

EECS 388 Homework #5 Solutions

Assigned: October 30, 2018

Due (at the beginning of class): November 6, 2018

This homework concerns FreeRTOS and TM4C1294 ADCs. You may have to refer to the FreeRTOS API at: <http://www.freertos.org/>. On the upper left side of the page, expand the "FreeRTOS" menu item and then expand the "API Reference" menu item. A list of API groups should appear. Each group has a list of subroutines for that group API.

You may also have to access and read the manuals at: http://www.freertos.org/Documentation/RTOS_book.html. In particular, the "FreeRTOS V9.0.0 Reference Manual." While this manual is for FreeRTOS version 9.0, we use basic concepts and subroutines that have not changed significantly.

Each problem is worth 10 points unless otherwise noted.

1. When generating a Pulse Width Modulated (PWM), what are the two key parameters used to set the period or pulse width?

The scale factor and the load value

2. Explain a timer pre-scaler and its purpose.

The pre-scaler divides the system clock by an integer factor. The resulting clock has a longer (larger) period and lower frequency.

*3. Suppose a general-purpose timer is configured for A/B mode, i.e. two 16-bit timers (**TIMER_CFG_SPLIT_PAIR | TIMER_CFG_A_PERIODIC in TimerConfigure**). The timer generates a periodic signal with a period of 80 ms. What values of K (scale factor) and M (load value) will generate this signal. The System Clock is 120 MHz.*

$$T_t = (8.33 \text{ ns} * K) * M$$

Pick $M = 50,000$.

$$80 \text{ ms} = (8.33 \text{ ns} * K) * 50000 \Rightarrow K = 80 \text{ ms} / (8.33 \text{ ns} * 50000) \Rightarrow K = 192.08$$

Pick $K = 192$ and $M = 50,000$.

$$T_t = (8.33 \text{ ns} * 192) * 50000 = 79.97 \text{ ms}.$$

4. For an ADC, the input signal (V_{in}) can change while the conversion is taking place. What circuit is used to prevent the changing V_{in} signal from affecting the measurement?

A sample and hold circuit is used.

5. If a general-purpose timer is configured to run in 32-bit mode, what is the longest possible interval between “zero flags”? Assume the System Clock is 120 MHz.

$$T_{max} = (8.33 \text{ ns} * 1) * (2^{32} - 1 + 1) = 35.78 \text{ s.}$$

6. For the TM4C1294 ADCs, how many sequencers are there for each ADC? What is the FIFO size for each sequencer in ADC1?

There four sequencers per ADC on the TM4C1294.

The FIFO size for each sequencer, 0, 1, 2, and 3 is 8, 4, 4, and 1, respectively (Table 15-2 in TM4C1294 datasheet).

7. What is the base address of the PWM peripheral?

0x4002.8000

8. How many analog inputs are available to ADC1 on the TM4C1294 micro-controller?

ADC0 has 20 possible analog inputs.

9. The TM4C1294 ADCs can oversample in hardware. Explain oversampling and why one would use it.

Oversampling is taking multiple measurements and averaging those measurements to obtain a value. The purpose of oversampling is to reduce the effect of signal noise on the average value.

10. Name three capabilities (functions, ways to use) a general-purpose timer.

Timers can be used for:

A single time interval (one-shot mode)

A periodic time interval

Counting external events

Measuring the time interval between two external events