Lecture 18:
Input and Output

Today's Goals

- Input and Output (I/O)
  - Port-mapped I/O
  - Memory-mapped I/O
- How to use I/O of HCS12 on Dragon12+

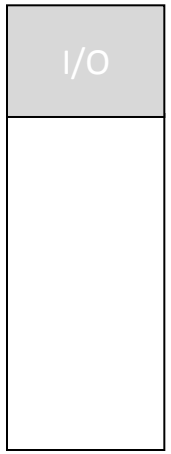
What are Input and Output?

- I/O allows microprocessors to communicate with other devices such as switches, LCD screens, and keypads.
- Important terms
  - Pin and Port:
  - Directions
  - Full-duplex and Half-duplex
  - Asynchronous and Synchronous

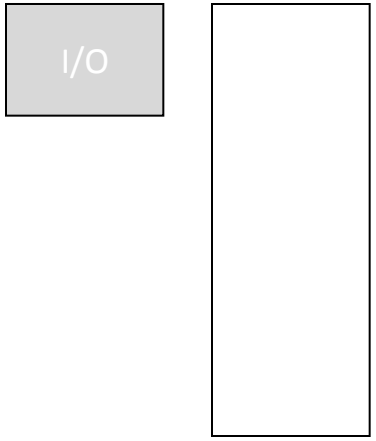
Accessing I/O

Memory-mapped vs. Port-mapped I/O

- I/O can be accessed by a program just much like accessing memory addresses.
- There are two different approaches.
  - Memory-mapped I/O



  - Port-mapped I/O



I/O in HCS12

- Ports
  - A, B, E, H, J, K, L, M, P, S, T, U, V, and W. (naming is somewhat random)
- These ports can be used as general-purpose I/O.

Ports B, H, and P

General purpose (used either input or output)

- There are 8 pins in each these ports (B, H, and P).
- Each port has corresponding memory address that shows the values of the 8 pins.
  - B: $0001
  - H: $0260
  - P: $0258
- When they are used as input ports
- When they are used as output ports
  - The program stores a value into the location
  - The hardware set the voltage according to the value.
- How do we determine if a port is being used as input or output?

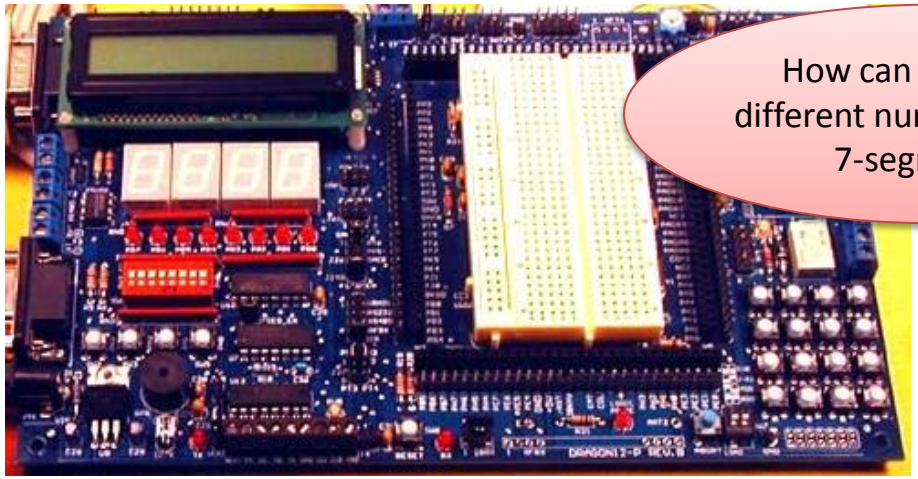
Data Direction Registers

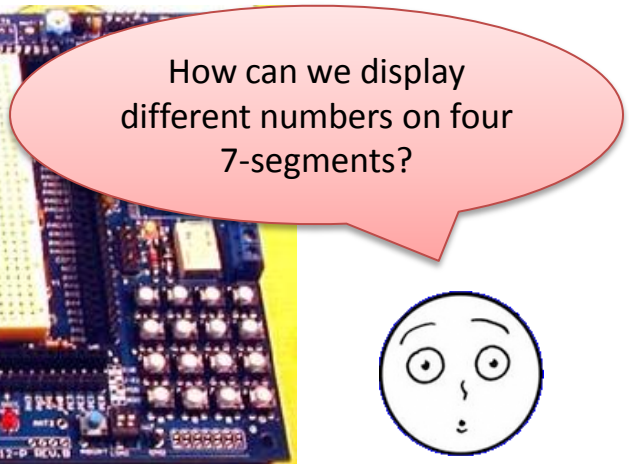
- Data direction registers
  - A general purpose I/O must be set whether input or output.
- Each port has its own register and the pins of each port can be configured separately.
  - $0003: DDR for B
  - $0262: DDR for H
  - $025A: DDR for P
- To configure the ports, store a value into the corresponding DDR based on the values below.
- Note:
  - When a pin is configured for an input, storing a value to its data bit is ignored.
  - When a pin is configured for an output, the voltage at the pin is ignored.

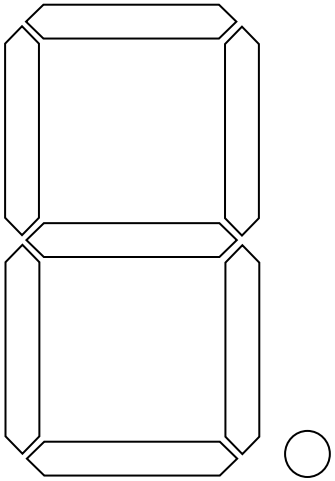
Port B, P, and H in the Dragon12+

Port B – 7 segment digits

- HCS12 has already been connected to hardware.
- Port B
  - Port B supplies the values to the 7-segment digits
  - Each digit actually has 8 LEDs including decimal point.
  - The diagram shows which bit controls each LED.
  - The pins of Port B are connected to all four digits in the Dragon12+.



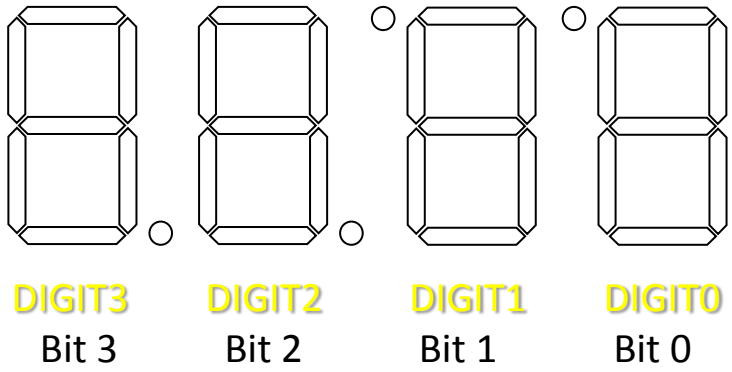




Port B, P, and H in the Dragon12+

Port P – Selecting a 7-segment digit

- 7 segment digit selection
  - Port P is used to select which of the four 7-segment LED digits are enabled.
  - Remember that the display pattern is determined by Port B.
  - Those digits that are not selected will be off (all LEDs off).
  - Note: only lower 4 bits are used .
- Enable/Disable

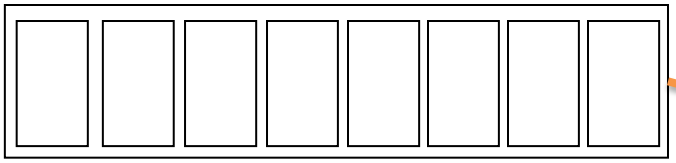


Port B, P, and H in the Dragon12+

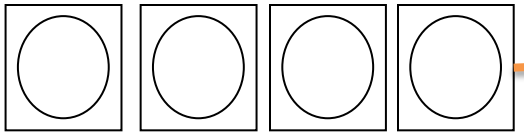
Port H – switch input

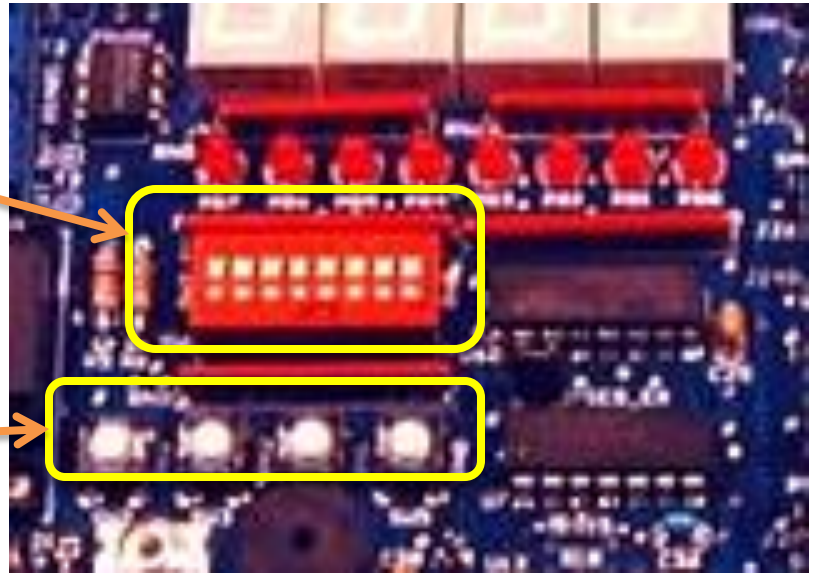
- Port H is used to read the 8-DIP switches and 4 push buttons.
  - Only four pins that monitor both switches.
  - Note 1: No way to distinguish which is being pressed.
  -

- DIP switches



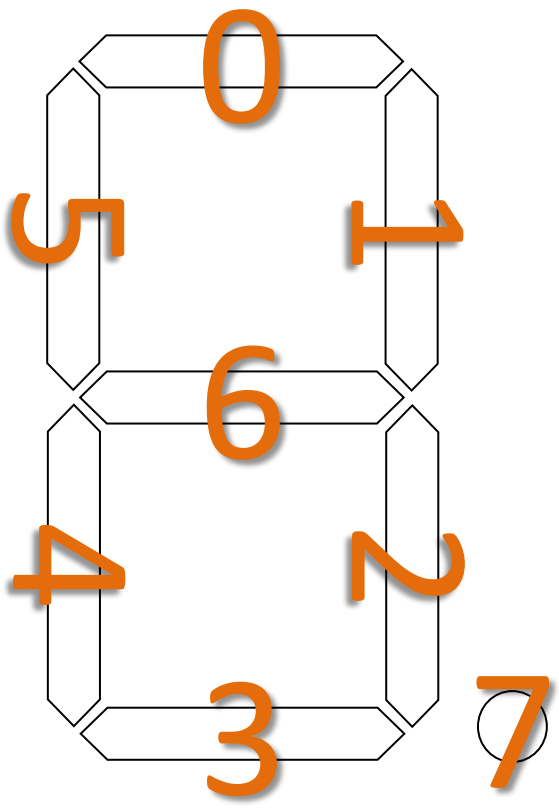
- Push Buttons





Example Program

- Write a program
  - Turns on one LED segment of DIGIT3 at a time.
  - When the program begins, only segment 0 should be on.
  - Every time BUTT3 is pressed,
    the current LED segment turns off
    and the next one
    (see the numbers on the figure) turns on.

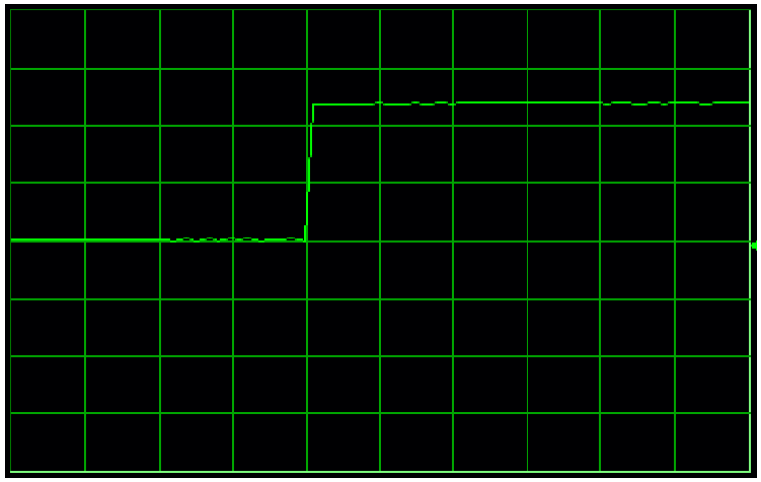


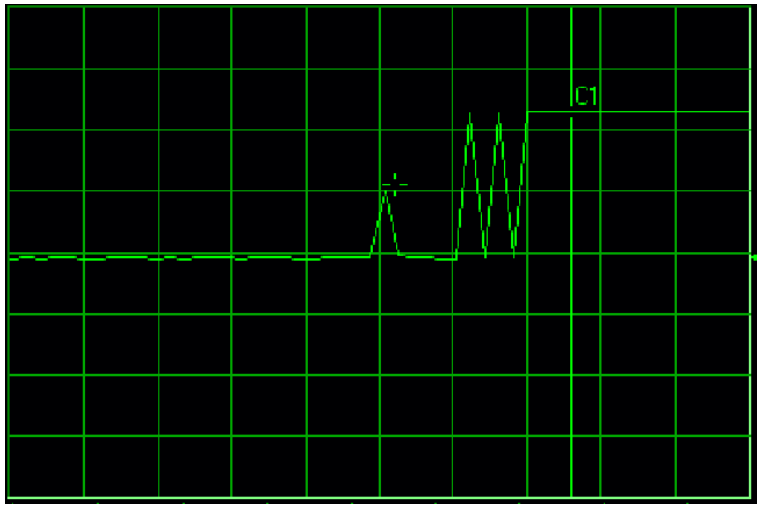
```
DATASTART    equ $1000
PROGSTART    equ $2000

; Ports on Dragon12+
PORTB        equ $0001
DDRB         equ $0003
PORTH        equ $0260
DDRH         equ $0262
PORTP        equ $0258
DDRP         equ $025A
```

Switch Bounce

- When a switch is asserted, we expect a signal something like the top right picture.
- However, signals has a transient period.
- When a switch (or button) is asserted (or pressed), the actual signal can be the bottom right figure.
  - For a short period of time, the switch signal is bouncing.
- That is why the program detects multiple buttons.





Switch Debounce

```
PORTB       EQU     $0001
DDRB        EQU     $0003
PORTH       EQU     $0260
DDRH        EQU     $0262
PORTP       EQU     $0258
DDRP        EQU     $025A

            ORG     $2000
```

File: d12plus.inc

```
PORTB           EQU       $0001
DDRB            EQU       $0003
PORTH           EQU       $0260
DDRH            EQU       $0262
PORTP           EQU       $0258
DDRP            EQU       $025A

DOUT            EQU       $FF
DINP            EQU       $00
DIGIT0          EQU       $FE  ; %11111110
DIGIT1          EQU       $FD  ; %11111101
DIGIT2          EQU       $FB  ; %11111011
DIGIT3          EQU       $F7  ; %11110111

BUTT0           EQU       $08  ; %00001000
BUTT1           EQU       $04  ; %00000100
BUTT2           EQU       $02  ; %00000010
BUTT3           EQU       $01  ; %00000001
```

```
INCLUDE d12plus.inc

ORG  $2000
```

File: d12plus.inc

```
;*************************************************************
; Purpose:
;     Define constants for D12PLUS
;
; History:
;     2/21/2010: Prof. Kwon created
;
;*************************************************************

;-------------------------------------------------------------
; Memory mapping of Dragon12+
DATASTART   equ   $1000
PROGSTART   equ   $2000

;-------------------------------------------------------------
; Constants
TRUE        equ   $FF
FALSE       equ   $00

;-------------------------------------------------------------
; Ports on Dragon12+
PORTB       equ   $0001
DDRB        equ   $0003
PORTH       equ   $0260
DDRH        equ   $0262
PORTP       equ   $0258
DDRP        equ   $025A

;-------------------------------------------------------------
; Logical name of the ports on Dragon12+
SEGPATTN    equ   PORTB
PSHBUTTN    equ   PORTH
DIGITNUM    equ   PORTP

;-------------------------------------------------------------
; General I/O port configuration
DOUT        equ   $FF
DINP        equ   $00
```

File: d12plus.inc - continued

```
;---------------------------------------------------------------
; DIGIT 7-segment LEDs on Dragon12+
; DIGIT3, DIGIT2, DIGIT1, DIGIT 0 from the left
DIGIT0            equ   $F7   ; %11110111
DIGIT1            equ   $FB   ; %11111011
DIGIT2            equ   $FD   ; %11111101
DIGIT3            equ   $FE   ; %11111110

;---------------------------------------------------------------
; Push buttons on Dragon12+
; BUTT3, BUTT2, BUTT1, BUTT0 from the left
BUTT0       equ   $08   ; %00001000
BUTT1       equ   $04   ; %00000100
BUTT2       equ   $02   ; %00000010
BUTT3       equ   $01   ; %00000001
```

File: lec18.asm

```
            INCLUDE d12plus.inc

MXDLY       equ   $6000

            ORG   PROGSTART
```

Questions?

Wrap-up

What we've learned

What to Come