APSC 380 : INTRODUCTION TO MICROCOMPUTERS
1997/98 WINTER SESSION TERM 2

# Assignment 5 - Analog Interfaces

*due Monday, March 23 1998*

1. An A/D converter is interfaced to a microcomputer through two one-byte ports at memory locations 0xff00 and 0xff01. The port at the lower address is used for control (when written) and status (when read from). A '1' must be written to the least-significant bit of this port to start a conversion. When the least-significant bit of this port is read as a zero (binary xxxx xxx0) it indicates that a conversion is in progress. When the LS bit is one, it indicates that the conversion is complete. The port at the higher address (0xff01) contains the converted value. The value read from this port is in offset binary format (most negative value = 0x00, most positive=0xff).

   Write a C function that causes a conversion to be performed and returns the converted value as a signed int (from -128 to 127). You may use the `speek()` function used in the labs.

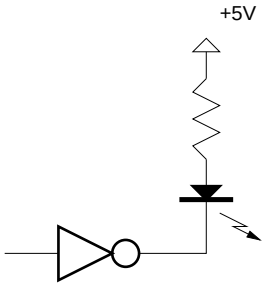
2. Match the most likely type of A/D converter given in the second column with the specifications (resolution, conversion rate) given in the first column.

| Specifications | Converter Type |
|---|---|
| 1. 12 bit, 50 kHz | (a) Dual Slope |
| 2. 6 bit, 50 MHz | (b) Successive Approximation |
| 3. 18 bit, 5 Hz | (c) Flash |

3. A distance sensor is built using two moving plates to form a capacitor. This capacitor is connected to an oscillator. The frequency of this oscillator is determined by the capacitance of the sensor. The oscillator frequency is measured and this gives an indication of the spacing between the plates.

   The frequency is proportional to the square root of the plate spacing. Assume the initial oscillator frequency is 1 MHz. If the distance between the plates increases by 1%, what will be the new frequency? If the frequency is determined by counting oscillator output cycles for a period of 100 ms, how many cycles will be counted in each case?

4. The following diagram shows a logic gate being used to drive an LED. When the gate output is low, it sinks current and the LED turns on. Assume that the low-level output of the gate is 0.7 V and that the voltage drop across the diode is 1.5 V. What value of resistance (R) should be used to obtain a current through the diode of 8 mA? How much power will be dissipated by the resistor? How much power will be consumed by the LED?




5. An NPN bipolar transistor being used to control a 12V motor. The motor is designed to draw 5 A for a supply voltage of 12 V DC. The switching transistor will be housed in a compartment with an estimated maximum ambient temperature of 60C.

   Assume the specifications given in Table 1 for the "Darlington" power transistor.

   (a) What is the minimum base current required for a 5 A collector current?

   (b) Assume that the base-emitter voltage at saturation is 0.7 V and the logic gate high-output level is 3.7 volts. What value of resistance R will result in a base current 3

| specification | value | units |
|---|---|---|
| maximum collector current | 15 | A |
| collector-emitter voltage at saturation | 0.4 | V |
| current gain (in this ‘CE’ configuration) | 2500 | - |
| maximum power dissipation | 90 | W |
| maximum junction temperature | 180 | degrees C |
| junction-case thermal resistance | 1.5 | degrees C per W |

times greater than the minimum value calculated above?

(c) How much power would be dissipated by the base resistor in this case? By the transistor? By the motor? Would the transistor be operating within its specifications?

(d) Assume the case-to-heatsink thermal resistance is negligible. What is the maximum allowable thermal resistance of the heat sink?

6. A signal from a sensor ranges between -5.050 and -5.250 volts. You need to feed this signal to an 8-bit A/D converter that has a full-scale input range from 0 to 5 volts. What values would you pick for R1 and R2 in the circuit below to obtain the best resolution from this A/D converter.