RMV ELECTRONICS INC.	Application note #: 20
Application Note	**Date**: Feb 1995
Title: LIQUID LEVEL MEASUREMENT USING AN ITC232-A	**Status: Final**

Keeping track of the level of water or any other polar solution using conductivity is not a trivial task. It involves (1) measuring the liquid's resistance, (2) digitizing the resulting analog signal and (3) transferring the results to a computer. Since the intrinsical conductance of the liquid can change (due to temperature variation or different liquid batches) it is best to take a ratiometric measurement. For this, the resistance of a pair of electrodes going from the top to the bottom of the tank is compared to the resistance of a short pair of electrodes placed at the bottom.

Instead of using an AC generator, a precision rectifier and an A/D converter (all this to prevent electrode polarization), a simpler approach can be taken: The liquid in question can be the resistance in an RC network (Fig 1). The time it takes to charge C to a given voltage is a direct and linear function of R. To prevent electrode polarization, the electrodes are switched around ~ 1000 times/s.

Generating the square wave necessary for flipping the electrodes around, selecting the pair of electrodes, reading the RC network constant and sending the results to a computer is all done by just an ITC232-A, a pair of 4066 analog switches, and a few other components as shown in Figure 2. The system requires only minimal programming time on the computer side, the necessary functions for reading resistance and generating the PWM are embedded in the ITC232-A. Thus, a great deal of time is saved in developing costs.

The command used to generate the square pulse out the PWM pin is <W>idth <f><;> <dc> where f=frequency and dc=duty cycle (Notes: only the characters within <> are sent, a command must end with a CR and any communications software can be used to issue the commands). In Fig. 2, U1 converts TTL into RS232 levels. The ITC232-A PWM pin drives an analog switch (U3) which flips the electrodes around. U4 selects the electrode pair and it is controlled by PA0 and PA1 on U2. The <P>ort <C>onfigure <A> <3> command (required only once in a session) configures PA0 and PA1 as outputs. <P>ort <W>rite <A> <1> or <2> select the Reference or the Measuring electrodes respectively. Finally, we read the RC constant using PC0 and the command <R>esistance <0>, which returns a value between 0 and 32767. The sequence of commands is then: PCA2, PWA1, R0 (the result of which goes into a variable {CalVar}), PWA2 and R0 (which is stored in MeasVar). The cycle (excluding PCA2) is repeated in an endless loop. Though the ITC232-A can work all the way up to 115200 Baud, we found 9600 (the default) to be perfectly suitable for this project, thus allowing for a very friendly user interface created in Visual Basic. The fluid level is calculated using Level[in cm or inches] = MeasVar * Length[in cm or inches] of Reference Electrodes / CalVar.

VCC

R

PC0

C

Fig. 1

C2 25pF   X1 3.6864 MHz   C3 25 pF

RESET

SW1

10K
R2

VCC

R1
10M

RST   OSC1   OSC2   PC7   21
VDD   PC6   22
IRQL   PC5   23
IRQH   PC4   24
PWM   PC3   25
                       PC2   26
                       PC1   27
PA7   PC0   28   PC0
PA6   PB7   19   CAP
PA5   PB6   18
PA4   PB5   17
PA3   PB4   16
PA2   PB3   15
PA1   PB2   14
PA0   PB1   13
                       PB0   12
BAUD   PD3/PS_VDD   34
232 TX PD2/PS_CK   33
232 RX PD1/PS_TX   32
       PD0/PS_RX   31

U2
ITC232-A

C5 10nF

VCC

U1

C1+   V+
C1-
C2+   V-
C2-

C1 10nF

C6 10nF

C4 10nF

TO COMPUTER SERIAL PORT

RX
TX
GND

TO1   TI1
RI1   RO1
TO2   TI2
RI2   RO2

VCC

MAX232

VCC

U3

IN1   OUT1
IN2   OUT2
IN3   OUT3
IN4   OUT4

PC0

CTL1
CTL2
CTL3
CTL4

4066

VCC
R3 1K

R4
1K

Q1
2N3904

U4

IN1   OUT1
IN2   OUT2
IN3   OUT3
IN4   OUT4

PA0   CTL1
CTL2
PA1   CTL3
CTL4

4066

REFERENCE ELECTRODE 1
REFERENCE ELECTRODE 2
MEASURING ELECTRODE 1
MEASURING ELECTRODE 2

Fig. 2