output.

The probe contains a pulse generator, a microphone and a temperature sensor. The probe is designed to easily attach to a standard well cap vent opening while also allowing the display unit to be operated in a convenient location up to 6 feet away.

The Well Sounder works by transmitting a sound pulse into the pipe, then measuring the time it takes for the echo to return. The distance is calculated using the sound speed and the time. Since the sound speed changes with temperature, a temperature sensor is included in the probe to adjust for variations.

There are many advanced features included in this unit, however, none are required for basic depth measurement. Simply press the ON button and the unit powers up in the depth measurement mode. After a few seconds, read the depth to the water on the display. Other features can be found by pressing the SET or DISP buttons.

Several accessories are available for the Well Sounder 2010 PRO which can be found on our website at [www.enoscientific.com](http://www.enoscientific.com).



## QUICK START GUIDE

The Well Sounder is nearly ready to go right out of the box. Follow the few steps below to find the depth to water. If depth to the water is all you are interested in, then this is all you need to read. To learn about the more advanced features continue reading the operation section of this manual.

1. **Attach probe to meter.** Make sure that the probe plug is fully inserted.
2. **Attach probe to well.** Insert the probe end into the vent hole on the well. If the casing is open, it should be covered with anything solid such as cardboard or plastic with a hole in it for the probe. The cover does not need to be air tight, but the tighter it is, the stronger the signal will be.
3. **Turn meter on.** Press the ON button to turn the meter on. You should hear a popping sound coming from the probe. If not, make sure the probe connector is firmly seated.
4. **Measure well.** Read the measured depth on the display. If the measured distance is not as expected, then proceed to the next step to change the initial settings.
5. **Change initial settings.** Press the SET button repeatedly to show the various settings to be changed. Press the UP or DOWN button to change setting. When set as desired, press SET again to change another setting or press DISP to return to read the measured depth. For best depth results, the **range min**, **range max**, and the **well temperature** should all be set.
6. **Read other information.** While reading the depth display, press the UP or DOWN buttons to read other information. The water in well and recovery rates etc are available but will only be correct if the well parameters (diameter and well depth) are set correctly in the settings.

We encourage you to read the frequently asked questions section. They really are frequently asked.

## **CAUTIONS**

### **The Well Sounder is not water proof!**

It is resistant to rain and splashing but not saturation or submersion. This is true for the meter unit and the probe. They will be damaged if submerged.

### **Both sides of the probe must be near atmospheric pressure!**

The probe cannot be used on a well which is significantly above or below atmospheric pressure. A vent port must be provided in these cases. Applying pressure to either side of the probe will damage the pulse generator.

### **External power cannot exceed 16 volts DC!**

When supplying external power to the well sounder, care must be taken to insure that voltage spikes or induced transients are not conducted into the unit. Over voltage and surge protectors and proper grounding should be used if this is a possibility.

### **Use surge suppressors and grounding on signal lines!**

When connecting the well sounder to remote equipment through the RS232 port or analog outputs, care is required to prevent ground loops, lightning induced transients etc from reaching the well sounder. Over voltage and surge protectors and proper grounding should be used if this is a possibility.



## BACKGROUND – HOW IT WORKS

The Well Sounder works by pushing an air pressure wave or low frequency sound wave into the well. For this reason, it is important that the probe be connected to a closed end of the pipe to prevent the air pressure from just escaping the open end. After the Well Sounder sends its sound pulse, it listens for the pulse to return. And since sound travels at a predictable rate, it can tell where in the well the pulse was reflected by timing the returning pulse.

The pressure wave generated by the probe will continue to travel into the well until something disturbs it. Every imperfection in the well will disturb the wave, and every time it is disturbed, some of the wave changes direction and is reflected back to the Well Sounder leaving the main wave a little weaker. A complete obstruction like the surface of the water, reflects the entire remaining wave. Most common obstructions like wires and tubes and pipe couplings do not reflect enough of the wave to cause a

problem, provided that the remaining part of the main wave is relatively big enough to be obviously the one of interest.

Some imperfections like a change in casing diameter can cause a significant part of the wave to be reflected. Where the water may be very far away and its reflected pulse very weak, the reflection from the imperfection could be the largest wave returning to the Well Sounder. In this case, the Well Sounder would lock in on the erroneous reflection and tell you that the water was at the end of the casing. The Well Sounder therefore offers settings to limit the range in which it will look for reflections. If for example the casing in your well ended at 40 feet and the water was around 80 feet, then the minimum range could be set to 60 feet so that the Well Sounder would ignore any reflection from the casing.

The sound wave traveling through the well also loses energy as it travels, more as the surface of the well casing gets rough or porous. To compensate for this, the Well Sounder increases its gain with time to listen for fainter signals. This can cause problems if the Well Sounder listens for too long. The gain will get so high that the pump noise or even noise from outside the well will outweigh the desired pulse. Therefore, the maximum range setting is available to tell the Well Sounder how long to listen. If for example the pump is mounted at 200 feet, then there is no reason to set any more than that as a maximum range.

The strength of the sound pulse generated by the probe depends on how much space it needs to fill. A 12" pipe is 4 times larger than a 6" pipe in volume and therefore the pulse will be 4 times smaller. A weaker pulse becomes more susceptible to pump noise and loss with depth. While the Well Sounder is being used in wells up to 30", many of these installations do not get reliable results with running pumps etc. These wells usually require a sounding tube installed in the well which reaches into the water and provides a tight connection to the probe at the top. A 3/4" or 1" tube is adequate.

Something to keep in mind, especially for shallow wells, is that the sound wave bounces off the top and bottom of the well. So it is possible for the pulse to bounce back and forth many times. In a well where the water level is at 6 feet, the Well Sounder would hear a reflection at 6 feet, then again at 12 feet, then 18 etc, until the pulse gets weak enough to ignore. In this example, you would be able to see the multiple reflections by increasing the min range. When set to 9ft, the depth would read 12. When set to 14ft, it would read 18 etc. In this case, it may be helpful to leave a small leak at the probe to help dissipate the pulse.

## OPERATION

**POWER ON:** Press the ON button located on the front panel of the control unit to start the Well Sounder. The probe will pulsate and the LCD screen will display a product information screen for a few seconds then go to the default DISPLAY mode screen. The depth is displayed on the top line once the unit adjusts to the well and calculates a stable reading. While the unit adjusts to the well the display will read "DEPTH SEARCHING." Additional information is displayed on line two such as the battery voltage, the optional flow meter, or the temperature sensor.

*Note: If error conditions exist, line two of the display will be replaced by an alternating error message. See the ERROR CODES section for details.*

**POWER OFF:** Press the OFF button located on the front panel of the control unit to turn off the power. All system settings as well as the time and date, and log data are maintained while the power is off.

The Well Sounder has two different operating modes, DISPLAY modes and SET modes. The DISPLAY modes are accessed by repeatedly pressing the DISP button, and the SET modes are accessed by repeatedly pressing the SET button. The DISPLAY modes are used to show measurement data, and the SET modes are used to change operating parameters of the Well Sounder.

There are three DISPLAY modes:

- 1 – DEFAULT display screen which shows current measurement data
- 2 – LOG display screen which shows recorded log data
- 3 – TIME AND DATA display screen which shows the system time and date.

Pressing the DISP button advances the DISPLAY mode by one with each press and starts over when reaching the end.

There are 16 primary user SET modes which similarly advance with each press of the SET button. A complete description of the SET modes can be found in the SET MODE section of this manual. While in any SET mode, pressing the DISP button will return to the default DISPLAY mode. Similarly when in a DISPLAY mode, pressing the SET button puts the Well Sounder in the first SET mode.

**DEFAULT DISPLAY:** While the display shows depth on the top line, press the UP or DOWN button to scroll through additional information on the second line. The following information may be available depending on options installed and enabled:

1. Probe – temperature measured by the probe.

2. Resrv – amount of water in well in gallons (liters) .
3. ResRate – rate of change of Resrv in gallons/minute.
- \*\* (4-6 will only be displayed if the flow meter option is enabled)
4. Flow – total flow through optional flow meter in gallons (liters).
5. FlwRate – rate of flow through the flow meter in gallons/minute.
6. Recov – net recovery rate in gallons/minute (liters/minute).
7. Bat – battery voltage. Batteries should be replaced at 6.5 volts.
8. Diagnostic Data – information about the quality of the measurement.

**LOG DISPLAY:** While the default depth display is active, press the DISP button to enter the LOG DISPLAY mode. The display screen appears showing the most recent logged data point. The first display line shows the logged data point number and the time. The second line displays the depth and the date. Press the ENTER button to alternate between this screen and a second screen of data associated with this data point. Press the UP or DOWN button to scroll through the logged data points.

**TIME AND DATE:** While the LOG DISPLAY mode is active, press the DISP button to view the system date and time. While the date and time are displayed, press the SET button to edit the date and time. Use the arrow buttons to adjust the information. Press the SET button again to advance to the next number to be set. Press the DISP button to return to the depth reading.

**SET MODES:** Press the SET button while the depth or log are displayed to view and change any of the system settings. Continue to press SET to scroll through all of the settings. Sounding stops while in a SET mode. After 30 seconds of inactivity sounding will automatically resume or press the DISP button at any time to return to the depth reading instantly. While viewing a SET screen, press the UP or DOWN button to change the value. Rapid scrolling is activated by holding the up or down button for 2 seconds. Scrolling gets faster and faster while the button is held down. When the value is as desired, press the SET button to go to the next setting or the DISP button to return to operation. The new settings are saved automatically as they are changed so there is no need to press ENTER.

There are 19 main system settings screens (SET MODES) as follow:

1. Product Info – displays model number, version and serial number.
2. Unit ID – user settable well ID number .
3. Range Min – sets the minimum range to detect.
4. Range Max – sets the maximum depth to be measured.
5. Well Temp – sets the well deep temperature.
6. Methane % – sets the concentration of methane in the well.

7. Sound Tube Dia – sets the sounding tube diameter.
8. Diameter – sets the well diameter for water volume calculations.
9. Well Depth – sets the well depth for water volume calculations.
10. Offset – sets the probe offset.
11. Logging – enables data logging and additional set screens.
12. Flow Meter – enables flow meter functions and additional set screens
13. Output – enables alarm or analog outputs.
14. Clear Log – press up or down to erase all logged data.
15. RS232 Data – enables data reporting on RS232 connection.  
(additional set screens are available if this is enabled)
16. Units – changes display units, decimal feet, feet & inches, or metric.
17. Power Mode – enables power save functions.
18. Contrast – adjusts the contrast level on the LCD screen
19. Factory Reset – press up or down to set all settings to factory defaults.

## DISPLAY MODE DESCRIPTIONS

**DEPTH DISPLAY** – The default display mode after power-up. While this display is active, the unit is operational, sending pulses and timing the echoes. The depth is displayed on the top line and additional user selectable information is displayed on the second line. The depth is displayed as “searching” when the unit is turned on and adjusting to the well. Once the signal is locked and stable, the depth is displayed in the units selected. Occasionally a spurious depth reading will be calculated due to random noise in the well. Software in the Well Sounder identifies the anomaly and holds the last good data through a few bad data points while a good depth is obtained. An asterisk is displayed before the depth while holding. If a stable depth is not found in several tries, the depth is replaced with “searching” until one can be found. Data displayed on the second line can be changed by pressing the UP or DOWN arrow. Data available varies depending on options enabled on each unit. If there are any error conditions, such as when the probe is not on the well or is missing, or when the battery low, an error message will alternately be displayed on the second line.

**PROBE TEMP**– displays the temperature measured by the probe. This temperature is used to automatically compensate sound speed variations due to temperature in the upper part of the well.

**RESRV** – reserve is the total amount of water in the well in gallons (liters) calculated from the well diameter and well depth entered in the user settings, and the measured depth.

**RESRATE** – displays the rate of change in gallons/minute (liters/minute) calculated from changes in the total water in well over time. The rate is calculated using an averaging technique on the last 20 measurements to stabilize the reading. Press the ENTER button to reset the average to an instantaneous reading. As additional readings are obtained, they are automatically added to the average back up to the last 20 points.

**\*\*FLOW** – displays the total water pumped through the optional flow meter in gallons (liters) when the flow meter is attached and enabled. The flowmeter is plugged into the probe connector with the probe using an optional flow meter adapter. Press the ENTER button to reset the total to 0.

**\*\*FLWRATE** – displays the flow rate through the optional flow meter in gallons/minute (liters/minute) when the flow meter is attached and enabled. The flowmeter is plugged into the probe connector with the probe using an optional flow meter adapter or accessory splitter. The rate is calculated using an averaging technique on the last 20 measurements to stabilize the reading. Press the ENTER button to reset the average to an instantaneous reading. As additional readings are obtained, they are automatically added to the average back up to the last 20 points.

**\*\*RECOV** – displays the recovery rate of the well by subtracting the flow meter flow from the change in the calculated water in the well.

**BAT** – displays the measured voltage of the battery or external power supply if used. The Well Sounder maintains calibration down to 6.5 volts. An alarm is displayed when the voltage drops below 6.5 volts. The unit will continue to operate, but with reduced signal strength down to about 5.5 volts.

**DIAGNOSTIC DISPLAY** – This display varies with the software revision and provides diagnostic data for each pulse for technical support.

**LOG DISPLAY** – If logging is enabled, displays the logged data points. The first data point shown is the last point measured, and displays the sequential number for the point, the depth reading, and the date and time stamp. Pressing the ENTER key shows additional data stored for the data point, the ID number, the temperature, the battery level, the signal gain and the error code (if any). More data is available when the log is dumped through the RS232 connection. Other points are displayed by pressing the up or down button. Rapid scrolling is activated by holding the up or down button.

**TIME AND DATE DISPLAY** – displays the system time and date on the internal clock. The time is in 24 hour format. Press the SET button while viewing the time to change

the system time and date. Press the SET button repeatedly to cycle through the time and date. Press the DISP button at any time to return to the DEPTH DISPLAY.

## **SET MODE DESCRIPTIONS**

**PRODUCT INFO** – displays the product type, configuration and the software version number. The unit serial number is displayed by pressing the UP or DOWN button.

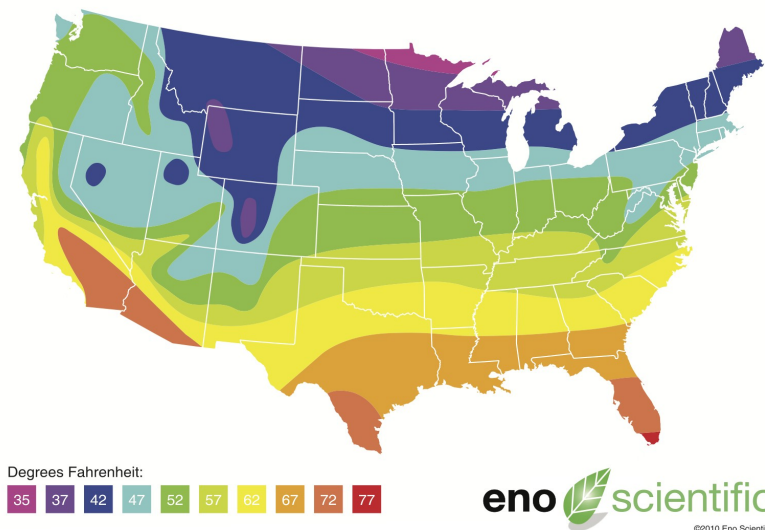
**UNIT ID** – sets a user selectable ID number in the range 0-255 to identify the source of logged data. Set the unit ID number by pressing the UP or DOWN button.

**RANGE MIN** – sets the minimum distance to start detecting in feet (M). This is used where there may be a known defect in the well such as a step down in bore diameter. This kind of defect will reflect some of the pulse which could compete with the desired reflection from the water surface. If for example this transition occurred at 42 feet, then set the range min to 45 feet or more.

**RANGE MAX**– sets the maximum distance in feet (M) the Well Sounder will listen for a returning pulse. A shorter range means more frequent pulses and faster updates. A longer range gives less frequent updates and increases the possibility of collection spurious noise.

**WELL TEMP** – sets the deep temperature in the well. If you do not know the well temperature, reference the Water Temperature chart included with your unit. The temperature near the surface is automatically sensed by the probe. These two temperatures are used to calculate the sound speed and in turn, the distance. The distance error is fairly small for variations in temperature, about 1% for a 10 °F (5.6 °C) temperature error.

## Groundwater Temperature Map



**METHANE %** – sets the average concentration of methane in the well. This compensates for a increased sound speed in methane. If uncompensated, the well sounder will calculate a shorter distance by nearly 30% if the well is full of methane.

**SOUND TUBE DIAMETER** – sets the sounding tube diameter. This compensates for a reduced sound speed in tubes smaller than 2" in diameter. For tubes 2" or greater, set to "None".

**WELL DIAMETER** – sets the diameter of the well casing in inches (cm). This is used to calculate the total water in the well.

**WELL DEPTH** – sets the drill depth of the well in feet (M). This is used to calculate the total water in the well in gallons (liters). The pump depth may be used here to calculate useable water in the well.

**OFFSET** – sets the offset of the probe position from ground level. If for example, the probe is inserted into a well cap on a well casing that extends 30" above the ground. Then enter 30" for the offset. This will automatically be deducted from the depth

reading. This may also be negative if the probe is installed on a casing below ground level.

**FLOW METER** – enables the optional flow meter functions including the display for the totalized water flow pumped from the well, flow rate and net recovery. Pressing the UP or DOWN button turns the flow meter on or off.

**LOGGING** – enables the logging features of the Well Sounder. Press the UP or DOWN button to select the logging preference. Three logging modes are available: Disable, Enable or Change. Enable sets the unit to record data each logging period. Change sets the unit to compare data each period against the last logged data point. The new data point is stored in memory if the measurement has changed more than the log change margin (as defined in the Log Change mode.) When it is time to record a new data point, a log message is displayed on the error line and remains until valid data is recorded. *Do not remove the probe or turn off the well sounder until this message disappears.*

Once logging is enabled, new data points will be added to the end of the list until the memory is full. When the memory is full the Well Sounder will continue to function but new data points will be discarded. The 2010 PRO records data additionally in windows readable text files which has a much larger capacity and will continue to record.

**\*\*LOG RATE** – sets the time interval in minutes between logged data points in the range 0 to 60 minutes. This is accessed by pressing SET after choosing ON CHANGE or ENABLED in the LOGGING menu. Every measurement is recorded if it is set to zero.

**\*\*LOG CHANGE** – this margin determines the distance in feet (M) that the depth must change to in order for the new data point to be recorded to the log. If the new data is within the margin of the last recorded data, then the new data is discarded. This function is accessed by pressing SET after setting the LOG RATE.

**OUTPUT** – enables the output features on newer models of the 2010PRO. These outputs are accessible with an optional breakout adapter and include an alarm output, a 0-5 volt analog output and a 4-20 ma current loop output. Select High or Low Alarm or Analog 0-5v to enable the output as well as additional setup screens.

**\*\*ALARM SETPOINT** – this screen is added to the set screens when the High or Low Alarm feature is activated. Press the UP or DOWN button to select the level at which the output level is driven high.

**\*\*ANALOG HIGH SETPOINT/ ANALOG LOW SETPOINT** – these screens are added to the set screens when the Analog 0-5v feature is activated. Press the UP or DOWN button to select the range over which the output voltage will vary from 0 to 5 volts. (This is also converted to 4-20ma in the output adapter.) So for example, if the Analog High is set to 100 and the Analog Low is set to 50, then the output level will be 0 volts when the depth is 50 or less, and it will be 5 volts when the depth is 100 or more, and vary linearly in between.

**CLEAR LOG** - displays the number of data points collected in the log, out of the total number of data points available in the internal flash memory. Press the UP or DOWN button to erase all data from the log and free the memory for additional logging. The 2010 PRO stores log data in flash memory like the 2010, and also in extended memory available only through the USB connection. The clear log function only clears the flash memory, and leaves the extended memory intact.

**RS232 DATA** – enables the transmission of current data over the RS232 connection. This feature is used when the well sounder is used with a remote readout or data transmission system such as SCADA. Press the UP or DOWN button to make the selection. Four serial modes are available: Off, Continuous, Logged Only and Depth only. When set to Continuous, every measurement is sent over the serial port. When Logged Only is selected, data is only sent when it is logged. Transmitted data includes the time, date, and all measured data, as well as the highest priority error code. When Depth Only is selected, only the depth is included in the data. Select Off to deactivate this feature.

**\*\*RS232 BAUD RATE** – this screen is added to the set screens when the RS232 DATA feature is activated. Press the UP or DOWN button to select available serial baud rates. The default is 19,200. The data format is always 8 bit with 1 stop bit.

**UNITS** – selects the measurement system for the data. Press the UP or DOWN button to scroll through the options: English for decimal feet, degrees Fahrenheit and gallons; English ft-in for distance displayed as feet and inches; or Metric for meters, degrees Celsius, and liters.

**POWER MODE** – enables the power save function. Press the UP or DOWN button to scroll through the options: Normal or Power Save. When logging data and the Power Save function is activated, the unit goes into sleep mode between logging periods. Battery life can be extended by more than 6 times using this function. The 2010 PRO also has an auto off function which can be set to from 10 sec to 24 hrs and is enabled when the power save mode is on and logging is off.

**\*\*AUTO-OFF TIME** – (2010 PRO only) available when the power save function is active. Press the UP or DOWN button to set the time of inactivity after which the well sounder will turn itself off. The time can be set to from 10 sec to 24 hrs.

**CONTRAST** - sets the contrast level on the LCD screen from 0 (brightest) to 20 (dimnest).

**FACTORY RESET** – allows the user return the unit to the factory default configuration. Press the UP or DOWN button to make the selection. All user settings will be set to the default values, but any recorded log data will remain intact.

## LOGGING

The Well Sounder includes a built-in data logger which can record the measurement data on command when the LOG button is pressed or automatically at preset intervals when automatic logging is enabled. Each data point includes the depth, temperature, flow, well ID, battery voltage, error codes, and the system time and date. The data is recorded in the internal flash memory which maintains the data even if the battery goes dead. The internal memory is large enough to hold more than 13000 data points. The recorded data can be viewed in the DISPLAY LOG mode or exported using the RS232 port to a computer or other external device.

The 2010 PRO additionally offers an extended memory large enough to hold over 25 million data points. This memory is only accessible using the USB interface as described in the next section.

To record a single data point, press the LOG button. This initiates the log sequence. The second line of the display changes to indicate logging is in progress and shows the point number being recorded. The logging message remains until a stable reading is obtained and the data is recorded. It is important that the Well Sounder remain on until the logging indication goes out.

To automatically log data on a schedule, press the SET button repeatedly until the logging screen appears. Then press the UP or DOWN button until the second display line reads ENABLED. Then press the SET button again to show the log period screen. Press the UP or DOWN button to set the log interval in minutes. If the log period is set to 2 minutes, the Well Sounder will initiate a log sequence every two minutes. The time between logged data may vary by a few seconds depending on how long it takes to get a stable reading. If the log period is set to zero minutes, then every reading is logged.

Log margin is a second logging option available to reduce the the amount of data collected on wells where the water level may not change for long periods. To turn on this feature, press the SET button repeatedly until the logging screen appears. Then press the UP or DOWN button until the second display line reads "ON CHANGE". Then press the SET button again to show the log period screen. Press the UP or DOWN button to set the log interval in minutes. Then press the SET button again to show the log margin screen. Press the UP or DOWN button to set the log margin in feet (M). If the log period is set to 2 minutes and the log margin is set to 1 ft, then every 2 minutes the current reading is compared to the last logged reading. If the difference is less than 1 ft then the current log sequence is cancelled.

## **USB COMMUNICATIONS**

The Well Sounder 2010 PRO in addition to the logging features above offers enhanced logging capabilities. Expanded memory provides enough memory to record one data point per minute for over 50 years. This memory supports a windows compatible file system which can be accessed using the USB port. When the Well Sounder is connected to a computer with the included USB cable, the computer will identify the Well Sounder as a mass storage device and show the available log files in an explorer window which can be copied directly to a directory on the computer and deleted from the Well Sounder.

The log data files are simple ascii text files which can be opened with any common program such as Notepad, MS Word or Excel. The data files created are named WSLOGxxx.TXT where xxx is the well ID in the form 001 etc. Each data point stored is appended to the file corresponding to the currently set well ID. If a file does not exist for the well ID selected, it is created. Once the data is copied to the computer, the file can be deleted from the Well Sounder. A new file will be created if the same ID is used.

## **RS232 COMMUNICATIONS**

The Well Sounder offers a standard serial communications port for connection to a computer or remote device such as a SCADA system or remote readout. A 9 pin D connector on the side of the unit allows the unit to connect to a computer or other RS232 device using a standard straight through serial cable. A simple serial to USB adapter is available from Eno Scientific or most computer stores to use with laptops without serial ports. The default serial configuration on the Well Sounder is 19200

baud, 8 data bits, 1 stop bit, no parity, and no flow control. The baud rate can be changed from the set screen on the keypad.

The serial port is bi-directional and allows communication from the Well Sounder to the remote device and back. This allows the Well Sounder to be programmed and operated from a remote location. The Well Sounder offers a complete command set over the serial link to allow configuring the Well Sounder settings as well as requesting a down load of the log data. A standard terminal emulator program such as HyperTerminal (included with windows) or Tera Term Pro 4.69 (available for free download) can be used from a computer to operate the Well Sounder remotely (see the section on remote operation).

The Well Sounder can also be instructed to automatically transmit new data over the serial port as it is generated. To activate this feature from the keypad, press the SET button until RS232 data is displayed. Press the UP or DOWN button to select continuous, logged only, or depth only. When set to continuous, the complete data set is transmitted with each pulse. When set to logged only, data is only transmitted when a log point is recorded. When set to depth only, only the depth is transmitted.

## REMOTE OPERATION

When the Well Sounder is connected to a computer or other bi-directional remote device, the Well Sounder can be controlled and configured using a set of simple commands. Connect the unit to a serial com port on a computer or other RS232 device using a standard straight through serial cable or to a USB port using a simple serial to USB adapter. (Available from Enoscientific or most computer stores to use with laptops without serial ports). On a computer, a standard terminal emulator program such as HyperTerminal (a standard program installed as a part of windows), can be used to communicate with the Well Sounder.

HyperTerminal can be found on Windows from the start menu. Select All Programs > Accessories > Communications > HyperTerminal. Open Hyperterminal and enter a name for the well sounder connection. Select OK, then on the following screen, in the box labeled Connect using:, select the COM port connected to the Well Sounder. If your computer has a com port, it will probably be COM1. If you are using a USB adapter it may be any where from COM3 thru COM12. Select OK, then enter the port settings: 19200 baud, 8 data bits, parity none, 1 stop bit, and flow control none. Then select OK. Turn on the Well Sounder and press the return key on your computer. If it is set up correctly, the Well Sounder will return with a line of data and a WS2k> prompt

on the screen. If the Well Sounder does not respond, select a different COM port and try again. Once the communications are working, select "save" from the file menu at the top. The next time you start Hyperterminal, cancel the new connection screen and select file > open from the top menu and double click on your well sounder connection.

If the Well Sounder unit is in power save mode and shut down, press a key on the keypad to wake the unit. It will remain awake for 30 seconds after the last key or RS232 command. Then press the return key <return> on the computer. If it is set up correctly, the unit should respond with a line of data and a WS2k> prompt. The unit is now ready to receive commands from the remote device or computer.

The remote commands are case sensitive and must be entered exactly as shown on the list below. One command per line, terminated by a <return>. Extra tabs or spaces will not be accepted.

Examples:

Press "d<return>" to dump the log data to the screen.

Press "u0<return>" to set english mode or "u2<return>" to set metric.

Press "lp5<return>" to set the logging period to 5 minutes.

Press "tm15:30:00<return>" to set the system time to 3:30 PM.

If serial output is enabled, the prompt and input may be written over on the screen but the input will still be interpreted correctly. It may be easier to disable the serial output while using remote commands. Press "s0<return>" to turn off serial reporting and "s1<return>" to turn in back on when finished.

USER REMOTE COMMANDS - In the following list, [iiii] indicates a parameter of up to a 4 character integer (no decimal point), [dddd] indicates up to 5 character decimal number (decimal point optional), and <ret> indicates a return.

<ret>	send current data
a0<ret>	alarm off
a1<ret>	low alarm on
a2<ret>	high alarm on
a3<ret>	both alarms on
ah[iiii] <ret>	set high alarm level
al[iiii] <ret>	set low alarm level
cX<ret>	clear log memory
d<ret>	dump log to RS232 connection
f0<ret>	enable flow meter
f1<ret>	disable flow meter

fp[ddddddddd] <ret>	preset flow totalizer
gf[iiii] <ret>	set min measurement range
h <ret>	display command list
i[iii] <ret>	set unit ID
l0<ret>	logging off
l1<ret>	logging on
l2<ret>	log on change
lp[iiii] <ret>	logging period minutes
lm[dddddd] <ret>	log change distance
m0<ret>	puts unit in normal operation mode
m1<ret>	puts unit in set mode
o[dddddd] <ret>	offset to subtract from all distance measurements
p0<ret>	power saver off
p1<ret>	power saver on (CAUTION – while in power down, RS232 is off and no further communications will be accepted)
r[iiii] <ret>	set max measurement range
s0<ret>	turn off RS232 reporting
s1<ret>	turn on RS232 continuous reporting
s2<ret>	turn on RS232 reporting for logged points only
s3<ret>	turn on RS232 continuous reporting depth only
sb[i] <ret>	set baud rate (CAUTION – once the command is accepted, communications will cease until the Hyperterminal setting are changed to match)
	0 – 300
	1 – 1200
	2 – 2400
	3 – 4800
	4 – 9600
	5 – 14400
	6 – 19200
	7 – 38400
	8 – 57600
tm[hh:mm:ss] <ret>	set time
td[yy/mm/dd] <ret>	set date
u0<ret>	set english units (ft)
u1<ret>	set english units (ft in)
u2<ret>	set metric units
w[dddddd] <ret>	set well temperature
Ca[dddddd] <ret>	calibrate temp sensor 1
Cb[dddddd] <ret>	calibrate temp sensor 2

Cc[dddddd] <ret>	calibrate temp sensor 3
Cd[dddddd] <ret>	calibrate battery sensor
?<return>	send a list of the current settings

Most of these commands are the same as those described under Mode Definitions. There are, however, a couple additional functions.

The calibrate commands allow the user to calibrate the unit for use with a particular probe. Each probe is slightly different, so while the unit is measuring a temperature, for example, the command “Ca73.1<ret>” could be entered. This would cause the unit to recalibrate so that it would currently read 73.1 degrees.

The flow command allows the user to preset the flow totalizer with up to a ten digit decimal number.

## DOWNLOADING DATA

The procedure for collecting data stored in the flash memory from field installed logging units in power save mode should be as follows:

- 1 – Connect the laptop computer to the unit using a serial cable.
- 2 – Start HyperTerminal and configure the connection as described above.
- 3 - .Press the “SET” button on the unit to wake it up. There should be a single click.
- 4 – Press <enter> on the computer, and the unit should respond with a line of data and a WS2k> prompt. If not, press again.
- 5 – If the unit is sending continuous lines of data, press “s0<return>” to turn it off.
- 6 – Open log file. Click on the “transfer” drop down menu and select “capture text”. Enter a file name and click open. A log indicator will light up at the bottom of the screen. When finished, go back to the “capture text” menu and select “stop”.
- 7 – Press “?<enter>” on the computer keyboard if desired to include the unit information in the log.
- 8 – Press “d<enter>” on the computer keyboard to start the download. The last data line will be followed by END.
- 9 – Close the log file as described in item 6.
- 10 – Press “cX<enter>” to clear the data log to make room for additional data logging if desired.
- 11 – If serial data was running, press “s1<return>” to turn it back on.

12 – Disconnect computer. The well sounder should resume sounding within 30 seconds, and if power save is active the unit should go back to sleep after the next log point.

## INTERPRETATION OF DATA

DATA QUERY - A simple <return> sent to the unit instructs the unit to send the current data set. Each data element is preceded by an upper case letter for the identity of the following number. A typical data line is as follow: data, time, D depth, other data, B battery voltage and the R error code. (see the error code section for codes).

Other data includes any enabled options which are reporting valid data. This may include the T probe temperature, X external temperature, and F flow.

Example:

WS2k >

2008/07/21 10:12:06 D 74.45 T 76.4 F 0.00 B 5.97 R 2

WS2k >

This indicates that the depth is 74.45 feet, the probe temp is 76.4 F, the flow is 0 gal, the battery voltage is 5.97, and the error code is 2 meaning that the battery voltage is below 6.5 volts.

SYSTEM STATE - A "?" command sent to the unit instructs the unit to send its current operating state. This will include 3 lines of data. The first line reports the model number and features, the software version, the unit serial number, and the user set ID number. The second and third lines report the applicable system settings prefixed by the commands used to set them as listed in the table in the section on external commands. In addition to the settings is the log memory state prefixed with "ls" and includes the number of log points in memory/ total number available. So in the following example 168 points have been used out of 14975.

Example:

WS2k > ?

Mod #WS1100-1023 Ver # 1018 Ser #080628015 ID #001

t2008/07/21 10:12:33 l0 lp15 lm 0.30 s0 r 700.00 o 0.00 p0 u0

ls 168/14975 a0 al 100.00 ah 100.00 w 60.5

WS2k >

In this example, "l0" indicates that logging is turned off, "lp15" indicates that the logging period is 15 minutes, and the well temperature is set to 60.5 degrees.

DATA DUMP - The "d" command instructs the unit to send the contents of the data log. The information is sent one data point per line and is formatted like the data query. Other data may be included in the log if it is enabled and contains valid data. The following example shows typical data with the date and time, from unit ID of 2. The depth is 300.23 feet, temperature is 75.2°F, total flow is 761.26 gallons, battery voltage is 8.06 volts, signal gain is 652, and there are no errors.

Example:

WS2k > d

Log Dump

```
2009/09/29 20:36:00 #002 D 300.23 T 75.2 F 761.26 B 8.06 G652 R 0
2009/09/29 20:37:01 #002 D 300.23 T 75.2 F 761.26 B 8.06 G652 R 0
2009/09/29 20:38:01 #002 D 300.23 T 75.2 F 761.26 B 8.06 G652 R 0
2009/09/29 20:39:00 #002 D 300.23 T 75.2 F 761.26 B 8.06 G652 R 0
2009/09/29 20:40:00 #002 D 300.23 T 75.2 F 761.26 B 8.06 G652 R 0
End
```

## FLOW METER OPTION

An optional accessory splitter is available for the Well Sounder to allow more than one device to be connected to the probe port such as the optional flow meter. The Eno Scientific flow meter comes with a plugged cable which can plug right into the splitter. Or by using the optional breakout adapter with screw terminals, it may be connected to any flow meter which provides a TTL level (0 or 5 volt) or switched output.

When the flow meter is enabled on the Well Sounder, the Well Sounder monitors the input for any change in voltage level and records a count for each level change. Caution: some flow meters output a full pulse for a count (i.e. the voltage goes from low to high and then back to low again). The Well Sounder will count this as two counts, and must be compensated for when setting the scale factor by adjusting it to half.

The scale factor is used to calculate how much flow has passed for each count. The Eno Scientific flow meters output full pulses and have scale factors like .0057 gallons per pulse for the 1" flow meter. So since the flow meter outputs full pulses the entered scale factor should be half of that or .00285 gallons per count. Once this is set, the Well Sounder will increase the total flow by .0057 gallons each time it receives a pulse. The total flow and flow rate can be observed on the display screen as the flow meter is running.

There are three ways to set the scale factor: using the keypad either automatic or manual, and using the remote programming through the RS232 port.

**AUTOMATIC** - by selecting automatic on the set screen after enabling the flow meter from the keypad, the following screen says "up to start". A self calibration routine is initiated when the user presses the UP button. The total flow is cleared, and the Well Sounder counts all pulses until the DOWN button is pressed. A new screen then asks the user to input the total amount of water pumped between the up and down button presses. When finished, press the ENTER button to calculate and store the new scale factor.

A typical calibration sequence is to point the pump output into an empty 5 gallon bucket with the pump off. Press the UP button to start, when the bucket is full, press the DOWN button. Set 5 gallons as the amount pumped and press ENTER. This procedure will also compensate for irregularities in the flow meter installation such as elbows or reducers in the line.

**MANUAL** - By selecting manual on the set screen after enabling the flow meter asks the user to input the scale factor in gallons per pulse (liters per pulse). Remember to

adjust the scale factor by half when full pulses are output from the flow meter. Press the DISP button to return operation and the UP or DOWN button to show the flow.

REMOTE - It is also possible to set the scale factor using the procedure described in the remote operation section, by typing "Fjnnnnnn" where nnnnnn is the scale factor, and then return.

## **ANALOG OUTPUT OPTION**

An optional accessory splitter is available for the Well Sounder to allow more than one device to be connected to the probe port such as the optional analog output adapter. The analog output adapter provides screw terminals to allow connection to the 0-5 volt alarm or analog output voltage, and two terminals for connection to the 4-20 ma output current. These outputs are only available in the 2010 PRO.

## **MAINTENANCE**

**BATTERIES** – The Well Sounder is powered by 6 internal AA batteries which are located in the battery compartment in the rear of the meter unit. The access door can be opened by removing the single screw in the middle of the unit. It is recommended that dead batteries be removed promptly to prevent damage from leaking batteries. Note when replacing the battery access door to install the stand hinge with the raised part going into the hinge cradle on the door.

**LITHIUM BATTERY** – There is also a lithium coin cell inside the unit to maintain the system clock and settings. This is a common type 2032 battery most local outlets. This battery typically lasts 2 years or more. If the unit powers up in the set date mode, this indicates that the battery needs replacing. This battery can be accessed by removing the 4 corner screws on the back of the unit. Then separate the case rear while the unit remains on the table face down to prevent the AA battery case from falling out. After replacing the battery, make sure that the battery wires are routed in the channel while replacing the case. Then replace the screws and tighten to snug being careful not to strip the screws.

## FREQUENTLY ASKED QUESTIONS

Q: Can I use the Well Sounder on an open well?

A: The Well Sounder was designed to work on a closed well. A simple piece of rigid card board or plastic held against the opening is enough to meet this requirement. In many cases it will work on the open well but may be off by a couple feet.

Q: Does the Well Sounder work on wells with the pump installed?

A: Yes. The sound pulse used for measuring is not disturbed by the presence on pump wiring or piping.

Q: What if there are guard rings or torque arresters on the pump line?

A: The Well Sounder will read past most guard rings and torque arresters with little signal attenuation. Some torque arresters may block more than 90% of the well opening and may cause problems.

Q: Will the Well Sounder work with the pump running?

A: Generally yes. If however the pump is exceptionally noisy and or the water level is near or below the pump, it is possible that the noise from the pump could interfere with the depth measurement.

Q: Does the Well Sounder work on larger diameter wells?

A: The Well Sounder with the standard probe works on wells up to 18" in diameter. However, as the well diameter increases, the signal strength weakens and becomes more susceptible to pump noise and imperfections in the well. It is recommended that on wells larger than 8" that a sounding tube be used.

Q: How deep will the Well Sounder measure?

A: The maximum range is 2000 feet for model 2010 and the 2010 PRO. This may not be achievable on all wells however. On a good 6" well with tight clean casing all the way down and little or no obstructions along the way, maximum range can be achieved. On uncased wells drilled through porous stone or with irregular walls, or any obstructions such as spacer rings or couplings the range will be reduced.

Q: Does the Well Sounder work in wells with perforated casing?

A: If the perforations are exposed (above the water line) and the exterior of the casing is very porous like crushed stone, then the perforations will dampen the sound pulse and there will be no reflection for the Well sounder to detect. In this case, the Well Sounder will track the descending water level until it gets to the perforations and then stick at the start of the exposed perforations as the water level continues to descend.

Q: Does the Well Sounder work in crooked wells?

A: Yes. The sound pulse used to measure the depth will even go around corners and obstructions which block less than 90% of the well opening.

Q: How long do the batteries last?

A: The Well Sounder will run continuously on its 6 AA batteries for approximately 80 hours, or up to 21 days using power save mode. There is also an internal lithium battery used only to maintain the time and date which typically last from one to two years.

Q: Will the log memory be lost if the batteries go dead?

A: No. The memory is stored in flash memory and is safe even without power.

Q: What happens when the log memory is full?

A: When the log memory is full, the sounder stops recording new data and preserves the first data points. The Well Sounder 2010 PRO will continue to record data in its extended data memory up to 2GB, and be accessible with the USB connection.

Q: Why does the unit need the time set when the power is turned on?

A: The lithium battery needs to be replaced. This is a common type 2032, 3 volt lithium coin cell. The unit will continue to operate without the lithium battery but the time and settings will have to be reset every time the power is turned on.

Q: What if the well contains a constant pressure pump system with the accumulator tank in the well?

A: The in well accumulators tend to block the well shaft entirely. If this is the case then the Well Sounder will be unable to find the distance to the water past the accumulator.

Q: Can the Well Sounder measure past a pit-less adapter?

A: Yes. The common side mount pit-less adapter typically does not block a significant portion of the well opening and will not interfere with the depth sensing. Some pit-less adapters, however, are recessed into the well and do block most of the opening. These installations may be more difficult. There are two ways to handle these cases: The probe can be lowered into the well and seated on the access hole through the pit-less adapter. A probe extension cable is available for this purpose.

Q: Can the Well Sounder be used on hand dug wells?

A: Hand dug wells are often fairly large and irregular, and as such may cause problems for the Well Sounder due to multiple or weak reflections. Some work and some do not. However, in any difficult to measure well, a small tube can be installed specifically for

measurement. A 3/4" PE pipe can be used for up to 1000' provided splicers do not restrict the ID.

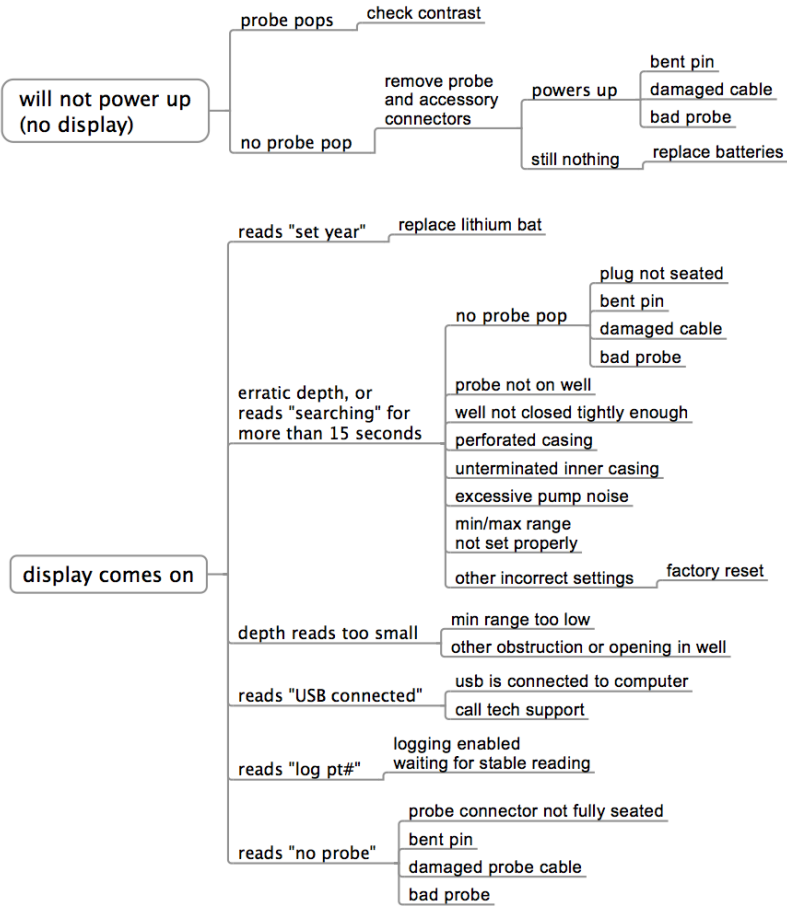
Q: Can I use the Well Sounder to measure the water level in a tank?

A: There are three issues here. First, the Well Sounder is designed to be used in a constant diameter pipe. Tank measurement is generally into a large opening which would create multiple reflections and hence an uncertain reading. Second, the minimum measurement distance is about 9 feet, so unless the sounder is mounted at least 9 feet from the maximum water level, it would not be useful. And third, the sensing probe is not designed for use with any pressure. Both sides of the probe must be maintained at atmosphere. This being said, it is possible to install the sounder on a sensing tube above the tank extending 10 feet above the maximum water level and down to the lowest level to be measured.

Q: My sounding tube is 3/4" PVC schd 80 with threaded couplings every 20ft. The Well sounder reads the depth at 20'. Why?

A: The pocket created at each joint is significant compared to the inside diameter of the PVC pipe, and therefore causes the pulse to reflect at each coupling. You will notice that if the min range is increased to 25ft, the depth will jump to 40ft. And when increased to 45ft, the depth will jump to 60ft etc. In many cases, after the pulse has passed the nearby stronger reflections, the stronger reflection from the water will dominate and the depth will jump up to the water level.

# TROUBLESHOOTING



## ERROR CODES

0	No error	
1	No probe	The unit does not see the temperature sensor in the probe.
2	Low Battery	The input voltage has dropped below 6.5V. The unit will continue to function properly until the voltage reaches about 5.4V. Once the battery voltage reaches 6.5V there is less than 10% battery life remaining
3	FP	An internal processor over run is occurring. May indicate an internal fault.
5	CC	An internal processor over run is occurring. May indicate an internal fault.
6	Log Full	Indicates that the internal log memory has been filled and no additional logging will be performed. The log memory must be cleared to continue.
7	RS232 over run	The command line reached the end of the buffer without identifying a command.
8	Probe Error	Indicates that the signal levels received from the probe are outside the normal range. This could be caused by a probe not installed in a well, excessive noise, or a wet or faulty probe.
9	Low Level Alarm	Indicates that the well water level has dropped below the low alarm set point. The alarm will continue until the level increases, the alarm is disabled, or the set point is changed.
10	High Level Alarm	Indicates that the well water level has increased above the high alarm set point. The alarm will continue until the level decreases, the alarm is disabled, or the set point is changed.
11	Low Signal Level	Indicates that the signal levels received from the probe are below the normal range. This could be caused by a probe not installed in a well, a blocked or wet microphone tube or a faulty probe.
12	High Signal Level	Indicates that the signal levels received from the probe are above the normal range. This could be caused by a probe not installed in a well, excessive noise, or a faulty probe.

# SPECIFICATIONS

## POWER:

External Power (optional): 5.5 to 12VDC at 50ma. Do not exceed 16V. Connector 5.5mm x 2.1mm center post positive. Internal Power: 6 AA Alkaline batteries. The unit will run continuously for approximately 80 hours on a set of batteries or up to 21 days in power saver mode.

Real time clock: Li Ion 3V battery CR2032.

## MEASUREMENT:

Resolution: .05 ft

Accuracy: .1 ft (see notes)

Range: 9 to 2000 feet. (see notes)

## LOGGING:

Memory: nonvolatile flash memory for approx 13,000 data points, settings, calibration and user data.

Additional memory (2010 PRO only) for over 28,000,000 data points.

Logging rates: 1 sec to 60 minutes per sample.

## ENVIRONMENTAL:

Temperature: -10 to 110 F

Humidity: 10 to 90% non-condensing.

## PHYSICAL:

Dimensions: 4x7.5x1.25"

Control Unit Weight: ~14 oz with batteries.

Probe Weight: ~5.5 oz.

## FEATURES:

Display: 2x16 character LCD

Temperature compensation: in probe

Serial Output: baud 300 – 57600, 8 data bits, one stop bit. (19200 baud default).

## INPUTS:

Acoustic probe

Flow meter input (with optional adapter) – TTL level transition counting.

Temperature sensor input

Serial port

## OUTPUTS:

Serial port

USB (2010 PRO only)

Analog 0-5 volt, 4-20 ma, 0 or 5 volt alarm (with optional adapter)

## ADDITIONAL NOTES

The specified accuracy is achieved provided certain conditions are met. Since the distance calculation is determined by timing the returned echo, it is important that a free path is available for the pulse to travel to the water surface and return. It is possible that an obstruction such as torque arrester or centering ring on a pump pipe can cause a premature echo or distort the pulse causing the effective pulse to shift one way or the other. It is also possible that a breakout or large fracture opening can also cause a false echo. Ordinary pump piping and wiring will not interfere with the measurements.

The accuracy is also dependent on the sound speed in the well. Since the sound speed is determined by the temperature, the average temperature must be specified correctly. The error is approximately  $.1\%/^{\circ}\text{F}$ .

The maximum range is limited by the maximum time during which the echo is monitored, and the strength of the echo signal. Uncased wells drilled through porous material can attenuate the signal faster than the rated distance, making detection impossible.

## WARRANTY AND SERVICE

Eno Scientific warrants to the user that all products manufactured by Eno Scientific, will be free from defects in workmanship and materials for 1 year from the date of shipment.

Eno Scientific warrants to repair or replace any such defective equipment or part (determined to our satisfaction to have a defect in workmanship or original material) upon receipt and inspection of such defective equipment to Eno Scientific with all shipping pre paid by the user.

In no event shall Eno Scientific be liable for any direct, indirect or consequential damages, abuse, acts of third parties (rental equipment), environmental conditions or other expenses which may arise in connection with such defective equipment. This warranty shall not apply to damage of equipment caused by incorrect installation, usage, lightning, storage, alteration or inadequate care.

This warranty does not apply to parts, assemblies or devices not manufactured by Eno Scientific which are covered by other manufacturers' warranties. There are no warranties except as specifically provided in writing herein.

Contact Eno Scientific with any warranty or service questions.

For additional information, please visit our website at [www.enoscientific.com](http://www.enoscientific.com).

