



**Well Watch 700
User Manual:
710 Controller/
730 Probe**



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WELL WATCH 700 USER MANUAL

TABLE OF CONTENTS

PRODUCT OVERVIEW.....	4
QUICK START GUIDE.....	5
CAUTIONS.....	7
BACKGROUND – HOW IT WORKS.....	9
INSTALLATION.....	11
SET UP.....	14
LOGGING.....	27
USB COMMUNICATIONS.....	28
ANALOG OUTPUT.....	28
RS232 COMMUNICATIONS.....	30
REMOTE SERIAL OPERATION OVER RS232.....	32
INTERPRETATION OF SERIAL DATA.....	34
MODBUS COMMUNICATIONS.....	34
MAINTENANCE.....	40
FREQUENTLY ASKED QUESTIONS.....	41
Appendix A: UPDATE RATES.....	43
Appendix B: BAUD RATES.....	44
SPECIFICATIONS.....	49
ADDITIONAL NOTES.....	50
WARRANTY AND SERVICE.....	51



PRODUCT OVERVIEW

The Well Watch 700 is a simple to use self-contained acoustic ranging instrument designed specifically to find the distance through a closed pipe (well casing or sounding tube as small as 1/2") from one closed end to the to the other. The Well Watch works by sending a low frequency sound pulse into the pipe, then measuring the time it takes for the echo to return from the opposite end, which could be a plug or water surface. The distance is calculated using the sound speed and the time. The low frequency sound can follow the pipe around corners and in any direction up/down or horizontally. It can be used to measure any closed pipe, straight or crooked with a constant diameter.

The Well Watch 700 consists of a model 710 control unit and a model 730 smart probe which are which are interconnected by a 4 conductor cable. The 710 controller contains the driver electronics, processor, data logger, display, and keypad, while the smart probe contains a second processor, drive electronics, speaker, a microphone and a threaded spout to connect to the test pipe.

When the unit powers on, it immediately begins sending sound pulses into the well and attempts to characterize the well. After a few seconds, the depth is calculated and output for the user. Data can be output in a variety of formats through the several outputs provided. The controller requires 12-36 vdc external power. The probe is powered by the controller through the 4 conductor interconnect cable.

QUICK START GUIDE

The Well Watch 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. **Mount Probe to Well.** Connect the threaded end of the probe to a well access port. A reducing bushing down to as little as 1/2" can be used if necessary, however it is better to use as big as possible up to 2". The probe is heavy and may require additional support if connected to the well with a small or flexible tube. The well casing must be closed for the Well Watch to perform correctly. (See Setup in the manual if this is an issue.)
2. **Mount Controller.** Mount the controller in a protected area. It is not weather proof. It can be mounted using the screw flange or to a DIN rail.
3. **Connect the Controller to the Probe.** It is recommended that 1/2" flexible liquid tight conduit be used between the probe and controller area to prevent damage and moisture intrusion. However, a moisture tight strain relief may also be used. Connect the four conductor cable between the probe and 4 probe terminals on the controller matching pin for pin.
4. **Connect Power to the controller.** Connect the power source to the Ext Pwr terminal and adjacent GND terminal. The unit requires 12 to 36 VDC at a peak load of 150 ma.
5. **Turn meter on.** Apply power to turn the meter on. You should see the display show the product name and hear a popping sound coming from the probe.
6. **Measure well.** After the unit characterizes the well, the measured depth will be displayed on the screen. If the measured distance is not as expected, then proceed to the next step to change the initial settings.
7. **Change initial settings.** Press the SET button once to enter the settings mode. Press the UP or DOWN button to scroll through the available settings. To change a setting, press ENTER to start the number flashing, press the UP or DOWN button to change as desired, then press ENTER to enter the new setting and stop the flashing. Press the UP or DOWN button to continue to

scroll through the other available settings. Press DISP at any time to return to read the measured depth. For best depth results, the **Range Min**, **Range Max**, and the **Well Temperature** should all be set.

- 8. Read other information.** While reading the depth display, press the UP or DOWN buttons to read other information.

We encourage you to read the frequently asked questions section. They really are frequently asked. Also, visit our website www.enoscientific.com for the latest manual and installation tips.

CAUTIONS

The Well Watch 710 Controller is not water proof!

The controller is designed to be housed in a weather proof shelter. A gasketed enclosure or well shelter are desired.

Sudden application of well pressure may damage the probe!

The 730 Probe was designed to be used on wells under pressure up to 100 psi. However, when first connecting the probe to pressure, allow pressure to build slowly (1 psi/second) would be desirable.

External power cannot exceed 36 volts DC!

When supplying external power to the Well Watch, 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 Watch 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 Watch. Over voltage and surge protectors and proper grounding should be used if this is a possibility.

FCC Warning Statement.

THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES. OPERATION IS SUBJECT TO THE FOLLOWING TWO CONDITIONS: (1) THIS DEVICE MAY NOT CAUSE HARMFUL INTERFERENCE, AND (2) THIS DEVICE MUST ACCEPT ANY INTERFERENCE RECEIVED, INCLUDING INTERFERENCE THAT MAY CAUSE UNDESIRE OPERATION.

NOTE: THE GRANTEE IS NOT RESPONSIBLE FOR ANY CHANGES OR MODIFICATIONS NOT EXPRESSLY APPROVED BY THE PARTY RESPONSIBLE FOR COMPLIANCE. SUCH MODIFICATIONS COULD VOID THE USER'S AUTHORITY TO OPERATE THE EQUIPMENT.

Industry Canada.

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.



BACKGROUND – HOW IT WORKS

The Well Watch 700 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 Watch sends its sound pulse, it listens for the pulse to return. Since sound travels at a predictable rate, the Well Watch can calculate 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 Watch 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 Watch. In this case, the Well Watch would lock in on the erroneous reflection and tell you that the water was at the end of the casing. The Well Watch 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 Watch 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 Watch increases its gain with time to listen for fainter signals. This can cause problems if the Well Watch 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 Watch how long to listen. If for example the pump is mounted at 200 feet, then there is no reason to set any more than 250 ft as a maximum range.

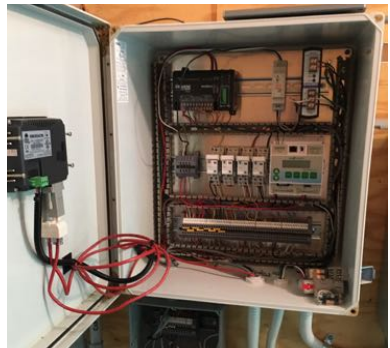
The strength of the sound pulse generated by the probe depends on how much space it needs to fill. A 12" pipe is 4 times larger than a 6" pipe in volume and therefore the pulse will be 4 times smaller. A weaker pulse becomes more susceptible to pump noise and loss with depth. While the Well Watch is 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 Watch 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.

INSTALLATION

1. **Mount Probe to Well.** Connect the threaded end of the probe to a well access port. A reducing bushing down to as little as 1/2" can be used if necessary, however it is better to use as big as possible up to 2". The well watch pushes air pressure waves into the well. It is therefore important that the connection to the well and top of the well be closed to air to prevent the air pressure from escaping and for the Well Watch to perform correctly. It is best to install the probe mostly vertical with the wire connection toward the lower side to prevent any water leakage past a poor seal. Also keep in mind that the probe is heavy and may require additional support if connected to the well with a small or flexible tube.

2. **Mount Controller.** Mount the controller in a protected area. It is not weather proof and will suffer damage if exposed to the elements. It can be mounted in any orientation using the screw flange or to a DIN rail where access to the keypad and visibility of the display can be achieved.



3. **Connect the Controller to the Probe.**



Four wires are required to connect the probe to the controller. Any gauge wire from #18 to #28 can be used. A 4 conductor direct bury cable is usually adequate, or if conduit is used ethernet wire is sufficient. 1/2" flexible liquid tight conduit is recommended between the probe and controller area to

prevent damage and moisture intrusion. However, a moisture tight strain relief with the direct bury cable may also be used. Connect the four conductor cable between the probe and 4 probe terminals on the controller matching pin for pin.

4. **Connect Power to the controller.** Connect the power source to the Ext Pwr terminal and adjacent GND terminal. The unit requires 12 to 36 VDC at a peak load of 150 ma. GND on the controller refers to the signal ground and power supply negative, not earth ground.

5. **Connect Outputs from the controller.** The controller offers several options for data and control outputs.

There are two independently programmable relay outputs which have a UL rating for 30 VDC, 2 A (resistive), or 110 VDC, 0.3 A (resistive) , or 125 VAC, 0.5 A (resistive). These outputs can be used for a remote alarm or control signal to a pump controller. The outputs are not sufficient to run a pump or possibly a contactor directly.



There are 3 available serial output options of which one can be software selected at a time. RS232, RS485 Modbus, and SDI-12.

RS232 – 3 wires are required to connect the RS232 port to another device such as a PC with a 9 pin D connector. The TX terminal on the well watch connects to pin 2 of the D connector, RX to pin 3, and GND to pin 5.

RS485 - 3 wires are required to connect the RS485 port to a Modbus bus. The A line, the B line, and the shield to the GND terminal.

SDI-12 - 2 wires are required to connect the SDI-12 port to an SDI-12 bus, the SDI-12 line, and the shield to the GND terminal.

There are 2 analog outputs, 0-5V and 4-20mA. These outputs are available concurrently and are independently programmable. The 0-5V output can source up to 15mA and requires and requires one wire for the output as well as a ground wire or common ground with the destination device.

The 4-20mA output acts as a throttle valve for an applied voltage and is isolated so that the device power can be used to power the current loop. In this case a jumper from the ext pwr terminal to 4-20mA+ will power the loop, and 4-20mA- will act as a source for output current to the target device. This also requires either a ground wire or common ground with the target device.

Last is the input for a pulsed flow meter. This input requires a signal wire and a ground wire. The input is designed to accept an input from a flow meter that provides either a switch closure or a TTL level pulse.

6. **Turn meter on.** Apply power to turn the meter on. You should see the display show the product name and hear a popping sound coming from the probe. The Well Watch is now ready to run.

SET UP

POWER ON: Apply power to start the Well Watch. 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.”



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.

The Well Watch has two different operating modes, DISPLAY mode and SET modes. The DISPLAY modes are accessed by pressing the DISP button, then the UP and DOWN keys cycle through the available display options. The SET modes are accessed by pressing the SET button, then the UP and DOWN keys cycle through the available setting options. When a parameter is shown, pressing the ENT key causes it to flash, during which time the UP and DOWN keys change the parameter. Press ENT again or BACK to stop the flashing and return to scrolling through the setting options.

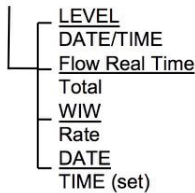
*The DISP key will always return the display to the first display option and the SET key will always return to the first setting option.

**If left on a set screen, the system will return to the first display screen automatically after 30 seconds of inactivity.

DISPLAY MODES

There are several DISPLAY options as follow:

DISPLAY



DEFAULT display screen which shows current water level with the time/date on the second line. 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 Watch 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. If there are any error conditions, such as when the probe is not on the well, or when the external power supply is low, an error message will alternately be displayed on the second line.

Flow Meter display screen if the flow meter is enabled, shows the current flow rate with the totalized flow on the second line. Pressing ENT while on this screen will reset the flow total to 0.

WIW display screen which shows the total reserve of water in the well with the rate of change on the second line. The WIW (water-in-well) is calculated using the set well diameter and the set depth of well. These settings are only used for this calculation. If the well depth is set to the level of the pump, the WIW number will be the number of usable gallons (liters) of water in the well.

TIME AND DATE display screen which shows the system time and date. Pressing ENT while on this screen allows the time and date to be set. Each time ENT is pressed, the next number will flash, showing which number is to be changed. Press BACK or DISP any time to return to normal operation.

SET MODES

Press the SET button at any time to select the first SET option then UP or DOWN to show the available settings. While viewing a SET screen, press the ENT key to select the value for change and cause it to flash. While the value flashes, press the UP or DOWN button to change the value. Rapid scrolling is activated by holding the up or down button for about a second. Scrolling gets faster and faster while the button is held down. The button can be released briefly then repressed to resume change at the high speed. If the button is released, the scroll rate will be decreased at the same rate that it increased. When the value is as desired, press the ENT or BACK button to allow scrolling to the other settings or press the DISP button to return to normal operation. The new settings are saved automatically as they are changed so there is no need to press ENTER.

There are several setting options as follow:



SYSTEM INFO – Displays the controller product type, configuration and the software version number. Press the ENT button to cycle through the controller serial number, the probe configuration, and the probe serial number. The reported information for the probe will be all zeros if the controller is not communicating with the probe. Press ENT or BACK to return to scroll settings.

PROBE SETTINGS – Displays and changes the settings for the probe. Press ENT to cycle through the available probe settings or BACK to return to scroll through other setting groups.

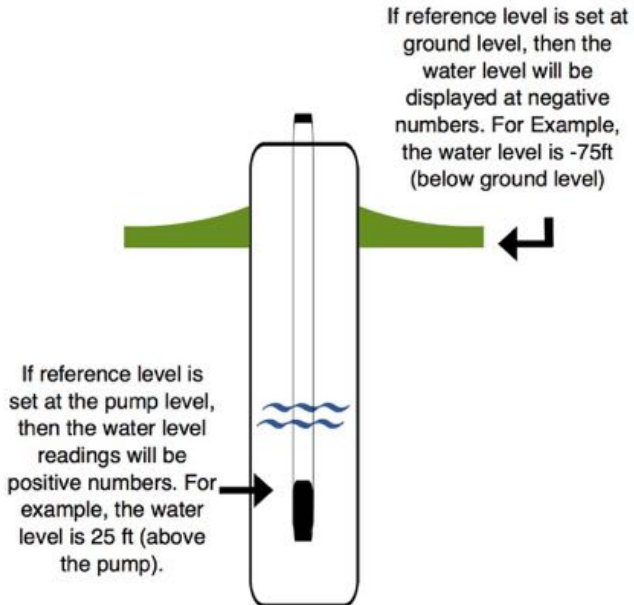
UNIT ID – Sets a user selectable ID number in the range 0-255 to identify the source of logged data. The default is 0.

UPDATE RATE – Selects the time interval for sounding by the probe. Setting to 0 causes continuous sounding. The default is 0.

LEVEL MAX – Sets the highest level (with respect to the probe level) at which the Well Watch will start looking for the surface of the water. 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 50 feet or more to ignore this erroneous reflection.

LEVEL MIN – Sets the lowest level (with respect to the probe level) at which the Well Watch will continue to look for the surface of the water. 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. This should be set just beyond the lowest level expected.

REFERENCE LEVEL – THIS IS IMPORTANT! All depth measurements by the Well Watch will be displayed with reference to this reference level. Positive numbers are higher than the reference level into the sky, and negative numbers are below the reference level into the earth. The default reference level is 0, meaning that all reported depths are from the Well Watch. It is common to set the reference level to the level of the pump (for example -550ft), so that numbers will be positive feet (meters) above the pump. When this number is changed all other settings and readouts will be changed accordingly.



AUTOCAL – Autocal automatically searches for and sets the best probe configuration to compensate for irregularities due to the physical configuration of the well and probe installation. Press UP to start. The Well Watch will generate a series of pulses to characterize the well, then set the internal pulse parameters to optimize the response. This operation should be performed on installation or after a factory reset.

WELL SETTINGS - Displays and changes the settings for the well. Press ENT to cycle through the available probe settings or BACK to return to scroll through other setting groups.

WELL TEMP – Sets the average air temperature in the well. If you do not know the well temperature, reference the Water Temperature chart below. It is also usually very close to the water temperature. This temperature is used

to calculate the sound speed and in turn, the distance. The distance error is fairly small for variations in temperature, about 1% (1 ft per 100 ft) for a 10 °F (5.6 °C) temperature error.

SOUND TUBE – Sets the diameter of a tube used to carry the sound pulse to the water. Small diameter (less than 2") tend to reduce the sound speed. At 1/2" diameter it is approximately 2% less, which results in approximately 2' per 100'. This setting corrects for this error.

METHANE – Sets the methane concentration % in the well. The speed of sound in methane is nearly 40% higher than in air, so the unadjusted measured distance will appear much less than actual with a significant amount of methane in the well. This setting corrects for this error.

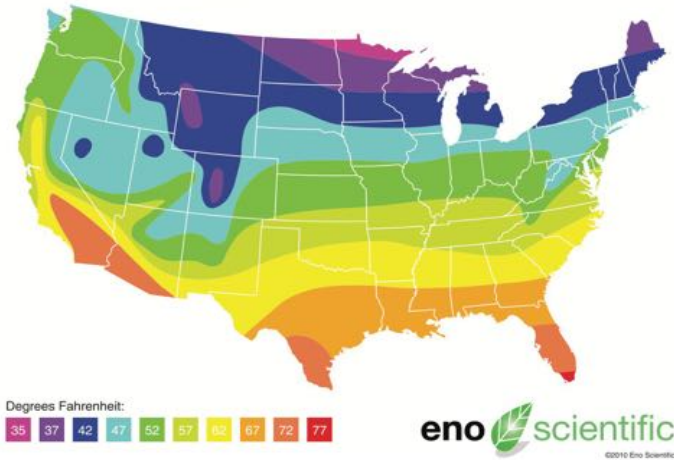
WELL DIAMETER – Sets the diameter of the well casing. This setting is used exclusively to calculate the amount of water in the well. It does not effect the measurement.

WELL DEPTH – Sets the depth of the well (with respect to the probe level). This setting is used exclusively to calculate the amount of water in the well. It does not effect the measurement. This is usually set to the level of the pump so that the WIW display indicates the amount of useable water in the well.

FLOW METER – Enables the flow meter functions in software if the flow meter input is being used. Press ENT to enable the flow meter. Press enter again to set the scale factor for the flow meter in gal/pulse (liters/pulse). Press ENT again or BACK to return to setting scroll mode.

LOGGING – Enables the logging features of the Well Watch. When logging is enabled, The Well Watch schedules the next periodic log point to align with the system clock so all log periods will result with a point on the hour. When the next scheduled time arrives, a message is displayed on the error line and remains until valid data is recorded. Logged data is stored in the SD memory card and is appended to a data file named WSLOGxxx.txt, where xxx is the 3 digit well ID set earlier.

Groundwater Temperature Map



****LOG RATE** – Sets the time interval in minutes between logged data points. This setting is available if logging is ENABLED. Every measurement is recorded if it is set to zero.

ETHERNET – Ethernet communications are enabled by pressing ENT on the ethernet screen and selecting enabled. This powers up the ethernet drivers and allows access to the controllers internal variables by MODBUS as well as serve a webpage to any web browser on port 80. Press enter to cycle through the settings available for the ethernet setup. Currently the web server is very limited, but this will be expanded in future firmware releases. MODBUS information can be accessed using the format described in the MODBUS section.

SERIAL COMMUNICATIONS – Selects the type of serial communications to be used and the parameters for the selected option. Even though there are 3 sets of serial communications terminals on the controller, only one can be used at a time.

SERIAL COMM – Press ENT to select RS232, RS485 Modbus, SDI-12 or none. (NOTE: SDI-12 IS NOT AVAILABLE AT THIS TIME)

RS232 DATA – enables the transmission of current data over the RS232 connection. This feature is used when the Well Watch is used with a remote readout or data transmission system such as SCADA or a PC. Press the ENT to change the setting, then UP or DOWN button to select: Off, Continuous, Depth only. When set to Continuous, a data line for every measurement is sent over the serial port automatically. Transmitted data includes all measured data, as well as the error code. When Depth Only is selected, only the depth is included in the data. Select Off to disable automatic data transmission, but retain the ability to program the unit remotely or request data. (See the section on serial communication for details)

RS232 UPDATE – if advanced scheduling is enabled allows reporting of serial data to be scheduled independently of the system update time.

RS232 SETUP – if RS232 is selected, sets the serial port parameters. The default is 19,200 baud, 8 data bits, 1 stop bit, and no parity. Press ENT to cycle through the various parameters. Then ENT again or BACK to return to settings scroll mode.

RS485 MODBUS DATA – if RS485 is selected, sets MODBUS parameters for transmission of data over the RS485 connection. Two modes are available: RTU (default) or ASCII.

RS485 SETUP – if RS485 is selected, sets the serial port parameters for RS485 communications. The default is 9,600 baud, 8 data bits, 1 stop bit, and no parity. Press ENT to cycle through the various parameters. Then ENT again or BACK to return to settings scroll mode.

MODBUS ADDRESS – if RS485 is selected, sets the MODBUS address. This is the address which will identify the Well Watch on the Modbus bus, which can be any unused address on the bus from 1 to 247.

ANALOG OUTPUT –

0-5V OUTPUT – Sets the depths with respect to the reference level at which the outputs will be 0V and 5V.
Choose: OFF

ENABLE: 0V@__ft/ 5V@__ft

4-20MA OUTPUT – Sets the depths with respect to the reference level at which the outputs will be 4mA and 20mA.

Choose: OFF

ENABLE: 4mA@__ft/ 20mA@__ft

ALARM OUTPUT – Enables the alarm output relay. The output contacts are normally open, activating the alarm closes the contacts.

The alarm relay can be configured as one of the following options:

OFF: Keeps the contacts open

LOW: (D<__ft) Closes the contacts when the water level reaches below the low set point

HIGH: (D>__ft) Closes the contacts when the water level reaches above the high set point

HIGH/LOW: (D<__ft/ D>__ft) Closes the contacts when either the high or low alarm conditions are met.

FORCE OFF: Keeps the contacts locked open

FORCE ON: Keeps the contacts locked closed

ALARM HIGH ON – available if the high alarm is enabled, sets the high level with respect to the reference level at which the alarm contacts will close. So for example, if Alarm High is selected and the high set point is set to -150, then the alarm contacts will close when the level rises above -150 ft and open otherwise.

ALARM LOW ON – available if the low alarm is enabled, sets the low (deep) level with respect to the reference level at which the alarm contacts will close. So for example, if Alarm LOW is selected and the low set point is set to -650, then the alarm contacts will close when the level drops below -650 ft and open otherwise.

AUX OUTPUT– enables the auxiliary output relay. The output contacts are normally open, activating the aux output closes the contacts. The aux relay output works differently than the alarm output. The aux relay contacts close if the water level rises above the high set point and opens when the level drops below the low set point. This would be appropriate for controlling a pump to maintain a water level.

The aux output can be configured as one of the following options:

OFF: Keeps the contacts open

AUTO: AUX OFF- (Level D<__ft)

AUX ON- (Level D>__ft)

FORCE OFF: Keeps the contacts locked open

FORCE ON: Keeps the contacts locked closed

AUX OFF LEVEL – available if the aux output is enabled, sets the low (deep) level with respect to the reference level at which the aux contacts will open. So for example, if the Aux low set point is set to -650, then the aux contacts will open when the level drops below -650 ft. Once opened, the contacts will not close again until the level rises above the ON level.

AUX ON LEVEL – available if the aux output is enabled, sets the high level with respect to the reference level at which the aux contacts will close. So for example, if Aux High set point is set to -150, then the aux contacts will close when the level rises above -150 ft. Once closed, they will remain closed until the level drops below the OFF level.

OUTPUT TEST – The output test function is provided to verify the operation of the analog, alarm and aux outputs. Press enter when Output Test is shown on the display. The display will show a flashing depth display which will be used to control the outputs. While flashing, the outputs will behave as if the actual measured depth was as displayed. Press enter again to return to normal operation. This would be helpful for example to verify the proper wiring and programmed turn-on and turn-off points for the pump control function of the Aux Output.

SYSTEM SETTINGS

UNITS – selects the measurement system for the data.

The following options are available:

English ft-in for distance displayed as feet and inches;

English for decimal feet, degrees Fahrenheit and gallons;

Imperial for feet, degrees Fahrenheit and imperial gallons.

Metric for meters, degrees Celsius, and liters, or

DISPLAY DEPTH AS – Chooses to display measured depth as a level (where depth is reported as a negative number), or as a depth (where it is displayed as a positive number).

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.

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

FACTORY RESET – allows the user return the unit to the factory default configuration. Press the ENT button to make the selection. All user settings will be set to the Factory default values.

FIRMWARE UPDATE – The 710 controller has the ability to update the firmware in either the controller or the probe using an update file loaded onto the SD memory card on the 710 controller. This requires that the loader program Cbootldr.bin and the update file WS71xxxx.bin for the controller or WS73xxxx.bin (where xxxx is the firmware version number) be loaded on the SD card. This can be done using the USB cable or by removing the SD card and a card reader with a computer or smart phone. The update files will be available from Eno Scientific.

DESTINATION – selects the device to update. Either the 710 controller or the 730 probe.

FILE – selects the available update files for the selected device. This also allows restoring an older version in case a problem was found.

START – Are you sure? This process cannot be interrupted once started. Updating the controller only takes a couple of seconds. The probe update takes about 15 seconds and will show a progress bar as it completes. CAUTION: If there is an interruption while updating the controller, from an intermittent power connection for example, the controller may become unusable and require reflashing by Eno Scientific.

DIAGNOSTICS – allows the user to display and perform some diagnostic functions.

Last update – showing D for the last reported depth without filtering, BC for the number of bad readings since a good one, F is the strength of the outgoing pulse, E is the strength of the returning pulse, N is the level of background noise. The signal strength numbers refer to the amplifier gain where 150 represents a strong signal and 300 is very weak.

Probe Codes – show actual uncompensated depth reported by the probe and 32 bits of information, each screen segment represents a bit and will be a '.' if normal or a letter if the condition exists. These are not all error codes but also represent for example signals within certain strength bands. (see the section on error codes for an explanation)

Probe Status – show 32 bits of information, each screen segment represents a bit and will be a '.' if normal or a letter if the condition exists. These are not all error codes but also represent for example signals within certain strength bands. (see the section on error codes for an explanation)

Controller – shows the measured controller board temperature and the input voltage.

Probe – shows the measured probe board temperature and the probe driver voltage before and after a pulse.

Error codes – press ENT to scroll through the current controller internal error codes (for factory diagnostics).

Log Raw Data – allows the user to record internal diagnostics with raw data from the well for factory analysis. This data file is recorded to the SD memory card with the name: WSRAWxxx.txt, where xxx is a sequential number assigned automatically. Press ENT to initiate, then watch the % complete bar scroll to completion. This should be done 2 to 3 times in problem situations and emailed to Eno Scientific for analysis.

LOGGING

The Well Watch 710 controller includes a built-in data logger which can record the measurement data automatically at preset intervals when automatic logging is enabled. Each data point includes the system time and date, well ID, depth, temperature, battery voltage, signal strength, and error codes. The data is recorded in the SD memory which maintains the data even if the battery goes dead. This memory is only accessible using the USB interface as described in the next section or by removing the SD card and using an external reader.

To automatically log data on a schedule, press the SET button then scroll to the logging screen. Press ENT to select the option for change, then the UP or DOWN button until the second display line reads ENABLED. Press the ENT button again or BACK to return to the setting scroll mode. When enabled every time the Well Watch takes a new reading, it will be recorded in the log. If advanced scheduling is enabled, press UP to show the log period screen. Press the UP button to set the log interval in minutes. If the log period is set to 2 minutes, the Well Watch 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. Logging intervals are available from every reading up to every 24 hours. (For available rates, see Appendix A)

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 Watch. A new file will be created automatically if the same ID is used.

The log data is formatted as follows:

```
2018/04/20 18:26:02 D-566.23 T 88.5/81.8 B23.5/11.4/11.2 G171/199/300 N001 R0005/F04000
2018/04/20 18:26:04 D-566.23 T 88.5/81.8 B23.5/11.5/11.2 G171/199/300 N002 R0001/F04000
2018/04/20 18:26:06 D-566.12 T 88.5/81.6 B23.5/11.4/11.2 G171/199/240 N002 R0001/F24000
2018/04/20 18:26:07 D-566.01 T 88.5/81.4 B23.5/11.4/11.2 G171/199/300 N002 R0001/F24000
```

The interpretation of this data is as follows:

Data – year/month/day

Time – hour:min:sec

Depth – in feet (meters) with respect to the reference level

Temperature – controller temp/probe temp

Battery Voltage – controller ext pwr/probe cap before pulse/probe cap after pulse
Gain – outgoing pulse/return pulse/noise
Noise level – index
Error codes – (see appendix)

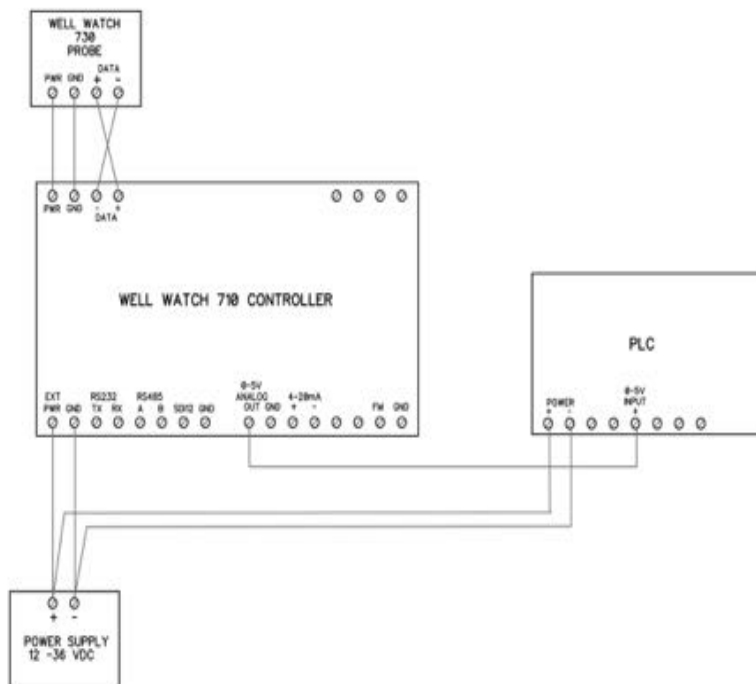
USB COMMUNICATIONS

The Well Watch 710 contains an expanded memory which 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 Watch is connected to a computer with a USB cable, the computer will identify the Well Watch as a mass storage device and show the available files in an explorer window which can be copied directly to a directory on the computer and deleted from the Well Watch. This can be used to load firmware update files onto the SD card or to download log files or raw data diagnostic files. Other Well Watch functions are disabled while accessing the SD card through the USB port.

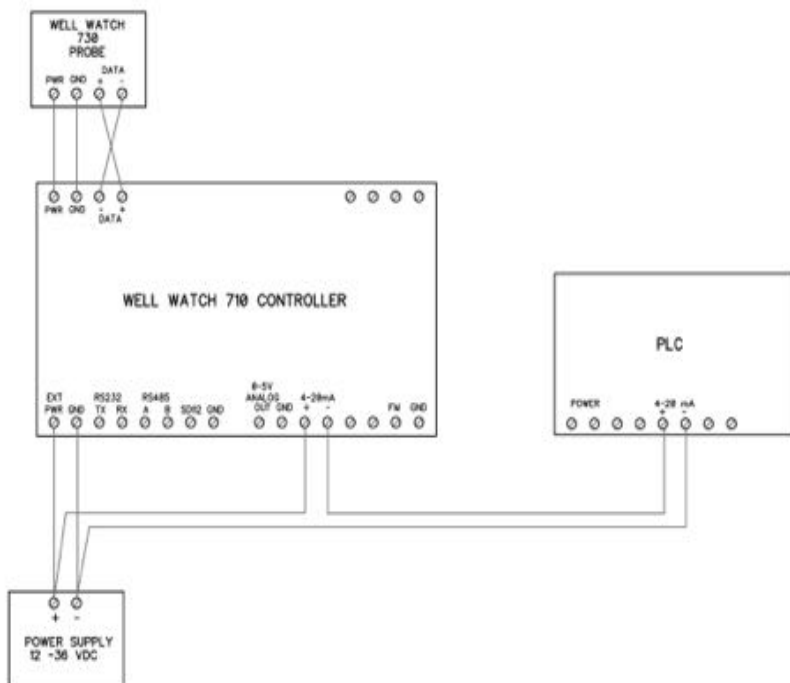
ANALOG OUTPUT

The Well Watch comes standard with 0-5 volt and 4-20 ma analog outputs. The 0-5 volt and the 4-20 ma outputs are independent and can be used simultaneously with separate ranges. The output range is set by the user by selecting the Analog depth @0v (@4ma) and the Analog depth @5v (@20ma). The voltage will then vary monotonically over this range and may be increasing or decreasing depending on the order of the limits set.

The 0-5 volt output supplies an output voltage with respect to the common controller power supply ground and can supply a maximum of 15ma. The following diagram shows a typical setup.



The 4-20 ma output is an optically isolated current regulator for a supply voltage up to 36 v supplied externally. The loop power does not require an isolated supply and can use same power source feeding the 710 controller. The Well Watch external power can be jumped to the +4-20 terminal to allow the -4-20 terminal to source 4-20mA. This can be done provided the destination device uses a common ground, otherwise a return ground must be provided. The following diagram shows a typical setup.

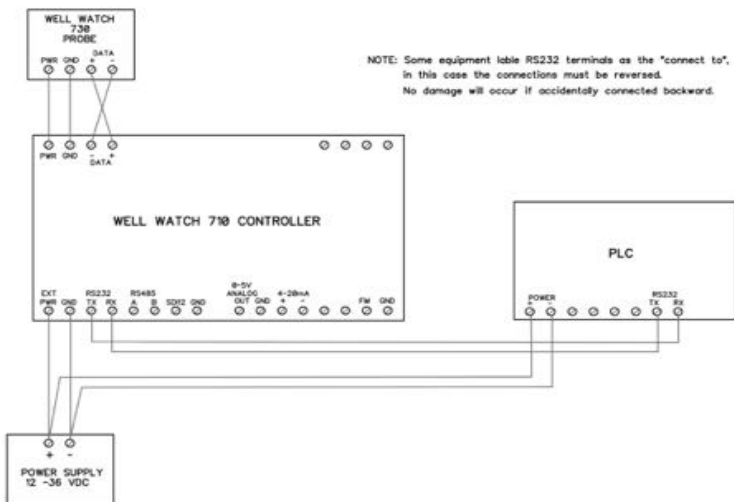


RS232 COMMUNICATIONS

The Well Watch offers a standard serial communications port for connection to a computer or remote device such as a SCADA system or remote readout. To connect to a standard device such as a PC with a standard 9 pin D connector, only 3 wires are necessary. The TX terminal on the well watch goes to pin 2 on the D connector, RX goes to pin 3 and GND goes to pin 5. 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 Watch is 19200 baud, 8 data bits, 1 stop bit, no parity, and no flow control. These settings can be changed from the set screen on the keypad.

The serial port is bi-directional and allows communication from the Well Watch to the remote device and back. This allows the Well Watch to be programmed and operated from a remote location. The Well Watch offers a complete command set over the serial link to allow configuring the Well Watch settings. A standard terminal emulator program such as HyperTerminal (included with windows) or Tera Term Pro (available for free download from <http://www.logmett.com>) can be used from a computer to operate the Well Watch remotely (see the section on remote operation).

The Well Watch can also be instructed to automatically transmit new data over the serial port as it is generated. To activate this feature from the keypad, select RS232 on



the serial comm screen, then select continuous or depth only on the RS232 screen. When set to continuous, the complete data set is transmitted with each pulse. When set to depth only, only the depth is transmitted.

REMOTE SERIAL OPERATION OVER RS232

When the Well Watch is connected to a computer or other bi-directional remote device, the Well Watch can be controlled and configured using a set of simple commands.

If using a terminal emulator on the computer, establish a connection with the Well Watch by selecting the COM port connected to the Well Watch. If your computer has a built-in com port, it will probably be COM1. If you are using a USB adapter it may be any where from COM3 thru COM12. Then enter the port settings: 19200 baud, 8 data bits, parity none, 1 stop bit, and flow control none. Turn on the Well Watch and press the <return> key on your computer. If it is set up correctly, the Well Watch will return with a line of data and a WS2k> prompt on the screen. If the Well Watch does not respond, select a different COM port and try again.

Once the connection has been established, commands can be send from the computer to the Well Watch. 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 "m30<return>" to set the min range to 30 feet.

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

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 "cs0<return>" to turn off serial reporting and "cs1<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), [ddddd] indicates up to 5 character decimal number (decimal point optional), [cc] indicates two nonnumeric characters, and <ret> indicates a return.

<ret>	send current data line
a[i] <ret>	alarm 0=off 1=low 2=hi 3=both
ah[dddddd] <ret>	set high alarm level
al[dddddd] <ret>	set low alarm level
b[iiiii] <ret>	display modbus addr
d[i] <ret>	depth polarity 0=negative, 1=positive
ff[i] <ret>	flow meter 0=off 1=enable
fa[ddddddd] <ret>	flow meter scale factor
ft[iiiiiiiii] <ret>	flow meter total
h <ret>	display command list
i[iii] <ret>	set unit ID
l[i] <ret>	logging 0=off 1=on
lu[ii] <ret>	log rate index
n[i] <ret>	0-5v output 0=off 1=enable
nh[dddddd] <ret>	set 0-5v output level @0v
nl[dddddd] <ret>	set 0-5v output level @5v
m[i] <ret>	4-20ma output 0=off 1=enable
mh[dddddd] <ret>	set 4-20ma output level @4ma
ml[dddddd] <ret>	set 4-20ma output level @20ma
p[i] <ret>	probe enable 0=off 1=on
pu[ii] <ret>	set probe update rate index
rn[dddddd] <ret>	set range min
rx[dddddd] <ret>	set range max
ro[dddddd] <ret>	set reference level
s[i] <ret>	set serial mode 0=off 1=RS232 2=RS485 3=SDI12
sd[i] <ret>	select RS232 data 0=off, 1=continuous, 2=depth
su[ii] <ret>	set the data update rate index
tm[hh:mm:ss] <ret>	set time
td[yy/mm/dd] <ret>	set date
u[i] <ret>	set units 0=eng ft, 1=eng ft in, 2=metric, 3=imperial
wd[dddddd] <ret>	set well depth
wi[dddddd] <ret>	set well diam
wm[iii] <ret>	set methane %
ws[dddddd] <ret>	set sound tube
wt[dddddd] <ret>	set well temp
x[i] <ret>	aux output 0=off 1=enable
xh[dddddd] <ret>	aux output high level
xl[dddddd] <ret>	aux output low level
?<return>	send a list of the current settings

INTERPRETATION OF SERIAL 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, unit ID, D depth, board temp for the controller and probe, B battery voltage for the controller, probe high and low, signal gains, noise level, and the R error codes. (see the error code section for codes).

Example:

```
WW712>
```

```
>>2018/10/15 18:56:51 #000 D -100.1 T 85.8/ 89.3 B12.1/11.4/11.3 G162/202/000 N000 R0001/700000  
WW712> ?
```

This indicates that the depth is -100.1 feet, the probe temp is 89.3 F, and the battery voltage is 12.1 volts.

SYSTEM STATE - A "?" command sent to the unit instructs the unit to send its current operating state. This will include 8 lines of data. The first 2 lines reports the model number and features, the software version, the unit serial number, and the user set ID number for both the controller and the probe. The following 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.

Example:

```
?>2018/10/15 18:56:59
```

```
Contr #WW712- 0-0FFBFF Ver # 7100-046 Ser #000001025 ID #000
```

```
Probe #WW730- 0-077003 Ver # 7300-046 Ser #000001036 ID #000
```

```
u0 d0 Ps0 p1 pu 1 l0 lu 0 s1 sd 0 su 0 f0 fa 0.01000 fb 0.00000 ft 0
```

```
rx -1000.0 m -25.0 ro 0. wd -500.0 wi 18.00 in wm 0 ws 2.00 in wt 60.5
```

```
a3 al -500.0 ah -10.0 x0 xl -500.0 xh -10.0
```

```
n1 nh 0.0 nl -500.0 m1 nh 0.0 nl -500.0
```

```
ACm0080 pt01 pg1-0.10 pg2 0.05 p1082 p2082 md 00 rc0.60 Bs0.03540 Ta1.02214 Tb 77.0
```

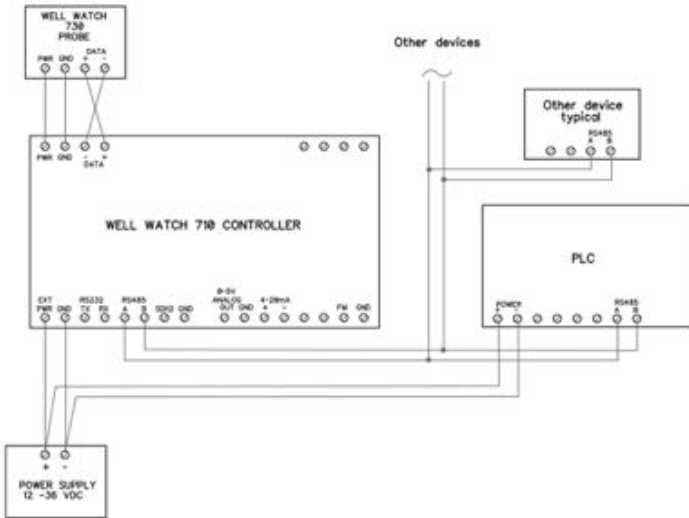
```
WW710 >
```

In this example, "rn" indicates that the min range is -25.0, and the well temperature is set to 60.5 degrees, etc.

MODBUS COMMUNICATIONS

The RS485 port on the Well Watch is configured to communicate as a slave device on a two wire Modbus bus. When the RS485 Modbus port is enabled, the Well Watch becomes a Modbus slave device listening for data requests from a Modbus master device using either RTU or ASCII mode. Data requests with the address set in the Well Watch will be processed and a data packet containing the requested data will be sent back to the master.

The Well Watch can be configured for a Modbus network by setting the Serial mode to RS485. Then select the Modbus mode, either RTU or ASCII. Then set the serial settings, the baud rate, number of data bits, stop bits and the parity. Scroll the setting once more to set the MODBUS address for the Well Watch. This can be any number from 1 to 243 which has not been used by any other device on the network.



By default, the Well Watch is set to the most typical settings:
 9600 baud, 8,1,even
 RTU mode
 address 011

WS710 Modbus Addressing:

All registers are internally 32 bits wide, accessed through modbus as 16 bit words. 2 registers are required for a complete read or write. Therefore each 32 bit register is addressed as all even numbers. Address numbers require the addition of 1 to 4 thousand to define the formatting of the data. Addition of 1000 sends data high byte of the high word first to low byte of the low word last. Addition of 2000 swaps words, 3000 swaps bytes of each word, and 4000 swaps both. So for example if registers 20 and 21 contained A B, and C D respectively, then:

- address 1020 would send A B C D
- address 2020 would send C D A B
- address 3020 would send B A D C
- address 4020 would send D C B A

ADDR	ACCESS	TYPE	DESCRIPTION
0	R/O	Flo32	depth adjusted for reference level
2	R/O	Flo32	depth running average
4	R/O	Flo32	last good logged distance
6	R/O	Int32U	count bad readings since last good dist
8	R/O	Int32S	quality factor for current reading
10	R/O	Flo32	slope of short line fit
12	R/O	Flo32	intercept of short line fit
14	R/O	Flo32	error from short line fit
16	R/O	Flo32	slope of long line fit
18	R/O	Flo32	intercept of long line fit
20	R/O	Flo32	error from long line fit
22	R/O	Flo32	probe bat voltage high
24	R/O	Flo32	probe bat voltage low
26	R/O	Flo32	probe temperature

28	R/O	Flo32	probe reported depth
30	R/O	Int32U	amp gain fingerprint
32	R/O	Int32U	amp gain echo
34	R/O	Int32U	amp gain for max noise
36	R/O	Int32U	probe noise level as % of signal max
38	R/O	Int32U	probe error codes
40	R/O	Int32U	system error code
42	R/O	Flo32	controller battery voltage
44	R/O	Flo32	controller temperature 1
46	R/O	Flo32	flow total
48	R/O	Flo32	flow rate from flow meter G/S
50	R/O	Flo32	calculated water in well
52	R/O	Flo32	calculated rate of change of water in well
54	R/O	Int32U	system time packed
56	R/O	Int32U	system date packed
58	R/W	Int32U	system seconds
60	R/W	Int32U	system minutes
62	R/W	Int32U	system hours
64	R/W	Int32U	system days
66	R/W	Int32U	system months
68	R/W	Int32U	system years
70	R/O	Int32U	time of last good reading
72	R/O	Int32U	number of good readings
100	R/O	Int32U	controller type
102	R/O	Int32U	software version
104	R/O	Int32U	software build number
106	R/O	Int32U	build parameters
108	R/O	Int32U	product features
110	R/O	Int32U	unit serial number
112	R/W	Int32U	unit ID
114	R/O	Int32U	probe type
116	R/O	Int32U	probe software version
118	R/O	Int32U	probe software build number
120	R/O	Int32U	probe build parameters
122	R/O	Int32U	probe product features
124	R/O	Int32U	probe unit serial number

126	R/W	Int32U	probe unit ID
128	R/W	Int32U	power save mode
130	R/O	Int32U	enable and next turn on time for probe
132	R/W	Int32U	english=0; metric=1
134	R/W	Flo32	max range (min level)
136	R/W	Flo32	min range (max level)
138	R/W	Flo32	depth of well
140	R/W	Flo32	diameter of well
142	R/W	Flo32	reference level
144	R/W	Flo32	well temperature
146	R/W	Int32U	methane concentration %
148	R/W	Flo32	sounding tube diameter
150	R/W	Int32U	type of autocal bit field (see prb_mode_enum)
152	R/O	Int32U	type of operation bit field (see prb_mode_enum)
154	R/W	Int32U	pulse type 0,1
156	R/W	Flo32	pulse volume -1.00 - +1.00
158	R/W	Flo32	not used
160	R/W	Int32U	pulse duration * .1ms
162	R/W	Int32U	not used
164	R/W	Int32S	lag from spkr to mic * .1ms
166	R/W	Flo32	Internal reflection coef -1.00 - +1.00
168	R/W	Int32U	alarm 0-off, 1-low, 2-high, 3-high&low, 4-force off, 5-force on
170	R/W	Flo32	high alarm setpoint
172	R/W	Flo32	low alarm setpoint
174	R/W	Int32U	auxout 0-off, 1-on, 2-force off, 3-force on
176	R/W	Flo32	high auxout setpoint
178	R/W	Flo32	low auxout setpoint
180	R/W	Flo32	analog_v enable 0-off, 1-on
182	R/W	Flo32	0v analog setpoint
184	R/W	Flo32	5v analog setpoint
186	R/W	Flo32	analog_ma enable 0-off, 1-on
188	R/W	Flo32	4ma analog setpoint
190	R/W	Flo32	20ma analog setpoint
192	R/W	Int32U	probe enable
194	R/W	Int32U	probe interval minutes
196	R/W	Int32U	logging enable
198	R/W	Int32U	logging interval minutes
200	R/W	Int32U	serial enable 0-off, 1-rs232, 2-rs485, 3-sdi12
202	R/W	Int32U	serial interval minutes

204	R/W	Int32U	flow meter enable
206	R/W	Flo32	scale factor for flow meter
208	R/W	Flo32	offset for flow meter
210	R/W	Int32U	flow accumulator
212	R/W	Flo32	battery voltage scale factor
214	R/W	Flo32	scale factor for thermistor
216	R/W	Flo32	offset for thermistor
218	R/W	Int32U	zero level for analog output
220	R/W	Int32U	max level for analog output
222	R/W	Int32U	packed rs232 config
224	R/W	Int32U	rs232 mode
226	R/W	Int32U	rs232 baud rate index (see appendix)
228	R/W	Int32U	rs232 data bits
230	R/W	Int32U	rs232 stop bits
232	R/W	Int32U	rs232 parity enable
234	R/W	Int32U	rs232 parity
236	R/W	Int32U	packed rs485 config
238	R/W	Int32U	rs485 mode
240	R/W	Int32U	rs485 baud rate index (see appendix)
242	R/W	Int32U	rs485 data bits
244	R/W	Int32U	rs485 stop bits
246	R/W	Int32U	rs485 parity enable
248	R/W	Int32U	rs485 parity
250	R/W	Int32U	modbus address
252	R/W	Int32U	modbus mode
254	R/O	Int32U	FM input state
256	R/W	Int32U	0
258	R/W	Int32U	0
260	R/W	Int32U	local ip addr 1
262	R/W	Int32U	local ip addr 2
264	R/W	Int32U	local ip addr 3
266	R/W	Int32U	local ip addr 4
268	R/W	Int32U	gateway ip addr 1
270	R/W	Int32U	gateway ip addr 2
272	R/W	Int32U	gateway ip addr 3
274	R/W	Int32U	gateway ip addr 4
276	R/W	Int32U	ip mask 1
278	R/W	Int32U	ip mask 2
280	R/W	Int32U	ip mask 3

282	R/W	Int32U	ip mask 4
284	R/W	Int32U	mac address 1
286	R/W	Int32U	mac address 2
288	R/W	Int32U	mac address 3
290	R/W	Int32U	mac address 4
292	R/W	Int32U	mac address 5
294	R/W	Int32U	mac address 6
296	R/W	Int32U	modbus port number

MAINTENANCE

LITHIUM BATTERY – There is a lithium coin cell in the unit to maintain the system clock and settings. This is a common type 2032 battery available at 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 on the front lower left of the controller and removed with a needle nose pliers. Caution: cover one side of the battery with a piece of paper or plastic when using pliers to prevent shorting the power supply.

FREQUENTLY ASKED QUESTIONS

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

A: The Well Watch was designed to work on a closed well. A simple piece of rigid card board or plastic held tight 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 Watch 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 Watch 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 Watch 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 Watch work on larger diameter wells?

A: The Well Watch, 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.

Q: How deep will the Well Watch measure?

A: The maximum range is 7000 feet. This may not be achievable on all wells however. On a good 6" well with tight clean casing all the way down to the water 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 Watch 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 Watch to detect. In this case, the Well Watch 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 Watch 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: 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 Watch will be unable to find the distance to the water past the accumulator.

Q: Can the Well Watch 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 spout can be extended into the well and seated on the access hole through the pit-less adapter. When this is done, the microphone tube must also be extended to reach into the well cavity.

Q: Can the Well Watch 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 Watch 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 Watch to measure the water level in a tank?

A: There are three issues here. First, the Well Watch 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 15 feet, so unless the sounder is mounted at least 15 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 15 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 Watch 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 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.

Appendix A: UPDATE RATES

Only certain update rates are allowed and are therefore referenced from a table by index number. When setting the update rate remotely the rate must be specified by its index as follows:

index	
0	0 minutes
1	1
2	2
3	3
4	4
5	5
6	6
7	10
8	15
9	30
10	60
11	2 hours
12	3
13	4
14	6
15	12
16	24

Appendix B: BAUD RATES

Only certain baud rates are allowed and are therefore referenced from a table by index number. When setting the baud rate remotely the rate must be specified by its index as follows:

0	300
1	1200
2	2400
3	4800
4	9600
5	14400
6	19200
7	38400
8	57600

Appendix C: ERROR AND STATUS CODES

Error and status codes are binary words where each bit represents a condition. These codes are display differently on the display than in the log or serial communication.

Display error codes – On the display error codes are represented one character per bit and is a period '.' if the condition is normal or a capital letter if a condition is true.

Letters are used to make identification easier. These can be interpreted as follows:

Probe errors:

- A - data overrun
- B - driver voltage low
- C - good pulse following long line (probable water surface)
- D – undefined

- E – out going signal low
- F – out going signal high
- G – returning signal gain low
- H – returning signal gain high

- I - echo signal low
- J - echo signal high
- K - echo gain low

L - echo gain high

M - no distinct pulses found

N - too many peaks

O - primary pulse too weak

P - retry gives erratic results

Q - excessive background noise

R - high noise to pulse sig ratio

S – undefined

T – undefined

U - quiet noise to sig ratio above level 1

V - quiet noise to sig ratio above level 2

W - quiet noise to sig ratio above level 3

X - quiet noise to sig ratio above level 4

Probe Status:

A - power on normal mode

B - auto run mode

C – probe awake

D – probe running

E – probe incomplete

F – probe error

G – probe complete

H – set range max

I - set range min

J – set well temp

K – set pulse type

L – set pulse gain 1

M - set pulse gain 2

N – set pulse 1

O – set pulse 2

P – received depth result

Q – received out going gain result

R - received echo gain result
S – received noise gain result

Controller Error Codes:

A - power reset
B - low voltage
C – save log to SD card fail
D – RS232 bad command

E – controller board temperature high
F – probe board temperature high
G – autocal running
H – low alarm

I - high alarm
J – aux output on
K – probe error detected
L – USB connected

M – SD card fail

Error codes in the log or serial data – These error codes are the same as the display codes except they are sent here as hexadecimal numbers. So the order is reversed making the A bit the first on the right. Four bits are expressed for each hexadecimal digit where each digit is composed of 4 bits with values of 1,2,4, and 8. You add the 4 bit values together to get the resulting code. This sounds complicated but it really is not.

Here is how it works for the right digit expressing the error codes above:

The bits are:

1 – A
2 – B
4 – C
8 - D

So if error C was set, the right digit would be 4. If A was also set, it would be 5. If B was also set, the digit would be 7. If D was set, the total could get up to 15. This is where the hexadecimal comes in. Any total greater than 9 gets a letter from A to F. So 10 = A, 11 = B, 12 = C, 13 = D, 14 = E, and 15 = F.

For the second digit the bits are:

- 1 - E
- 2 - F
- 4 - G
- 8 - H

etc.

SPECIFICATIONS

POWER:

External Power: 12 to 36VDC at 130ma max. Do not exceed 36V.

Real time clock: Li Ion 3V battery CR2032 front access.

Measurement:

Units: Selectable English(ft, gal, °F), Metric(M, L, °C), Imperial(ft, Imp gal, °F)

Resolution: .05 ft

Accuracy: .1 ft (see notes)

Range: 15 to 7000 feet. (see notes)

LOGGING:

Memory: nonvolatile flash memory for approx 25,000,000 data points.

Logging rates: 1 sec to 24 hours per sample.

ENVIRONMENTAL:

Temperature: -10 to 130 F

Humidity: 10 to 90% non-condensing.

PHYSICAL:

Controller:

Dimensions: 4" w x 5" h x 2.5" d (10.3cm w x 12.5 h x 6.5 d)

Unit Weight: ~10 oz (284 g).

Mounting: DIN rail, or mounting flange

Probe:

Dimensions: 4.5" w x 4.5" h x 10.5" d (11.5cm w x 11.5 h x 26.7 l)

Unit Weight: ~10 lb (4.5 kg).

Mounting: 2" FPT

FEATURES:

Display: 2x16 character LCD

USB for access to the log data

RS232 Serial Port: baud 300 – 57600, 8 data bits, one stop bit. (19200 baud default).

RS485 Serial Modbus Port: baud 300 – 57600, 8 data bits, one stop bit. (19200 baud default).

SDI-12

Ethernet

Analog Voltage Output: 0-5 volt @15ma max

Current Output: 4-20 ma @36v max.

Alarm Output: relay contacts normally open, UL rating for 30 VDC, 2 A (resistive), or 110 VDC, 0.3 A (resistive) , or 125 VAC, 0.5 A (resistive)

Aux Output: relay contacts normally open, UL rating for 30 VDC, 2 A (resistive), or 110 VDC, 0.3 A (resistive) , or 125 VAC, 0.5 A (resistive)

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%/°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.



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