A Simple, Inexpensive Device for Measuring Shallow Groundwater Levels

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A SIMPLE, INEXPENSIVE DEVICE FOR MEASURING SHALLOW GROUNDWATER LEVELS

by

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ABSTRACT

Previously available groundwater level measuring devices were either time consuming, bulky, or impractical for measuring the shallow groundwater levels in wet meadows. I developed this simple device to rapidly sample a shallow groundwater-well network of nearly 300 wells. Water levels within 200 cm from the top of the well casing can be easily sampled without modification of the device. Deeper wells can be sampled by attaching a measuring tape to the device. The device is constructed from 1.9 cm diameter PVC pipe and inexpensive electronic components available from Radio Shack. Only basic workmanship skills are required to construct the device, and the parts should cost less than $20 to purchase.

INTRODUCTION

I developed this simple, inexpensive device to rapidly and accurately measure shallow groundwater levels in wet meadows (Figure 1). Previously available equipment for measuring shallow groundwater levels (e.g. chalk and tape, cabled probe, and air lines) were either time consuming, bulky, or impractical for high intensity sampling in remote locations. Cabled probes may also cost more than $400 to purchase. In addition, many of these devices use measurement intervals too coarse for accurately measuring shallow groundwater levels. The typical measurement interval is either 30 cm (1 ft) or 152 cm (5 ft). My device, however, uses a measurement interval of your choice, typically 3 mm (0.01 ft), and the parts should require less than $20 to purchase. Each well takes only a few seconds to measure, since there is no cable to coil or line to rechalk. This device has been used successfully in the montane meadows and cold deserts of Wyoming, and along the Platte River in Nebraska.

Researchers interested in sampling groundwater levels within 200 cm (6.6 ft) from the top of their well casings will find this device convenient and rapid to use. Construction requires basic workmanship skills and the ability to use a soldering iron. An electronic circuit, constructed from inexpensive components available from Radio Shack, is housed within a 213 cm (7 ft) length of 1.9 cm (0.75 in) diameter PVC pipe (Figure 1). When

water inside the well completes the circuit, a piezo buzzer sounds, and the water depth is read from a measuring tape attached to the side of the PVC pipe. The device also can be easily modified to measure greater depths by attaching a tape measure.

ASSEMBLY PROCEDURE

The parts required to construct one groundwater measuring device are listed in Table 1. The length of the PVC body, and associated measuring tape and speaker wire, can be adjusted to suit the situation. For measuring deep wells, a short PVC body calibrated to add 46 or 61 cm (1.5 or 2.0 ft) to the end of a separate tape measure works well (Figure 1). If the entire device, including buzzer and batteries, must be inserted into well casings less than 4.4 cm (1.75 in) in diameter, substitute the following parts for the corresponding parts listed in Table 1: 1.3 cm (0.5 in) diameter PVC pipe, one penlight battery holder (R.S. catalog no. 270-401), and two 6 volt photo electronic batteries (Eveready A544). This configuration can be inserted into well casings as small as 2.54 cm (1 in) in diameter. The tape attached to the side of the device can be a scrap piece of fiberglass tape from a broken tape measure. A SPST submini slide switch (R.S. catalog no. 275-406) can be added to the circuit for added protection against accidental battery discharge. This switch is not required, however, since the buzzer will only sound when the electrodes contact a conductive

surface (e.g. water or metal). Construction of the device requires three steps: 1) prepare the PVC body, 2) connect the electronic circuitry, and 3) the final assembly.

Prepare the PVC body for the electronic circuitry by removing a 14 cm (5.5 in) portion of the pipe (Figure 2). Drill two pairs of 2 mm (5/64 in) holes through the opposite end of the pipe for the two electrodes. Use the edge of a flat file to make a 1.5 cm (0.6 in) deep notch between each pair of holes for the electrodes. This notch will increase the distance between the two electrodes along the PVC surface. Make the electrodes from two pieces of 14 gage solid copper wire. The electrodes should be long enough to fit just inside the outside diameter of the PVC pipe when placed into position. Feed the speaker wire through the PVC pipe and solder a wire to each electrode at the electrode's midpoint. Place the electrodes into position at the tip of the PVC pipe and glue with 5 minute epoxy. Before attaching the measuring tape, clean the back of the measuring tape and the PVC body with acetone or lacquer thinner. Spread 5 minute epoxy along the back of the measuring tape, and attach the tape to the back of the PVC body. Glue about 60 cm (2 ft) of tape at a time, and make sure the zero point of the tape is set at the electrodes. Temporarily place 2.54 cm (1 in) wide masking tape down the length of the pipe to hold the measuring tape in place until the epoxy sets. Remove the masking tape before the epoxy becomes hard. Remove the portion of the measuring tape that covers the notch between the two electrodes. The PVC body is now ready for the electronic circuitry.

The electronic circuitry has three resistors, one transistor, one piezo buzzer, and two electrodes. The electrodes were prepared in the previous paragraph. Solder the three resistors and one transistor together using Figure 3 as a guide. The polarity (direction) of the resistors is not critical, but the transistor wires must be connected exactly as shown. Remove the two tabs on the piezo buzzer for the screws; they are not needed. The piezo buzzer can be made water resistant by spreading liquid plastic or lacquer on the back of the buzzer element. To access the buzzer element, remove the back cover, but leave the buzzer element attached to the front housing. After reassembling the buzzer, solder the piezo buzzer and battery clips into place. The wire colors at each connection should match those shown in Figure 3. Now solder the wires leading from the electrodes into place. Both electrodes are similar, so their connections are interchangeable. Connect the batteries to the clips and test the circuitry by placing a wire across the two electrodes. If the buzzer does not sound, recheck all connections using Figure 3 as a guide. If the buzzer does sound, make a cut in the back of each battery clip, and fill the back of each clip with silicone. The silicone will help reduce the physical stress on the battery clip wires. Finally, coat all connections and the resistor/transistor group with silicone to waterproof the electronic circuitry.

Proceed with the final assembly when the silicone has hardened. Tuck the wires from the electrodes and the silicone coated resistor/transistor group into the PVC body. Place one

battery clip at each end of the cutout in the PVC body and hold the wires into place with masking tape. Glue the buzzer into place with silicone. Tape the two 9 volt batteries together end to end, and then tape the batteries to the PVC body with clear tape; fiberglass strapping tape works well. Construction is complete when the batteries are connected to the two battery clips.

OPERATION

To measure the groundwater level, lower the device into the well until the buzzer just begins to sound. At this point, read the distance marked on the side of the device to the reference point on the well casing. The entire process should take only a few seconds for well depths within the range of the device. Occasionally the buzzer will sound lightly just before full contact with the water. This "false" sound is caused by the attraction of water to the PVC body (meniscus) and should be ignored; read the water depth when the buzzer sounds fully. Residual water within the PVC body may cause the buzzer to continue to sound lightly after removal from the well. Once the water has dried, however, this sound will stop. The batteries do not need to be disconnected when the device is not being used, since the circuit is complete only when the electrodes contact water or other conductive material. One battery clip, however, should be disconnected during periods of storage to prevent accidental battery discharge.

Table 1. Parts required to construct one groundwater measuring device.

Quantity	Description	Radio Shack Catalog No.
213 cm	1.9 cm diameter, schedule 40 PVC pipe	-
213 cm	Fiberglass measuring tape	-
213 cm	24 gage, two conductor speaker wire	-
6 cm	14 gage, solid copper wire	-
1 roll	2.54 cm wide masking tape	-
28.4 g	5 minute epoxy	-
82.8 ml	Silicone glue	-
1	Miniature piezo buzzer element	273-064
1	470 ohm resistor	271-019
1	10k ohm resistor	271-034
1	220k ohm resistor	271-049
1	MPS2222A NPN silicon transistor	276-2009
2	9 volt battery connectors	270-325
2	9 volt batteries	-

Figure 1. The standard groundwater measuring device (left) can rapidly measure groundwater depths within 200 cm from the top of the well casing, while the modified device (right) can be used to measure greater depths.

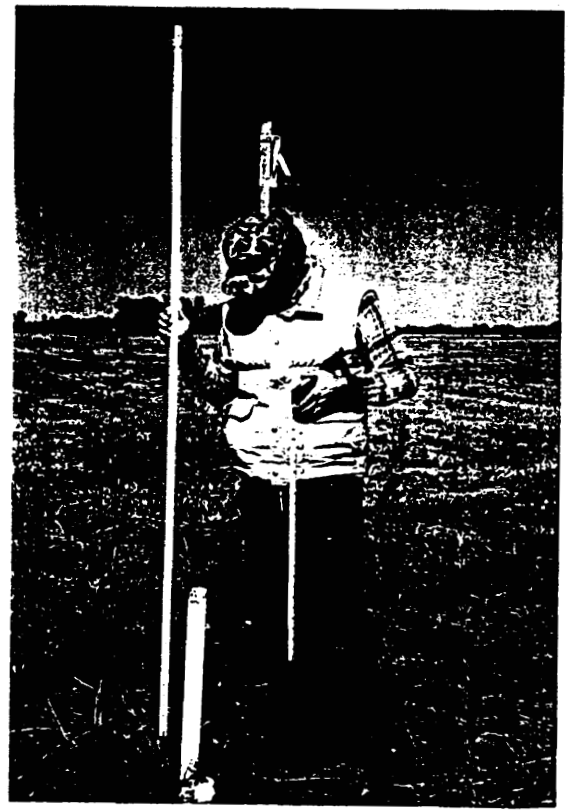
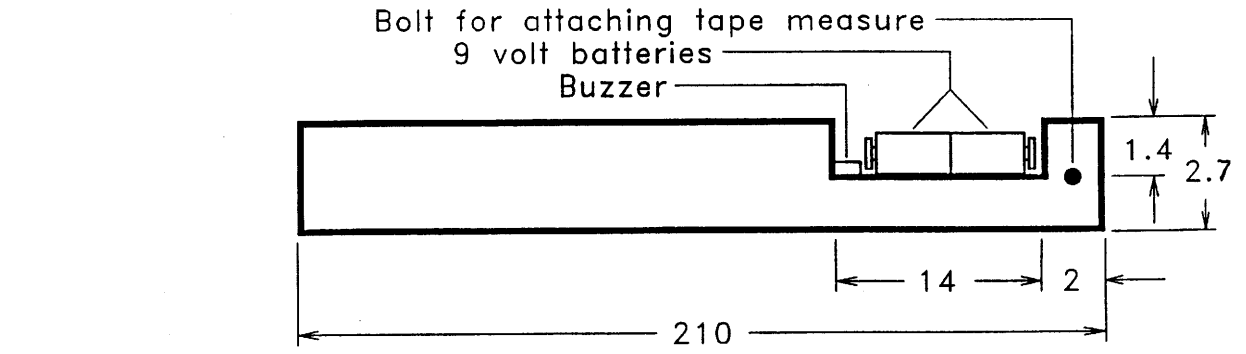
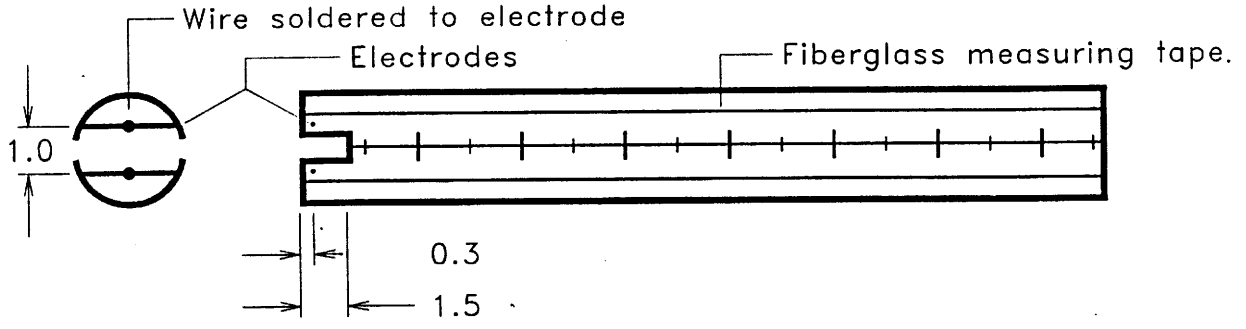


Figure 2. Construction of the PVC body for the groundwater measuring device (all measurements in cm, not drawn to scale).

Figure 3. Diagram showing the arrangement and connections for the electronic circuitry.



SIDE VIEW



END VIEW

BACK VIEW

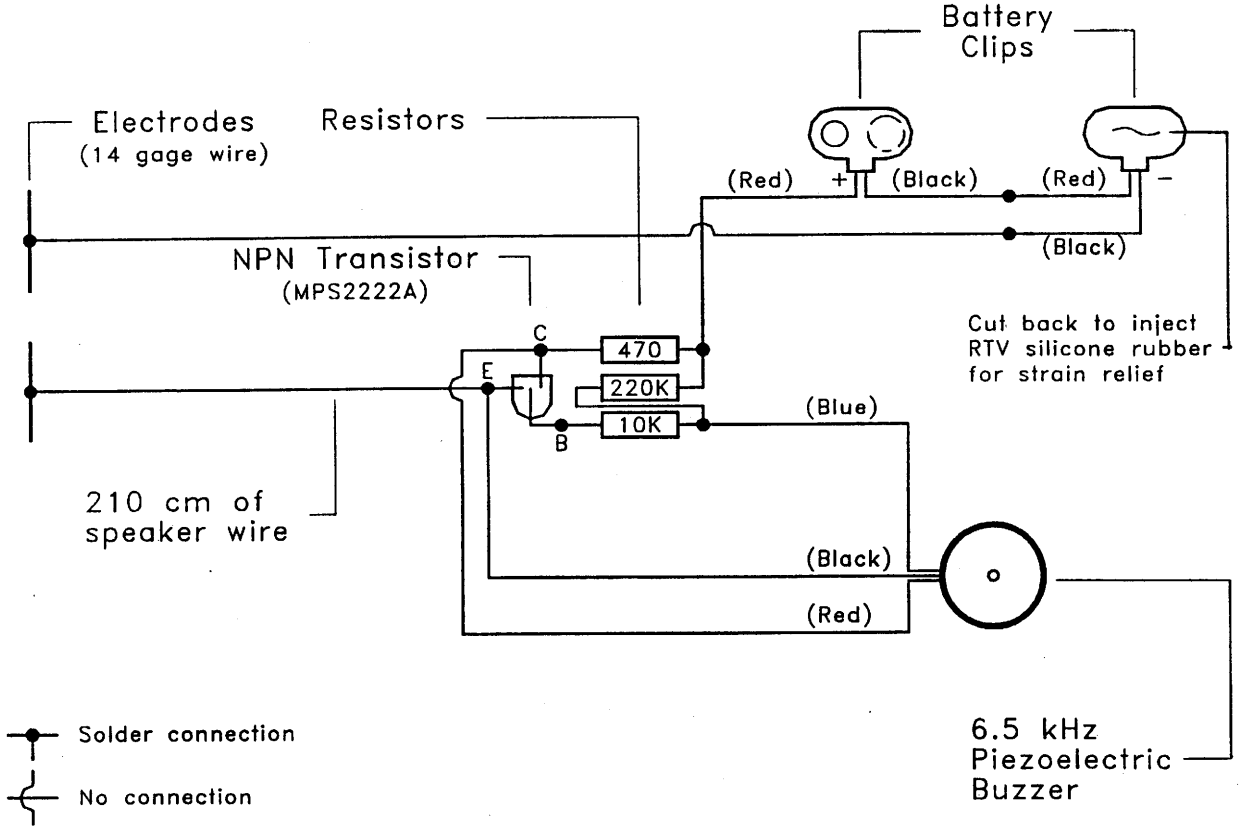


Figure 1. Typical dimensions for the PVC body of the groundwater-level measuring device (all measurements in cm, not drawn to scale).

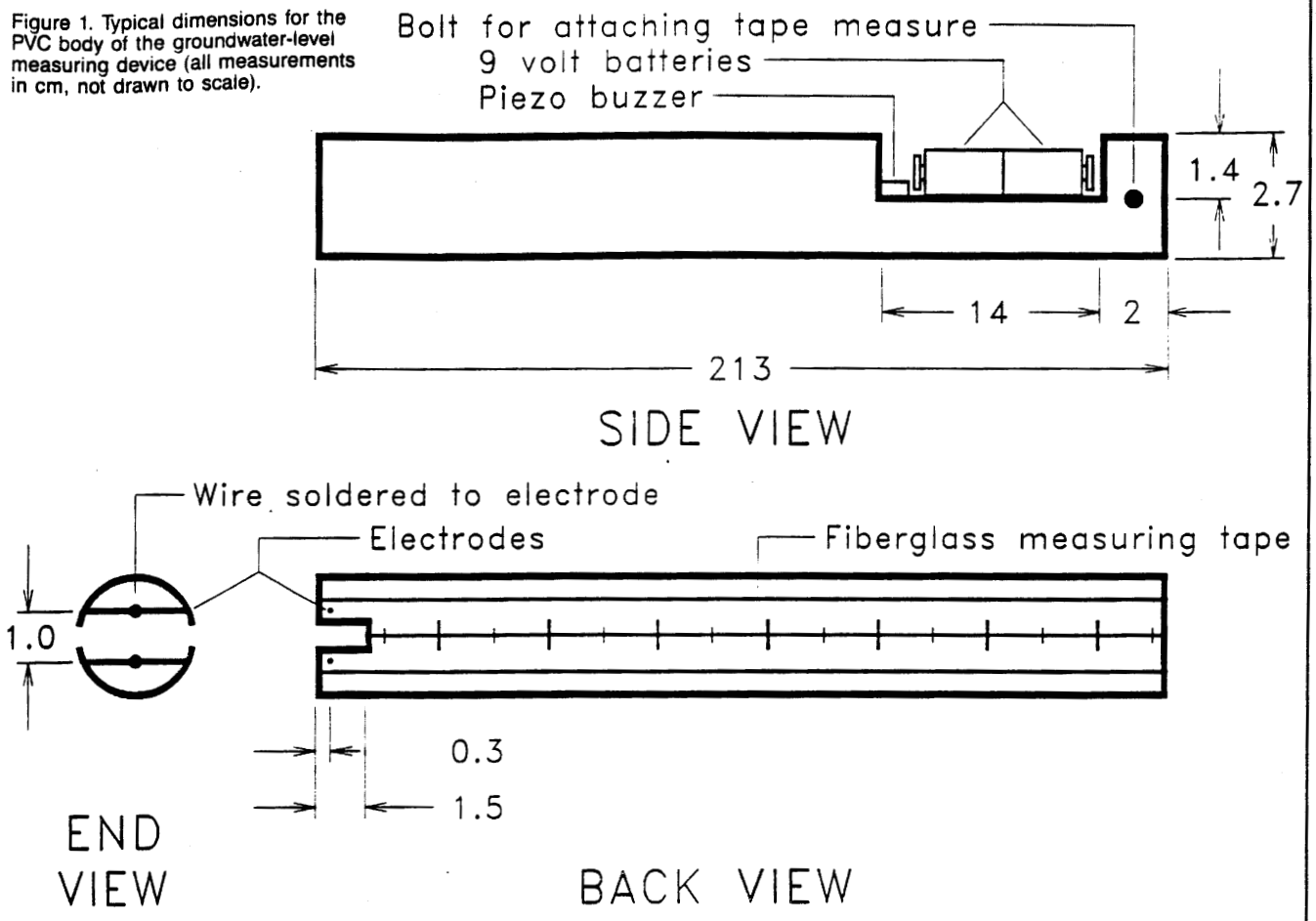
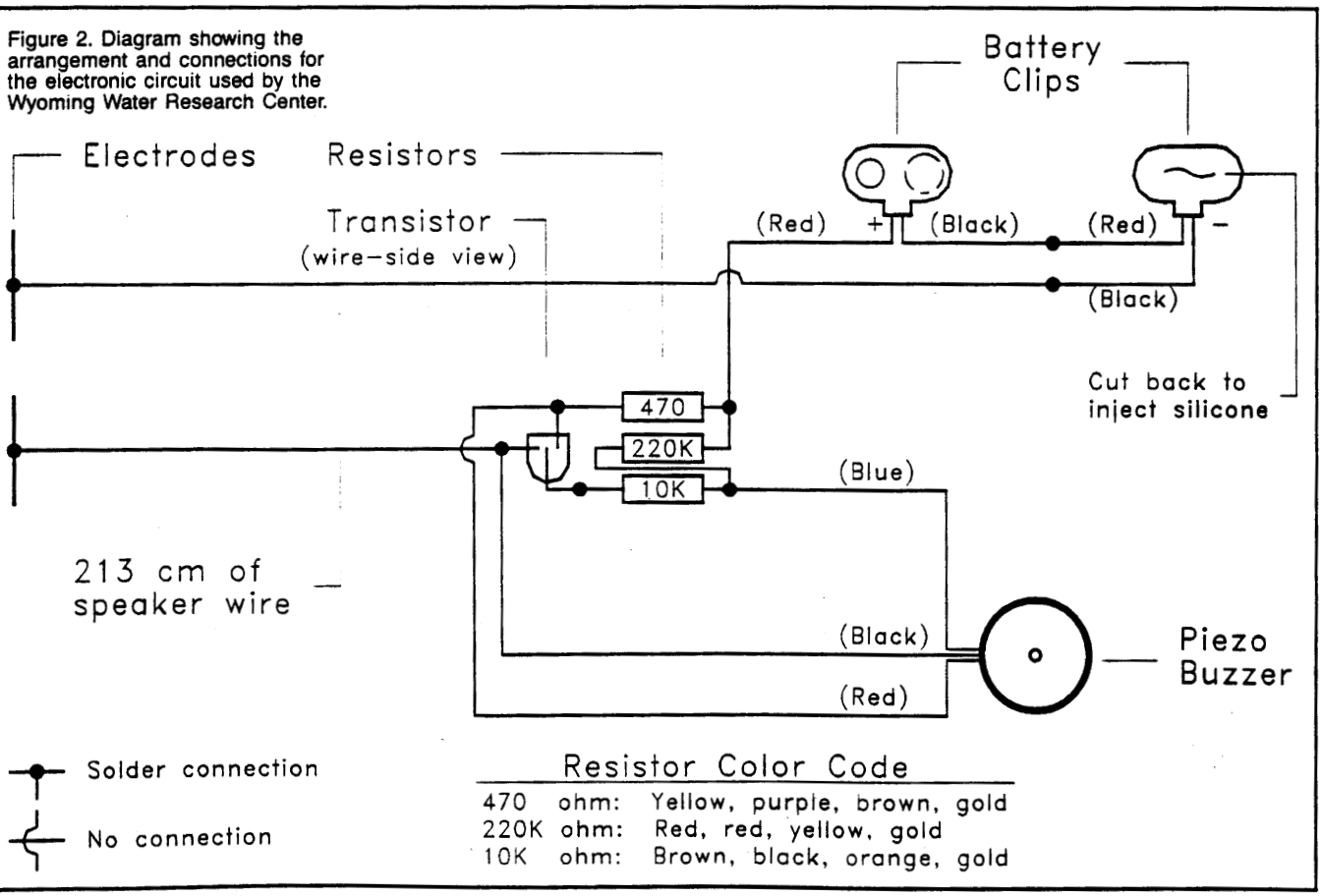


Figure 2. Diagram showing the arrangement and connections for the electronic circuit used by the Wyoming Water Research Center.



Resistor Color Code

470	ohm:	Yellow, purple, brown, gold
220K	ohm:	Red, red, yellow, gold
10K	ohm:	Brown, black, orange, gold

A simple, inexpensive device for measuring shallow groundwater levels

By Robert J. Henszey

ABSTRACT: Previously available groundwater-level measuring devices were either time-consuming, bulky, or impractical for measuring shallow groundwater levels in wet meadows. This simple device was developed to rapidly sample nearly 300 wells in a shallow groundwater-well network. The device requires basic workmanship skills to construct and is made from PVC pipe, 2 cm (0.8 inch) diameter, and inexpensive electronic components.

I developed a simple, inexpensive device to rapidly and accurately measure shallow groundwater levels in wet meadows. Previously available equipment, for example, chalk and tape and cabled probe, were either time-consuming, bulky, or impractical for measuring shallow groundwater levels. Cabled probes also may cost more than $400. In addition, many of these devices use measurement intervals too coarse to measure shallow groundwater levels accurately. The typical measurement interval is either 30 cm (1 foot) or 150 cm (5 feet).

My device uses a measurement interval of your choice, typically 3 mm (0.01 foot), and the parts should cost less than $20. Because there is no cable to coil or line to rechalk, each well takes only a few seconds to measure. The device has been used successfully in the montane meadows and cold deserts of Wyoming and along the Platte River in Nebraska.

Researchers interested in sampling groundwater levels within 200 cm (6.6 feet) of the top of their well casings will find this device convenient and fast to use. Construction requires basic workmanship skills and the ability to use a soldering iron. An electronic circuit, made from components available at many electronics hobby stores, is housed within a 210-cm (7-foot) length of 2-cm (0.8-inch) inside diameter PVC pipe (Figure 1). When water inside the well completes the circuit, a piezoelectric buzzer sounds, and the water depth is read from a measuring tape attached to the side of the PVC pipe. The device also can be easily modified to measure greater depths by attaching a tape measure to its end.

A general description for construction of the device follows. A more detailed description can be obtained from the author.

Construction

The body is made from a straight piece of PVC pipe with a section removed from one side to hold the electronic circuit (Figure 1). The length and configuration of the device can be adjusted to suit the situation. For measuring deep wells, a shorter PVC body, calibrated to add a known length to the end of a separate tape measure works well. Smaller components, for example, 1.3-cm-diameter pipe and 6-volt batteries, can be used when the device must be inserted into well casings < 4.5 cm (1.8 inches) in diameter. The scale on the side of the device can be made from a scrap piece of fiberglass tape from a broken tape measure.

The electronic circuit has three resistors, one NPN transistor, one piezoelectric buzzer, and two electrodes (Figure 2). Other circuit configurations are possible, but this configuration has worked well. The components are soldered together and then coated with RTV silicone rubber for water proofing. The piezoelectric buzzer can also be made water resistant by opening the buzzer housing and applying liquid plastic or lacquer to the back of the buzzer element. The wires for the electrodes are fed through the PVC body, and the electrodes are held in place with 5-minute epoxy. Construction of the device is complete after the buzzer is glued into place with RTV silicone rubber and the batteries are attached to the device with clear tape. □

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