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Simple, Portable Water Level Monitoring Package

Sponsor: MID-PACIFIC REGION, USBR

Electronic water level sensing equipment is becoming increasingly important for the implementation of water conservation programs in irrigation districts. A need has risen for information on costs, advantages/disadvantages, required support equipment, and required maintenance for the various options. For this reason, the Water Conservation Office of the Mid-Pacific Region of the USBR contracted with the Cal Poly ITRC to conduct a study on water level sensors and dataloggers and to produce a report.

One application covered in the water level sensor and datalogger report is the need to have a simple, portable water level monitoring package. This paper supplements the full report and covers the details necessary to put together a package. The models and manufacturers specified in this paper represent units that received favorable testing results from the original study. The recommendation is for equipment that is relatively inexpensive, but reliable. The following pages contain a summary of a set up for a simple, portable package that consists of a; i) water level sensor, ii) power supply, and iii) datalogger.

The full report, which is available for purchase from ITRC, explains useful information that was gained from the yearlong study. Sections on power requirements, sensor output signals, data storage, calibration, low-power applications, batteries, solar power, relays, lightning protection, stilling wells, and other items give recommendations and hints on setting up sensors and dataloggers. Eighteen sensors and 14 dataloggers are reviewed in detail, covering power requirements, options, installation, programming, wiring, maintenance, and other topics. Additionally, test procedures and specific results for each unit are supplied. For additional information, contact Charles Burt at cburt@calpoly.edu or (805)756-2379.

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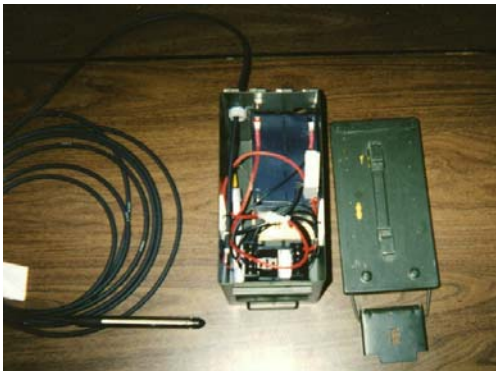
SENSOR DESCRIPTION AND COSTS

Low Power Sensor with Rechargeable Battery

This configuration is a low power package that requires battery replacement once per month. It is designed to work in a hostile environment. Depending on the sensor type, a single package costs about $1,200. A laptop computer, software, extra batteries, and a battery charger must also be purchased. The following are the components recommended:



1. The ACR OWL is a small, self-powered datalogger that is good for monitoring a single 4 – 20 mA input if an 8-bit resolution is acceptable. This datalogger works well with 0-1 psi sensors. If 0-2.5 psi is required, a different datalogger unit should be considered because better resolution may be needed. The loop accuracy is +/- 1% full scale. The datalogger is about 6x4x9cm in size.
2. The Druck PTX 1230 submersible level transmitters are NEMA-6 rated, the only submersible pressure transducers evaluated at the ITRC with a NEMA rating. The cable comes standard with a Kevlar cord (54-kg breaking strength) inside the polyurethane jacket, which is used to tie off the cable above water. Several useful options for the sensor units are available. This example uses a pressure transducer, although an ultrasonic level sensor (such as the Milltronics Probe) could be used just as easily.
3. Power-Sonic makes sealed rechargeable batteries in a whole range of sizes which can often be purchased locally.

Table 1. Components for a sample battery-powered compact setup using a pressure transducer and a rechargeable battery.

Component	Purchased From	Phone	Price Each*
ACR OWL-500 Datalogger	ACR	(800) 663-7845	$299
Druck PTX 1230/ 0-1 psi Submersible Sensor	Druck	(203) 746-0400	$695
TrendReader® software, w/optical cable**	Empire Instruments	(909) 943-2828	$159
Power-Sonic 12V, 10AH Sealed Battery	Power-Sonic	(650) 364-5001	$43
Mini Charger**	Power-Sonic	(650) 364-5001	$50
Battery Tester	Radio Shack		$12
Desiccant Tube	KPSI	(800) 328-3665	$15
Bulk 10 – 20 mesh drierite (desiccant). Price per lb.	W.A. Hammond Drierite Co	(937) 376-2927	$8
Misc. electrical parts			$150

*Does not include tax or shipping.
**Only 1 set is needed for multiple units.
Note: A laptop computer is needed to download information in the field.

COMPONENT INFORMATION

ACR OWL Datalogger

(800) 663-7845
http://www.acrsystems.com

General. The ACR OWL datalogger is a compact, easy-to-use device. Different models can log either one voltage or one current input. The OWL is housed in a "water-tight" enclosure, and the optical data link can even transfer data underwater. The housing does not have any type of environmental rating (such as NEMA), and should not be placed underwater. The TrendReader® software, when loaded onto a PC, provides a simple procedure for downloading data from the OWL, and for storing that data and displaying it graphically. The TrendReader® software must be configured by the user so that TrendReader® knows how to interpret the data, which is downloaded from the OWL. Note: the factory software settings need to be changed after installation. This is accomplished by opening the application, clicking on “Communicate” at the top of the menu bar, then clicking on “Preferred Logger”, then “Owl”.

Table 2. Specifications for the ACR OWL Datalogger

Power Supply	Needs External Battery?	Power Draw (amp-hr/day)	Number of Analog Inputs	Type of Input	Accuracy	Temp. Range	Logging Interval(s)
Internal 3.6V, 1AH lithium battery	Y	0.00018	1	0-24mA; 0-120 mV to 0-38.4V	± 1% full scale	-40 – 85°C	0.2 sec – 34 min

Size	Storage Capacity	Resolution	Date/ Time?	Communi-cations	Relays	Alarms	Local Display?	Remote Operations?	List Price
6x4x9 cm	32,767 readings	8-bit	Y	Optical data link	None	Flashing LED	N	N	$458 w/ software

Price includes:

- OWL 500 datalogger ($299 w/o software).
- TrendReader software for Windows (to be installed on a PC).
- Optical interface cable (between the ACR OWL and the PC).

Power. The OWL comes with an internal lithium battery that is guaranteed to last 10 years, and is factory replaceable. The datalogger, however, is only guaranteed for 3 years. An external battery is required to power the 4 – 20 mA loop. The external battery voltage must be within the specified input voltage range for the sensor.

Input. The OWL 500 can read a mA signal ranging from 0-24 mA. For a sensor which provides an output of 4-24 mA. Using TrendReader® software, the user sets the desired voltage range.

Options. There are five inputs available: internal temperature, external temperature, electric current (this is not a 0 – 24 mA logger), DC voltage, and 0 – 24 mA current.

Wiring Diagram.

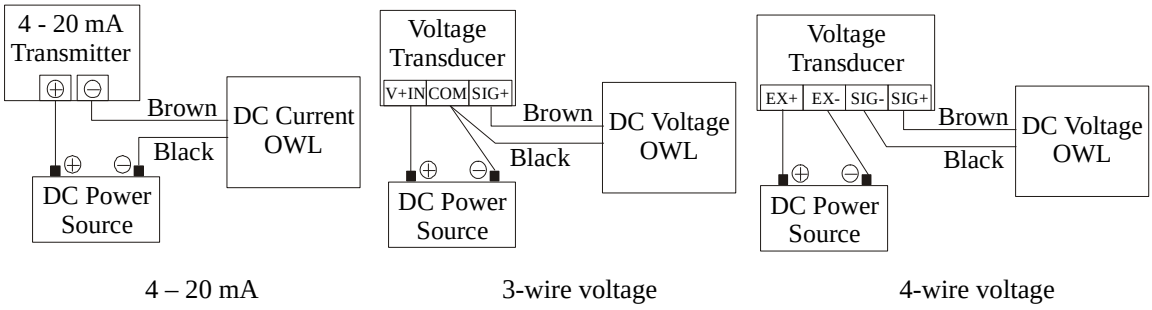


Figure 1. Three common OWL wiring schematics. The DC power source must be within the voltage input range for the sensor.

Installation. The logger can be easily mounted on a metal surface with its magnetic backing. However, it is recommended that the logger be securely mounted or placed on top of a horizontal metal surface. A hole in the corner of the OWL allows it to be locked in place with a standard padlock. Because of its small size, it can also be hidden from view. The watertight housing eliminates the need for an additional enclosure, but should be placed in a dry location.

The datalogger can be configured for a delayed start (for configuration away from the measurement site). Low and high trigger alarms can cause the optical port to blink when activated. The OWL can be re-calibrated to match voltage or current readings with the actual values.

Data Analysis. TrendReader® (on a PC) will automatically graph the downloaded data in the format of Figure 2 and put data in a table. Comma Separated Value (CSV) files can also be generated from within the software for use by spreadsheets.

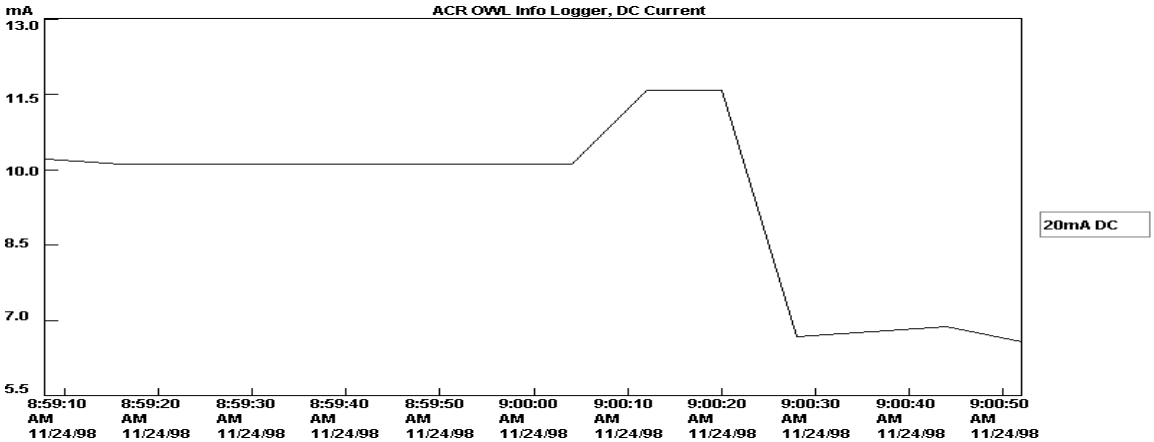


Figure 2. A TrendReader® trending graph for the OWL.

Test Results. The ACR OWL was very easy to set up and install. The 4 – 20 mA readings were within 0.8% full range of the actual current.

Table 3. Rating table for the OWL 500. These results were gathered by a study conducted at the ITRC.

Model	Simplicity and Correctness of Instructions	Ease of Install -ation	DC Power Require-ment	Ease of Program-ming	Controls and Tele-metry	Date/time error after external power loss?	Acc-uracy	Overall Rating
OWL 500	8	9	9	10	0	N	8	9

10 = excellent; 1 = horrible.

Calibration

The TrendReader® needs to be programmed to interpret the data, which is downloaded from the OWL. For a 0-1psi pressure transducer set for 4-20 mA output, the equation for the TrendReader® needs to be set within the program.

The equation is from:

Answer0={N}*[(Ymax-Ymin)/(Xmax-Xmin)]-
[Xmax*(Ymax- Ymin)/(Xmax-Xmin)-Ymax]

Where,

N = Source0/248*24

Source0 = output from OWL, 248 = 256-8 bits. The 8 bits are used for reference time and 24 is the range of channel (0-24mA).

Ymax-Ymin = the pressure transducer range: 1-0 psi or 27.7-0 inches

Xmax-Xmin = the mA readings range 20-4 mA

Assuming a 0-1psi (0-27.7 inches) pressure transducer with a 4-20 mA output:

Answer0 = ((Source0/248)*24)*(27.7/16)-[(20*27.7/16-27.7)]

Simplifying the equation:

Answer0 = Source0*0.16754 - 6.925

This equation needs to be created in the TrendReader® software under the **Equation** menu. From the **Equation** option, select **New Equation**. Type in the desired units and equation description. In the main field, type in the equation. Answer0 is the final result that is plotted and can be saved in the CSV format.

A high quality pressure transducer that outputs 4-20mA to the OWL will produce a 4mA at 0 psi and 20mA at 1 psi. If such a high quality transducer is used, no field calibration of the pressure transducer is necessary.

Primary advantages of the ACR OWL over other dataloggers

- Very easy to use.
- Small size.
- Low list price.

Primary disadvantages over other dataloggers

- Only one input.
- Data must be downloaded in the field.
- No control capabilities.
- Only 8 bit.

Druck Submersible Pressure Transducer

(203) 746-0400
http://www.druck.com/usa

General. The Druck PTX 1230 and PTX 1830 submersible level transmitters have a fully welded titanium construction, as opposed to the more standard stainless steel housing with O-ring seals. Titanium is more resistant to corrosion, which helps for applications in water with high mineral or low oxygen content. The lack of O-rings is advantageous if the sensor will be dry for extended periods of time as the O-rings can dry and crack if dried and heated often. The electronics are encapsulated so that any moisture that makes its way down the vent tube will not permanently harm the sensor. The sensors are NEMA-6 rated, the only submersible pressure transducers studied at the ITRC with a NEMA rating. The cable comes standard with a Kevlar cord (54-kg breaking strength) inside the polyurethane jacket, which is used to tie off the cable above water. This will help avoid cable stretching, especially in applications where a large length of cable is required. Several useful options are available.

Table 4. Specifications for the Druck Pressure Transducer

Power Supply	Power Draw (amp-hr/day)	Output	Advertised Accuracy	Advertised Thermal Error	Advertised Resolution	Lag Time	Over-pressure Rating	Temp. Range	Cost
9-30 VDC	0.3	4-20mA or 0-100mV	± 0.06, 0.1 or 0.25% full span	± 0.3 or 0.6% full span (depends on range)	Infinite	None	6x to 10x (depends on range)	Compen-sated -2 – 30°C	$685-1185 w/ enclosure (depends on range, accuracy)

Price includes:

- Sensor.
- STE 110 Sensor Termination Enclosure.

Power. Between 11 – 30 VDC is required across the transmitter terminals depending on the power being drawn. A 12-volt battery is adequate for this application. The PTX 1230 and 1830 have a 4 – 20 mA output, but other models are available with a 0 – 100 mV

output signal. No internal lightning protection is available, but optional lightning arresters are available for installation at the wiring end of the cable. Beginning the summer of 1999, lightning protection will be installed in the PTX 1830 and PTX 1230 at no extra cost. However, additional protection should also be installed by the user at the data acquisition end.

Options. The PTX 1230 is rated at ± 0.25% full scale accuracy and costs $595-695, while the PTX 1830 is rated at ± 0.1% full scale accuracy and costs $875-995, depending on the measurement range. Ranges from 0.7 to 630 m are available, with increasingly higher prices at ranges less than 5 PSIG (3.5 m). Druck does not supply desiccant tubes for use at the end of the vent tube, stating that a dry wire termination enclosure is more effective. If a dry enclosure is not already available, the STE 110 Sensor Termination Enclosure is available for $190. The STE 110's NEMA-4 enclosure comes with reusable color-changing desiccant packs to keep the inside air dry. The breather port, which allows the enclosure to equilibrate with barometric pressure, is covered with Gore-Tex to keep water drops out. This feature actually makes the STE 110, and therefore the end of the sensor cable, submersible. This is not possible with any of the other submersible pressure sensors that were reviewed. The STE 110 will keep not only the vent tube, but also the entire cable free of water. Tefzel cable is available instead of polyurethane, but is much more expensive and is not needed for typical irrigation applications. Different lightning arrester units are available for 4 – 20 mA, 1 – 5 V, and 0 – 100 mV output sensors. The SCU 220 Sensor Conditioning Unit allows the user to adjust the zero and span remotely, and can be used to convert a 0 – 100 mV signal to 4 – 20 mA. If only a ½-inch ID stilling well is available, see the section on other models below.

The following options are recommended:

- Sensor termination enclosure.
- Polyurethane vented cable.
- Lightning arrester.

Installation. Place the sensor tip slightly below the lowest water level that is of interest to monitor. Secure the cable to avoid changes in the sensor placement. If possible, hang the cable with the yellow, fibrous Kevlar cord.

Calibration. This sensor did not require any calibration. Tests conducted on multiple transducers resulted in accurate readings without calibration.

Maintenance. The construction of the Druck submersible sensors allows for several helpful cleaning options. If the inlet holes at the tip of the sensor clog, a wire brush can be used for cleaning. The black nose cap is removable, but no objects should be put inside the end of the sensor when the cap is removed. If mineral deposits build up, remove the cap and soak the unit in CLR (normally used to clean coffee makers). Do not try this on other sensor makes without first contacting the manufacturer.

Test Results. Overall, the Druck PTX 1830 performed well among the submersible pressure transducer. Especially impressive was the relatively high accuracy during fluctuating water temperatures. ITRC ratings of this sensor are shown below.

Table 5. Rating table for the Druck PTX1830. These results were gathered by a study conducted at the ITRC.

Model	Simplicity & Correctness of Instructions	Ease of Installation	Compatibility with Other Brand Dataloggers	Water Level Display?	Performance During Fluctuating Air Temperatures	Performance During Fluctuating Water Temperatures	Durability in Dirty Water	Water Level Response Time	Linearity & Hysteresis	Output Stability	Resistance to Drying Effects	DC Power Requirement	Long-term Reliability	Overall Rating
PTX 1830	10	9	10	N	10	8	10	10	8	9	7	9	8	8

10 = excellent; 1 = horrible.

Primary advantages of Druck over other submersible pressure sensors

- Excellent performance during fluctuating water temperatures.
- Rugged construction.
- Need no calibration (4mA at depth = 0, and 20 mA output at the maximum depth).

Primary disadvantages of Druck over other submersible pressure sensors

- Large termination enclosure usually needed.

Milltronics Ultrasonic Sensor

(817) 277-3543
http://www.milltronics.com

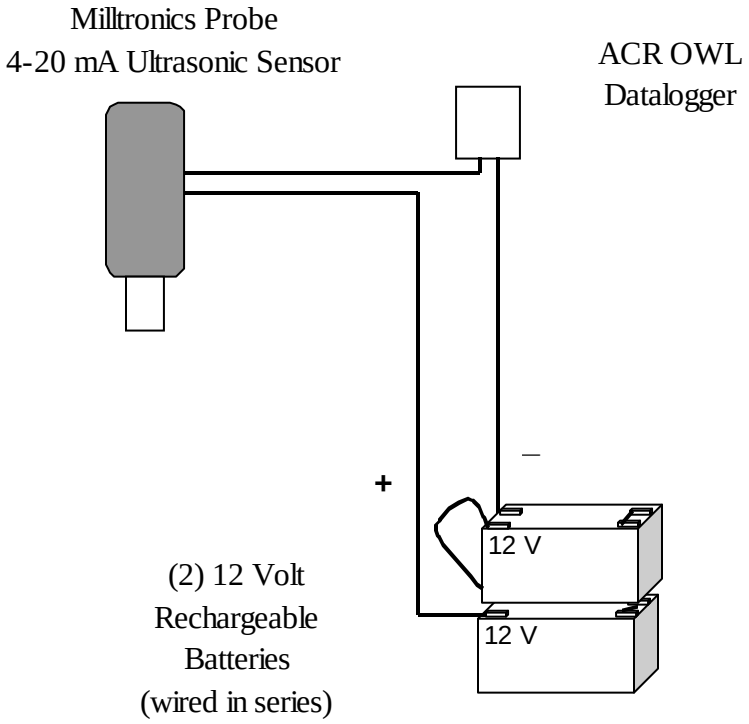
General. "The Probe," manufactured by Milltronics, combines an ultrasonic sensor and all its electronics in a single NEMA-4X unit. The Probe uses a simple 2-wire, 4 – 20 mA loop for power. Powering a capacitor prior to each burst produces the ultrasonic pulses. The sensor will ignore a reading unless it is received five times in a row, which helps to eliminate noise and zeroing. An easily programmable "window" can be set around the output so that any single reading outside this range will be ignored. If the window is not used, the sensor will read continuously and have basically no lag time.

Table 6. Specifications for the Milltronics Ultrasonic Sensor

Power Supply	Power Draw (amp-hr/day)	Output	Advertised Accuracy	Advertised Resolution	Lag Time	Temp. Range	Cost
12-28 VDC	0.3	4-20mA, 1 relay (5A/250VAC)	± 0.25% full scale	0.3 cm	0.8-4.2 seconds	-40 – 60°C	$695

Power. For the 2-wire units, a 18 – 28 VDC loop is needed to power the sensor and

electronics. For the 3-wire units, 18 – 30 VDC power supply is required. The VDC rating is dependent on the load requirement. Both are reverse polarity protected, so that switched wires will not damage the unit. While the 3-wire version does not have any delay associated with charging a capacitor, it takes more power to run. When the 2-wire loop-powered unit was tested for time lag, none could be easily detected. The measurement interval decreases from around 4 seconds at 4 mA to about 1 second at 20 mA, due to a longer capacitor charging time at lower currents. A transient suppressor is recommended if AC equipment is used, but is not available from Milltronics. The configuration of the combined Milltronics Sensor and ACR OWL configuration must have an input power supply of more than 12 volts. The recommendation is to either use 2-12V batteries or to use a 12V to 24V (DC to DC) converter. A DC to DC converter can be purchased from Sierra Controls (775)883-0443 for $65.



Options. The available versions of the 3-wire unit are: a standard 5 m version, an extended range 8 m version, and a sanitary version (not needed for irrigation use). All are programmable for a fault or level alarm, and HART™ Communications Protocol is optional with the 3-wire unit. Standard 5 m and intrinsically safe (for hazardous areas with a high risk of explosion) options are available for the 2-wire loop-powered unit. No relays are available for the 2-wire version. The Probe can be configured with three 2-inch thread types, and several adapters are available for flange mounting. A loop-powered rate meter can also be ordered if a remote display (installed anywhere on the 4 – 20 mA loop) is desired. The user must supply all wiring for the sensor.

The following options are recommended:

- Standard version.
- 2-wire loop-powered (unless <4-second response time is needed).

Installation. Easy installation is one of The Probe's main advantages. The face of the sensor should be mounted at least 25 cm above the highest anticipated water level with the mounting threads. The optional adapter is good for mounting on a plain horizontal surface, but a non-metal mounting must be used if the ambient temperature will drop below –20°C. A bubble level is needed to assure vertical installation.

Calibration. This is accomplished with a small LCD display and two-button keypad, located on the top of the sensor itself. This display, which shows the water level during normal operation, is accessible with a flat-head screwdriver. The buttons marked "4" and "20," located adjacent to the LCD display, are used for calibration. The blanking distance is a specified distance down from the sensor. The sensor will not take readings within this distance (about 12-inches) because of anticipated errors. The blanking distance, speed of response to level changes, and units of measurement can also be easily set with the keypad.

Calibration Procedure. The following instructions are designed to set up a Milltronics Probe using an ACR OWL as the datalogger. The OWL has an 8-bit resolution so the Probe should be set for a low head application (i.e., 0-1 psi). These steps are for setting up the Probe for a 0-1 psi range of readings.

Low reading = 3.81 feet. Output = 4 mA at this reading.
High reading = 1.50 feet. Output = 20 mA at this reading.

The following are the steps to set up the Probe:

1. Put the Probe sideways on a table. Aim the sensor towards a wall or flat partition so that the readings on the Probe can be easily changed.
2. Turn the sensor on. Place the sensor so that the Probe is reading the maximum level at 1.50 feet. This will be as close to the sensor as the water will possibly be. Press 20, wait 2-3sec and hit 20 again. At this water level, the sensor output will be 20 mA. If the output is not 20 mA there is probably a problem with the voltage. The Milltronics and OWL combination require at least 18 volts.
3. Put the sensor at the minimum water level. This will at 3.81 feet. Press 4, then wait 2-3 sec and press 4 again. At this water level, the sensor output will be 4 mA.
4. Between these 2 distances is the working range for the datalogger. The output screen on the sensor itself will work out of this range. But data will not be collected and stored to the OWL. It is possible to have the Probe operate with different low and high level readings.

Test Results. The Probe performed about average among the ultrasonic sensors during testing. It was significantly affected by air temperature fluctuations, but was able to penetrate through foam better than all other ultrasonics except the Badger Meter 2500. Linearity was almost perfect, but the Probe had a large hysteresis. The hysteresis test range exceeded the sensing range of the Probe, which may have resulted in the problems encountered.

Table 7. Rating table for the Milltronics "Probe". These results were gathered by a study conducted at the ITRC.

Model	Simplicity & Correctness of Instructions	Ease of Installation	Ease of Calibration	Compatibility with Other Brand Dataloggers	Water Level Display?	Performance During Fluctuating Air Temperatures	Foam Penetration	Wave Damping	Water Level Response Time	Linearity & Hysteresis	Output Stability	DC Power Requirement	Long-term Reliability	Overall Rating
The Probe	9	9	9	10	Y	2	5	Adjustable*	10*	2	8	9	NA	8

*Increasing the wave damping effect will decrease the water level response time.
10 = excellent; 1 = horrible; NA = not available.

Other Models. For about $2545, Milltronics offers the OCM III, an ultrasonic sensor with a datalogger and totalizer, higher accuracy, and faster response than The Probe. 9 – 30 VDC is needed to run the OCM III.

Primary advantages of Milltronics over other ultrasonic sensors that were tested are that they have a low power requirement and they are easy to install. The primary disadvantages to the unit are that the display can only be accessed with a screwdriver and the unit requires 18-24 volts to operate in conjunction with a datalogger.

Power Sonic Rechargeable Battery

Call (650) 364-5001 or log on to http://www.power-sonic.com to find a nearby distributor or representative. Table 8 gives battery sizing suggestions.

Table 8. Rechargeable battery sizing suggestions for a single 4 – 20 mA loop-powered sensor. Amp-hour and weight data are for Power-Sonic batteries.

Sensor power	Datalogger power	Battery replacement interval	Battery amp-hours	Approximate battery weight, kg
Constant	Self-powered	1 week	4.5	1.7
Constant	Self-powered	2 weeks	7	2.6
Constant	Self-powered	1 month	10	4.2
Constant	Self-powered	2 months	26	8.5
Constant	Self-powered	**Solar powered**	1.2	0.6
Switched	External	2 months	1.2	0.6
Switched	External	6 months	2.5	1
Switched	External	1 year	7	2.5

Desiccant

W.A. Hammond Drierite Co.
(937) 376-2927
138 Dayton Avenue
Xenia, Ohio
45385-2830

General. Chemicals that absorb water and humidity are called desiccants. Many chemical desiccants have some sort of indicator to determine when they are saturated with water and need replacement. Desiccants can come in a breathable pouch that will swell as water vapor is absorbed. The most convenient form comes in the shape of small blue pellets or beads that turn pink and eventually white with increasing absorption. This type should be replaced or replenished when it not longer contains any blue coloring.

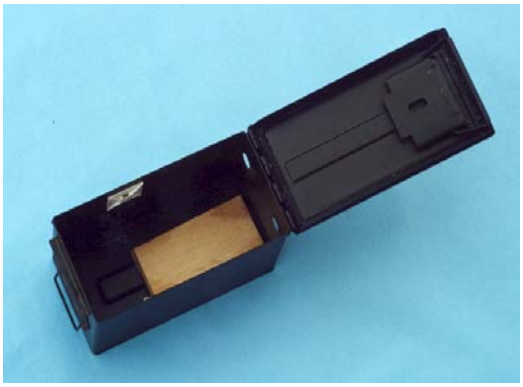
Desiccants are often used to keep water out of electronics enclosures, submersible pressure sensor vent tubes, and bubbler tubes. It is either supplied in a plastic tube, which all incoming air must flow through, or as a pouch. A desiccant pouch absorbs the surrounding air inside an enclosure, and usually requires changing every 6 months in semi-arid conditions. 10 – 20 mesh indicating drierite (desiccant) can be purchased from W.A. Hammond Drierite Co. at (937) 376-2927 for about $8 per pound, which is much cheaper than buying replacement desiccant from a sensor manufacturer. Desiccant packs can also be bought in bulk. A list of 20 companies that sell desiccant can be found at http://www. iscpubs.com/bg/us/prod/prod1288.html.

DETAILED CONSTRUCTION INSTRUCTIONS

Detailed Equipment List

Ammo box

Size: 6"wide x 8"tall x12"long
(Druck Pressure Transducer set up)
5.5"wide x 14"tall x 14"long
(Milltronics Ultrasonic Sensor set up)



Rechargeable Battery: Power-Sonic

Size: 12 Volt, 10 AH

Pressure Transducer: Druck Inc.

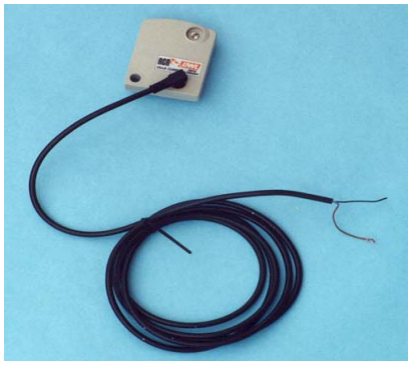
Transmitter type: PTX 1230

Range/Pressure units: 1 psi g

Current Output: 4 to 20mA

Size: 6"x1/2" round

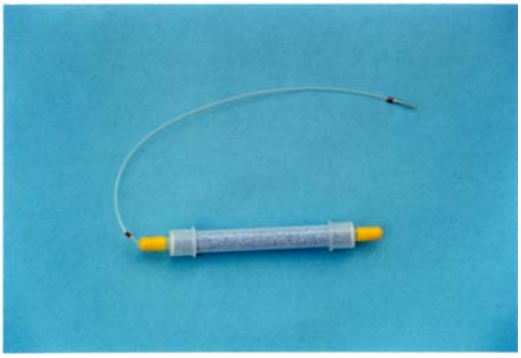
Datalogger: ACR Systems
Size: 2"x2"x1/2"
Type: Owl-500
Software: TrendReader for Windows



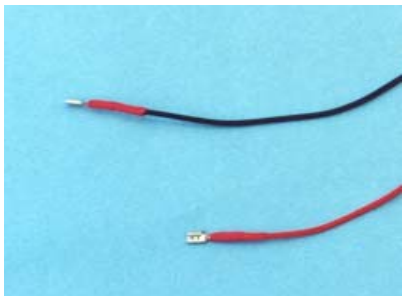
Desiccant Tube: KPSI
Model: Series 810
Pre-filled with desiccant

Contact:

KPSI
34 Research Dr.
Hampton, VA 23666
Phone #:(800)328-3665
www.KPSI.com



Wiring Harness:
Wire: red 22-18 flex wire.
black 22-18 flex wire.
1/4" shrink tubing
Female Battery Connectors: Noble Electrical
Part #: 512H

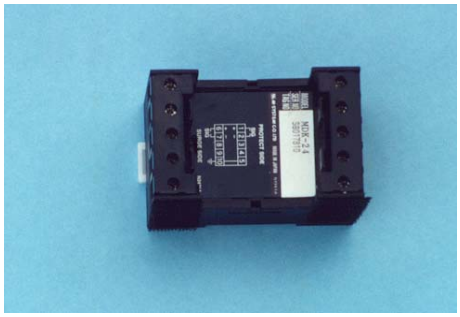


Straight Cord Grip Connector:

Order #: E 16902
WT/SC-35.1
Locknut order #: E 05905
Item #: L 59
Plastic insulating bushing
Order #: E 05295
Item #: L 52 PL
Distributor:
Thomas & Betts
8155 T&B Boulevard
Memphis, Tennessee 38125
(901)252-8000.
http://www.tnb.com/

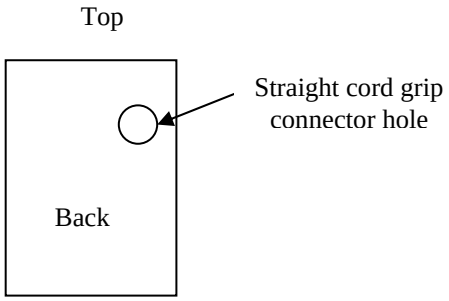
Optional Surge Arrester:

Lightning Arrester: Can be ordered from Druck Inc.
Model: M-System, MDK-24



Construction Procedure:
Low Power Sensor with Rechargeable Battery

A. The first step is to set up the ammo box with the holes needed for the sensor wire. Below is the back view of ammo box. On the back of the ammo box, drill a hole for the straight cord grip connector. The front of the ammo box is where the ammo box latches.



End View of Ammo Box (back)

Accessories needed:

(1) - 1/2" Straight cord grip connector. Round gromet size to fit .375 wire.
(1) - 1/2" Locknut for rigid conduit.
(1) - 1/2" Plastic insulating bushing for rigid conduit.

Procedure for Setting up the Ammo Box.

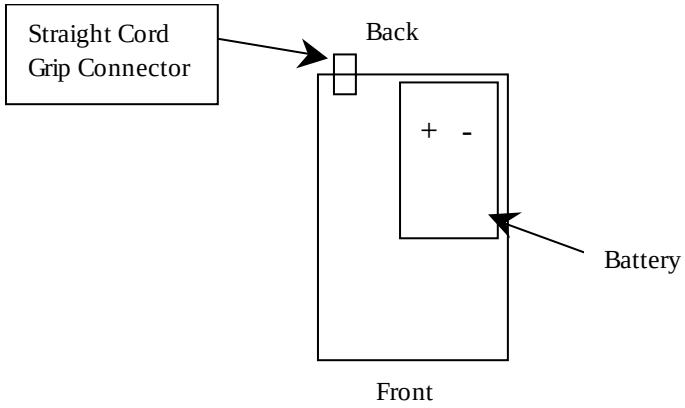
1. Remove top from ammo box
2. Drill 1 hole on the back
   a) Drill the hole on the right side with the back of the box facing you
      - Place hole 3/4"from the side and 2 1/4" from the top.
      - Drill a 13/16" hole. Make sure the cord grip connector fits in the hole.
      - Clean loose metal from the hole.
      - Put straight cord grip connector in the hole with rubber grommet on the outside of the box.
      - Screw locknut on and tighten down securely.
      - Screw on insulating bushing. Tighten lightly, be careful not to strip threads.

3. Eyebolt for locking (optional)
   a) Put the top back onto the box. Locate the small hole on the front closing mechanism for the top. Close this mechanism so lid is completely shut. Drill a 17/64" hole through the box in the center of this hole on the closing mechanism.
   b) Remove lid from box. Make a notch in the closing mechanism. The notch should be vertical from the center of the hole, the same width as the hole. The length should be about 1 1/8" long total. Use the existing hole as a reference. The notch should be 9/16"from the center of the hole, up and down. It is easiest to punch or machine this notch.
   c) Put a 1/4" eyebolt into the hole you drilled into the box. Use a normal nut as a spacer by screwing it all the way onto the eyebolt before inserting it into the hole.

Then use a locknut on the threads inside the box. This nut should be snug, but does not have to be tightened fully. The eyebolt should be allowed to rotate, the locknut will prevent the eyebolt from being unscrewed.

d) Replace the top of the ammo box and make sure the eyebolt goes through the notch.

B. Place the battery in the back of the box and secure with velcro strips. A piece of wood cut to fit the inside of the ammo box and placed under the battery will aid in battery life. Place the battery on top of the wood so that the open connections are against the back of the box. Velcro along the back and side can be used to secure the battery in place and allow for easy removal.



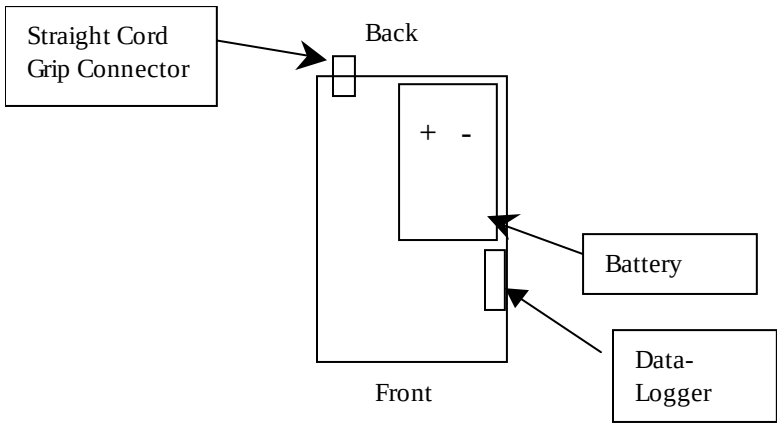
Top View of Ammo Box

Wiring to battery
Accessories needed:

(2) - Female battery connectors.
(2) - 10" lengths of red 22-18 flex wire.
(2) - 10" lengths of black 22-18 flex wire.
(2) - 2" long pieces of 1/4" shrink tubing.

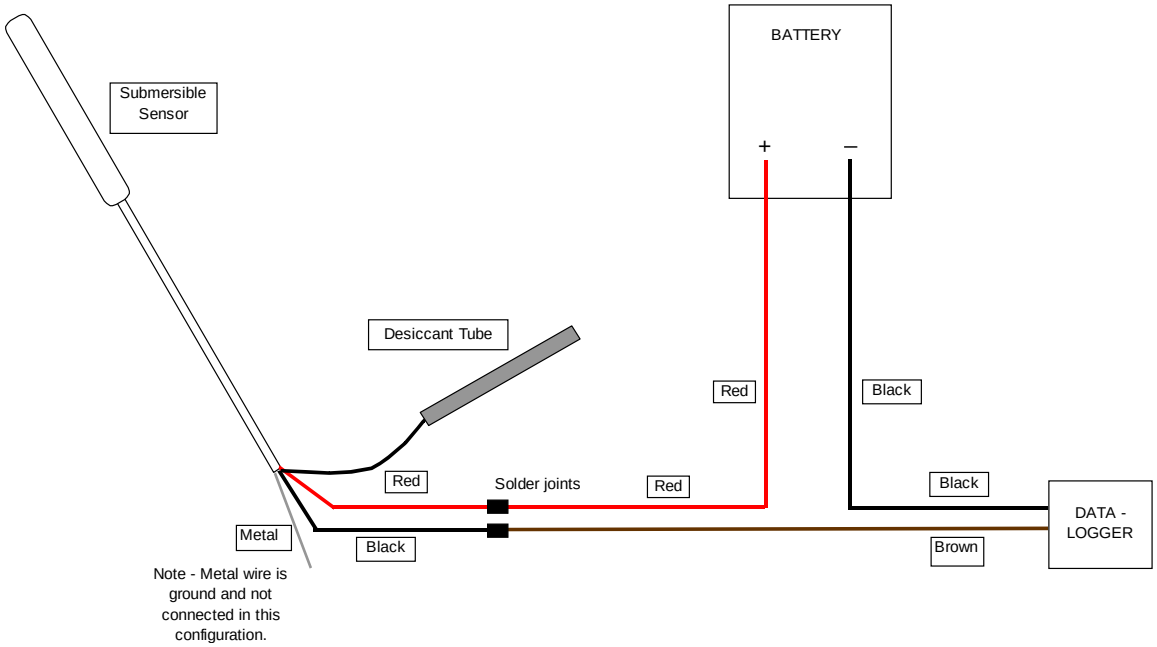
1. Cut a 1-2' length of wire, one red and one of black.
2. Place one piece of shrink tubing on each of the loose wires.
3. Insert each exposed wire all the way into the female battery connector. Using wire crimpers, crimp the connectors onto the wires (where the crimpers have a red dot, or says 22-18). Make sure they are securely fastened.
4. Move shrink tubing over the plastic end of the connectors. Heat with heating tool to shrink the tubing. A lighter or match will also work to shrink the tubing.

D. Placement of datalogger, battery and desiccant tube. It is recommended that the data logger be attached near the top of the box using velcro to give easy access.



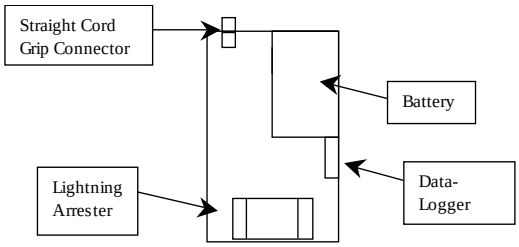
Top view of Ammo Box

The pressure transducer wire should run through the straight cord grip connector and attach to the datalogger and battery. Securely attach the small tube coming from the desiccant tube to the small tube coming from the sensor cable. This is critical for the operation of the sensor. Place desiccant tube in the bottom of the box. Below is the wiring diagram.

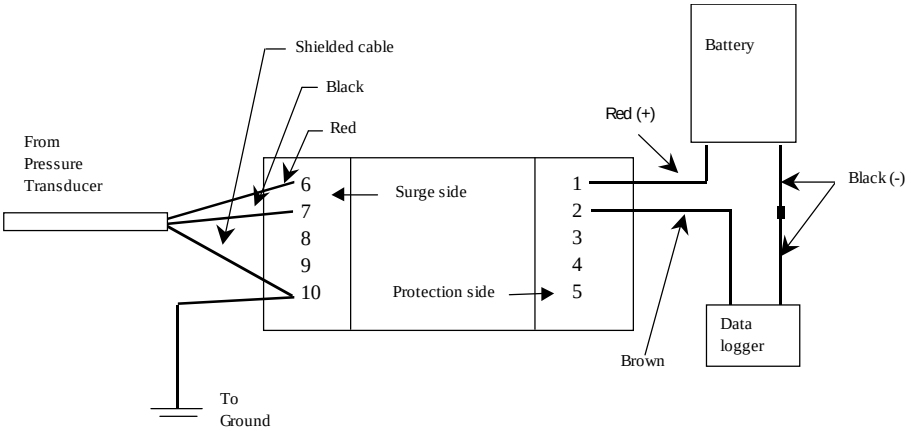


Wiring Diagram

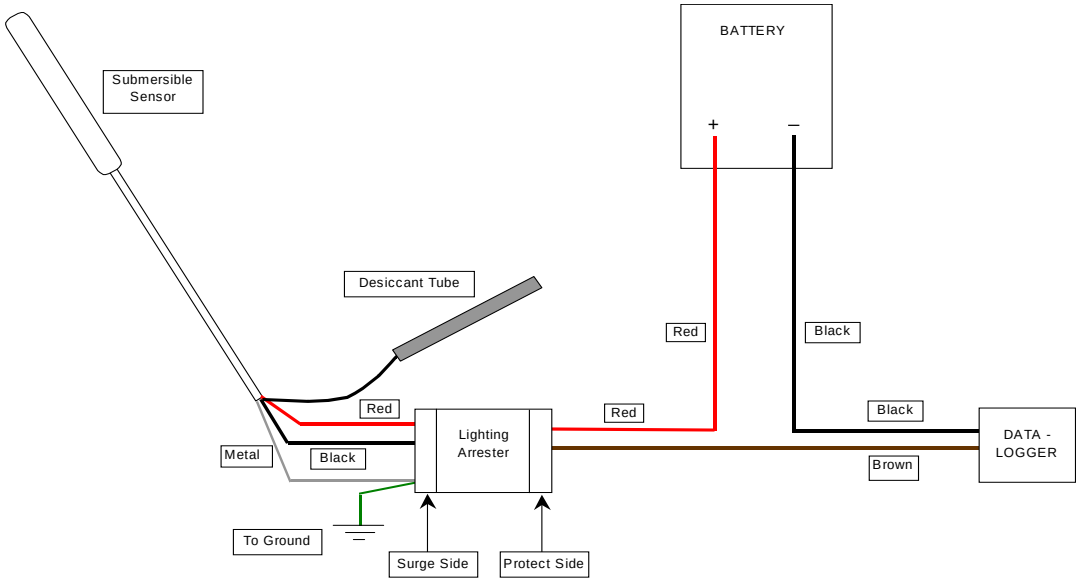
E. Ammo box with optional lighting arrester. The pressure transducer wire should run through the straight cord grip connector and attach to the surge side of the lightning arrester. The battery wires will attach to the data logger and then to the protection side of the lightning arrester.



Top view of Ammo Box (with optional lightning arrester)



Wiring Detail for the Lightning Arrester



Overall Wiring Diagram with Optional Lightning Arrester

Photos of Completed Monitoring Packages

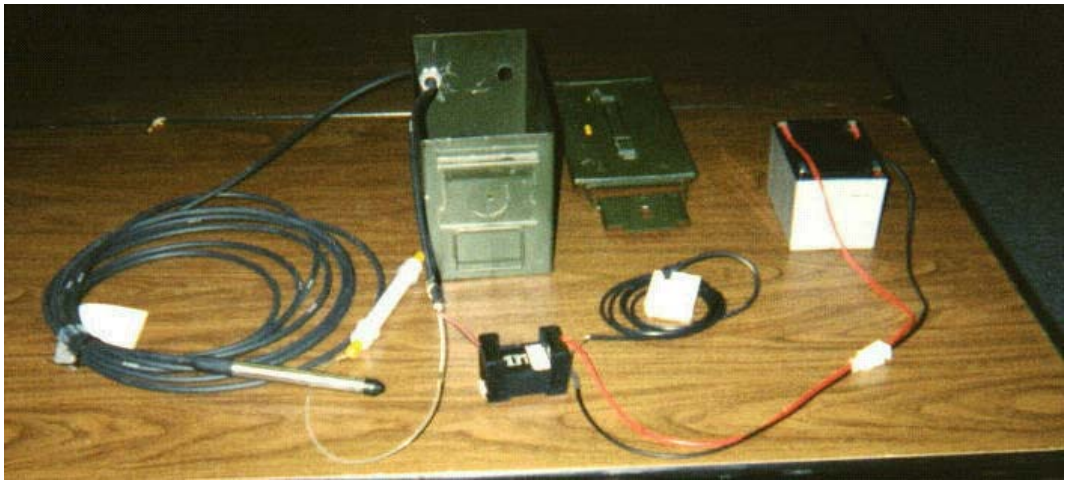


Photo 1. Components of portable water level monitoring package prior to installation in ammo box. This is the set up using the Druck pressure transducer and the ACR OWL datalogger.

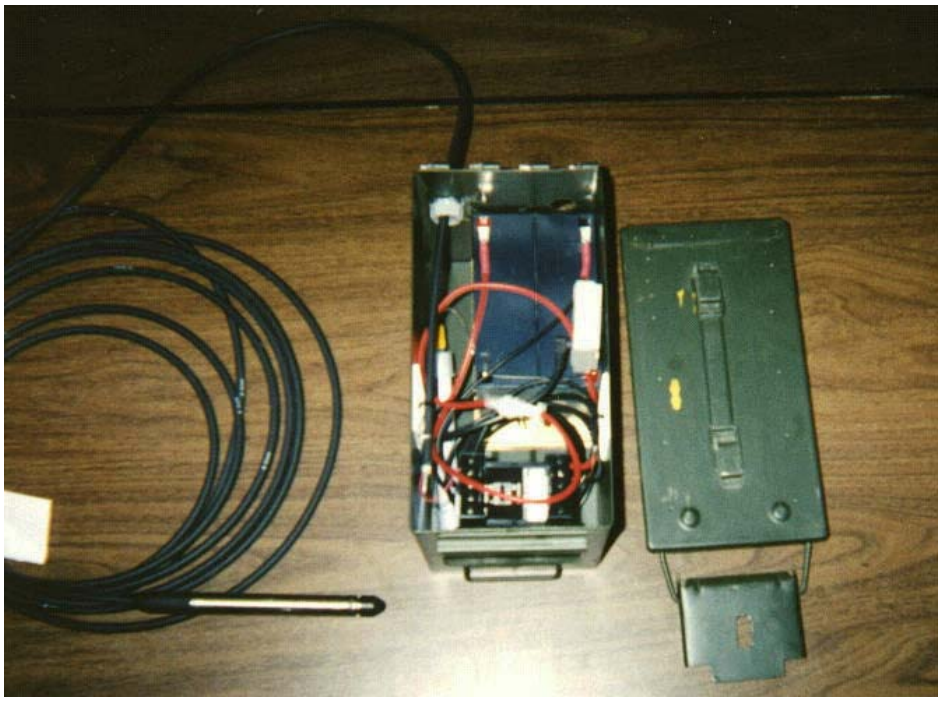


Photo 2. Components after installation in ammo box.

Photo 3. Field installation of portable water level monitoring package. The installation is using the Druck pressure transducer and the ACR OWL datalogger.

Photo 4. Ammo box with cable, lock, and paint.

Photo 5. Field installation of portable water level monitoring package using an ultrasonic sensor. The installation is using the Milltronics Probe ultrasonic sensor and the ACR OWL datalogger.

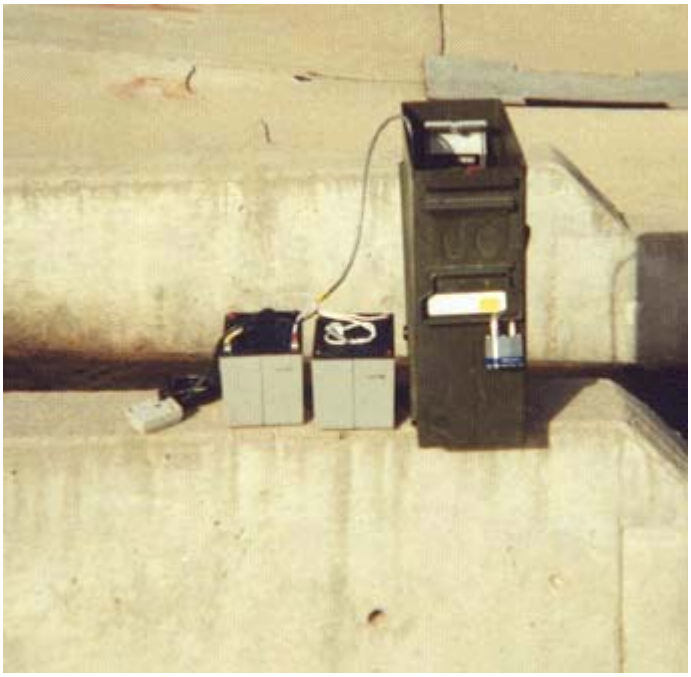


Photo 6. View inside the ammo box using the Milltronics Probe ultrasonic sensor and the ACR OWL datalogger. Note the size of the ammo box is 5.5" x 14" x 14". Also, 2 batteries are required for the installation because the Millronics Probe requires more than 12 volts. Foam rubber was used to prevent the batteries from moving around inside the ammo box.