EE 308

Final Exam, Part 1

May 14, 2009

Name: _____

No calculators allowed. Show all work. Partial credit will be given. No credit will be given if an answer appears with no supporting work.

1. Fill in the blanks in this table. The numbers are stored in an 8-bit register.

Hex	Binary	Unsigned Decimal	Signed Decimal
AC			
		212	
			119
	10010110		

2. The following operations are done in accumulator A of an 9S12. Indicate the answer in accumulator A, and the state of the flags after the operations.

	5C + 7B	4D + B3	A7 + F2	C7 - 7A	35 - 7F
Acc. A					
C					
V					
N					
Z					

EE 308

Final Exam

May 14, 2009

Name: _____

You may use any of the Freescale data books, the class lecture notes, and a calculator. Show all work. Partial credit will be given. No credit will be given if an answer appears with no supporting work.

For all the problems in this exam, assume you are using an MS9S12 with an 8 MHz crystal, resulting in a 24 MHz bus clock.

Also, assume that `hcs12.h` has been included, so you can refer any register in the MC9S12 by name rather than by its address in any C code you write.

1. An MC9S12 executes the following set of instructions:

```
        org   $2000

        LDS   #$2000
        LDAA  #$A2
        PSHA
        DES
        LDX   #$89C4
        BSR   my_sub
        ...

        org $2040
foo:    LEAS  -4,SP
        STX   2,SP
```

   Show the value of the stack pointer and the stack frame (as much as you can tell) after the MC9S12 executed the `STX 2,SP` instruction.

2. The following tables show the values of an MC9S12's registers and some of its memory:

Reg	–	–
	S X H I N Z V C	
CCR	1 0 0 0 1 0 0 1	
A:B	A3	92
X	82F2	
Y	12F7	
SP	1F8D	
PC	21F4	

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
1000	C6	05	CE	09	00	DD	5A	33	6A	05	10	53	26	F7	3F	CE
1010	E0	00	CD	00	00	E6	00	0F	00	01	02	19	ED	10	8E	E0
1020	20	25	F2	7A	09	00	3F	CF	0A	00	15	FA	00	01	5F	A0
1030	01	3F	C6	80	5B	86	C6	03	5B	8D	C6	FF	5B	02	4C	80
FFD0	AB	20	CD	30	EF	40	F5	50	56	60	78	70	98	80	20	90
FFE0	84	A0	3F	B0	F3	D0	74	F0	9A	12	C2	10	A7	20	D9	30
FFF0	A5	3C	10	59	3A	43	10	19	93	7A	A4	5C	82	10	89	A0

(a) What is the address of the first instruction the MC9S12 will run after coming out of reset? _____

(b) What is the address of the first instruction of the Timer Overflow Interrupt interrupt service routine? _____

(c) Show what will be in the MC9S12's registers when it starts executing the first instruction of the Real Time Interupt interrupt service routine. (Use the table from above for the initial values of the registers.) For the stack frame, show the addresses and the contents of the stack which you can determine from the information you have.

Reg	–	–	Stack Frame
	S X H I N Z V C		
CCR			
A:B			
X			
Y			
SP			
PC			

3. Fill in the following table, showing the values of each of the registers and flags after execution of each instruction. Also, show the address where each instruction will be located, and indicate the addressing mode, effective address, and number of cycles it will take to execute the instruction. You do not have to put down a value if the value did not change.

Address	Inst	A	B	X	Y	SP	PC	N	Z	V	C	Addressing Mode	Effective address	Number of Cycles
		FF	FF	7FF0	8008	FFFF	1000	1	1	1	1			
$2000	lds #$8000													
	ldx $8000													
	orab 2,+X													
	inca													
	staa $75													
	puly													
	jsr $3085													

The table below shows some values in memory which will be needed to do the above.

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
7FE0	10	23	3B	7C	10	04	86	80	B7	10	25	3B	FC	10	18	F3
7FF0	12	50	FD	10	18	86	40	B7	10	23	3B	FC	10	12	DD	02
8000	86	02	B7	10	23	3B	7C	10	03	86	40	B7	10	25	3B	86

4. Below are the values of some timer registers in the MC9S12:

TIOS	TSCR1	TCTL1	TCTL2	TCTL3	TCTL4	TIE	TSCR2	TFLG1	TFLG2
53	80	58	A3	EA	65	31	83	A3	80

   (a) Which timer channels are being used for output compare?

   (b) Which timer channel interrupts are enabled?

   (c) What action is timer channel 2 set to perform? (I.e., if it is set up as input capture, which edge will it capture; if it is set up as output compare what action will occur when `TCNT` equals `TC2`?)

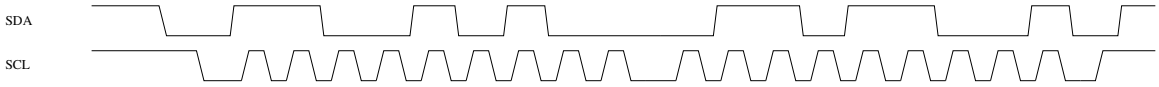
   (d) Which timer flags are set?

   (e) What is the timer prescaler set at – i.e., by what factor will the bus clock be divided before driving the `TCNT` register?

   (f) How long (in seconds) will it take for the `TCNT` register to overflow?

   (g) The first time an edge is captured, the corresponding timer register read 0xE219. The second time an edge is captured, the timer register reads 0x7134. How much time was there between the two edges? (The time between the edges was less than the timer overflow time.)

5. The figure below shows some activity on the IIC bus, with an MC9S12 as the bus master.



(a) What is the 7-bit address of the IIC slave? Explain.

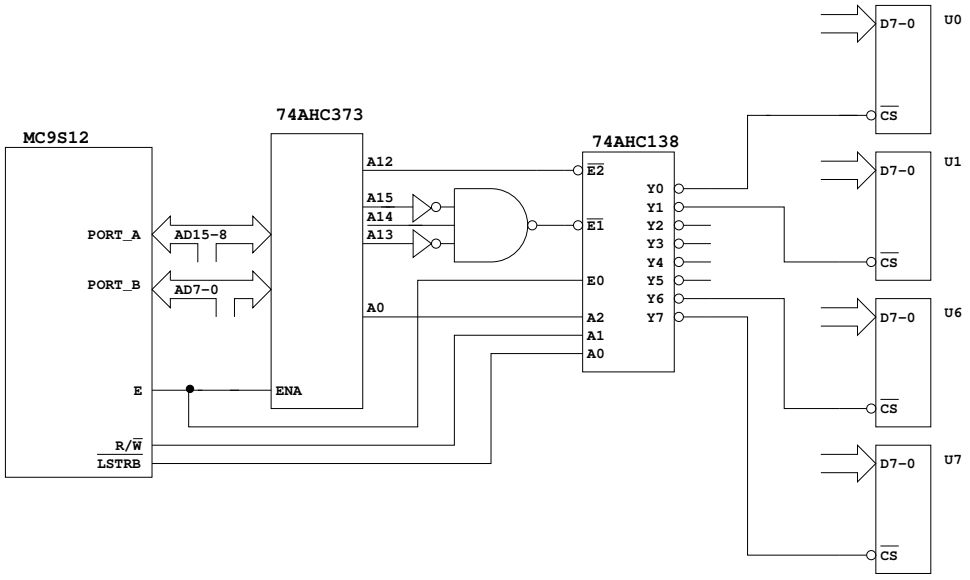
(b) Is the MC9S12 reading from the slave or writing to the slave? Explain.

(c) On the diagram, indicate when the MC9S12 controls the data bus and when the slave controls the data bus.

(d) Describe a feature of the START condition that can be used to distinguish it from any other type of activity on the I2C bus. Identify the START condition on the diagram.

(e) Are there any ACKs or NACKs on the diagram? If so, identify them on the diagram.

6. You are the supervisor of an engineering project. An engineer submits the following design for you to check. The design is to connect four interface chips to an MC9S12 microcontroller. At least one of the devices is connected incorrectly. Also, the engineer failed to show whether the chips function as input or output devices, and failed to show where the data lines should be connected to the MC9S12.



U0 Is device U0 connected correctly? _____

If the device is conncected correctly, provide the following information.

- Is this an input chip or output chip? Why? _____
- Should the data lines be connected to Port A or Port B? Why? _____
- Give an example of an address the chip will respond to. _____

If it is not connected correctly, explain what is wrong.

U1 Is device U1 connected correctly? _____

If the device is conncected correctly, provide the following information.

- Is this an input chip or output chip? Why? _____
- Should the data lines be connected to Port A or Port B? Why? _____
- Give an example of an address the chip will respond to. _____

If it is not connected correctly, explain what is wrong.

U6 Is device U6 connected correctly? _____

If the device is conncected correctly, provide the following information.

- Is this an input chip or output chip? Why? _____
- Should the data lines be connected to Port A or Port B? Why? _____
- Give an example of an address the chip will respond to. _____

If it is not connected correctly, explain what is wrong.

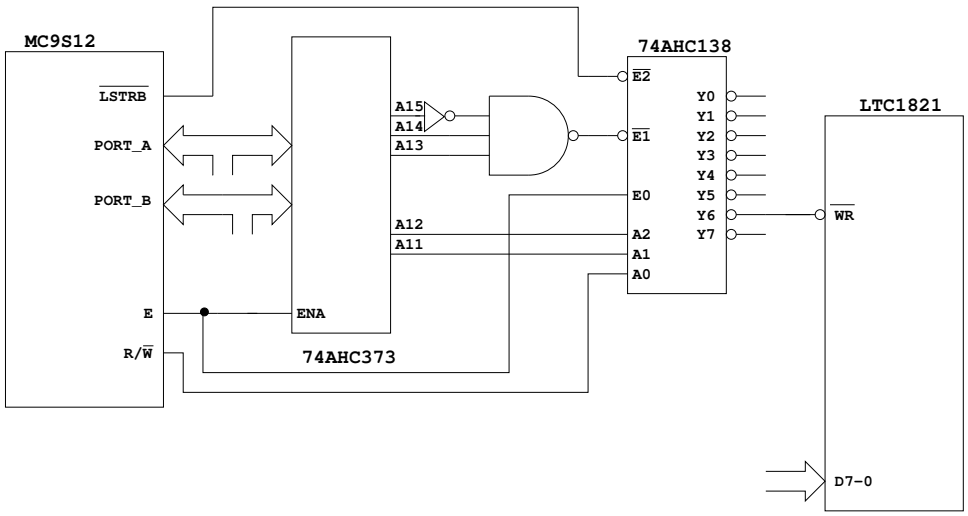
U7 Is device U7 connected correctly? _____

If the device is conncected correctly, provide the following information.

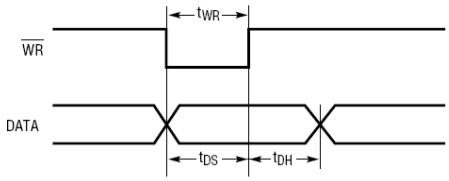
- Is this an input chip or output chip? Why? _____
- Should the data lines be connected to Port A or Port B? Why? _____
- Give an example of an address the chip will respond to. _____

If it is not connected correctly, explain what is wrong.

7. The LTC1821 is a digital-to-analog converter from Linear Technology. The figure below shows one way to interface the LTC1821 to an MC9S12. It also shows the timing diagram for the LTC1821.



TIMING DIAGRAM



Timing Characteristics				MIN	
t_{DS}	Data to $\overline{WR}$ Setup Time		●	60	ns
t_{DH}	Data to $\overline{WR}$ Hold Time		●	0	ns
$t_{\overline{WR}}$	$\overline{WR}$ Pulse Width		●	60	ns

(a) Should the data lines of the LTC1821 be connected to Port A or Port B? Explain.

(b) Write some C code to write the value 0xAA to the LTC1821.

(c) Draw a timing diagram starting with the E clock for the MC9S12, showing the timing of the $\overline{WR}$ line of the LTC1821 and the data to the LTC1821.

(d) Is the t_{WR} timing compatible with the MC9S12 with no E clock stretches? If not, will it work by adding E clock stretches? How many? Explain.

(e) Is the t_{DS} timing compatible with the MC9S12 with no E clock stretches? If not, will it work by adding E clock stretches? How many? Explain.

(f) Is the t_{DH} timing compatible with the MC9S12 with no E clock stretches? If not, will it work by adding E clock stretches? How many? Explain.