Mittuniversitetet
MID SWEDEN UNIVERSITY

Försättsblad Prov Original

Kurskod	Provkod	Tentamensdatum
ET032G	T209	2018-04-03
Kursnamn	Elektroteknik GR (A), Mikrodatorteknik	
Provnamn	Skriftlig tentamen 2	
Ort	Sundsvall	
Termin	V18	
Ämne	Elektroteknik	

Exam in Introduction to Embedded System Programming Part 2 (HT2017)

Course codes: ET032G, ET095G

Information

Date:	2018-04-03
Duration:	3 hours
Examiner:	Sebastian Bader
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Maximum achievable points:	50
Minimum required points to pass:	25
Aids (Hjälpmedel):	Calculator

General Instructions

- Begin the answer to every question on a separate sheet of paper
- Do not write in red color
- For calculations, the way towards the result has to be clearly understandable
- Direct citations from lecture slides will not be accepted as an own contribution

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Questions

Question 1:

Documentation is an essential part of working with software development, which is also true for embedded system programming. Documentation can have different purposes and can be intended for different target groups. It is, for example, possible to separate documentation into *Code Documentation* (e.g., through code comments); *API Documentation* (e.g., through library websites); and *Application/Program Documentation* (e.g., through flowcharts or state diagrams).

Describe the difference of these three documentation groups by describing the overall purpose of each category and by exemplifying their intended target audience. (6)

Question 2:

Assume that an analog sensor is connected to the ADC of a microcontroller. The ADC has a resolution of 14-bit and uses a 3 V reference. The ADC rounds to the closest integer.

(a) What value will the ADC output if the sensor provides a voltage of 1 V? (4)

(b) In which range can the sensor voltage be if the ADC provides an output value of 13652? (4)

(c) Explain what effect changes in the reference voltage have (ADC resolution stays constant). (4)

Question 3:

Pulse Width Modulation (PWM) is a common resource in modern microcontrollers, which allows to some extend to emulate analog outputs on a digital output pin.

(a) Explain how PWM performs this emulation. (4)

(b) Explain the terms *Duty Cycle*, *Pulse Width* and *Period* in the context of PWM. (6)

Question 4:

Counter registers can not only store digital information (as normal registers do), but its content can change based on a clock input.

How long will it take for a 16-bit counter register to reach its maximum value if it starts at an initial value of 0 and is connected to a 8 MHz clock signal? Motivate. (4)

Question 5:

Timers (which are based on counter registers) are frequently used to generate periodic events (i.e., to perform code executions repeatedly with a fixed time interval).

(a) Timers can be polled, but often also provide interrupts. Describe the main advantage, and its consequences, of using interrupts in combination with timers. (4)

(b) Timers also often provide different operating modes and respective interrupts. What is the difference between an *overflow interrupt* and an *output compare interrupt*? (4)

Question 6:

In low-level programming of microcontrollers, peripherals are typically controlled by bit manipulations in registers. In C/C++, these manipulations are performed through bitwise logic operators. Provide C/C++ code lines that achieve the following manipulations on an 8-bit register (bit7 to bit0) with the name reg:

(a) Set bit0 without changing any other bit. (2)

(b) Clear bit4 without changing any other bit. (2)

(c) Toggle bit5 without changing any other bit. (2)

Question 7:

GPIO interrupts can typically be configured to occur on rising or falling edges. Assume that a pushbutton is connected to an interrupt-enabled GPIO pin (configured as an input). The pushbutton generates a high-level (logic one) at the GPIO pin when it is pressed and a low-level (logic zero or zero volt) otherwise.

Does the configuration of the interrupt (falling or rising edge) have an effect? And if so, what effect does it have? Motivate. (4)