ECE 355 Assignment 1

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1.

```
#define PBIN (volatile unsigned char *) 0xFFFFFFF3
#define PBOUT (volatile unsigned char *) 0xFFFFFFF4
#define PBDIR (volatile unsigned char *) 0xFFFFFFF5
#define CNTM (volatile unsigned int *) 0xFFFFFFD0
#define COUNT (volatile unsigned int *) 0xFFFFFFD4
#define CTCON (volatile unsigned char *) 0xFFFFFFD8
#define CTSTAT (volatile unsigned char *) 0xFFFFFFD9
#define IVECT (volatile unsigned int *) (0x20)

interrupt void intserv();
unsigned char digit = 0;
unsigned char isAllowed = 0;

int main()
{
    *CTCON = 0x2;  /* Stop Timer (if running) */
    *CTSTAT = 0x0; /* Clear “reached 0” flag */
    *PBDIR = 0xF0; /* Configure Port B direction*/
    *CNTM = 100000000; /* Initialize Timer */
    *IVECT = (unsigned int*) &intserv; /* Set up interrupt vector */
    asm(“ MoveControl PSR, #0x40 ”); /* CPU responds to IRQ */
    *CTCON = 0x11; /* Enable Timer interrupts and start counting */

    *PBOUT = 0x00; /* Display 0*/

    while (1) {
        while ((*PBIN & 0x2) != 0); /* Wait for E to be pressed */
        isAllowed = 1;

        while ((*PBIN & 0x1) != 0); /* Wait for D to be pressed */
        isAllowed = 0;
    }
    exit(0);
}

interrupt void intserv() {
    *CTSTAT = 0x0; /* Clear “reached 0” flag */
    if (isAllowed) {
        digit = (digit + 1) % 10; /* Increment digit */
    }
    *PBOUT = ((digit << 4) | 0x00); /* Update Port B */
}
```

2.

```
#define PBIN (volatile unsigned char *) 0xFFFFFFF3
#define PBOUT (volatile unsigned char *) 0xFFFFFFF4
#define PBDIR (volatile unsigned char *) 0xFFFFFFF5
#define CNTM (volatile unsigned int *) 0xFFFFFFD0
#define COUNT (volatile unsigned int *) 0xFFFFFFD4
#define CTCON (volatile unsigned char *) 0xFFFFFFD8
#define CTSTAT (volatile unsigned char *) 0xFFFFFFD9
#define IVECT (volatile unsigned int *) (0x20)
#define PSTAT (volatile unsigned char *) 0xFFFFFFE6
#define PCONT (volatile unsigned char *) 0xFFFFFFE7


interrupt void intserv();
unsigned char isAllowed = 0;
unsigned char digit = 0;


int main() {
    *CTCON = 0x2;  /* Stop Timer (if running) */
    *CTSTAT = 0x0; /* Clear “reached 0” flag */
    *PBDIR = 0xF0; /* Configure Port B direction*/
    *CNTM = 100000000; /* Initialize Timer */
    *IVECT = (unsigned int*)&intserv; /* Set up interrupt vector */
    asm(“ MoveControl PSR, #0x40 ”); /* CPU responds to IRQ */
    *PCONT |= 0x40; /*enable PBIN interrupts*/
    *PBOUT = 0x00; /* Display 0*/
    *CTCON = 0x11;


    while (1) {
        while ((*CTSTAT & 0x1) == 0); /* Wait until 0 is reached */
        if (isAllowed) {
            digit = (digit + 1) % 10; /* Increment digit */
            *CTSTAT = 0x0; /* Clear “Reached 0” flag */
        }
        *PBOUT = ((digit << 4) | 0x00); /* Update Port B */
    }
    exit(0);
}

interrupt void intserv() {
    if ((*PSTAT & 0x1F) == 1) { //IAIN event

        *PSTAT &= 0xFB; // Clear PBSIN flag

        if ((*PBIN & 0x2) == 0) { /* Wait for E to be pressed */
            isAllowed = 1;
        }
        if ((*PBIN & 0x1) == 0) { /* Wait for D to be pressed */
            isAllowed = 0;
        }

    }
}
```

3.

Data transfer rate: $R_{I/O} = 512\ KB/s = 512 \cdot 2^{10}\ B/s$

Transfer block size: $1KB = 1 \cdot 2^{10}\ B = 2^{10}\ B$

Let the activity percentage require be x

$x \in (0, 1)$

$$\text{Cost of DMA} = x \cdot \frac{R_{I/O}}{d_{I/O-DMA}} \cdot (N_{DMA\,start} + N_{DMA-end})$$

$$= x \cdot \frac{512 \cdot 2^{10}}{2^{10}} \cdot 1000$$

$$= x \cdot 5,12 \cdot 10^5$$

$$\text{- Cost of polling} = x \cdot \frac{R_{I/O}}{d_{I/O}} \cdot N_{Poll-ready} + (1-x) \frac{R_{I/O}}{d_{I/O}} \cdot N_{Poll\,not\,ready}$$

$$= x \cdot 2^{16} \cdot 300 + (1-x) \cdot 2^{16} \cdot 200$$

$= x \cdot 2^{16} \cdot 300 + 2^{16} \cdot 200 - x \cdot 2^{16} \cdot 200$

$= x \cdot 2^{16} \cdot 100 + 2^{16} \cdot 200$

For DMA cost to be 1000 time cheaper

$\Rightarrow$

$x \cdot 5,12 \cdot 10^5 \cdot 10^3 = x \cdot 2^{16} \cdot 100 + 2^{16} \cdot 200$

$\Leftrightarrow \quad x \cdot 5,12 \cdot 10^6 = x \cdot 2^{16} + 2^{17}$

$\Leftrightarrow \quad x \cdot 2^9 \cdot 10^3 = x \cdot 2^{16} + 2^{17}$

$\Leftrightarrow \quad x = \frac{2^{17}}{(2^9 \cdot 10^3 - 2^{16})} \approx 0,29$

$\Rightarrow$ At 29% active rate that DMA cost become 1000 times cheaper than polling cost