



ECE375

Data Manipulation and the LCD

TA:

School of Electrical Engineering and Computer Science
Oregon State University

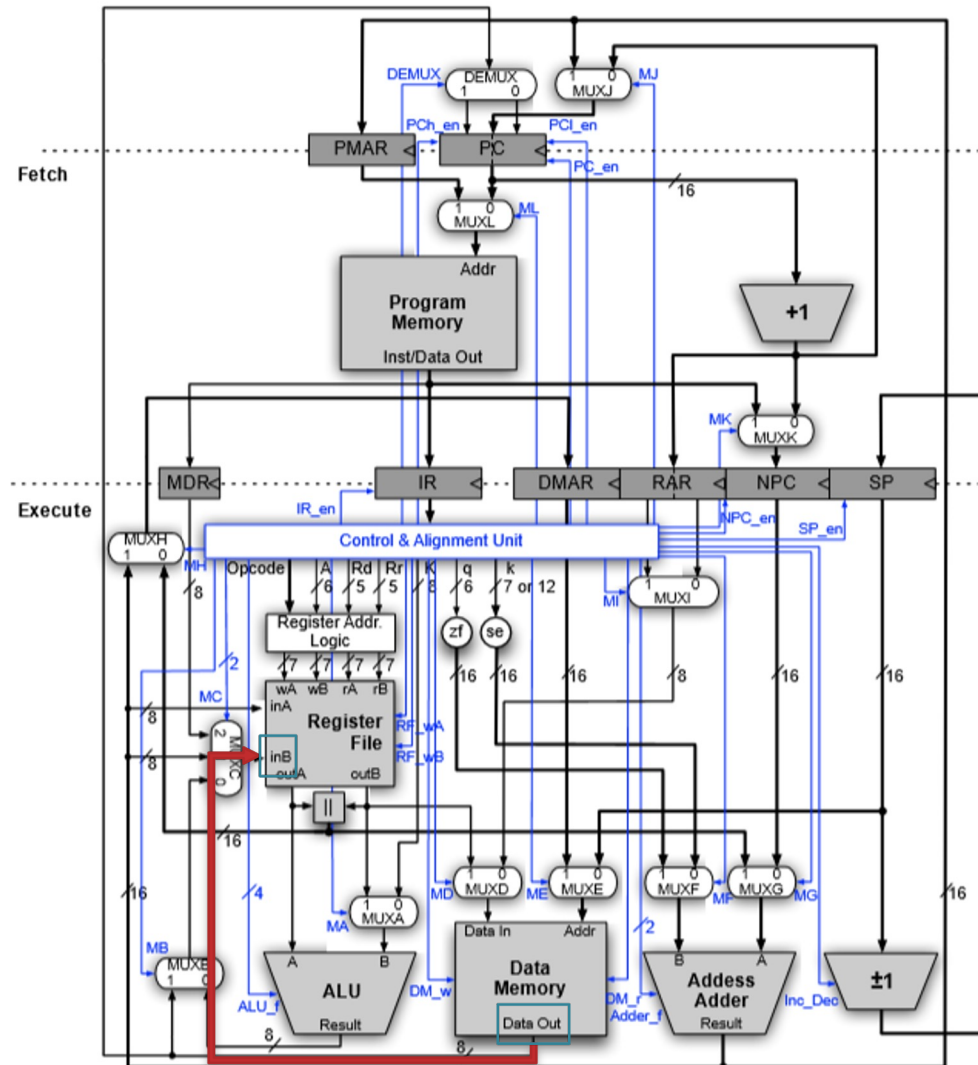
Goal of this Lab

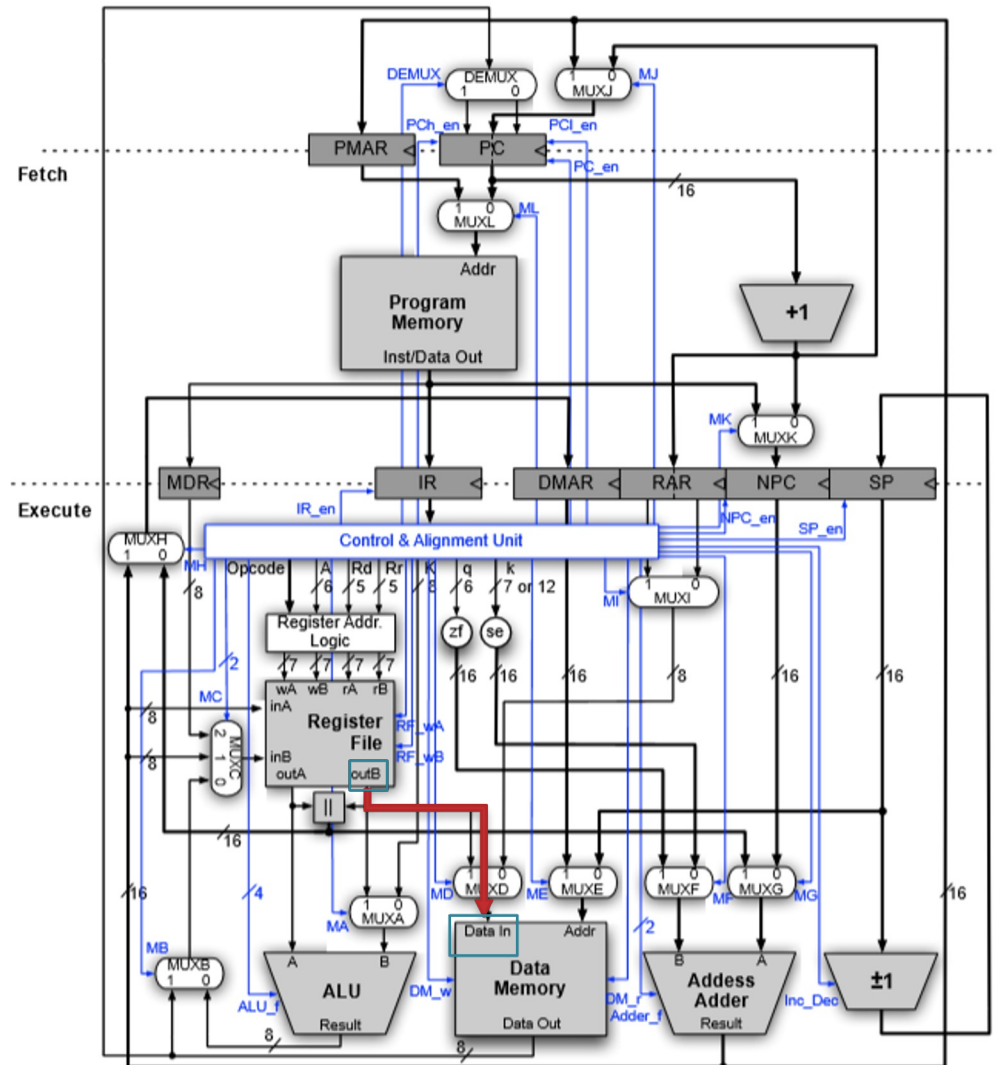
- Learn data manipulation in Assembly.
- Use X/Y/Z registers as pointers.
- Use LCD driver function.

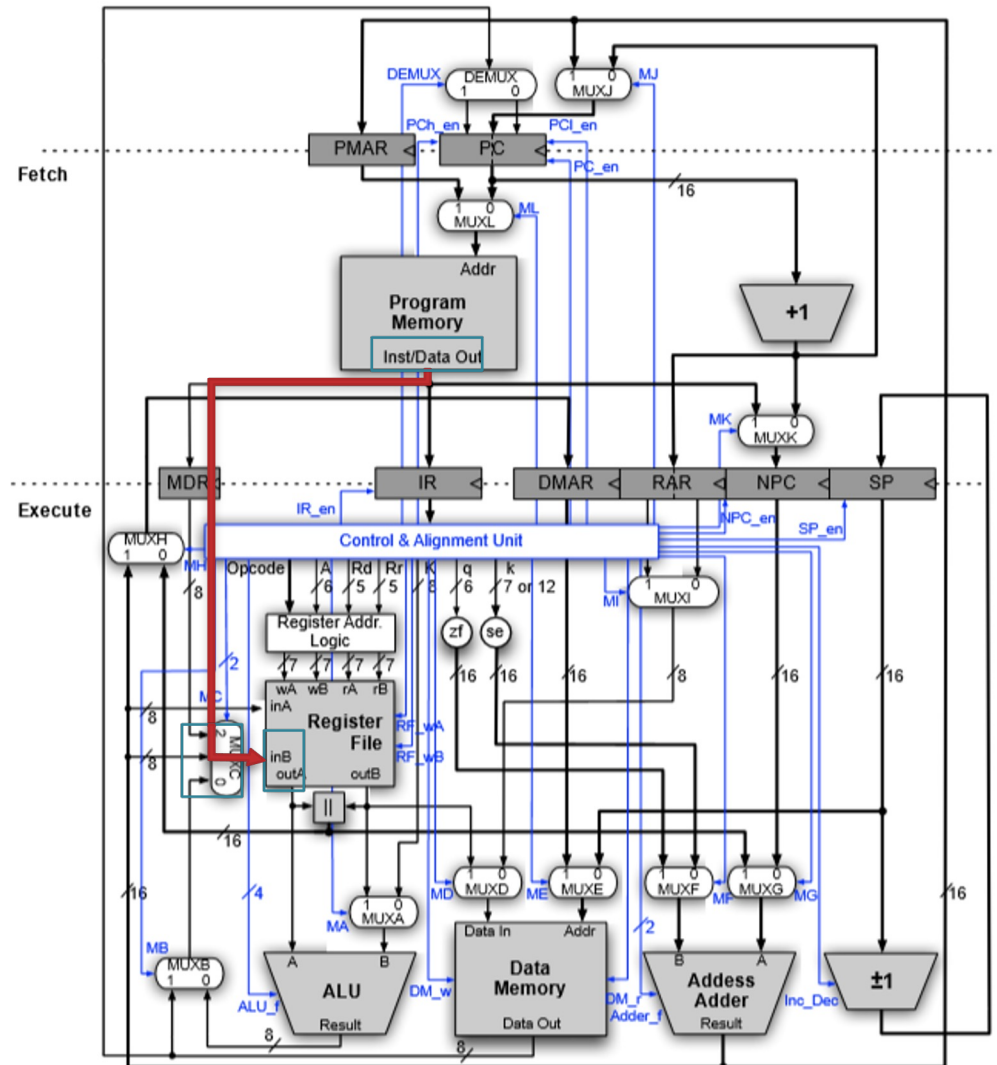
Data Manipulation

- Data memory – Register
- Data memory – Program Memory
- Register – Program Memory

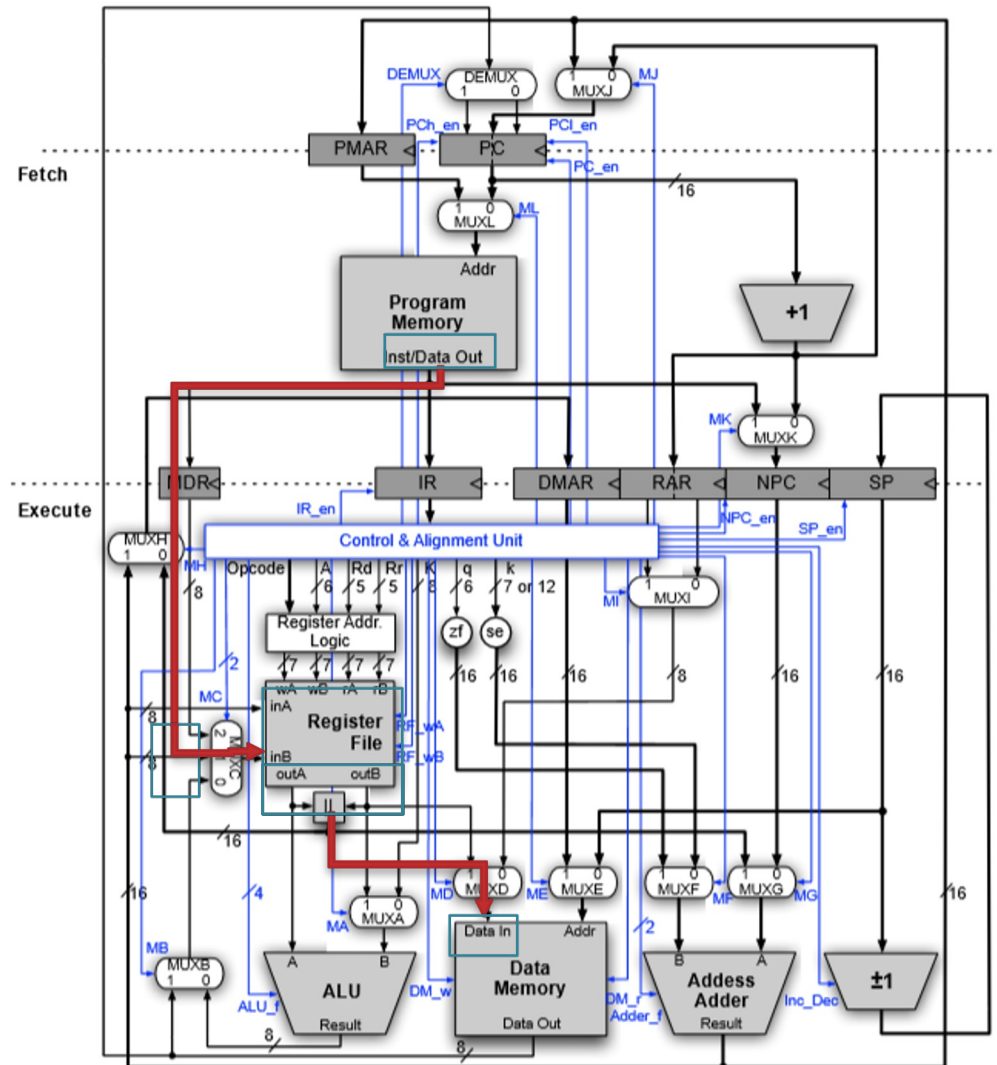
Data memory -> Register





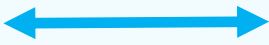


Program memory -> Data memory




Data Memory & Register

\$D1	\$0100
\$D2	\$0101
\$D3	\$0102
\$D4	\$0103
\$D5	\$0104
\$D6	\$0105
\$D7	\$0106



8 Bit

\$16	R16
\$17	R17
\$18	R18
\$19	R19



8 Bit

Data Memory to Register



\$D1	\$0100
\$D2	\$0101
\$D3	\$0102
\$D4	\$0103
\$D5	\$0104
\$D6	\$0105
\$D7	\$0106

8 Bit

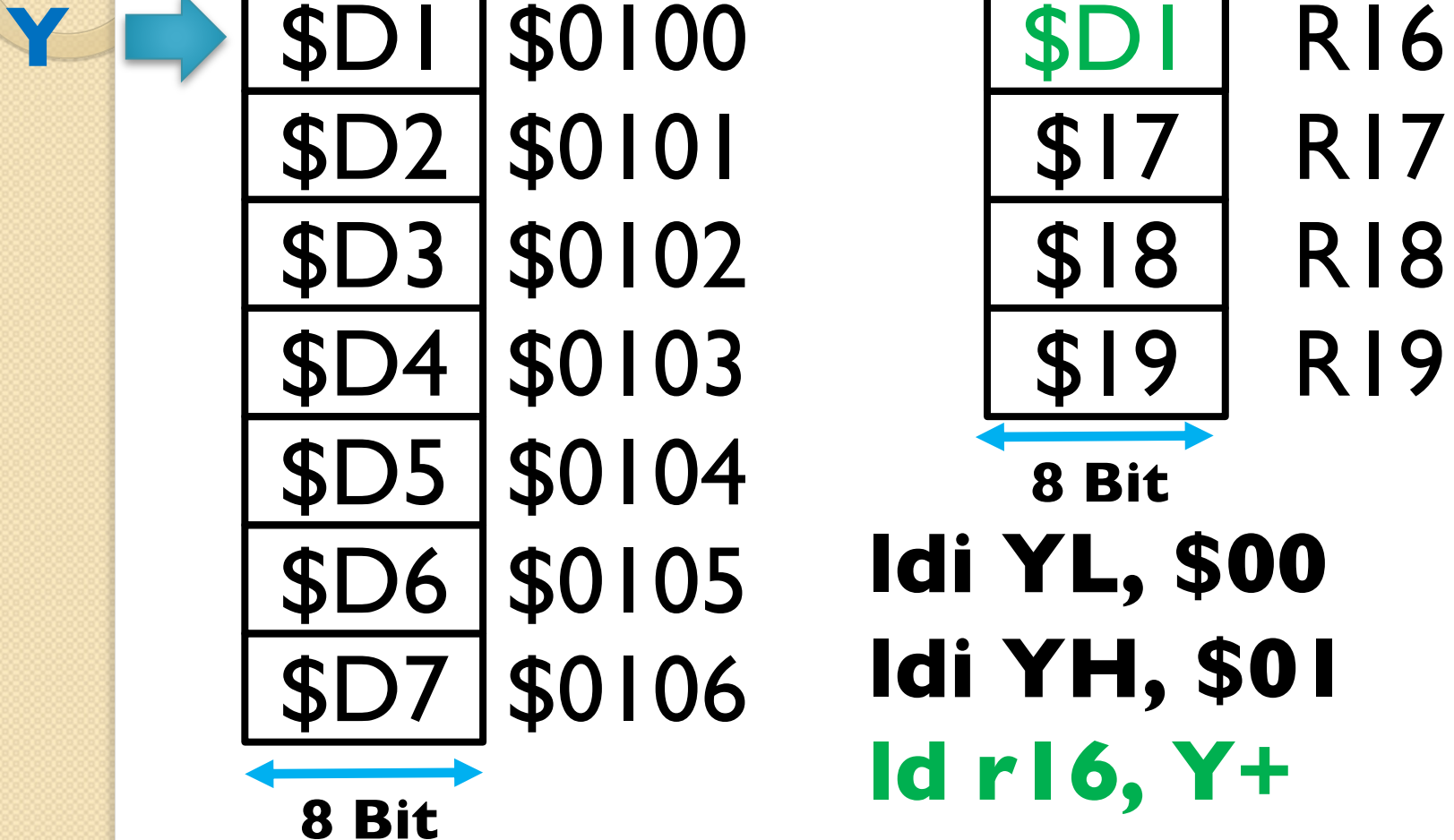
\$16	R16
\$17	R17
\$18	R18
\$19	R19

8 Bit

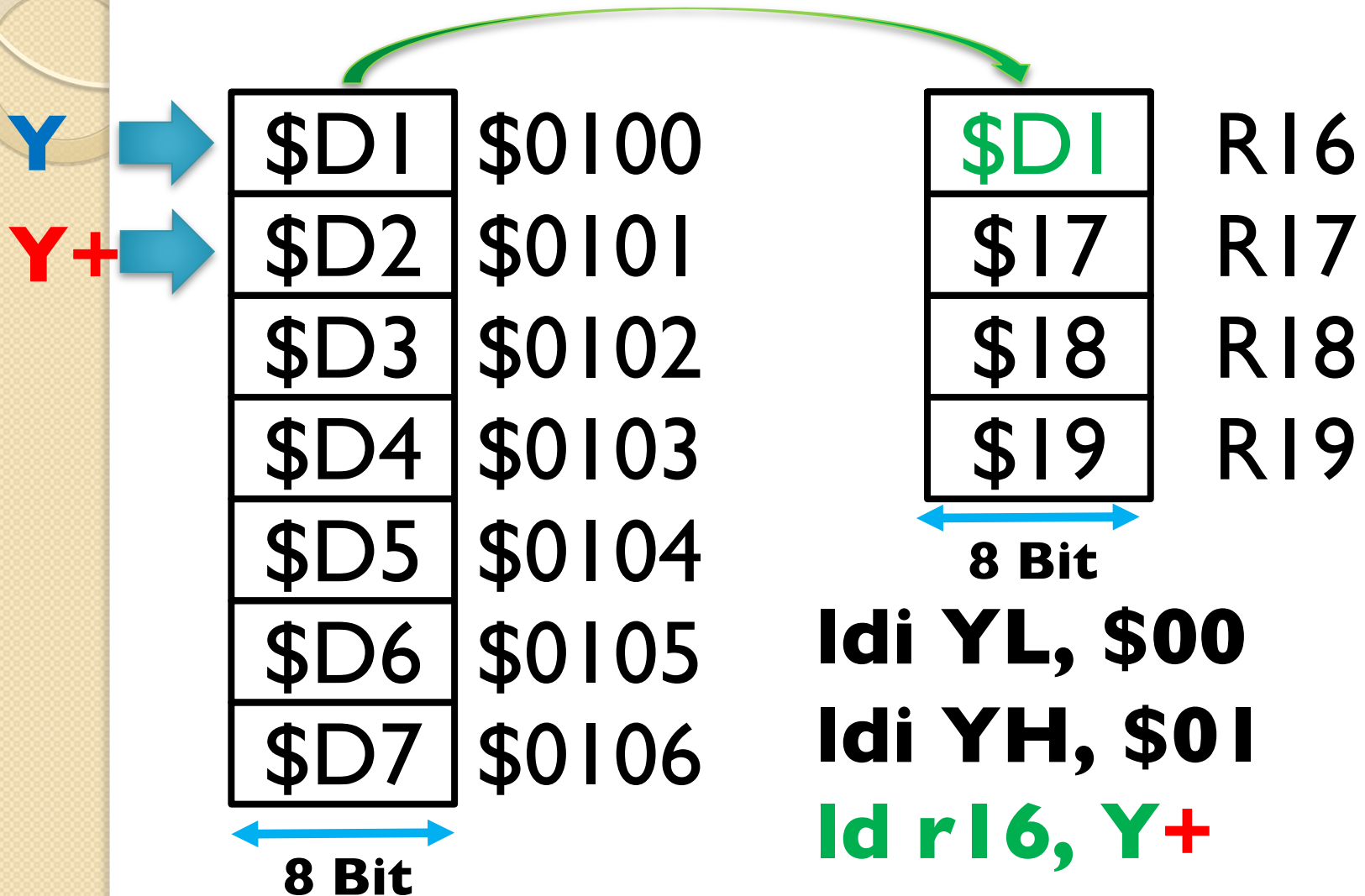
Idi YL, \$00

Idi YH, \$01

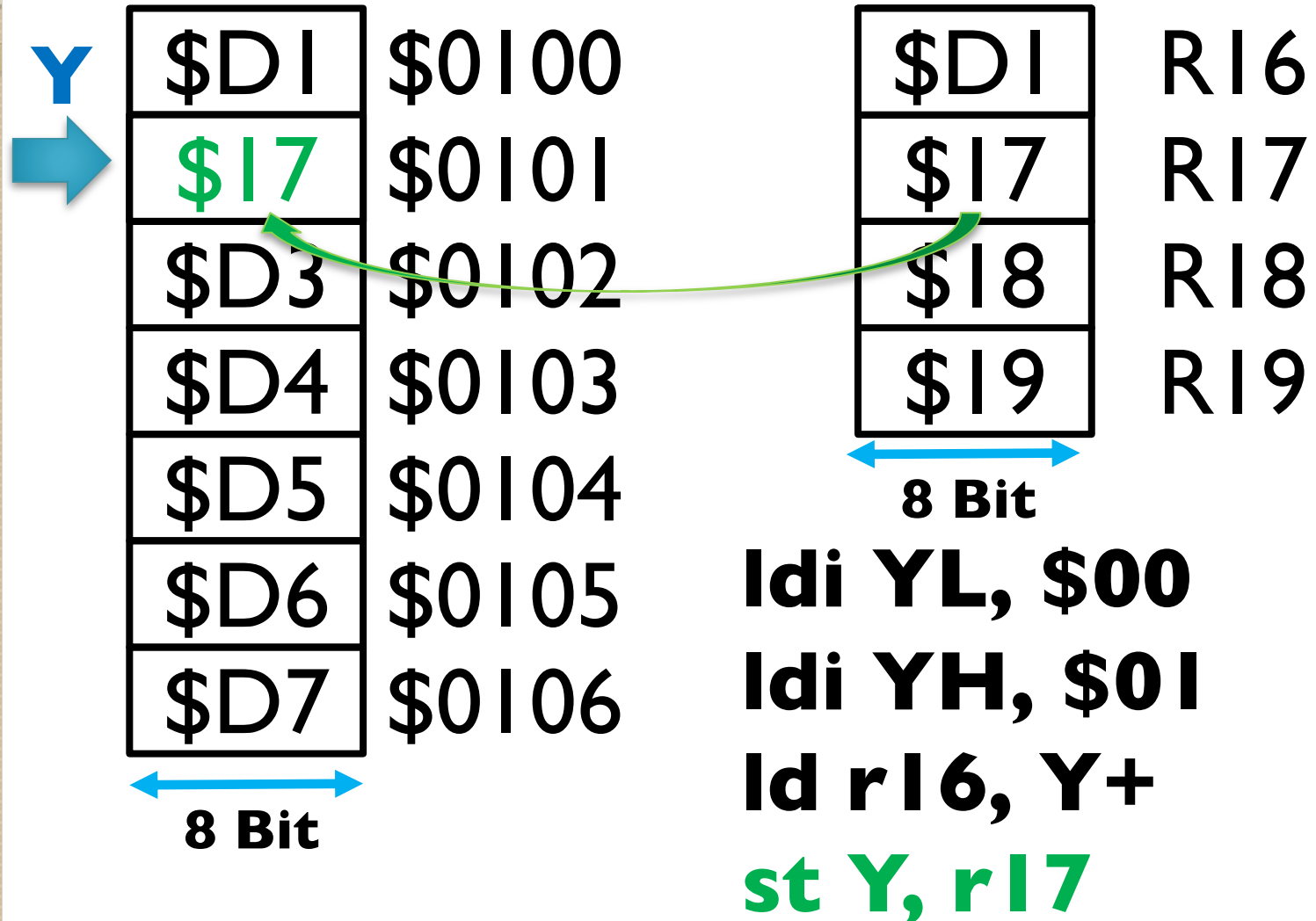
Data Memory to Register



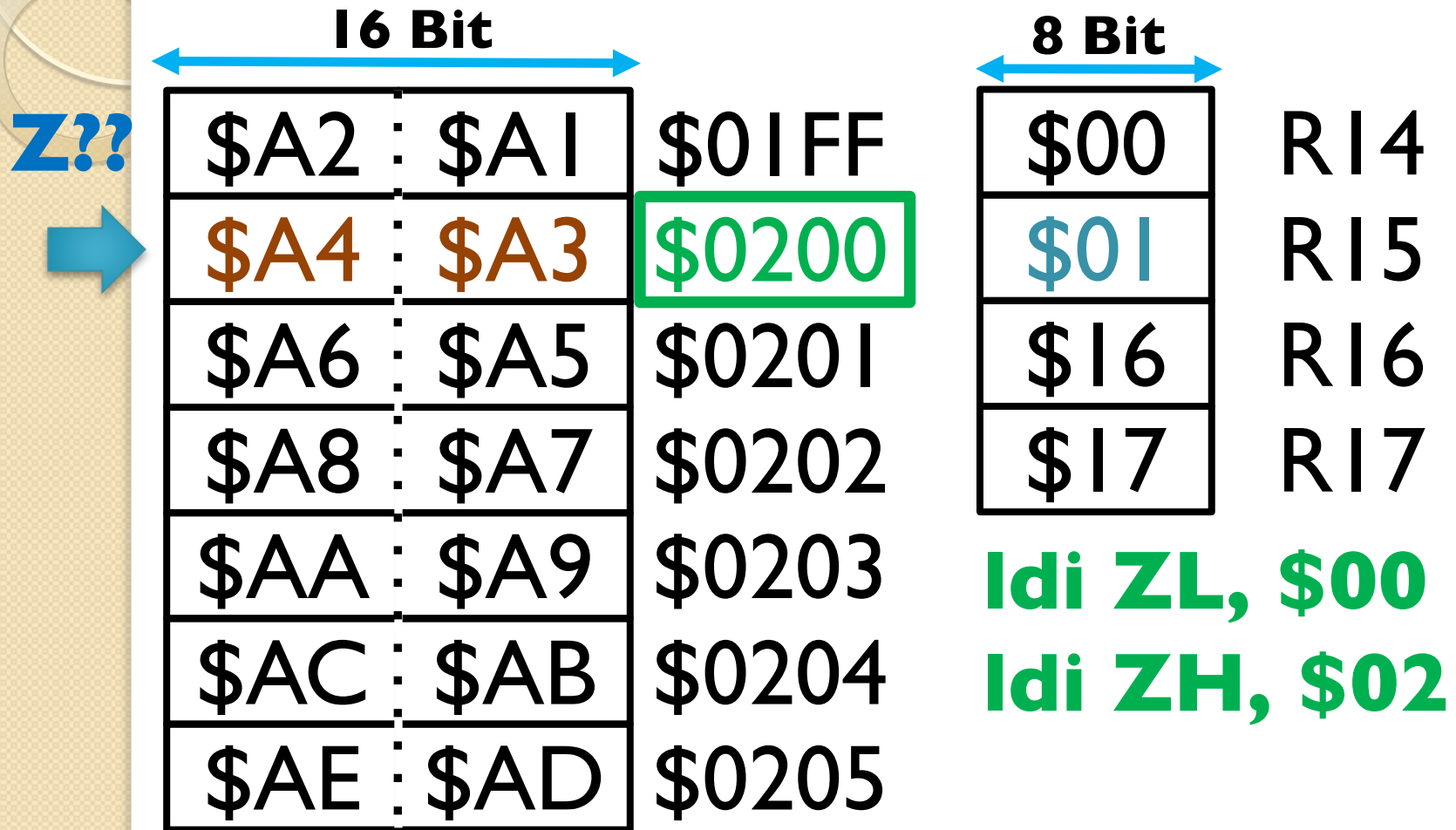
Data Memory to Register



Register to Data Memory



Program Memory to Register



Program Memory(16 bits) ≠ Register (8bits)

Cannot move data directly

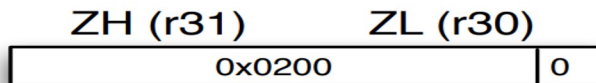
Program Memory to Register

16 Bit		
\$A2 : \$A1	\$01FF	
\$A4 : \$A3	\$0200	
\$A6 : \$A5	\$0201	
\$A8 : \$A7	\$0202	
\$AA : \$A9	\$0203	
\$AC : \$AB	\$0204	
\$AE : \$AD	\$0205	

8 Bit	
\$00	R14
\$01	R15
\$16	R16
\$17	R17

Idi ZL, \$00 << I

Idi ZH, \$02 << I



Low/high byte (bit 0)



Z = 0b0000001000000000 << I

Program Memory to Register

16 Bit

\$A2 : \$A1	\$01FF
\$Z → \$A3	\$0200
\$A6 : \$A5	\$0201
\$A8 : \$A7	\$0202
\$AA : \$A9	\$0203
\$AC : \$AB	\$0204
\$AE : \$AD	\$0205

8 Bit

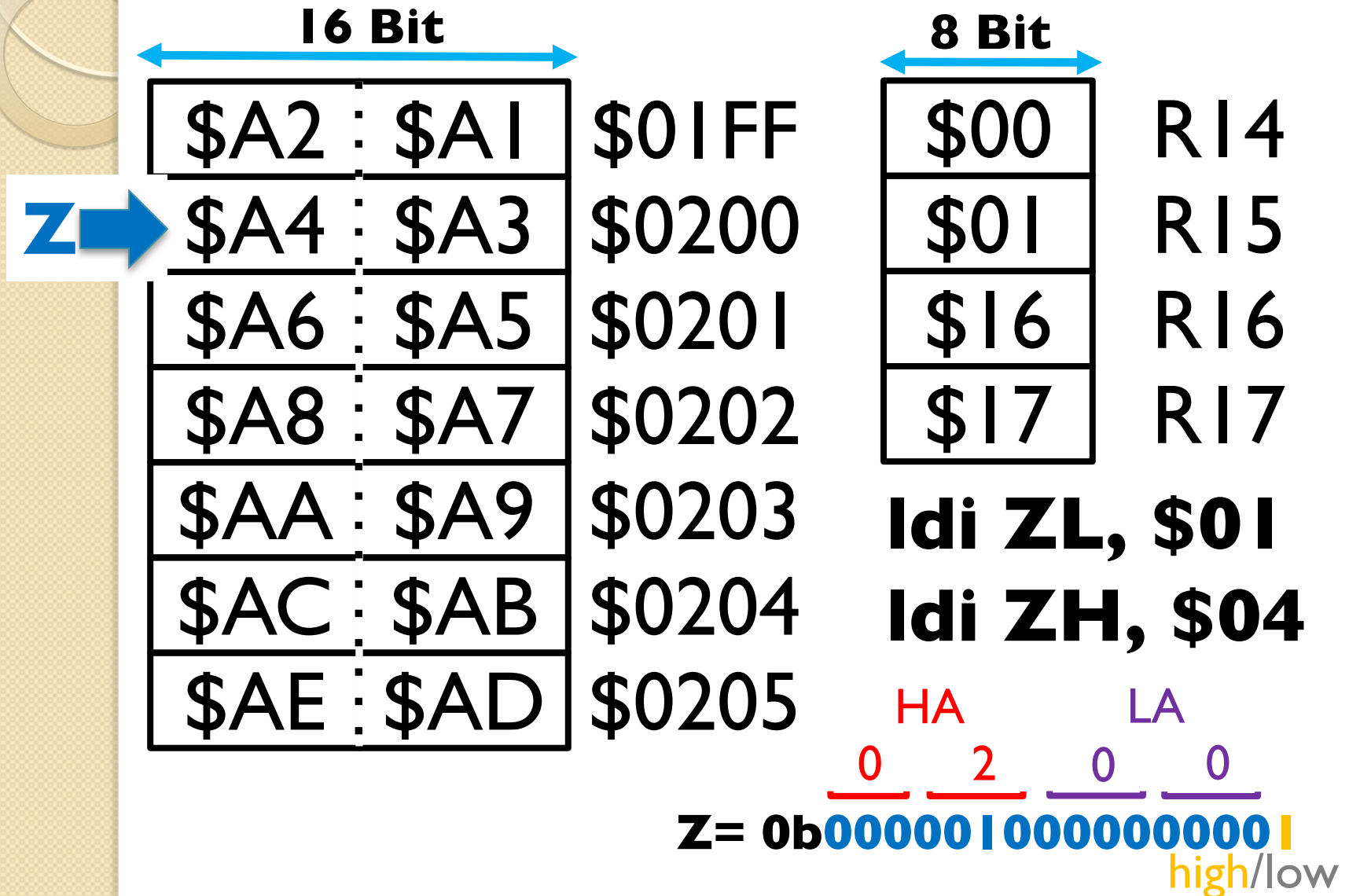
\$00	R14
\$01	R15
\$16	R16
\$17	R17

ldi ZL, \$00

ldi ZH, \$04


HA LA
 0 2 0 0
 Z= 0b0000010000000000
 high/low


Program Memory to Register



Program Memory to Register

16 Bit



\$A2 : \$A1	\$01FF
 \$A3	\$0200
\$A6 : \$A5	\$0201
\$A8 : \$A7	\$0202
\$AA : \$A9	\$0203
\$AC : \$AB	\$0204
\$AE : \$AD	\$0205

~~ldi ZL, \$00~~
~~ldi ZH, \$02~~

ldi ZL, (\$00<<1)
 ldi ZH, (\$02<<1)

or

ldi ZL, \$00
 ldi ZH, \$04

HA LA
0 2 0 0
 Z= 0b0000010000000000
high/low

Program Memory to Register

16 Bit		
\$A2 : \$A1	\$01FF	
\$Z → \$A3	\$0200	
\$A6 : \$A5	\$0201	
\$A8 : \$A7	\$0202	
\$AA : \$A9	\$0203	
\$AC : \$AB	\$0204	
\$AE : \$AD	\$0205	

8 Bit	
\$00	R14
\$01	R15
\$16	R16
\$17	R17

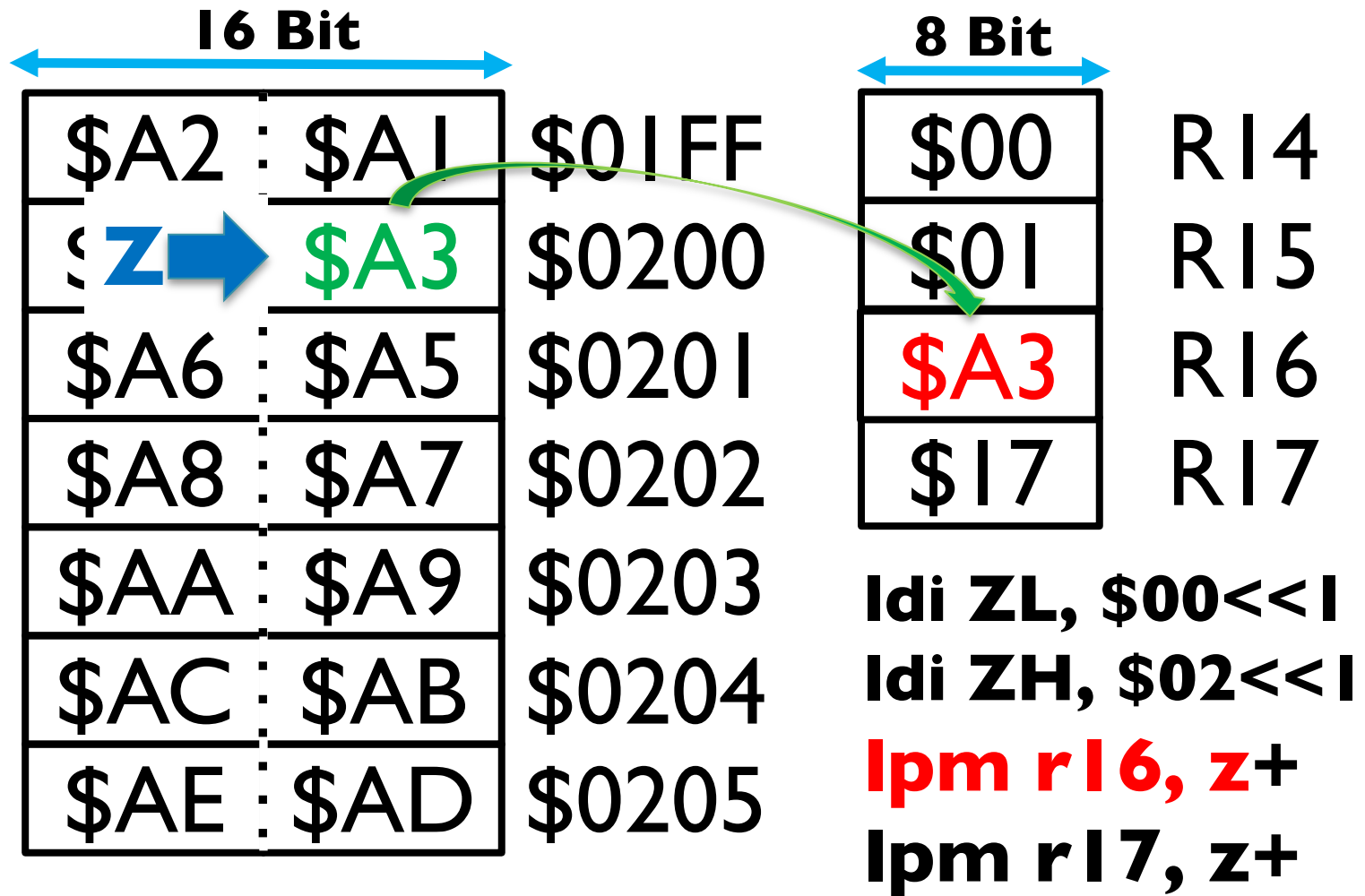
ldi ZL, \$00<<1

ldi ZH, \$02<<1

lpm r16, z+

lpm r17, z+

Program Memory to Register



Program Memory to Register

16 Bit

\$A2 : \$A1	\$01FF
\$A4 : \$A3	\$0200
\$A6 : \$A5	\$0201
\$A8 : \$A7	\$0202
\$AA : \$A9	\$0203
\$AC : \$AB	\$0204
\$AE : \$AD	\$0205

Z+

8 Bit

\$00	R14
\$01	R15
\$A3	R16
\$17	R17

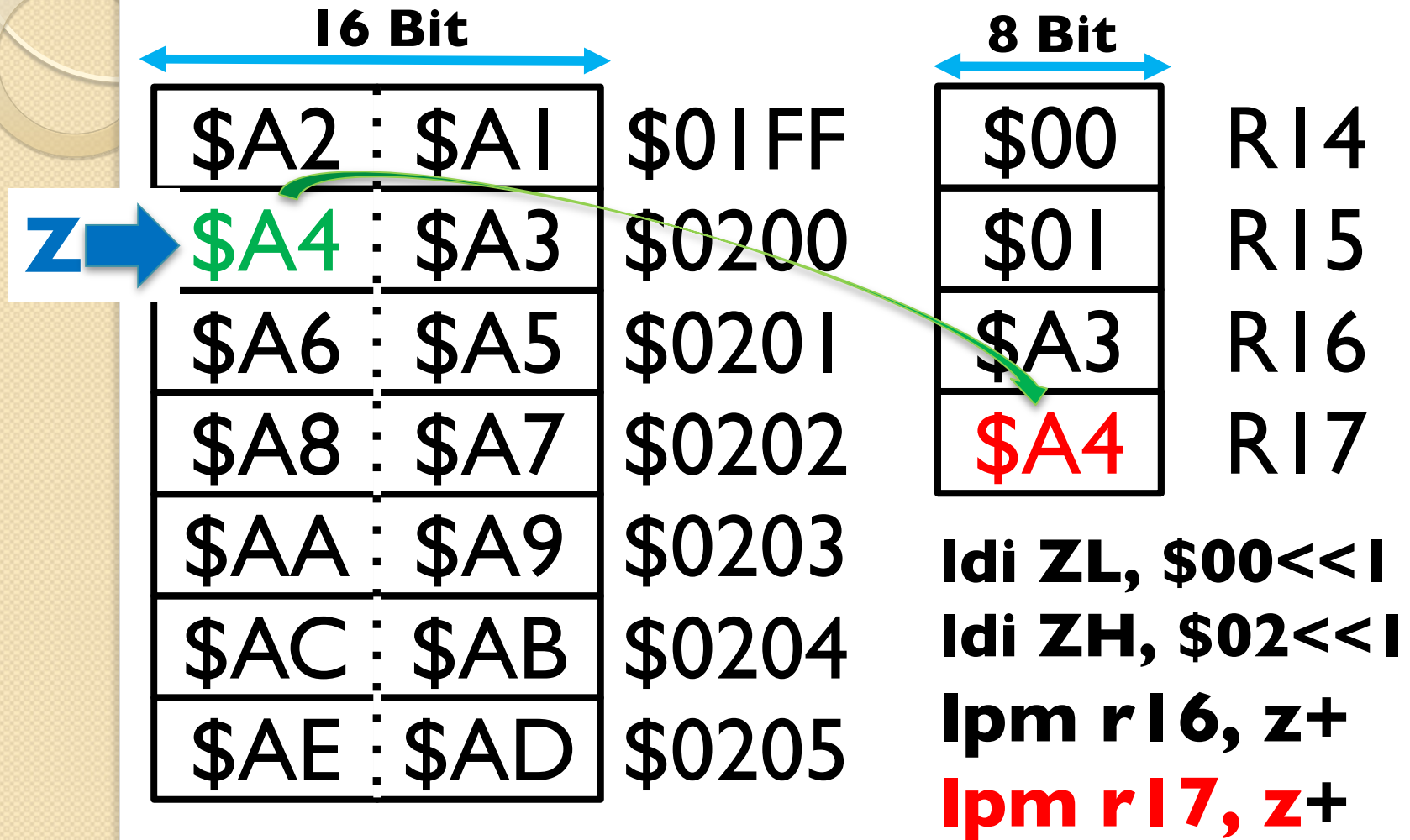
ldi ZL, \$00<<1

ldi ZH, \$02<<1

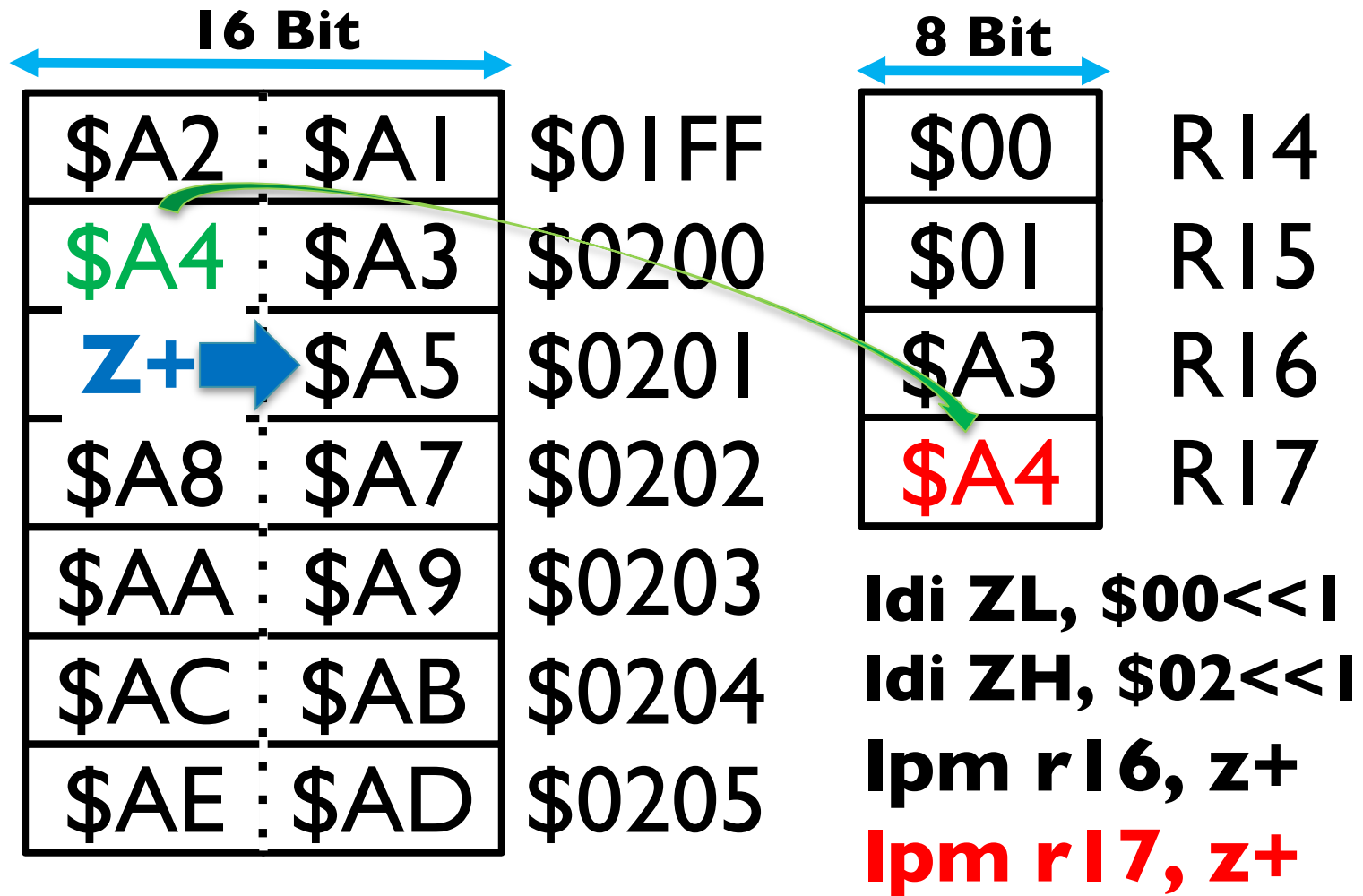
lpm r16, z+

lpm r17, z+

Program Memory to Register



Program Memory to Register



Program Memory to Data Memory

\$BB	:	\$AA	\$0200
\$DD	:	\$CC	\$0201
\$FF	:	\$EE	\$0202

\$16	R16
\$17	R17
\$18	R18
\$19	R19

\$D1	\$0100
\$D2	\$0101
\$D3	\$0102
\$D4	\$0103

Program Memory to Data Memory

\$BB	:	\$AA	\$0200
\$DD	:	\$CC	\$0201
\$FF	→	\$EE	\$0202

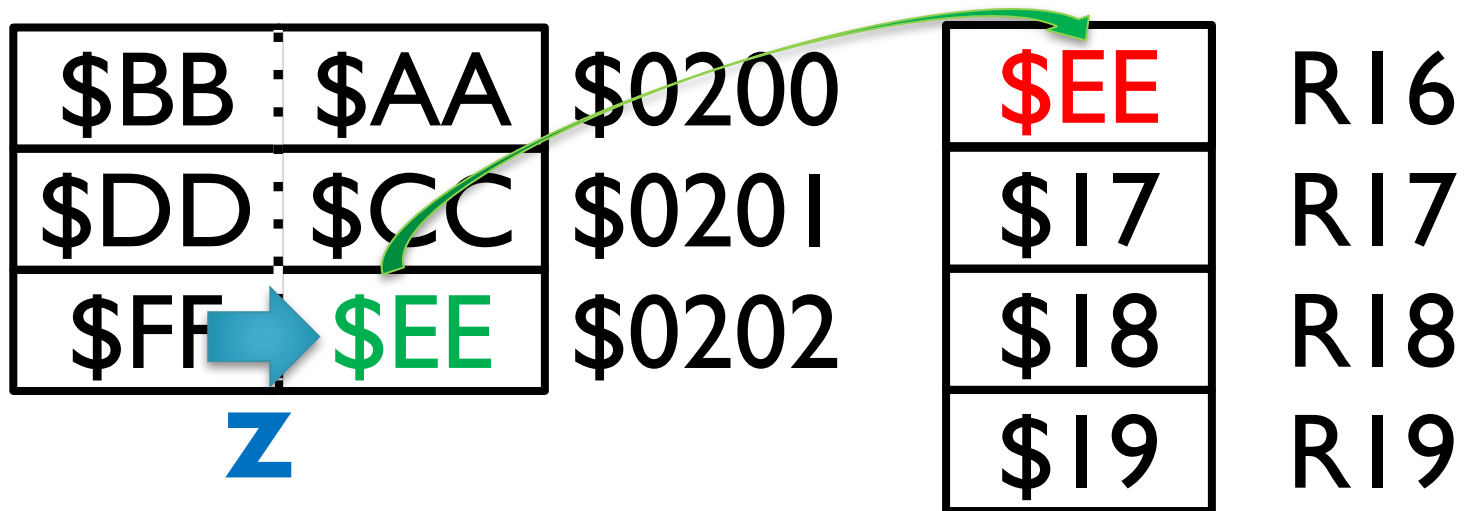
Z

\$16	R16
\$17	R17
\$18	R18
\$19	R19

\$D1	\$0100
\$D2	\$0101
\$D3	\$0102
\$D4	\$0103

ldi ZL,\$02<<1
ldi ZH,\$02<<1
lpm r16,Z

Program Memory to Data Memory



\$D1	\$0100
\$D2	\$0101
\$D3	\$0102
\$D4	\$0103

ldi ZL,\$02<<1
ldi ZH, \$02<<1
lpm r16, Z

Program Memory to Data Memory

\$BB	:	\$AA	\$0200
\$DD	:	\$CC	\$0201
\$FF	→	\$EE	\$0202

Z

\$EE	R16
\$17	R17
\$18	R18
\$19	R19

Y
→

\$D1	\$0100
\$D2	\$0101
\$D3	\$0102
\$D4	\$0103

ldi ZL,\$02<<1
ldi ZH, \$02<<1
lpm r16, Z
ldi YL, \$00
ldi YH, \$01

Program Memory to Data Memory

\$BB : \$AA	\$0200	\$EE	R16
\$DD : \$CC	\$0201	\$17	R17
\$FF → \$EE	\$0202	\$18	R18
		\$19	R19

Z

Y →

\$EE	\$0100
\$D2	\$0101
\$D3	\$0102
\$D4	\$0103

```

ldi ZL,$02<<1
ldi ZH,$02<<1
lpm r16,Z
ldi YL,$00
ldi YH,$01
st Y,r16
    
```

LCD Display

- Address of Data memory
 - 1st line of LCD : \$0100 - \$010F
 - 2nd line of LCD : \$0110 - \$011F
- Stored Data in Program memory
 - STRING1_BEG: ; denotes the name of address
.DB "Han Jang"
 - STRING2_BEG:
.DB "HelloWorld"

Text Scroll from left to right

- Refer to Data Transfer instructions in
Ch.4: Atmel's AVR 8-bit Microcontroller, Part 1
– Assembly Programming

Check-off Lists

- Correct display functions accordingly with correction switch buttons.
- LCD Scrolling from left to right
- No dummy characters.
- Correct use of program memory.
- Correct use of data manipulation.

Questions?

