Ryerson Polytechnic University
Department of Electrical and Computer Engineering
ELE538 – Microprocessor Systems

Final Examination **December 6, 1996**

Name:______________________________ **Section:**____________

Time: 3 hours Examiners: A.Lee, G.Pizer
Use the examination book for your detail answers **Encircle your instructor's name**
Please hand in these question sheets. **and write it on your exam booklet**

PART A: Short I/O Problems

Answer any *five* questions - (3 marks each)

A.1 **Explain** why the initialization of the Stack Pointer register is usually the first action following a system reset. **Describe** a worst-case scenario as a result of failing to do so.

A.2 In the PONG project, the common phenomenon at higher ball speeds is for the ball to disappear at one wall, and then to reappear from the opposite wall. **Discuss** the cause of this problem and the solution needed to fix this fault. (Note: we are merely asking for an explanation, and NOT the actual lines of 6811 code!)

A.3 In the LED display project, you were required to write a *lcd_str* subroutine that accepts an address parameter passed to it in the X register, and sends each character of the string (starting at that address parameter) to the LCD. Furthermore, due to the size of the LCD panel, you were required to set the cursor to the start of second line display after the 16th character.

Discuss how would you implement a procedure to ensure that the cursor moved to the second line of LED display. (Note: Do not write down the complete source code for this subroutine!)

A.4 **Write a 6811 subroutine** *form_ans* which **converts** a 2-digit BCD quantity (already passed in accumulator A) into two separate Ascii characters, then **embeds** them inside a predefined output message string. (example: When the BCD quantity in A is $23, the resulting message string would be "The output is 2.3 volts") Your code **must include all the necessary data declarations**.

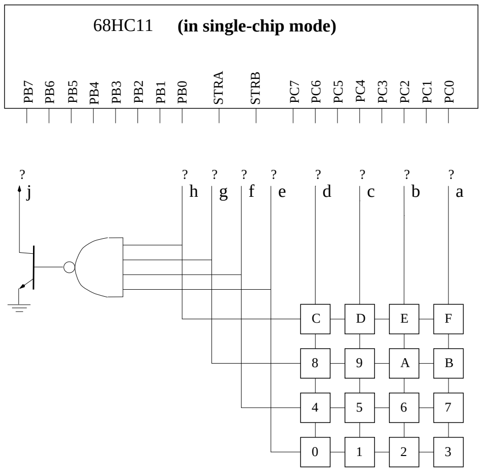
A.5 **List** all possible software causes as to **why** in the interrupt-driven keypad project (lab #4A) the first line of your interrupt service routine would never get executed. (Hint: Think of at least three possible programming errors)

A.6 Recall that lab project #4B involved generating a timer interrupt every 10 ms via the Output Compare 2 Register. Inside the Interrupt Service Routine, part of the required task was to update the contents of TOC2 register such that TOC2 = TOC2 + 10,000. **Comment** on the difference in outcome if the updating process of TOC2 is changed to TOC2 = TCNT + 10,000, where TCNT is the current value of the main timer counter.

PART B: Questions involving more detailed I/O interface

Answer any <u>*three*</u> questions - (10 marks each)

B.1 The diagram below shows a hex keypad to be interfaced with a 6811-based system in the *single-chip mode*. The only I/O pins available for this task are Ports B & C as well as STRA & STRB pins.



Connections to be made	
From circuit	To the 6811 I/O pin
a	
b	
c	
d	
e	
f	
g	
h	
j	

Propose a workable scheme for this interrupt-driven keypad interface **by giving your answers to the following questions**.

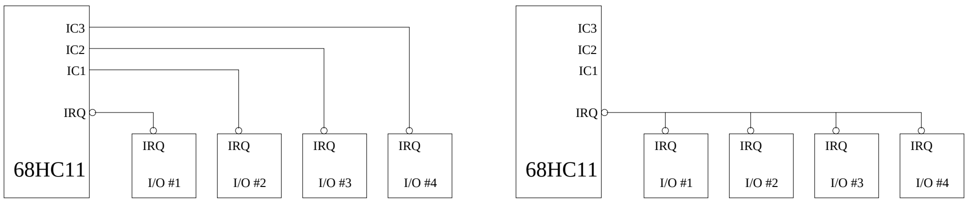
(a) Complete the above table to indicate which I/O pin from the 68HC11 is to be connected to each point of this keypad interface circuit. **(3 marks)**

(b) What is the required initialization to enable an interrupt as soon as any key is pressed? **Supplement** your answer with relevant 6811 code. **(4 marks)**

(c) Give sample 6811 code to scan the leftmost column of the keypad. Also give sample 6811 code to read back the raw result from this scan. What would be the reading of this raw result if currently the "8" key is pressed? **(3 marks)**

(Be sure to relate your answer to the way you specified this interface connection)

B.2 (a) Discuss the merits of using timer input capture channels as additional IRQ pins (shown on the left), as compared to the more conventional arrangement shown on the right. **(2 marks)**



(b) The 6811 timer's Input-Capture 1 (IC1) is to be set up to measure (without the use of interrupt) the pulse-width of an incoming **positive** going pulse. Illustrate your preliminary planning to achieve this objective by **listing the detailed steps** without writing the 6811 code. **(3 marks)**

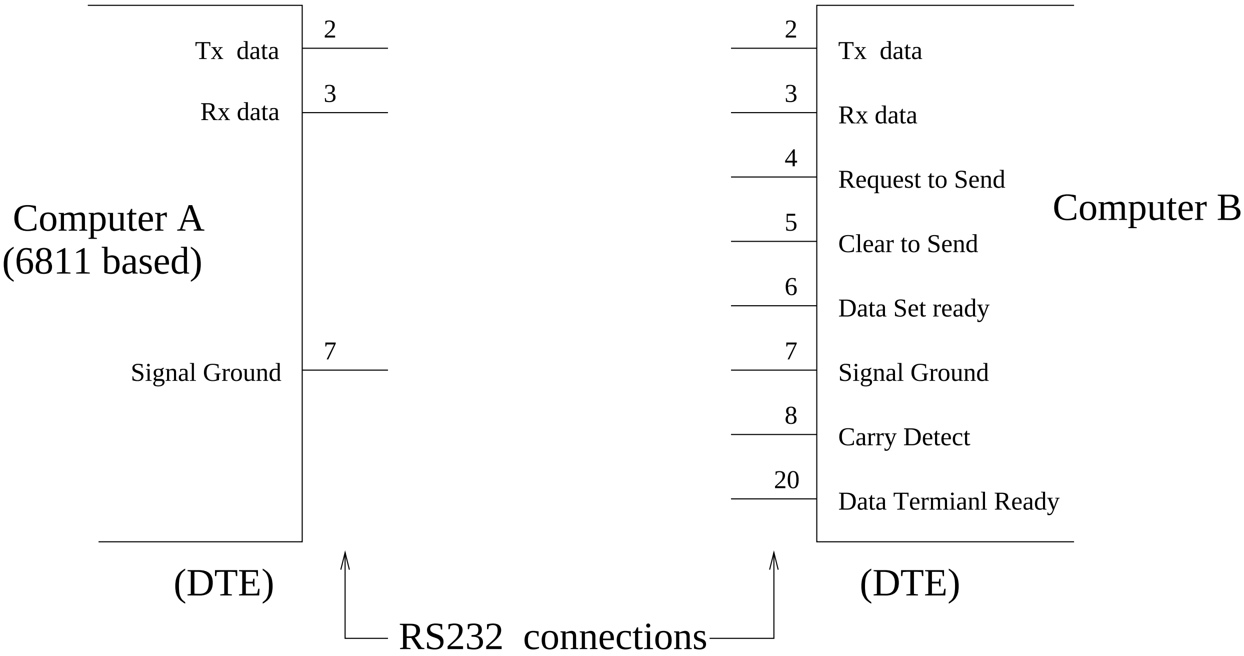
(c) Write the necessary 6811 code for the above (b). **(3 marks)**

(d) Given your 6811 code for the above pulse-width measurement, assume that there is ample time after your initialization code is executed before the arrival of the incoming pulse. For an E clock of 1 MHz, estimate the minimum pulse-width that your 6811 code can measure successfully. Show how you arrived at your answer. **(2 marks)**

B.3 Given the following specifications:

- The serial ports on both computer A & computer B are configured as Data Terminal Equipment (DTE).
- Data is to be transmitted asynchronously from computer A to computer B, but never from B to A.
- The serial port of computer B has been set already to 9600 Baud with a data format of 8N1 (i.e. 8 data bits, no parity bit and 1 stop bit).

(a) Complete the *minimum* interconnection between computer A & computer B in the following diagram. Be sure to terminate any unused pins properly. **(2 marks)**



(b) Sketch and label the RS232 output waveform representing the transmission of characters '82'. Be sure to mark down all relevant information, such as the voltage levels, bit pattern interpretation, and duration of bit time. What is the maximum rate that the character stream can be transferred here. **(3 marks)**

(c) Computer A is a 6811 based system with a 2 MHz E clock, and the serial port is derived from the on-board 6811 Serial Communication Interface (SCI) where **interrupt is not used** during serial transfer. List the detailed initialization steps needed to set up the SCI. (Omit the 6811 code here.)

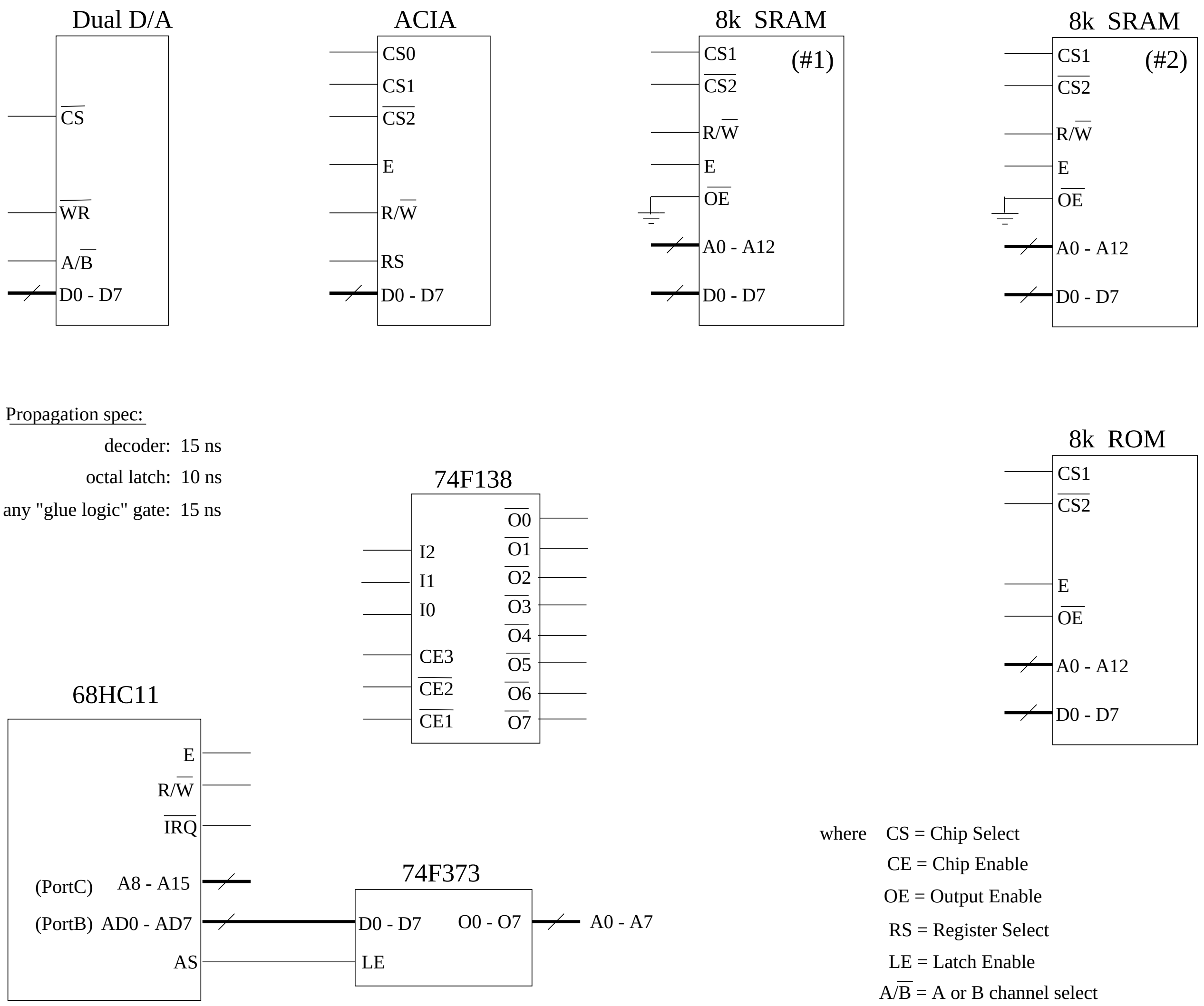
Note: Use the same symbolic names as appear in the reference sheet, when indicating the required values for your initialization. **(2 marks)**

(d) Write a subroutine *send_data* in 6811 code to send a null-terminated string (starting at the address passed in the X register) via the SCI interface. **(3 marks)**

B.4 Given a 68HC11 microcontroller operating in extended mode at 1 MHz, the following address space assignment is to be implemented for a particular system.

```
$0000-$1FFF: on-chip memory and register block
$2000-$3FFF: vacant (not assigned)
$4000-$5FFF: dual-channel D/A module
$6000-$7FFF: MC6850 ACIA
$8000-$9FFF: HM6264 8k SRAM (#1)
$A000-$BFFF: HM6264 8k SRAM (#2)
$C000-$DFFF: vacant
$E000-$FFFF: on-chip 8k ROM
```

The block dirgrams with relevant terminals are shown for each of the above chips, as well as for a 74F138 Decoder and a 74F373 Octal Latch.



(a) Show the required interconnections, carefully labelled, to implement the above system. **(4 marks)**

(b) Given the 6811 timing specifications, what would be the maximum allowable SRAM setup time? (Hint: consider the memory WRITE operation) **(3 marks)**

(c) What would be the SRAM Address Access time? (Hint: consider the memory READ operation) **(3 marks)**