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 October 5, 2005, 1 to 1:50pm

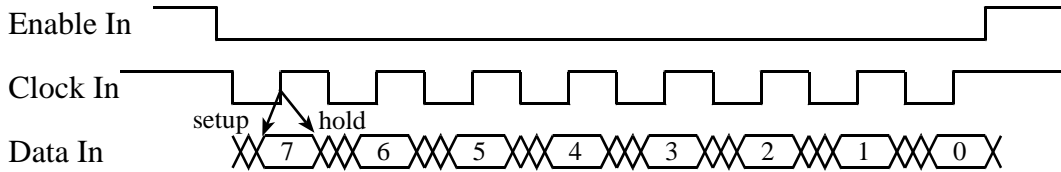
This is an open book, open notes exam. You may put answers on the backs of the pages, but please don't turn in any extra sheets.

(20) Question 1. In this question the input parameter is the temperature, T_C , which is a 16-bit signed binary fixed-point number with a resolution of $1/8^\circ\text{C}$. The integer portion of this parameter is stored in memory as the variable Ic . The output of this function will be the temperature, T_F , which is a 16-bit signed binary fixed-point number with a resolution of $1/8^\circ\text{F}$. The integer portion of this parameter is stored in memory as the variable If . Write C code that implements the conversion from $^\circ\text{C}$ to $^\circ\text{F}$ using fixed-point math. In particular, calculate $T_F = 1.8 * T_C + 32^\circ$.

```
short Ic, If;
void Convert(void){ // convert Ic to If
```

}

(15) Question 2. A, external device will be interfaced to the 6812 using SPI. There are three signals that will be outputs of the 6812 and inputs to the device (**Enable**, **Clock**, and **Data**). The timing of the external device is shown below.

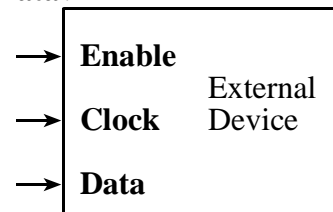


Part a) What CPHA, CPOL mode should you use? Put your answers in the boxes.

| | |
|------|--|
| CPHA | |
| CPOL | |

Part b) Should the 6812 be a master or slave?

Part c) Which 6812 pins should be connected to **Enable**, **Clock**, and **Data**?



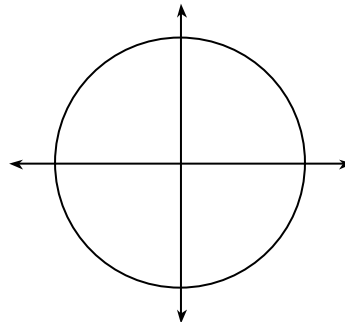
(10) Question 3. Assume the TCNT is running at 1.5 MHz, and channel 5 is armed as an output compare interrupt. The goal of the real-time data acquisition system is to accurately sample the ADC every 1ms using an output compare 5 interrupt. Consider the two implementations below. Draw a circle around the ISR that is more accurate, and why? If they are equally accurate, then explain why.

| | |
|--|---|
| <pre> interrupt 13 void TC5han(void){ TFLG1 = 0x20; // ack TC5 = TC5+1500; // rate Fifo_Put(ADC_In(0)); // sample } </pre> | <pre> interrupt 13 void TC5han(void){ TFLG1 = 0x20; // ack TC5 = TCNT+1500; // rate Fifo_Put(ADC_In(0)); // sample } </pre> |
|--|---|

(20) Question 4. The sampling rate of a real-time data acquisition system is 1000 Hz. Assume there are large amplitude noise components above 1000 Hz. There is also a large amplitude noise component at 125 Hz.

Part a) Without changing the sampling rate, how do you remove aliasing? Put as much detail into the space provided.

Part b) Show pole-zero plot for the design of a high-Q 125-Hz digital reject filter. Just draw the positions of the poles and zeros. You do not have to calculate the $H(z)$ or show the filter equation.

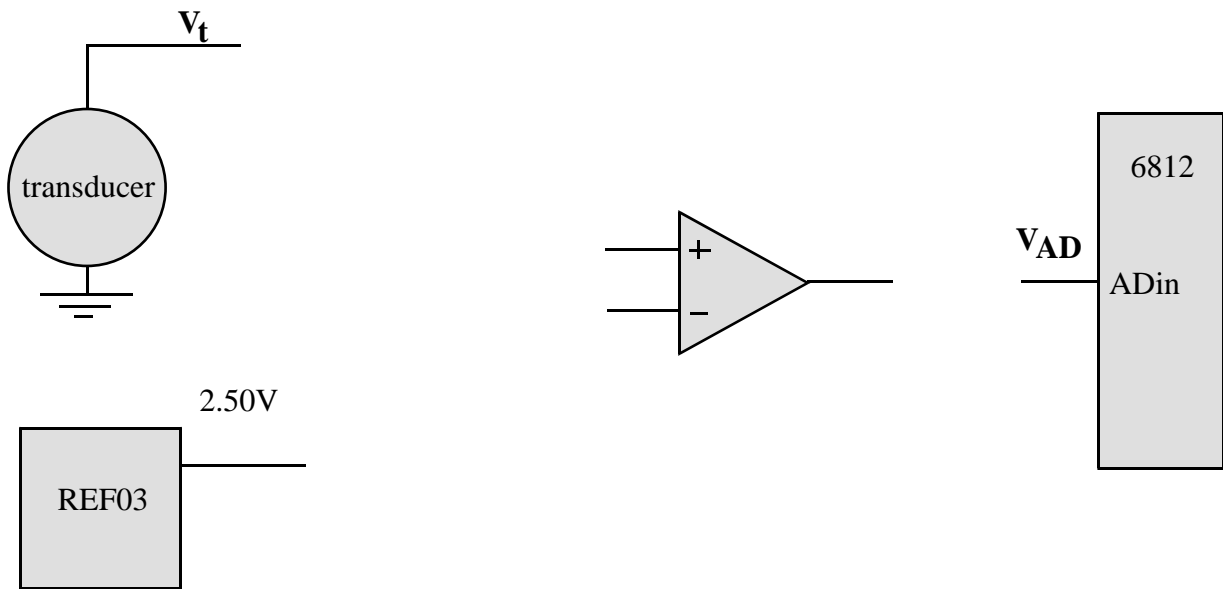


(5) Question 5. Did the solid state disk in Lab 25 have internal fragmentation? Explain.

(30) **Question 6.** The objective of this question is to design the analog electronics to interface a transducer to the 0 to +5V built-in ADC of the 6812. The transducer output, V_t , is a single voltage (relative to ground, not differential), with a range of 0.5 to 1 volts.

$$V_{AD} = 10V_t - 5$$

Part a) Build this interface with one op amp and a REF03 2.50V analog reference. You do not need to show the power connections. You do not need to include an analog low pass filter.



Part b) What is the voltage resolution, referred to input V_t , of the system if the ADC has 10 bits?