PROJECT NUMBER

TI0001

PROJECT DESCRIPTION

Floating swimming pool thermometer capable of being read at a distance

The temperature is displayed by flashing LEDs. For example, 73°F° is 7 flashes, a pause, and 3 flashes. 73.4°F is 7 flashes, a pause, 3 flashes, a short flash to represent the decimal point, then 4 flashes. Since zero flashes is invisible, the digit zero is displayed as a long flash. For example, 103.2° is 1 flash, pause, long flash, pause, 3 flashes, pause, short flash, pause, two flashes. The theoretical range -468° to 292°. The software correctly displays temperatures from 0.0°F to 199.9°F. Realistically, the batteries stop working about 32°F and the hottest I have measured is about 134°F.

To direct the light to the observer regardless of the orientation of the device as it floats in the pool, the LEDs are mounted in a circle pointing horizontally away from the center of the circle. Since the processor can only provide 10 ma of current, a measurement is displayed on one LED, then each subsequent measurement is displayed on another LED until the cycle is complete.

This device could use normal throwaway batteries, but to save the trouble of changing them, a solar cell is used to charge two AA ni-cd batteries during the day, providing enough power to operate the device all night long. The solar cell was salvaged from a broken solar patio light.

The entire circuit is enclosed in a clear plastic enclosure which is sealed to keep it dry. A small packet of silica gel dessicant is enclosed to absorb any moisture in the air when the enclosure was sealed.

SOFTWARE DESCRIPTION

The processor only executes instructions when an interrupt occurs from the ADC10 analog to digital converter, or from TIMER A. It is in low power mode most of the time. The microprocessor consumes about 70 µa. When the LEDs are on, each one consumes its maximum rated current of 10 ma.

The formula to convert the ADC10 value to degrees Fahrenheit is:

$$°F = (ADC10 - 630) * 76.142 / 1024;$$

To implement this using integer arithmetic with an accuracy of 0.1 degrees, compute 20 *°F using 171/23 for 20 * 76.142/1024, giving

$$20*°F = (ADC10 - 630) * 342 / 23$$

This means that a change in 1 count in the ADC10 value represents a change of 171/230 or about 3/4 degrees. To get a more accurate measurement, average together several values.

$$20*{}^{\circ}F = (ADC10 * 342 - (342 * 630) / 23$$

Instead of reading the ADC10 once and multiplying by 342, read the ADC10 342 times and add the values. Subtract 215460 and divide by 23 to get a value accurate to within 1/20 degree.

Compare this value with the previous value. If it is close, retain the previous value. If it has changed enough, replace the previous value. Display by turning on and off LEDs under control of TIMER A.

BILL OF MATERIALS

1 - Schmartboard

1 - MSP430F2012 microprocessor

1 - 47KΩ resistor to pull up the /RESET signal on the microprocessor

6 - LEDs

6 - 150 Ω current limiting resistors

1 - 3V photovoltaic cell

2 - rechargeable NiCad batteries

1 - Diode to prevent batteries from discharging at night

1 - Battery holder

1 - Cylindrical clear plastic enclosure with screw on lid

1 ½ pounds lead weights

1 - packet of silica gel to absorb moisture

Various wire, solder, connectors, insulators, and sealant.