Introduction to Microcontrollers III

Timing Functions

Delay5u.a11, Delay1m.a11

μp Laboratory #3

μP Laboratory #2 Hints

Data Entry :

- Use the pushbutton routine from count.a11 or count_br.a11 (WAIT0 and WAIT1 loops)
- Consider using Indexed addressing for entering data loops
- Store numbers to $D000-$D007
- Display numbers to output PortB ($1004)

μP Laboratory #2 Hints

Data Sum :

- Assume number located at $D000-$D007
- Consider using Indexed addressing for accessing each memory location
- Use AccA or AccB for temporary storage of sum

μP Laboratory #2 Hints

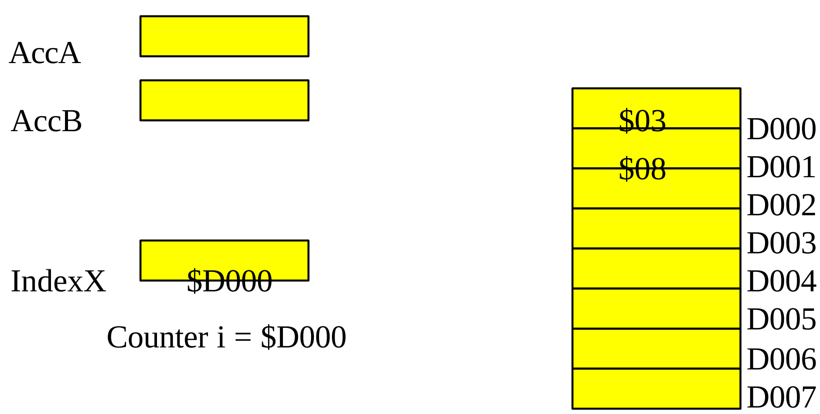
Data Sum :

- Assume number located at $D000-$D007
- Need two loops for sorting
- Consider using Indexed addressing for your loops

Sort Routine

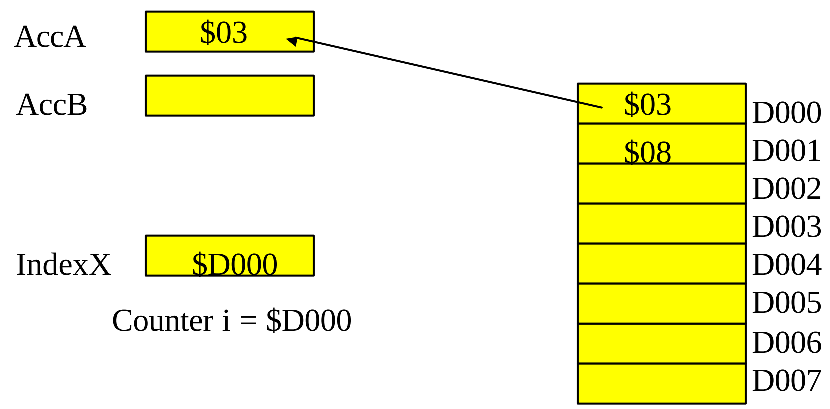
- Initialize counters
- Compare contents of location i with i+1
- If contents of i is less than contents of i+1, swap; otherwise increment counter
- If inner loop is done increment outer loop counter
- If outer loop is done, end; otherwise reset inner loop counter and begin again

Swap Routine



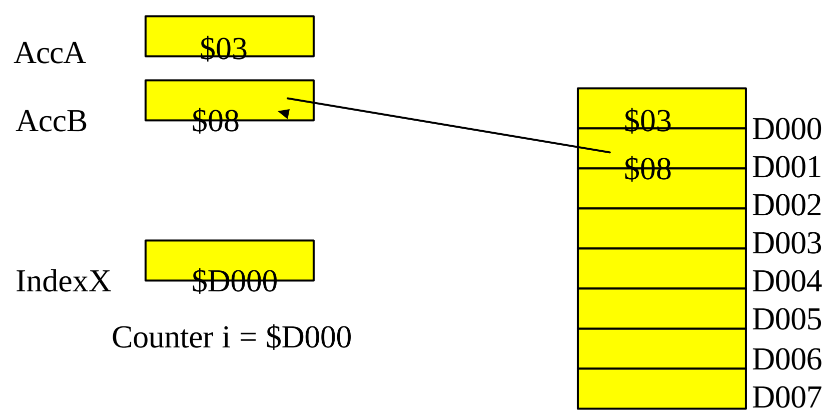
Swap Routine

ldaa 0,x



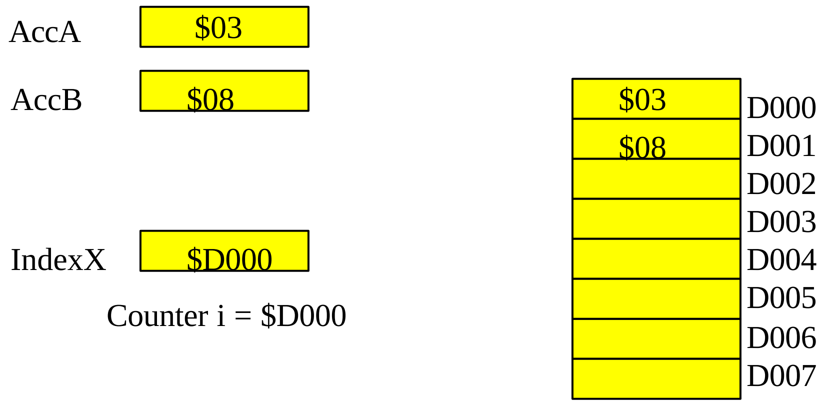
Swap Routine

ldaa 1,x



Swap Routine

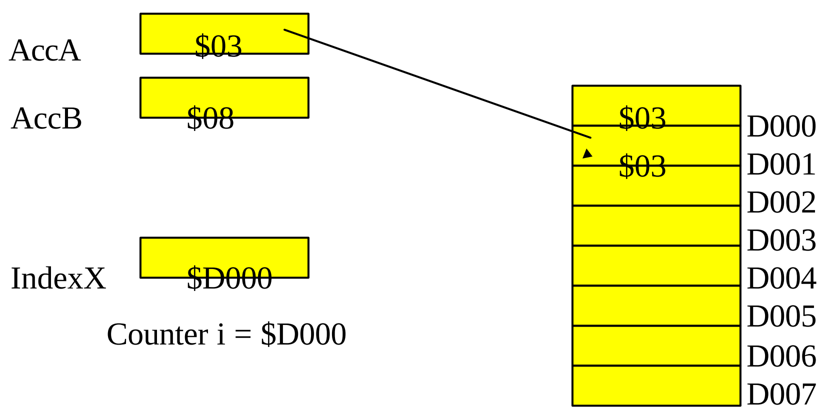
Compare AccB to AccA



Counter i = $D000

Swap Routine

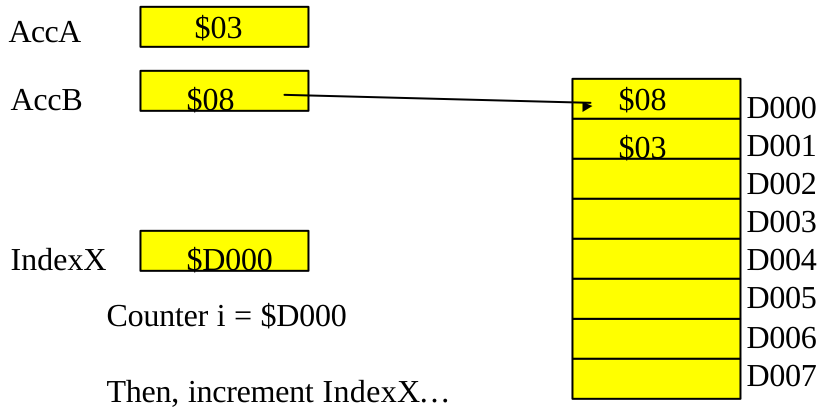
staa 1,x



Counter i = $D000

Swap Routine

stab 0,x



What about timing functions?

- Sometimes you want to put a delay in your program.The HC11 has advanced features that use a real-time clock. Refer to chapter 10 of the HC11 Reference Manual for information on usage.
- An alternative is the use of delay subroutines: delay5u.a11 and delay1m.a11

Timer Application 1: delay5u.a11

Delay = X * 5 µs

Load X with the number of times you want to delay for 5 µs.

```
***************************************************
* DELAY5U.A11
* AUTHORS                    DATE      COMMENTS
* JACOBSON/SEVCIK            2/26/90   VERSION 1.0
*
* DESCRIPTION
*  THIS ROUTINE GENERATES INTERNAL DELAYS IN
*  MULTIPLES OF FIVE (5) MICRO-SECONDS. THE
*  USER ENTERS A MULTIPLIER (16-BIT) INTO THE
*  X INDEX REGISTER WHICH DETERMINES THE
     NUMBER
*  OF FIVE MICRO-SECOND INTERVALS
*
* PARAMETERS
*  - X REGISTER CONTAINS MULTIPLIER
*  - INTERRUPTS ARE NOT AFFECTED
*  - SHORTEST DELAY IS 10 us (X < 3)
*  - RESOLUTION IS 5 us
*  - MAXIMUM DELAY IS 327680 us (X = 64K)
***************************************************
```



```
          ORG $COOO
          ldx #1000         ;FOR TESTING
          JSR DELAY5U       ;CALL ROUTINE TO TEST
          JMP $E00A         ;JUMP TO BUFFALO WHEN DONE
DELAY5U:  DEX               ;CORRECT FOR JSR/RTS
          DEX               ;OVERHEAD
          NOP
          NOP
DELWT1:   DEX               ;DECREMENT MULTIPLIER
          NOP
          NOP
          BNE DELWT1
          RTS
***************************************************
* END DELAY5U
***************************************************
```

This program uses the JSR instruction to call the subroutine: DELAY5U.

The actual subroutine consists of loops of instructions that just take up computer time.

Timer Application 2: delay1m.a11

Delay = X * 1 ms

Load X with the number of times you want to delay for 1 ms.

```
************************************************
* DELAY1M.A11     N*1ms Delay Routine
* AUTHORS                    DATE     COMMENTS
* JACOBSON/SEVCIK            2/26/90  VERSION 1.0
*
* DESCRIPTION
*  THIS ROUTINE GENERATES INTERNAL DELAYS IN
*  MULTIPLES OF ONE (1) MILLI-SECOND. THE
*  USER ENTERS THE DURATION OF THE DELAY
*  (ms) INTO THE X REGISTER
*
* PARAMETERS
*  - X REGISTER CONTAINS DURATION (ms)
*  - INTERRUPTS ARE NOT AFFECTED
*  - SHORTEST DELAY IS 1 ms (X =1)
*  - RESOLUTION IS 1 ms
*  - MAXIMUM DELAY IS 655,36 ms (X = 0)
*************************************************
   **
*
```



```
TEST ROUTINE
*  user must enter a value into X, then run
    ORG $COOO
* change operand of next instruction to change
* the delay
TEST        ldx #100     ;FOR 100 ms DELAY
    JSR DELAY1M          ;CALL ROUTINE TO TEST
    JMP $E00A            ;JUMP TO BUFFALO WHEN DONE
**************************************************
* DELAY1M N*1ms subroutine
**************************************************
DELAY1M:PSHA
* Primary Loop
DELWT2    LDAA #199;199 * 2ND LOOP = 1ms
    NOP
DELWT3    DECA                  ;SECONDARY LOOP = 1ms/199
    NOP
    BRN DELWT3           ;BRANCH NEVER = 3 CYCLE NOP
    BNE DELWT3           ;CONTINUE UNTIL 199 --> 0

    DEX                  ;# OF 1ms LOOPS
    BNE DELWT2           ;CONTINUE UNTIL IX = 0

    PULA
    RTS
************************************************
* END DELAY1M
------------------------------------------------
```

This program uses the JSR instruction to call the subroutine: DELAY1M.

The actual subroutine consists of 2 loops of instructions that just take up computer time. Notice: PSHA, PULA

Laboratory μP3: Count-down Timer

<u>Pre-lab:</u>

Design a circuit using the HC11EVB that will meet the following specs:

1. A two-digit BCD number will be entered.
2. Display the number on 7 segment displays as it counts down to zero @ 1.00Hz
3. Make an audible noise for the last 1 second before reaching zero.
4. When the number reaches zero, drive a relay closed (Output an active high signal)
5. Use the HC11EVb as the primary controller.
6. Use a minimum number of extra Ics
7. The two-digit bumber will be entered using an 8-position dip switch of two BCD switches.

Pre-compile all source code. Bring source code listings (on paper) and floppy disk containing the files to lab. The files should be error free at the beginning of the lab period.

Include flow charts for your source code.