

ECE-3120
Fall 2008
LAB 2 – Basic Arithmetic Programming

The purpose of this lab is to introduce you to basic programming with the 68HCS12 using assembler directives and arithmetic instructions. You will **NEED** to study the directives and arithmetic operation instructions in Huang chapter 2 before attempting this program.

PRE-LAB:

Prepare the pseudocode and the first draft of the program and calculate the expected results (Sum, Average, Difference) by hand. This must be completed before coming to the lab and shown to the lab instructor at the start of the lab session.

Approved: Lab TA _____ Date _____

PROGRAMMING ASSIGNMENT:

Write a fully-commented program for the HC12 board, including appropriate directives and labels for memory operands and constants, called **Arith.asm**. The program should do the following:

- The program should start execution at address \$1000.
- Use directives to create an array of five unsigned decimal byte values: 50, 188, 63, 211, and 3 stored in contiguous memory at locations \$2000-\$2004.
- Calculate the unsigned Sum of the five numbers and store this word at memory location \$2010-\$2011.
- Calculate the unsigned Average of the 5 numbers and store this byte in memory after the sum.
- Subtract the Average from the Sum and store the unsigned Difference (word) in memory after the Average.

Procedure: First, use D-Bug12 to fill memory locations \$1000 through \$3BFF with zeros. (User-accessible memory spans from \$1000 to \$3BFF.) Then assemble, download, and single-step through the program to debug it. Verify that each value change, in registers and memory, is correct and that the final values of Average, Sum, and Difference are correct. Then reset the processor, download the program again, run it at full speed until it stops, and verify that the final values are still correct. When finished debugging and executing, copy the entire terminal window output and paste it into a Notepad or Word document for inclusion in the report. You may edit out mistakes and repetitions before submission.

Approved: Lab TA _____ Date _____

PROGRAM FORMAT REQUIREMENTS:

Generally, follow the format for source code as described below:

- Include a title comment block at the top of the file like:
 - ;-----
 - ; Lab 2
 - ; Basic Arithmetic Programming
 - ; Your name and date
 - ; Describe program function and purpose,
 - ; using multiple lines if necessary.
 - ;-----
- Then include pseudocode in another comment block before beginning the code and data. It must clearly describe the program algorithm, step by step, using higher-level syntax such as math, C code, and English.
- Next, include the necessary directives for addresses and data, initialized with data values when needed. The allowed directives are: ORG, DC.B, DC.W, DS.B, DS.W, EQU, END.
- Finally, include the sequence of instructions.
- Include other comments throughout the code to explain your program details.
- Use labels or expressions with labels (not just "magic numbers" or numerical addresses) in your code when referring to constants and memory locations.
- Directives and instructions may be either upper or lower case, but be consistent.
- Start labels in column 1. Terminate labels with a colon.
- Start all comments with a semicolon.
- All instructions and directives start in column 9 or later.
- Carefully align the four fields of each instruction and directive line.
- Lines must NOT wrap around to the next line on printed documents (source or listing).
- All code and data must fit in our board's RAM space and code execution must end with SWI.

Things to turn in as your Lab Report, attached in this order:

1. This assignment sheet, with your name at the top, signed by the TA where shown.
2. Your uncorrected pre-lab document (commented source code).
3. A printout of the final Arith.asm and Arith.lst. You'll need to print the listing file in landscape mode to make it fit. Use Notepad to print them. Do NOT use MiniIDE to print the listing – it will not look right.
4. A printout from the terminal screen (method: highlight text, type ctrl+c, and paste into a Notepad or Word document, using Courier New as the font) that includes everything done.
5. Answer the following questions, in your document:
 - a) What are the final values, in both hex and decimal, of Sum, Average, and Difference?
 - b) Consider using this program to properly handle any five unsigned byte values. Answer these questions for this case:
 - i. Does the Sum really need to be a word? Why or why not?
 - ii. Does the Average really need to be a byte? Why or why not?
 - iii. Does the Difference really need to be a word? Why or why not?
 - c) Would your program properly handle any five signed byte values? If not, what changes would be necessary in your program?
 - d) How many memory bytes, in both hex and decimal, are used by your program code (excluding data)?
 - e) List the names of all the address modes used in your program, including the source code line number and the line of code for one example where each is used.