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ECE 427: Microcomputer Architecture Lab

Experiment #2

BCD & ASCII Addition and Subtraction

Performed: 9/17/2013

Submitted: 10/1/2013

Objective:

- To code Assembly language instructions to perform addition and subtraction on packed BCD numbers
- To code Assembly language instructions to perform addition and subtraction on ASCII data

Part 1: Using DEBUG, write Assembly language instructions to add two BCD numbers and store the result in BCD.

Part 2: Using DEBUG, write Assembly language instructions to subtract two BCD numbers and store the result in BCD.

Part 3: Write a subroutine to add two 10-digit ASCII numbers and store the result in ASCII.

Part 4: Write a subroutine to subtract two 10-digit ASCII numbers and store the result in ASCII.

Part 5: Write a subroutine to add two 10-digit BCD numbers and store the result in BCD.

Part 6: Write a subroutine to subtract two 10-digit BCD numbers and store the result in BCD.

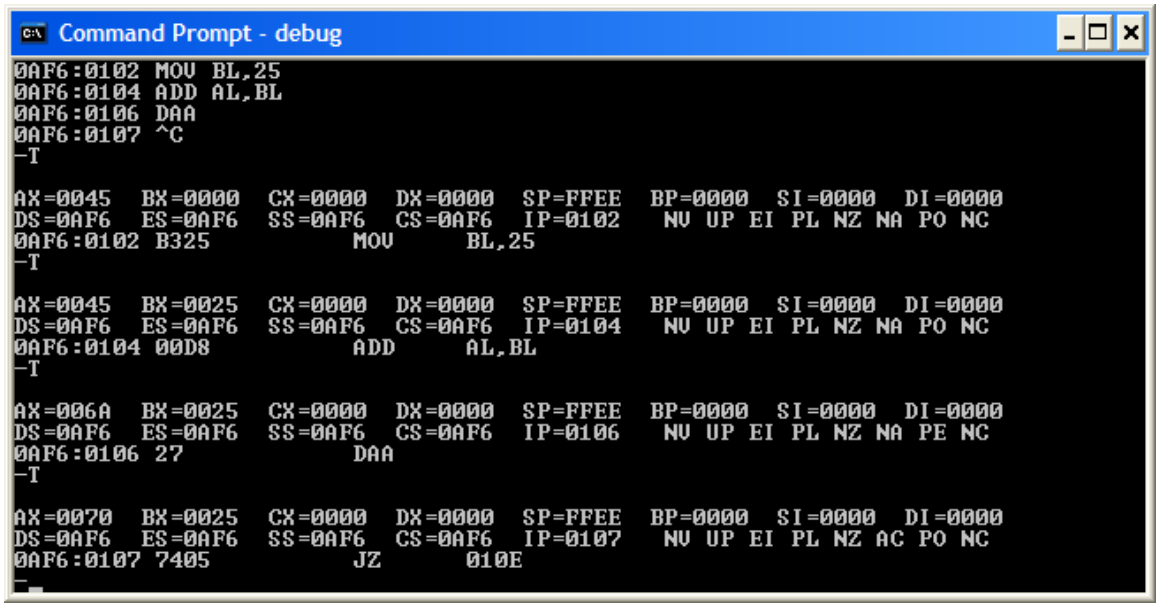
Word Description:

In this lab, gained practical experience with summing and subtracting BCD and ASCII Numbers.

Code & Screenshots:

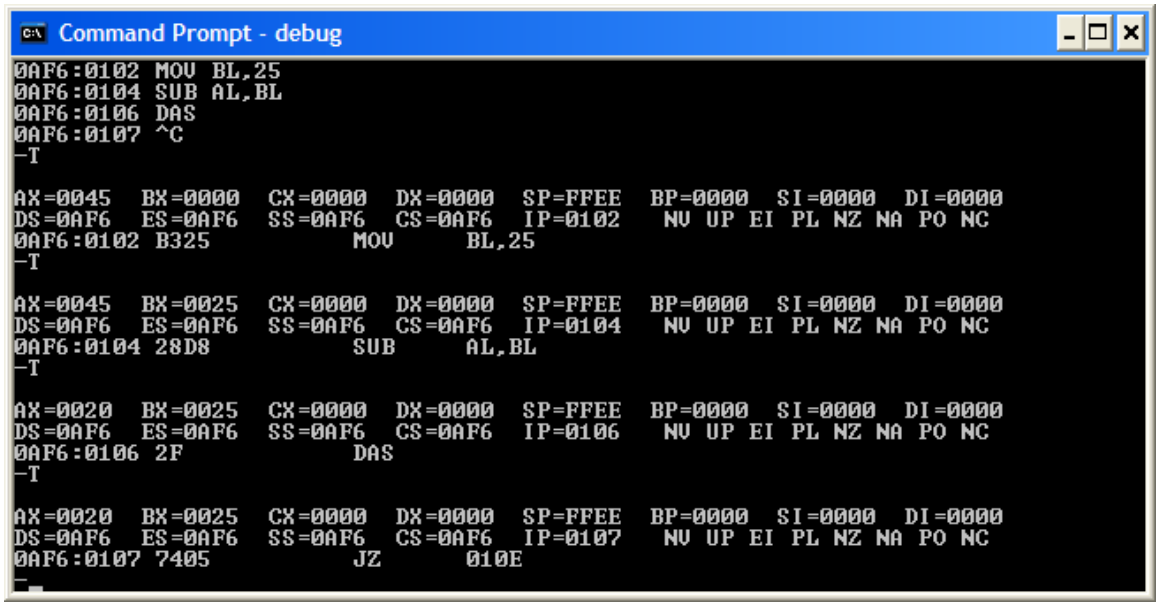
Part 1:

MOV AL, 45
MOV BL, 25
ADD AL, BL
DAA



Part 2:

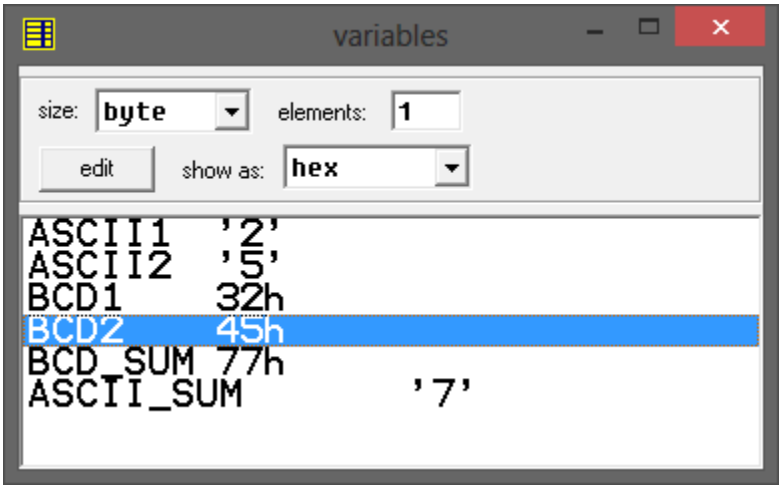
MOV AL, 45
MOV BL, 25
SUB AL, BL
DAS



Part 3 & 5:

```
;ASCII_SUM Holds the value of the sum in ASCII, while BCD_SUM holds the value of the sum in BCD
org 100h

.DATA
ASCII1 DB '2345623456'
ASCII2 DB '5432154321'
BCD1 DB 5 DUP(?)
BCD2 DB 5 DUP(?)
BCD_SUM DB 5 DUP(?)
ASCII_SUM DB 10 DUP(?)

.code
MAIN PROC FAR
   MOV AX, @DATA
   MOV DS, AX
   MOV BX, OFFSET ASCII1
   MOV DI, OFFSET BCD1
   MOV CX, 10
   CALL ASCII_TO_BCD
   MOV BX, OFFSET ASCII2
   MOV DI, OFFSET BCD2
   MOV CX, 10
   CALL ASCII_TO_BCD
   CALL ADD_BCD
   MOV SI, OFFSET BCD_SUM
   MOV DI, OFFSET ASCII_SUM
   MOV CX, 05
   CALL BCD_TO_ASCII
   MOV AH,4CH
   INT 21H
MAIN ENDP


ASCII_TO_BCD PROC
   ;Convert ASCII to BCD
   AGAIN: MOV AX,[BX]
   AND AX,0F0FH
   PUSH CX
   MOV CL,4
   SHL AH,CL
   OR AL,AH
   MOV [DI],AL
   ADD BX,2
   INC DI
   POP CX
   LOOP AGAIN
   RET
ASCII_TO_BCD ENDP

ADD_BCD PROC
```

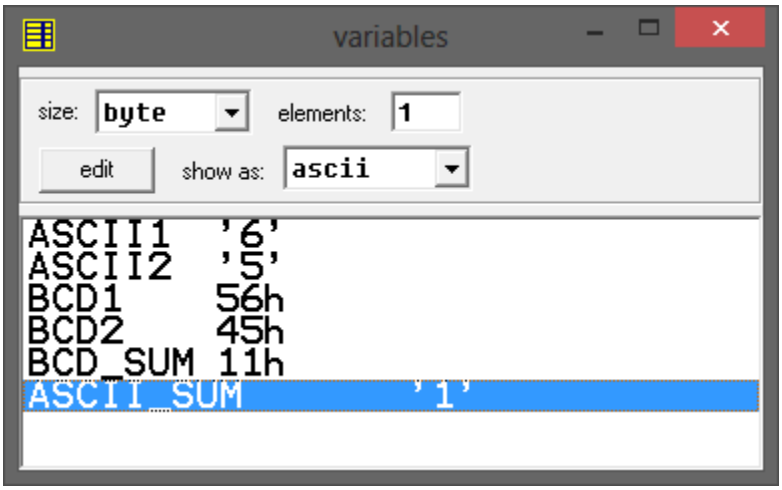
```
    MOV BX, OFFSET BCD1
    MOV DI, OFFSET BCD2
    MOV SI, OFFSET BCD_SUM
    MOV CX, 05
    CLC
    BACK: MOV AL,[BX] + 4
    ADC AL, [DI] + 4
    DAA
    MOV [SI] + 4, AL
    DEC BX
    DEC DI
    DEC SI
    LOOP BACK
    RET
ADD_BCD ENDP

BCD_TO_ASCII PROC
    AGAIN2: MOV AL, [SI]
    MOV AH, AL
    AND AX, 0F00FH
    PUSH CX
    MOV CL, 04
    SHR AH, CL
    OR  AX, 3030H
    XCHG AH, AL
    MOV [DI], AX
    INC SI
    ADD DI,2
    POP CX
    LOOP AGAIN2
    RET
BCD_TO_ASCII ENDP

END MAIN
```



Part 4 & 6:

```
org 100h

.DATA
ASCII1 DB '6543265432'
ASCII2 DB '5432154321'
BCD1 DB 5 DUP(?)
BCD2 DB 5 DUP(?)
BCD_SUM DB 5 DUP(?)
ASCII_SUM DB 10 DUP(?)

.code
MAIN PROC FAR
   MOV AX, @DATA
   MOV DS, AX
   MOV BX, OFFSET ASCII1
   MOV DI, OFFSET BCD1
   MOV CX, 10
   CALL ASCII_TO_BCD
   MOV BX, OFFSET ASCII2
   MOV DI, OFFSET BCD2
   MOV CX, 10
   CALL ASCII_TO_BCD
   CALL SUB_BCD
   MOV SI, OFFSET BCD_SUM
   MOV DI, OFFSET ASCII_SUM
   MOV CX, 05
   CALL BCD_TO_ASCII
   MOV AH,4CH
   INT 21H
MAIN ENDP


ASCII_TO_BCD PROC
   ;Convert ASCII to BCD
   AGAIN: MOV AX,[BX]
   AND AX,0F0FH
   PUSH CX
   MOV CL,4
   SHL AH,CL
   OR AL,AH
   MOV [DI],AL
   ADD BX,2
   INC DI
   POP CX
   LOOP AGAIN
   RET
ASCII_TO_BCD ENDP

SUB_BCD PROC
   MOV BX, OFFSET BCD1
```

```
    MOV DI, OFFSET BCD2
    MOV SI, OFFSET BCD_SUM
    MOV CX, 05
    CLC
    BACK: MOV AL,[BX] + 4
    SBB AL, [DI] + 4
    DAS
    MOV [SI] + 4, AL
    DEC BX
    DEC DI
    DEC SI
    LOOP BACK
    RET
SUB_BCD ENDP

BCD_TO_ASCII PROC
    AGAIN2: MOV AL, [SI]
    MOV AH, AL
    AND AX, 0F00FH
    PUSH CX
    MOV CL, 04
    SHR AH, CL
    OR  AX, 3030H
    XCHG AH, AL
    MOV [DI], AX
    INC SI
    ADD DI,2
    POP CX
    LOOP AGAIN2
    RET
BCD_TO_ASCII ENDP

END MAIN
```



Conclusion & Comments:

In this lab, we were able to convert ASCII numbers to Packed BCD, and then perform simple mathematical operations on the numbers (addition and subtraction). We also gained experience with the DAA and DAS operations, offsetting the values as needed to return a BCD value, rather than a hex value. We also were introduced to Processes in assembly, and how to use them effectively.

TASK 2
Worksheet

Name: _____
Date: _____
Section: _____

1- Demonstrate your understanding of the different formats ASCII, binary and BCD by filling in the corresponding formats for each of the decimal numbers below in the following table.

Decimal	ASCII(Hex)	Binary	BCD
0	30	00110000	00000000
3	33	00110011	00000011
6	36	00110110	00000110
9	39	00111001	00001001
19	31 39	00010011	00011001
99	39 39	01100011	10011001

2- For the test data you selected for activities 1 and 2, write the result of the addition in BCD as the program stored it. Also write it in hex. Verify that the addition was done correctly.

3- For the test data you selected for Activities3 and 4, write the result of the subtraction in BCD. Also write it in hex. Verify that the subtraction was done correctly.

4- Verify the sum obtained in the addition in Activity 5. Attach a trace of the execution to show your program obtained the same result.

5- Verify the result obtained in the subtraction in Activity 6. Attach a trace of the execution to show your program obtained the same result.

6- Verify the sum obtained in the addition in Activity 7. Attach a trace of the execution to show your program obtained the same result.

7- Verify the result obtained in the subtraction in Activity 8. Attach a trace of the execution to show your program obtained the same result.

For parts 2-7, see lab report.