EE 308

Final Exam

May 7, 2002

Name: ____

You may use any of the Motorola data books, the overheads posted on the Internet, your notes your lab book, 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 HC12 with a 16 MHz crystal, resulting in a 8 MHz processor clock.

Also, assume that hc12b32.h has been included, so you can refer any register in the HC12 by name rather than by its address in any C code you write.

1. Consider the following program fragment:

Address		Op Code & Operands	Addressing Mode	Cycles
----	CODE: section .text	--------------	----	------
----	org $0800	--------------	----	------
	ldx #$1A00			
	std $0955			
	loop: com $82			
	pshx			
	bne loop			
	ldaa -3,x			

(a) Fill in the above table. In the column labeled Address, fill in the address of the first byte of the instruction. In the column labeled Op Codes & Operands show the op codes and operands (as hex numbers). In the column labeled Addressing Mode indicate the addressing mode used by the instruction. In the column labeled Cycles indicate the number of cycles needed to execute the instruction.

(b) How many bytes of memory does the code fragment occupy?

(c) How many microseconds will it take the fragment to execute on an HC12 with a 8 MHz E-clock?

2. An HC12 has the following values in its memory:

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0800	C6	05	CE	09	00	DD	5A	33	6A	05	08	53	26	F7	3F	CE
0810	E0	00	CD	00	00	E6	00	0F	00	01	02	19	ED	08	8E	E0
0820	20	25	F2	7B	09	00	3F	CF	0A	00	15	FA	00	01	5F	A0
0830	01	3F	C6	80	5B	86	C6	03	5B	8D	C6	FF	5B	02	4C	80
FFD0	20	20	20	30	20	40	20	50	20	60	20	70	20	80	20	90
FFE0	21	A0	21	B0	30	D0	32	F0	21	00	21	10	21	20	21	30
FFF0	20	A0	21	50	21	60	21	70	21	80	21	90	21	A0	C5	A3

Show the values of each of the registers after execution of the following instruction. You do not have to put down a value if the value did not change. You do not have to indicate the state of the H bit of the CCR . Also, indicate the effective address of the instruction.

Inst	A:B	X	Y	SP	CCR S X H I N Z V C	Effective
	FF:FF	0810	0820	0830	1 1 1 1 1 1 1 0	Address
ldd #$A583					X	
aba					X	
anda $0823					X	
addb 3,-X					X	
puly					X	
rti					X	

3. Using the same values of memory as for Problem 2, answer the following questions:

   (a) Explain what happens after an HC12 is reset. How does it know what mode (expanded, single chip) it should operate in, and how does it know what instruction to execute first?

   (b) What is the address of the first instruction the HC12 will execute when coming out of reset?

   (c) What is the address of the Timer Channel 3 interrupt service routine?

4. For this problem, assume the HC12 is in single-chip mode – i.e., Ports A and B are used for parallel I/O, and no external memory or peripherals are attached to the chip.

   (a) List six things which you need to do in software to be able to use interrupts on the HC12.

      i.

      ii.

      iii.

      iv.

      v.

      vi.

   (b) Write some C code to set up the HC12 to generate a Timer Output Compare interrupt on Bit 3 of Port T. The action the HC12 should take on a successful compare is to toggle Bit 3 of Port T. Set the timer subsystem up so that the period between toggles can be as long as 50 ms. Be sure to do all the setup needed for the timer subsystem. Also, do not change the functionality of any other bit of Port T.

   (c) Write an interrupt handler in C to respond to the interrupt in the previous part. In the interrupt handler increment the 8-bit number at address 0x0900, and set the next toggle to occur after another 50 ms.

5. The following deal with various topics on the HC12.

   (a) What is a flag in the sense used by the HC12 hardware?

   (b) How do you clear flags in the timer subsystem? Give an example by writing some C code to clear the flag for Timer Channel 7.

   (c) How do you clear flags in the serial peripheral interface subsystem? Give an example by writing some C code to clear `SPIF` .

   (d) Assume the HC12's SPI has been enabled, and the SPI is operating in master mode. When you write a byte to `SP0DR` , then read the value of `SP0DR` the value you read is usually different than the value you wrote. Why?

   (e) Write some C code to set up the SPI to operate in master mode, no interrupts, with `CPOL = 1`, `CPHA = 0`, `SSOE = 0`, and `LSB = 0`. Use a baud rate of 1 MHz. Use Bit 7 of Port S as the Slave Select. The SPI slave is selected with an active low signal. Be sure to do all the setup necessary to use the SPI.

   (f) With the SPI set up as above, write some code to send a 0xAA to the slave. Be sure to wait for the transmission to finish, then deselect the slave.

   (g) With the SPI set up as above, sketch what will be on Port S bits 7 (Slave Select), 6 (SCK) and 5 (MOSI) when you execute the code in the previous part.

6. Four sensors placed at sensitive locations on the hull of the Enterprise measure the power level of Klingon phasers attacking the Enterprise. Each sensor produces an analog voltage between 0 and 5 V which is proportional to the power level of the attacking phaser. When the analog voltage from any of the four sensors exceeds 1 V, all power should be diverted to the shields to protect the Enterprise. An HC12 is used to do this. The signals from the four sensors are connected to bits 4, 5, 6 and 7 of Port AD.

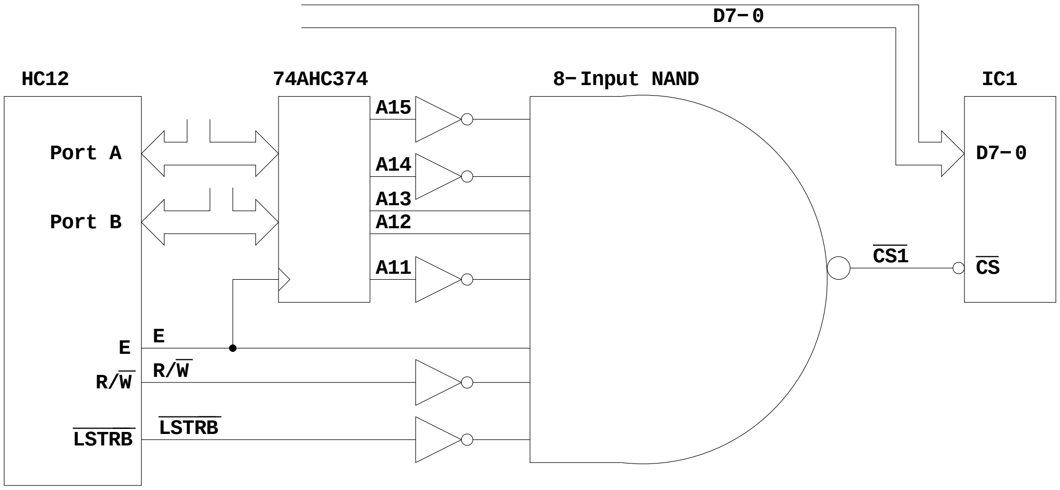
   (a) Write some C code to set up the A/D converter to convert all eight input pins continuously in 8-bit mode. Be sure to explain what each line of your code does.

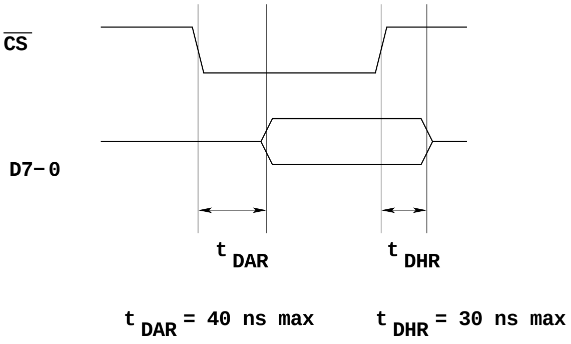
   (b) What A/D value corresponds to a voltage of 1 V? Assume V_{RH} = 5V, and V_{RL} = 0V.

   (c) The values read from the A/D result registers are shown in the table below. What was the voltage on Bit 4 of the A/D converter?

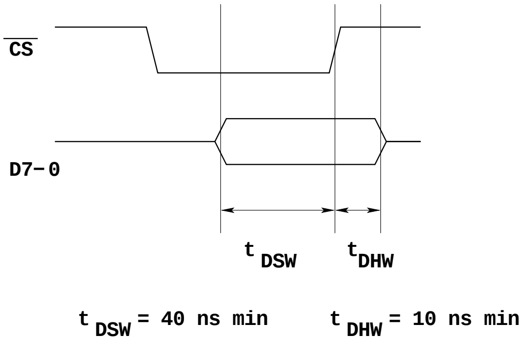
ADR0H	ADR1H	ADR2H	ADR3H	ADR4H	ADR5H	ADR6H	ADR7H
0x12	0x53	0xA7	0x2A	0x7F	0x9A	0x37	0x02

7. The figure below shows a peripheral chip connected to an HC12 using some standard CMOS logic chips. For this problem assume that the propagation delay through each CMOS logic chip is 10 ns.





IC1 Read Timing



IC1 Write Timint

(a) Will IC1 be an input device or an output device? Explain

(b) Should the data lines of IC1 be connected to Port A or Port B on the HC12? Explain.

(c) For what range of addresses will IC1 be selected?

(d) Sketch the signals on the E, $R/\overline{W}$, $\overline{LSTRB}$, $\overline{CS1}$ and $D7-0$ lines for the following actions:

- If IC1 is an input device, the HC12 reads from IC1, and IC1 returns an 0x55.
- If IC1 is an output device, the HC12 writes an 0xAA to IC1.

Note: Only do one of these, based on your answer to Part (a) above.

(e) Will the circuit shown work reliably with an HC12 running with an 8 MHz E-clock, and no E-clock stretches? Explain.

(f) Will the circuit shown work reliably with an HC12 running with an 8 MHz E-clock, and one E-clock stretch? Explain.