SOLUTIONS

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Tips & Tricks Using the 8-Pin PIC12F675

Part I: The RC Timing Method

PIC12F675 Features

- On-board 4 Channel 10-bit A/D converters
- 1 LSB INL/DNL (Comparable to most stand-alone A/D)
- VDD or External Voltage Reference

The benefits of these product features give your customers a highly accurate device while at the same time reducing the external components for their application. The 10-bit A/D allows you to eliminate external components for scaling and adjusting levels when measuring lower resolution signals. The result is an easy, direct interface to sensors or other analog signals.

Figure 1 depicts how the PIC12F675 could be used in a typical application for spa controls where there is a need to sense water level as well as water temperature. If the application requires a higher degree of resolution, this series also offers tips on implementing this type of solution.

Reading a Sensor with Higher Resolution

1. RC Timing Method with Reference Resistor
2. Charge Balancing Method
3. A/D Method

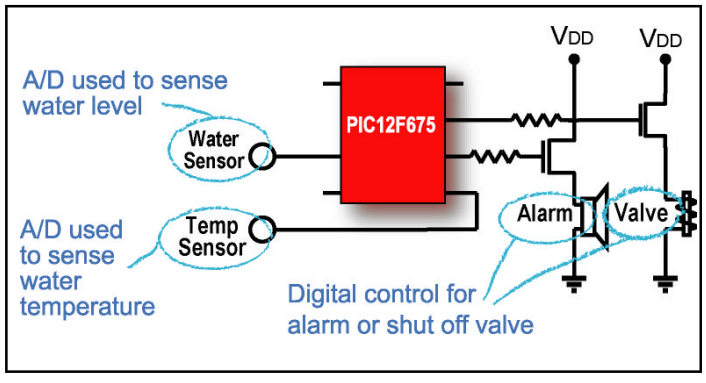

Figure 1: Use of A/D converter water level sensor

Sensors can be read directly with the A/D but in some applications, factors such as temperature, external component accuracy, sensor non-linearity and/or decreasing battery voltage need to be compensated for. In other applications, more than 10-bits of accuracy is needed and a slower sensor read is acceptable. This series will cover ways of dealing with these factors and getting the most of a PICmicro® microcontroller.

RC Timing Method

Simple RC step response
$Vc(t) = VDD * (1 - e^{-t/(RC)})$
$t = -RC \ln(1 - Vth/VDD)$
Vth/VDD is constant
$R2 = (t2/t1) * R1$

A reference resistor can be used to improve the accuracy of an analog sensor reading. In Figure 2, the charge time of a resistor/capacitor combination is measured using a timer, and a port input or comparator input switches from a '0' to '1'.

The R1 curve uses a reference resistor and the R2 curve uses the sensor. The charge time of the R1 curve is known and can be used to calibrate the unknown sensor reading, R2. This reduces the affects

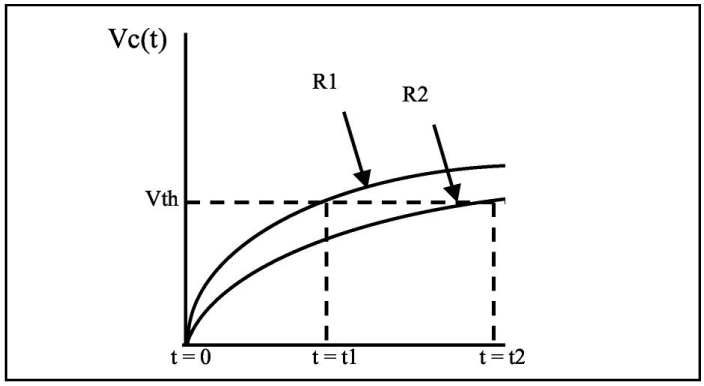

Figure 2: RC timing method with reference resistor

of temperature, component tolerance and noise while reading the sensor.

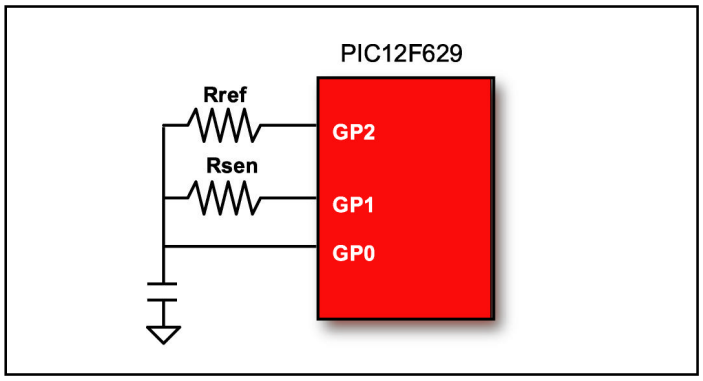

Figure 3: Using a reference resistor to improve accuracy of an analog sensor reading

Figure 3 is the schematic and software flow for using a reference resistor to improve the accuracy of an analog sensor reading. The reference resistor (Rref) and sensor (Rsen) are assigned an I/O and share a common capacitor. GP0 is used discharge the capacitor and represents the capacitor voltage.

Through software, a timer is used to measure when GP0 switches from a '0' to a '1' for the sensor and reference measurements. Any difference measured between the reference measurement and its calibrated measurement is used to adjust the sensor reading resulting in a more accurate measurement.

The comparator and comparator reference on the PIC12F629 /675 can be used instead of port pin for a more accurate measurement. Polypropylene capacitors are very stable and beneficial in this type of application.

Steps for Implementation

Step 1: Set GP1 and GP2 to inputs, and GP0 to a low output to discharge C.

Step 2: Set GP0 to an input and GP1 to a high output.

Step 3: Measure tRsen (GP0 changes to 1).

Step 4: Repeat step 1.

Step 5: Set GP0 to an input and GP2 to a high output.

Step 6: Measure tRref (GP0 changes to 1).

Step 7: Use film polypropylene capacitor.

Step 8: Rth = x Rref

Other alternatives: Voltage comparator in the PIC12F6XX

Additional Application Notes

AN512 *Implementing Ohmmeter/Temperature Sensor*

AN611 *Resistance and Capacitance Meter Using a PIC16C622*