

Lab02 Addressing Mode

(1) What is Addressing Mode?

Link: [IS for PIC18F4520](#)

(https://technology.niagaracollege.ca/staff/mboldin/18F_Instruction_Set/)

(2) PIC18F4520 Addressing Mode

No Operation

- NOP

Inherent Addressing (Implied Addressing)

- SLEEP 、 RESET 、 DAW

Literal Addressing (Immediate Addressing)

- MOVLW 、 ADDLW 、 SUBLW 、 ANDLW 、 GOTO 、 CALL...

Direct Addressing (Absolute Addressing)

Indirect Addressing

Bit Addressing

Relative addressing

No Operation

- NOP

NOP

No Operation

Syntax: [*label*] NOP

Operands: None

Operation: No operation

Status Affected: None

Encoding:

0000	0000	0000	0000
1111	xxxx	xxxx	xxxx

Description: No operation.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	No operation	No operation	No operation

Example:

None.

Sample code:

```
1  #INCLUDE <p18f4520.inc>
2      CONFIG OSC = INTIO67
3      CONFIG WDT = OFF
4      org 0x10 ;PC = 0x10
5  start:
6      nop
7      nop
8      nop
9      nop
10     nop
11  end
```

- PC += 2
- "wasting" 1 clock cycle
- delay loop

Inherent Addressing

- **SLEEP**

SLEEP	Enter SLEEP mode								
Syntax:	[<i>label</i>] SLEEP								
Operands:	None								
Operation:	00h → WDT, 0 → WDT postscaler, 1 → \overline{TO} , 0 → \overline{PD}								
Status Affected:	\overline{TO} , \overline{PD}								
Encoding:	<table><tr><td>0000</td><td>0000</td><td>0000</td><td>0011</td></tr></table>	0000	0000	0000	0011				
0000	0000	0000	0011						
Description:	<p>The power-down status bit (\overline{PD}) is cleared. The time-out status bit (\overline{TO}) is set. Watchdog Timer and its postscaler are cleared.</p> <p>The processor is put into SLEEP mode with the oscillator stopped.</p>								
Words:	1								
Cycles:	1								
Q Cycle Activity:									
	<table><tr><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td></tr><tr><td>Decode</td><td>No operation</td><td>Process Data</td><td>Go to sleep</td></tr></table>	Q1	Q2	Q3	Q4	Decode	No operation	Process Data	Go to sleep
Q1	Q2	Q3	Q4						
Decode	No operation	Process Data	Go to sleep						

- RESET

RESET	Reset								
Syntax:	[<i>label</i>] RESET								
Operands:	None								
Operation:	Reset all registers and flags that are affected by a <u>MCLR</u> Reset.								
Status Affected:	All								
Encoding:	<table><tr><td>0000</td><td>0000</td><td>1111</td><td>1111</td></tr></table>	0000	0000	1111	1111				
0000	0000	1111	1111						
Description:	This instruction provides a way to execute a <u>MCLR</u> Reset in software.								
Words:	1								
Cycles:	1								
Q Cycle Activity:									
	<table><tr><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td></tr><tr><td>Decode</td><td>Start reset</td><td>No operation</td><td>No operation</td></tr></table>	Q1	Q2	Q3	Q4	Decode	Start reset	No operation	No operation
Q1	Q2	Q3	Q4						
Decode	Start reset	No operation	No operation						

- DAW

DAW Decimal Adjust W Register

Syntax: [*label*] DAW

Operands: None

Operation: If $[W<3:0> > 9]$ or $[DC = 1]$ then
 $(W<3:0>) + 6 \rightarrow W<3:0>;$
 else
 $(W<3:0>) \rightarrow W<3:0>;$

 If $[W<7:4> > 9]$ or $[C = 1]$ then
 $(W<7:4>) + 6 \rightarrow W<7:4>;$
 else
 $(W<7:4>) \rightarrow W<7:4>;$

Status Affected: C

Encoding:

0000	0000	0000	0111
------	------	------	------

Description: DAW adjusts the eight-bit value in W, resulting from the earlier addition of two variables (each in packed BCD format) and produces a correct packed BCD result.

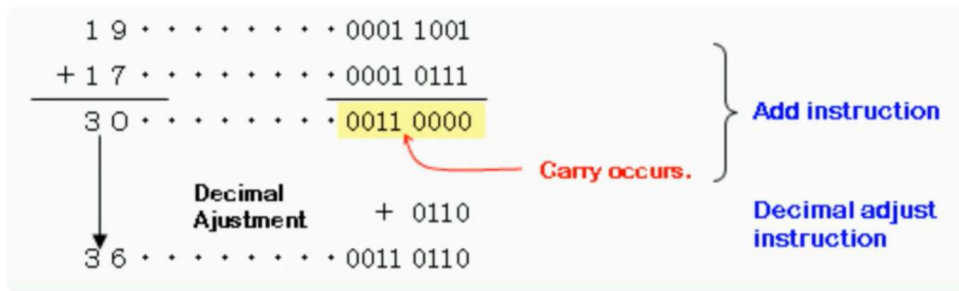
Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register W	Process Data	Write W

- BCD addition adjustment



Literal Addressing

- 8-bits literal MOVLW 、 ADDLW 、 SUBLW 、 ANDLW
- 20-bits literal *GOTO...

Sample code:

```

1  #INCLUDE <p18f4520.inc>
2      CONFIG OSC = INTIO67
3      CONFIG WDT = OFF
4      org 0x10 ;PC = 0x10
5  start:
6      MOVLW 0x05
7
8  end

```

SFRs x

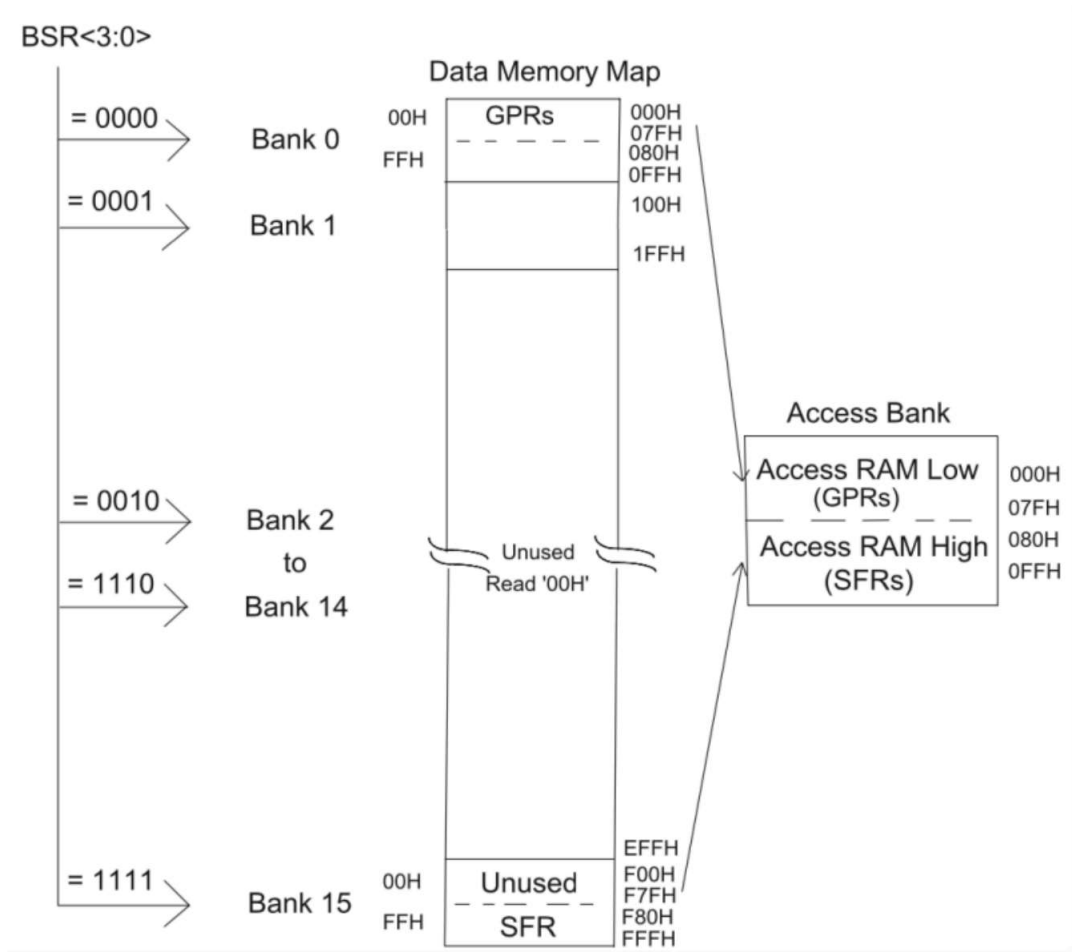
Address /	Name	Hex	Decimal	Binary	Char
FE0	BSR	0x00	0	00000000	'.'
FE1	FSR1	0x0000	0	00000000 00000000	'..'
FE1	FSR1L	0x00	0	00000000	'.'
FE2	FSR1H	0x00	0	00000000	'.'
FE3	PLUSW1	0x00	0	00000000	'.'
FE4	PREINC1	0x00	0	00000000	'.'
FE5	POSTDEC1	0x00	0	00000000	'.'
FE6	POSTINC1	0x00	0	00000000	'.'
FE7	INDF1	0x00	0	00000000	'.'
FE8	WREG	0x05	5	00000101	'.'
FE9	FSR0	0x0000	0	00000000 00000000	'..'
FE9	FSR0L	0x00	0	00000000	'.'
FEA	FSR0H	0x00	0	00000000	'.'
FEB	PLUSW0	0x00	0	00000000	'.'
FEC	PREINC0	0x00	0	00000000	'.'
FED	POSTDEC0	0x00	0	00000000	'.'
FEE	POSTINC0	0x00	0	00000000	'.'
FEF	INDF0	0x00	0	00000000	'.'
FF0	INTCON3	0xC0	192	11000000	'A'
FF1	INTCON2	0xF5	245	11110101	'5'
FF2	INTCON	0x00	0	00000000	'.'
FF3	PROD	0x0000	0	00000000 00000000	'..'
FF3	PRODH	0x00	0	00000000	'.'

Memory SFRs

Format Individual

Direct Addressing

Data Memory MAP



12-bits memory address, higher 4 bits for bank select.

==> 將整塊4096Bytes的記憶體區分成16個小區(bank0~bank15)

Some data movement instructions on file register

1. Access Bank

- Access RAM (or GPRs) (0x000 ~ 0x07F and 0xF80 ~ 0xFFFF)

2. Bank Select (higher address) (0x000 ~ 0xFFFF)

(*) 因為 data movement 的 file register 欄位只有 8 個 bits , 所以 Access Bank 方式只能存取 256 個 bytes 的記憶體空間(0x000 ~ 0x07F 和 0xF80 ~ 0xFFFF) 。

因此若要存取整個 4096-bytes 大小的記憶體空間，要使用 Bank Select 的方式存取。

- **MOVWF**

MOVWF Move W to f

Syntax: [*label*] MOVWF f[,a]

Operands: $0 \leq f \leq 255$
 $a \in [0,1]$

Operation: $(W) \rightarrow f$

Status Affected: None

Encoding:

0110	111a	ffff	ffff
------	------	------	------

Description: Move data from W to register 'f'.
 Location 'f' can be anywhere in the
 256 byte bank. If 'a' is 0, the
 Access Bank will be selected, over-
 riding the BSR value. If 'a' = 1, then
 the bank will be selected as per the
 BSR value (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write register 'f'

- **MOVLB** (Use MOVLB to select bank)

MOVLB Move literal to low nibble in BSR

Syntax: [*label*] MOVLB k

Operands: $0 \leq k \leq 255$

Operation: $k \rightarrow \text{BSR}$

Status Affected: None

Encoding:	0000	0001	kkkk	kkkk
-----------	------	------	------	------

Description: The 8-bit literal 'k' is loaded into the Bank Select Register (BSR).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Process Data	Write literal 'k' to BSR

- **MOVFF**

MOVFF Move f to f

Syntax: [*label*] MOVFF f_s, f_d

Operands: $0 \leq f_s \leq 4095$
 $0 \leq f_d \leq 4095$

Operation: $(f_s) \rightarrow f_d$

Status Affected: None

Encoding:

1st word (source)

2nd word (destin.)

1100	ffff	ffff	ffff _s
1111	ffff	ffff	ffff _d

Description:

The contents of source register ' f_s ' are moved to destination register ' f_d '. Location of source ' f_s ' can be anywhere in the 4096 byte data space (000h to FFFh), and location of destination ' f_d ' can also be anywhere from 000h to FFFh.

Either source or destination can be W (a useful special situation).

MOVFF is particularly useful for transferring a data memory location to a peripheral register (such as the transmit buffer or an I/O port).

The MOVFF instruction cannot use the PCL, TOSU, TOSH or TOSL as the destination register.

Note: The MOVFF instruction should not be used to modify interrupt settings while any interrupt is enabled. See Section 8.0 for more information.

MOVFF 是一個很特別的指令，他的指令格式是給你兩個 12-bits 的 file register 欄位去填，所以在整個 4096-bytes 大小的記憶體裡，想去哪就去哪，不需要在乎 bank 這件事，也就是這個指令可以隨意在 4096-bytes 大小的記憶體空間裡存取。

Sample code: Access Bank

```

1  #INCLUDE <p18f4520.inc>
2      CONFIG OSC = INTIO67
3      CONFIG WDT = OFF
4      org 0x10 ;PC = 0x10
5  start:
6      MOVLW 0x99 ; WREG = 0x99
7      MOVWF 0x10 ; [0x010] = 0x99
8  end

```

Address	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	ASCII
000	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
010	99	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
020	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
030	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
040	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
050	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
060	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
070	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
080	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
090	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
0A0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
0B0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
0C0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
0D0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
0E0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
0F0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....

Sample code: Bank Select

```

1  #INCLUDE <p18f4520.inc>
2      CONFIG OSC = INTIO67
3      CONFIG WDT = OFF
4      org 0x10 ;PC = 0x10
5  start:
6      MOVLW 0x99 ; WREG = 0x99
7      MOVLB 0x4 ; BSR = 4
8      MOVWF 0x10, 1 ; use BSR select bank ; [0x410] = 0x99
9  end

```

Address	Name	Hex	Decimal	Binary	Char
F1A	FSR2E	0x00	0	00000000	0
F1B	PIR2W3	0x00	0	00000000	0
F1C	FSRINC3	0x00	0	00000000	0
F1D	POSTINC2	0x00	0	00000000	0
F1E	POSTINC2	0x00	0	00000000	0
F1F	INDF2	0x00	0	00000000	0
F20	INDF2	0x00	0	00000000	0
F21	FSR1	0x0000	0	0000000000000000	0
F22	FSR1L	0x00	0	00000000	0
F23	FSR1H	0x00	0	00000000	0
F24	FSR1L	0x00	0	00000000	0
F25	PIR2W1	0x00	0	00000000	0
F26	POSTINC1	0x00	0	00000000	0
F27	INDF1	0x00	0	00000000	0
F28	WREG	0x99	153	10011001	0
F29	FSR0	0x0000	0	0000000000000000	0
F2A	FSR0L	0x00	0	00000000	0
F2B	FSR0H	0x00	0	00000000	0
F2C	FSRINC0	0x00	0	00000000	0
F2D	POSTDEC0	0x00	0	00000000	0

Sample code: MOVFF

```

1  #INCLUDE <p18f4520.inc>
2      CONFIG OSC = INTIO67
3      CONFIG WDT = OFF
4      org 0x10 ; PC = 0x10
5  start:
6      MOVLW 0x99 ; WREG = 0x99
7      MOVLB 0x4 ; BSR = 4
8      MOVWF 0x10, 1 ; use BSR select bank ; [0x410] = 0x99
9      MOVFF 0x410, 0x420 ; [0x420] = 0x99
10 end

```

[illegible]

Indirect Addressing

Three SFRs call FSRx (x for 0~2)

- FSR0、FSR1、FSR2
- 16bits (FSRxH : FSRxL) to cover all data memory address
- they are pointer

- LFSR (let FSRx point to memory address k)

LFSR	Load FSR								
Syntax:	[<i>label</i>] LFSR f,k								
Operands:	$0 \leq f \leq 2$ $0 \leq k \leq 4095$								
Operation:	$k \rightarrow \text{FSR}_f$								
Status Affected:	None								
Encoding:	<table><tr><td>1110</td><td>1110</td><td>00ff</td><td>$k_{11}kkk$</td></tr><tr><td>1111</td><td>0000</td><td>k_7kkk</td><td>kkkk</td></tr></table>	1110	1110	00ff	$k_{11}kkk$	1111	0000	k_7kkk	kkkk
1110	1110	00ff	$k_{11}kkk$						
1111	0000	k_7kkk	kkkk						
Description:	The 12-bit literal 'k' is loaded into the file select register pointed to by 'f'.								

Some SFRs related to pointer FSRx (x for 0~2)

- INDFx : 指針不變，對指向的記憶體位置進行操作
- POSTINCx : 對指向的記憶體位置進行操作後，指針 + 1
- POSTDECx : 對指向的記憶體位置進行操作後，指針 - 1
- PREINCx : 指針 + 1 後，對指向的記憶體位置進行操作
- PLUSWx : 指針 + WREG = 新的記憶體位置後，對指向的記憶體位置進行操作

Sample code:

```

1  #INCLUDE <p18f4520.inc>
2  CONFIG OSC = INTIO67
3  CONFIG WDT = OFF
4  org 0x00 ;PC = 0x00
5  setup1:
6  LFSR 0, 0x000 ; FSR0 point to 0x000
7  LFSR 1, 0x010 ; FSR1 point to 0x010
8  LFSR 2, 0x020 ; FSR2 point to 0x020
9  MOVLW 0x10 ; WREG = 0x10
10 start:
11 INCF POSTINC0
12 ; [0x000] += 1; FSR0 point to 0x001
13
14 INCF PREINC1
15 ; FSR1 point to 0x011 ;[0x011] += 1
16
17 INCF POSTDEC2
18 ; [0x020] += 1 ; FSR2 point to 0x01F
19
20 INCF INDF2
21 ; [0x01F] += 1 ;
22 ; FSR2 point to 0x01F(unchanged)
23
24 INCF PLUSW2
25 ; [0x01F+0x10] += 1
26 ; FSR2 point to 0x01F(unchanged)
27 end

```

Bit Addressing

BSF 、BCF 、BTFSC 、BTFSS

- Set or clear specific bit file register
- BSF : Bit set f
- BCF : Bit clear f
- BTFSC : Bit test f skip if clear
- BTFSS : Bit test f skip if set

Sample code:


```

1  #INCLUDE <p18f4520.inc>
2      CONFIG OSC = INTIO67
3      CONFIG WDT = OFF
4      org 0x10 ;PC = 0x10
5  start:
6      BSF 0x000, 1 ; [0x000] = b'00000010
7      BTFSC 0x000, 0 ; test bit 0 of [0x000], skip if bit 0 is 0
8      MOVFF 0x000, 0x001
9      BTFSC 0x000, 1 ; test bit 1 of [0x000], skip if bit 1 is 0
10     MOVFF 0x000, 0x001
11 end

```

Address	Symbol	Hex	Decimal	Binary	Char
000		0x02	2	00000010	','
001		0x00	0	00000000	','
002		0x00	0	00000000	','
003		0x00	0	00000000	','
004		0x00	0	00000000	','

Address	Symbol	Hex	Decimal	Binary	Char
000		0x02	2	00000010	','
001		0x02	2	00000010	','
002		0x00	0	00000000	','
003		0x00	0	00000000	','
004		0x00	0	00000000	','

Relative Addressing

- BC、BN、BNC、BNN、BNZ(branch if not zero) ...
- for all the "Branch" instruction to addressing
- relative address to PC value (branch的下一行)
- offset is word address(for PIC18F4520 1 word = 2Bytes)
- if branch: $PC = PC + 2 + n * 2$ (2's complement)
if not branch: $PC = PC + 2$

BZ Branch if Zero

Syntax: [*label*] BZ n

Operands: $-128 \leq n \leq 127$

Operation: if Zero bit is '1'
 $(PC) + 2 + 2n \rightarrow PC$

Status Affected: None

Encoding:

1110	0000	nnnn	nnnn
------	------	------	------

Description:

If the Zero bit is '1', then the program will branch.
The 2's complement number '2n' is added to the PC. Since the PC will have incremented to fetch the next instruction, the new address will be $PC+2+2n$. This instruction is then a two-cycle instruction.

Example:

Memory address	Op code				
		1:		#INCLUDE	<P18F4321.INC>
		2:		ORG	0x00
0000	0E02	MOVLW	0x2	3: BACK	MOVLW 0x02
0002	0802	SUBLW	0x2	4:	SUBLW 0x02
0004	E001	BZ	0x8	5:	BZ DOWN
0006	0E04	MOVLW	0x4	6:	MOVLW 0x04
0008	0804	SUBLW	0x4	7: DOWN	SUBLW 0x04
000A	E0FA	BZ	0	8:	BZ BACK
000C	0003	SLEEP		9:	SLEEP