**CG1112 Engineering Principles and Practices II for CEG**

**Week 6 Tutorial Part 2 – Interrupts and Timers**

Question 1.

We wish to read a block of 16384 bytes from a disk drive.

1. We have the following program that reads from the drive using polling.

byteCount=16384;

i=0;

while(byteCount>0)

{

while(!DRIVE\_READY);

buffer[i++]=DRIVE\_DATA\_LATCH;

byteCount--;

}

Assuming that our microprocessor runs at 50 MHz and the drive transfers data at a rate of 1 megabyte per second (1 MBPS), how many clock cycles are spent on polling between each byte? How many clock cycles are spent in total on polling? 50

1. We now use interrupt driven I/O instead, and an interrupt is triggered each time a byte arrives from the drive. Assuming that it takes 50ns to process each interrupt, how many clock cycles are spent processing each interrupt? How many clock cycles are spent in total when we transfer 1 block from the drive?
2. There is a 3rd transfer mode not covered in lectures called Direct Memory Access or DMA, where a separate piece of hardware called the DMA Controller or DMAC completely takes over the transfer of data and sends an interrupt when the transfer is complete. The downside is that it takes a little bit of time to set up the transfer.

Assuming it takes 1000ns to set up a DMA transfer and 200ns to process the DMA interrupt, how many clock cycles are spent in total when transferring one block from the disk drive?

Question 2

Repeat Question 1, but with a block size of 8 bytes instead of 16384 bytes. Comment on the relative efficiencies of polling, interrupt driven I/O and DMA. From your answers comment on why devices like the keyboard, mouse and UART port do not use DMA. Time taken for DMA is longer than the time required to process the 8bytes.

Question 3

We are given the following contents of TCCR1A and TCCR1B, and OCR1A holds the value of 247. Given that TCNT1 is initially 0, that we are operating Timer 1 in CTC mode, and that all interrupt flags in TIMSK1 and SREG are properly set:

TCCR1A = 0b01010000;

TCCR1B = 0b00001100;

1. What is the interval between which TIMER1\_COMPA\_vect is triggered?
2. Sketch the waveform on OC1A.

Question 4

We want to trigger TIMER0\_COMPA\_vect on Timer 0 once every 650 us (microseconds) in CTC Mode. Complete the following table. Round up any cases where V is not an integer (e.g. 34.3 -> 35, 38.8 -> 39, etc). Assume that the Atmega328P is being clocked at 20 MHz and that CLKIO is identical to the Atmega’s frequency.

Note: If the V value cannot be loaded into OCR0A, write “N/A” in the Actual Period column.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Prescalar | Period in us | V (no rounding) | V (rounding) | Actual period |
| CLKIO/1 |  |  |  |  |
| CLKIO/8 |  |  |  |  |
| CLKIO/64 |  |  |  |  |
| CLKIO/256 |  |  |  |  |
| CLKIO/1024 |  |  |  |  |

Based on the table above comment on which value of V gives the best accuracy. Why do you think this is so?