

EE443 - Embedded Systems

## Exercise - 3

### Microcontroller Hardware

1. What are the three other factors besides the clock frequency, that should be considered while evaluating performance of a processor?
2. Categorize (RAM or ROM/FLASH) the following memory functions in calculating memory requirements for RAM and PROM/FLASH size of a microcontroller in a typical application.
  - a) Calibration data
  - b) Memory stack
  - c) Variables
  - d) Program code
  - e) Data structures
  - f) Look-up tables
  - g) Internal I/O buffers
  - h) User settings
3. Describe the three important specifications for a clock generator indicating the conditions or application requirements that make each specification critical.
4. Describe four of the electrical specifications that can be critical for performance of a DAC.
5. What are the three common operating modes of timers? Give an application example for each mode of operation.
6. What is the usage of a watchdog timer? How does it check for proper program execution?
7. Describe the four advantages of integrating as many as possible peripheral units or interface circuits in a single microcontroller IC.
8. What are the four advantages of the on-board serial interface compared to a parallel interface that can be used for the same purpose?
9. You need to measure duration of pulses using a timer. Calculate the best timing resolution in ns you can achieve with the following conditions.
  - The maximum pulse duration you need to measure is 5ms.
  - You have a 16-bit timer.
  - You can select between 2MHz, 5MHz, 10MHz, and 20MHz timer clock frequencies.
  - The controller clock frequency has +/-20ppm absolute accuracy at 25°C.
  - Temperature dependence of the controller clock frequency is 1ppm/°C.
  - The system operating temperature range is -5°C min. to 55°C max.
  - The jitter at the input pulse falling edge is +/-50ns with respect to the rising edge.

**10.** Calculate the best temperature measurement accuracy in °C you can achieve with the following setup:

- Temperature sensor output sensitivity: 10mV/°C
- ADC resolution: 10 bits
- ADC input range: 0.0V...1.0V
- ADC reference voltage accuracy: +/-1000ppm
- Absolute ADC linearity error: +/-1 LSB

**11.** You need to control the speed of a motor. The motor speed will be detected by measuring the revolution time with a timer. Calculate the specifications for the timer according to the following requirements:

- Speed range: 3000-6000 rpm
- Speed accuracy: +/-1.0 %
- Timer clock stability over the temperature range: +/-100 ppm

**a)** What is the minimum clock frequency for the timer?

**b)** What is the minimum number of bits for the timer counter?

**12.** A power driver will be controlled through a pulse width modulator (PWM).

Calculate the specifications of the PWM controller for the following requirements:

- PWM frequency: 10 KHz
- Maximum PWM duty cycle: 50 %
- Minimum number of power output steps: 1000

**a)** What is the minimum clock frequency for the PWM controller?

**b)** What is the minimum number of bits for the PWM controller?