



**MICROCHIP**

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## Section 29. Instruction Set

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### HIGHLIGHTS

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# PICmicro MID-RANGE MCU FAMILY

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## 29.1 Introduction

Each midrange instruction is a 14-bit word divided into an OPCODE which specifies the instruction type and one or more operands which further specify the operation of the instruction. The midrange Instruction Set Summary in [Table 29-1](#) lists the instructions recognized by the MPASM assembler. The instruction set is highly orthogonal and is grouped into three basic categories:

- **Byte-oriented** operations
- **Bit-oriented** operations
- **Literal and control** operations

[Table 29-2](#) gives the opcode field descriptions.

For **byte-oriented** instructions, 'f' represents a file register designator and 'd' represents a destination designator. The file register designator specifies which file register is to be used by the instruction.

The destination designator specifies where the result of the operation is to be placed. If 'd' is zero, the result is placed in the W register. If 'd' is one, the result is placed in the file register specified in the instruction.

For **bit-oriented** instructions, 'b' represents a bit field designator which selects the number of the bit affected by the operation, while 'f' represents the number of the file in which the bit is located.

For **literal and control** operations, 'k' represents an eight or eleven bit constant or literal value.

All instructions are executed in one single instruction cycle, unless a conditional test is true or the program counter is changed as a result of an instruction. In these cases, the execution takes two instruction cycles with the second cycle executed as an NOP. One instruction cycle consists of four oscillator periods. Thus, for an oscillator frequency of 4 MHz, the normal instruction execution time is 1  $\mu$ s. If a conditional test is true or the program counter is changed as a result of an instruction, the instruction execution time is 2  $\mu$ s.

# Section 29. Instruction Set

Table 29-1: Midrange Instruction Set

Mnemonic, Operands	Description	Cycles	14-Bit Instruction Word				Status Affected	Notes	
			MSb		LSb				
<b>BYTE-ORIENTED FILE REGISTER OPERATIONS</b>									
ADDWF	f, d	Add W and f	1	00	0111	dfff	ffff	C,DC,Z	1,2
ANDWF	f, d	AND W with f	1	00	0101	dfff	ffff	Z	1,2
CLRF	f	Clear f	1	00	0001	1fff	ffff	Z	2
CLRW	-	Clear W	1	00	0001	0xxx	xxxx	Z	
COMF	f, d	Complement f	1	00	1001	dfff	ffff	Z	1,2
DECf	f, d	Decrement f	1	00	0011	dfff	ffff	Z	1,2
DECFSZ	f, d	Decrement f, Skip if 0	1(2)	00	1011	dfff	ffff		1,2,3
INCF	f, d	Increment f	1	00	1010	dfff	ffff	Z	1,2
INCFSZ	f, d	Increment f, Skip if 0	1(2)	00	1111	dfff	ffff		1,2,3
IORWF	f, d	Inclusive OR W with f	1	00	0100	dfff	ffff	Z	1,2
MOVF	f, d	Move f	1	00	1000	dfff	ffff	Z	1,2
MOVWF	f	Move W to f	1	00	0000	1fff	ffff		
NOP	-	No Operation	1	00	0000	0xx0	0000		
RLF	f, d	Rotate Left f through Carry	1	00	1101	dfff	ffff	C	1,2
RRF	f, d	Rotate Right f through Carry	1	00	1100	dfff	ffff	C	1,2
SUBWF	f, d	Subtract W from f	1	00	0010	dfff	ffff	C,DC,Z	1,2
SWAPF	f, d	Swap nibbles in f	1	00	1110	dfff	ffff		1,2
XORWF	f, d	Exclusive OR W with f	1	00	0110	dfff	ffff	Z	1,2
<b>BIT-ORIENTED FILE REGISTER OPERATIONS</b>									
BCF	f, b	Bit Clear f	1	01	00bb	bfff	ffff		1,2
BSF	f, b	Bit Set f	1	01	01bb	bfff	ffff		1,2
BTFSC	f, b	Bit Test f, Skip if Clear	1 (2)	01	10bb	bfff	ffff		3
BTFSS	f, b	Bit Test f, Skip if Set	1 (2)	01	11bb	bfff	ffff		3
<b>LITERAL AND CONTROL OPERATIONS</b>									
ADDLW	k	Add literal and W	1	11	111x	kkkk	kkkk	C,DC,Z	
ANDLW	k	AND literal with W	1	11	1001	kkkk	kkkk	Z	
CALL	k	Call subroutine	2	10	0kkk	kkkk	kkkk		
CLRWDt	-	Clear Watchdog Timer	1	00	0000	0110	0100	$\overline{TO}, \overline{PD}$	
GOTO	k	Go to address	2	10	1kkk	kkkk	kkkk		
IORLW	k	Inclusive OR literal with W	1	11	1000	kkkk	kkkk	Z	
MOVLW	k	Move literal to W	1	11	00xx	kkkk	kkkk		
RETFIE	-	Return from interrupt	2	00	0000	0000	1001		
RETLW	k	Return with literal in W	2	11	01xx	kkkk	kkkk		
RETURN	-	Return from Subroutine	2	00	0000	0000	1000		
SLEEP	-	Go into standby mode	1	00	0000	0110	0011	$\overline{TO}, \overline{PD}$	
SUBLW	k	Subtract W from literal	1	11	110x	kkkk	kkkk	C,DC,Z	
XORLW	k	Exclusive OR literal with W	1	11	1010	kkkk	kkkk	Z	

Note 1: When an I/O register is modified as a function of itself (e.g., `MOVF PORTB, 1`), the value used will be that value present on the pins themselves. For example, if the data latch is '1' for a pin configured as input and is driven low by an external device, the data will be written back with a '0'.

- 2: If this instruction is executed on the TMR0 register (and, where applicable,  $d = 1$ ), the prescaler will be cleared if assigned to the Timer0 Module.
- 3: If Program Counter (PC) is modified or a conditional test is true, the instruction requires two cycles. The second cycle is executed as a NOP.

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## 29.2 Instruction Formats

Figure 29-1 shows the three general formats that the instructions can have. As can be seen from the general format of the instructions, the opcode portion of the instruction word varies from 3-bits to 6-bits of information. This is what allows the midrange instruction set to have 35 instructions.

**Note 1:** Any unused opcode is Reserved. Use of any reserved opcode may cause unexpected operation.

**Note 2:** To maintain upward compatibility with future midrange products, do not use the `OPTION` and `TRIS` instructions.

All instruction examples use the following format to represent a hexadecimal number:

0xhh

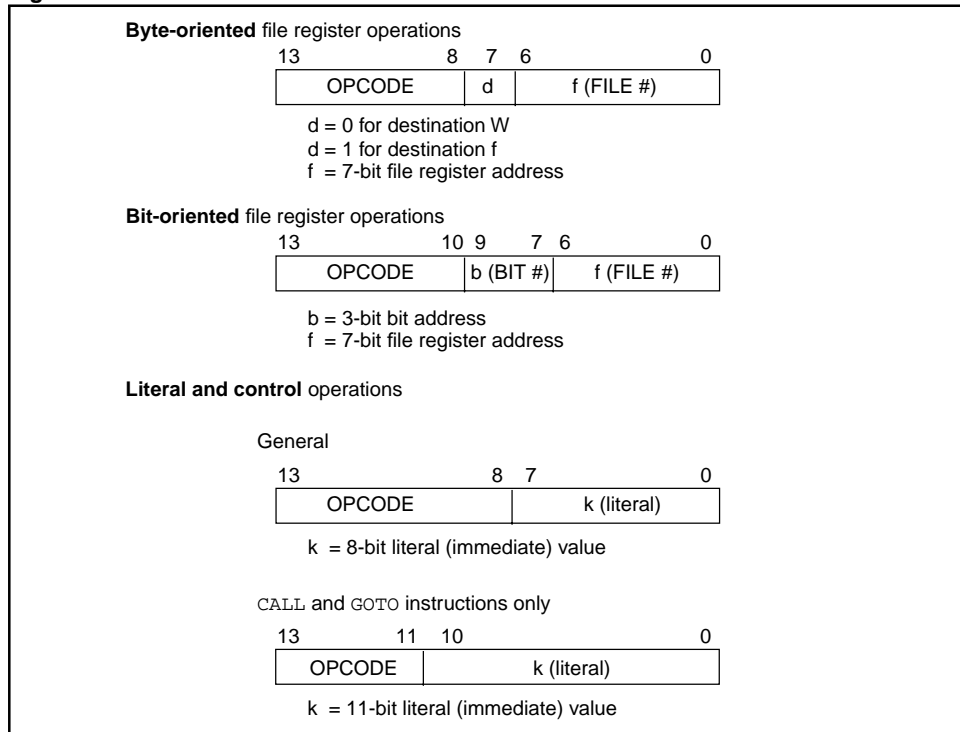
where h signifies a hexadecimal digit.

To represent a binary number:

00000100b

where b is a binary string identifier.

**Figure 29-1: General Format for Instructions**



# Section 29. Instruction Set

Table 29-2: Instruction Description Conventions

Field	Description
f	Register file address (0x00 to 0x7F)
w	Working register (accumulator)
b	Bit address within an 8-bit file register (0 to 7)
k	Literal field, constant data or label (may be either an 8-bit or an 11-bit value)
x	Don't care (0 or 1) The assembler will generate code with x = 0. It is the recommended form of use for compatibility with all Microchip software tools.
d	Destination select; d = 0: store result in W, d = 1: store result in file register f.
dest	Destination either the W register or the specified register file location
label	Label name
TOS	Top of Stack
PC	Program Counter
PCLATH	Program Counter High Latch
GIE	Global Interrupt Enable bit
WDT	Watchdog Timer
$\overline{TO}$	Time-out bit
$\overline{PD}$	Power-down bit
[ ]	Optional
( )	Contents
→	Assigned to
< >	Register bit field
∈	In the set of
<i>italics</i>	User defined term (font is courier)

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## 29.3 Special Function Registers as Source/Destination

The Section 29. Instruction Set's orthogonal instruction set allows read and write of all file registers, including special function registers. Some special situations the user should be aware of are explained in the following subsections:

### 29.3.1 STATUS Register as Destination

If an instruction writes to the STATUS register, the Z, C, DC and OV bits may be set or cleared as a result of the instruction and overwrite the original data bits written. For example, executing `CLRF STATUS` will clear register STATUS, and then set the Z bit leaving `0000 0100b` in the register.

### 29.3.2 PCL as Source or Destination

Read, write or read-modify-write on PCL may have the following results:

Read PC: PCL → dest; PCLATH does not change;

Write PCL: PCLATH → PCH;  
8-bit destination value → PCL

Read-Modify-Write: PCL → ALU operand  
PCLATH → PCH;  
8-bit result → PCL

Where PCH = program counter high byte (not an addressable register), PCLATH = Program counter high holding latch, dest = destination, W register or register file f.

### 29.3.3 Bit Manipulation

All bit manipulation instructions will first read the entire register, operate on the selected bit and then write the result back (read-modify-write (R-M-W)) the specified register. The user should keep this in mind when operating on some special function registers, such as ports.

**Note:** Status bits that are manipulated by the device (including the interrupt flag bits) are set or cleared in the Q1 cycle. So there is no issue with executing R-M-W instructions on registers which contain these bits.

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## 29.4 Q Cycle Activity

Each instruction cycle ( $T_{cy}$ ) is comprised of four Q cycles (Q1-Q4). The Q cycle is the same as the device oscillator cycle (TOSC). The Q cycles provide the timing/designation for the Decode, Read, Process Data, Write etc., of each instruction cycle. The following diagram shows the relationship of the Q cycles to the instruction cycle.

The four Q cycles that make up an instruction cycle ( $T_{cy}$ ) can be generalized as:

Q1: Instruction Decode Cycle or forced No Operation

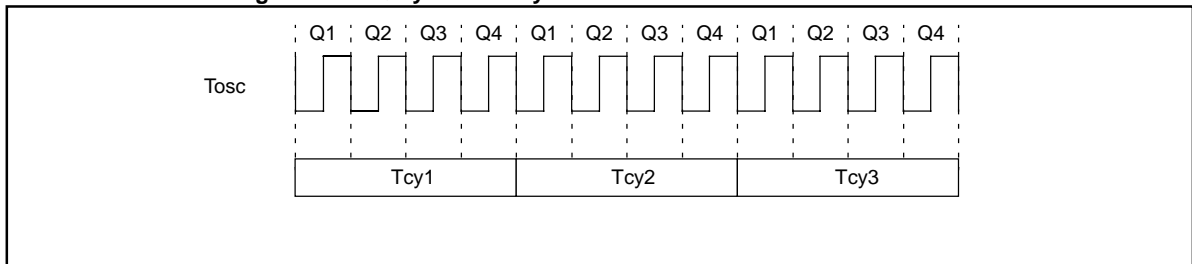
Q2: Instruction Read Cycle or No Operation

Q3: Process the Data

Q4: Instruction Write Cycle or No Operation

Each instruction will show the detailed Q cycle operation for the instruction.

**Figure 29-2: Q Cycle Activity**



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## 29.5 Instruction Descriptions

### ADDLW Add Literal and W

Syntax: [ *label* ] ADDLW *k*

Operands:  $0 \leq k \leq 255$

Operation:  $(W) + k \rightarrow W$

Status Affected: C, DC, Z

Encoding: 

11	111x	kkkk	kkkk
----	------	------	------

Description: The contents of the W register are added to the eight bit literal 'k' and the result is placed in the W register.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Process data	Write to W register

Example 1            ADDLW 0x15  
  
Before Instruction  
    W = 0x10  
After Instruction  
    W = 0x25

Example 2            ADDLW MYREG  
  
Before Instruction  
    W = 0x10  
    Address of MYREG † = 0x37  
    † MYREG is a symbol for a data memory location  
After Instruction  
    W = 0x47

Example 3            ADDLW HIGH (LU\_TABLE)  
  
Before Instruction  
    W = 0x10  
    Address of LU\_TABLE † = 0x9375  
    † LU\_TABLE is a label for an address in program memory  
After Instruction  
    W = 0xA3

Example 4            ADDLW MYREG  
  
Before Instruction  
    W = 0x10  
    Address of PCL † = 0x02  
    † PCL is the symbol for the Program Counter low byte location  
After Instruction  
    W = 0x12



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## ADDWF

Add W and f

Syntax: [ *label* ] ADDWF f,d

Operands:  $0 \leq f \leq 127$   
 $d \in [0,1]$

Operation: (W) + (f) → destination

Status Affected: C, DC, Z

Encoding: 

00	0111	dfff	ffff
----	------	------	------

Description: Add the contents of the W register with register 'f'. If 'd' is 0 the result is stored in the W register. If 'd' is 1 the result is stored back in register 'f'.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process data	Write to destination

Example 1      ADDWF    FSR, 0

Before Instruction

W = 0x17  
FSR = 0xC2

After Instruction

W = 0xD9  
FSR = 0xC2

Example 2      ADDWF    INDF, 1

Before Instruction

W = 0x17  
FSR = 0xC2  
Contents of Address (FSR) = 0x20

After Instruction

W = 0x17  
FSR = 0xC2  
Contents of Address (FSR) = 0x37

Example 3      ADDWF    PCL

Case 1: Before Instruction

W = 0x10  
PCL = 0x37  
C = x

After Instruction

PCL = 0x47  
C = 0

Case 2: Before Instruction

W = 0x10  
PCL = 0xF7  
PCH = 0x08  
C = x

After Instruction

PCL = 0x07  
PCH = 0x08  
C = 1

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## ANDLW

And Literal with W

Syntax: [ *label* ] ANDLW k

Operands:  $0 \leq k \leq 255$

Operation: (W).AND. (k) → W

Status Affected: Z

Encoding: 

11	1001	kkkk	kkkk
----	------	------	------

Description: The contents of W register are AND'ed with the eight bit literal 'k'. The result is placed in the W register.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Process data	Write to W register

Example 1

```
ANDLW 0x5F
```

```
Before Instruction      ; 0101 1111 (0x5F)
      W = 0xA3          ; 1010 0011 (0xA3)
After Instruction      ;-----
      W = 0x03          ; 0000 0011 (0x03)
```

Example 2

```
ANDLW MYREG
```

```
Before Instruction
      W = 0xA3
      Address of MYREG † = 0x37
      † MYREG is a symbol for a data memory location
After Instruction
      W = 0x23
```

Example 3

```
ANDLW HIGH (LU_TABLE)
```

```
Before Instruction
      W = 0xA3
      Address of LU_TABLE † = 0x9375
      † LU_TABLE is a label for an address in program memory
After Instruction
      W = 0x83
```

# Section 29. Instruction Set

## ANDWF AND W with f

Syntax: `[ label ] ANDWF f,d`

Operands:  $0 \leq f \leq 127$   
 $d \in \{0,1\}$

Operation:  $(W).AND.(f) \rightarrow \text{destination}$

Status Affected: Z

Encoding:

00	0101	dfff	ffff
----	------	------	------

Description: AND the W register with register 'f'. If 'd' is 0 the result is stored in the W register. If 'd' is 1 the result is stored back in register 'f'.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process data	Write to destination

**Example 1**            `ANDWF FSR, 1`

Before Instruction            ; 0001 0111 (0x17)  
                                   W = 0x17                    ; 1100 0010 (0xC2)  
                                   FSR = 0xC2                 ;-----

After Instruction             ; 0000 0010 (0x02)  
                                   W = 0x17  
                                   FSR = 0x02

**Example 2**            `ANDWF FSR, 0`

Before Instruction            ; 0001 0111 (0x17)  
                                   W = 0x17                    ; 1100 0010 (0xC2)  
                                   FSR = 0xC2                 ;-----

After Instruction             ; 0000 0010 (0x02)  
                                   W = 0x02  
                                   FSR = 0xC2

**Example 3**            `ANDWF INDF, 1`

Before Instruction  
                                   W = 0x17  
                                   FSR = 0xC2  
                                   Contents of Address (FSR) = 0x5A

After Instruction  
                                   W = 0x17  
                                   FSR = 0xC2  
                                   Contents of Address (FSR) = 0x15

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## BCF

Bit Clear f

Syntax: [ *label* ] BCF f,b

Operands:  $0 \leq f \leq 127$   
 $0 \leq b \leq 7$

Operation:  $0 \rightarrow f\text{-}b$

Status Affected: None

Encoding: 

01	00bb	bfff	ffff
----	------	------	------

Description: Bit 'b' in register 'f' is cleared.

Words: 1

Cycles: 1

Q Cycle Activity:

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

Example 1

BCF FLAG\_REG, 7

Before Instruction

FLAG\_REG = 0xC7 ; 1100 0111

After Instruction

FLAG\_REG = 0x47 ; 0100 0111

Example 2

BCF INDF, 3

Before Instruction

W = 0x17

FSR = 0xC2

Contents of Address (FSR) = 0x2F

After Instruction

W = 0x17

FSR = 0xC2

Contents of Address (FSR) = 0x27

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## BSF

Bit Set f

Syntax: [ *label* ] BSF f,b

Operands:  $0 \leq f \leq 127$   
 $0 \leq b \leq 7$

Operation:  $1 \rightarrow f \langle b \rangle$

Status Affected: None

Encoding: 

01	01bb	bfff	ffff
----	------	------	------

Description: Bit 'b' in register 'f' is set.

Words: 1

Cycles: 1

Q Cycle Activity:

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

Example 1

BSF FLAG\_REG, 7

Before Instruction

FLAG\_REG = 0x0A ; 0000 1010

After Instruction

FLAG\_REG = 0x8A ; 1000 1010

Example 2

BSF INDF, 3

Before Instruction

W = 0x17

FSR = 0xC2

Contents of Address (FSR) = 0x20

After Instruction

W = 0x17

FSR = 0xC2

Contents of Address (FSR) = 0x28

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## BTFSC

Bit Test, Skip if Clear

Syntax: [ *label* ] BTFSC *f*,*b*

Operands:  $0 \leq f \leq 127$   
 $0 \leq b \leq 7$

Operation: skip if (f<b>) = 0

Status Affected: None

Encoding: 

01	10bb	bfff	ffff
----	------	------	------

Description: If bit 'b' in register 'f' is '0' then the next instruction is skipped.  
 If bit 'b' is '0' then the next instruction (fetched during the current instruction execution) is discarded, and a NOP is executed instead, making this a 2 cycle instruction.

Words: 1

Cycles: 1(2)

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process data	No operation

If skip (2nd cycle):

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation

Example 1

```

HERE   BTFSC  FLAG, 4
FALSE  GOTO  PROCESS_CODE
TRUE   .
        .
        .
    
```

Case 1: Before Instruction  
 PC = addressHERE  
 FLAG= xxx0 xxxx  
 After Instruction  
 Since FLAG<4>= 0,  
 PC = addressTRUE

Case 2: Before Instruction  
 PC = addressHERE  
 FLAG= xxx1 xxxx  
 After Instruction  
 Since FLAG<4>=1,  
 PC = addressFALSE

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## BTFSS

Bit Test f, Skip if Set

Syntax: [ *label* ] BTFSS f,b

Operands:  $0 \leq f \leq 127$   
 $0 \leq b < 7$

Operation: skip if (f<b>) = 1

Status Affected: None

Encoding: 

01	11bb	bfff	ffff
----	------	------	------

Description: If bit 'b' in register 'f' is '1' then the next instruction is skipped.  
If bit 'b' is '1', then the next instruction (fetched during the current instruction execution) is discarded and a NOP is executed instead, making this a 2 cycle instruction.

Words: 1

Cycles: 1(2)

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process data	No operation

If skip (2nd cycle):

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation

Example 1

```
HERE   BTFSS  FLAG, 4
FALSE  GOTO   PROCESS_CODE
TRUE   .
      .
      .
```

Case 1: Before Instruction

```
PC = addressHERE
FLAG= xxx0 xxxx
```

After Instruction

```
Since FLAG<4>= 0,
PC = addressFALSE
```

Case 2: Before Instruction

```
PC = addressHERE
FLAG= xxx1 xxxx
```

After Instruction

```
Since FLAG<4>=1,
PC = addressTRUE
```

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## CALL

### Call Subroutine

Syntax: [ *label* ] CALL *k*  
 Operands:  $0 \leq k \leq 2047$   
 Operation: (PC)+ 1 → TOS,  
*k* → PC<10:0>,  
 (PCLATH<4:3>) → PC<12:11>

Status Affected: None

Encoding: 

10	0kkk	kkkk	kkkk
----	------	------	------

Description: Call Subroutine. First, the 13-bit return address (PC+1) is pushed onto the stack. The eleven bit immediate address is loaded into PC bits <10:0>. The upper bits of the PC are loaded from PCLATH<4:3>. CALL is a two cycle instruction.

Words: 1

Cycles: 2

Q Cycle Activity:

1st cycle:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Process data	No operation

2nd cycle:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation

Example 1                    HERE    CALL    THERE

Before Instruction

PC = Address HERE

After Instruction

TOS = Address HERE+1

PC = Address THERE



# Section 29. Instruction Set

## CLRF

Clear f

Syntax: [ *label* ] CLRF f

Operands:  $0 \leq f \leq 127$

Operation: 00h  $\rightarrow$  f  
1  $\rightarrow$  Z

Status Affected: Z

Encoding: 

00	0001	1fff	ffff
----	------	------	------

Description: The contents of register 'f' are cleared and the Z bit is set.

Words: 1

Cycles: 1

Q Cycle Activity:

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

Example 1

CLRF FLAG\_REG

Before Instruction

FLAG\_REG=0x5A

After Instruction

FLAG\_REG=0x00

Z = 1

Example 2

CLRF INDF

Before Instruction

FSR = 0xC2

Contents of Address (FSR)=0xAA

After Instruction

FSR = 0xC2

Contents of Address (FSR)=0x00

Z = 1

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## CLRW Clear W

---

Syntax: [ *label* ] CLRW

Operands: None

Operation: 00h → W  
1 → Z

Status Affected: Z

Encoding: 

00	0001	0xxx	xxxx
----	------	------	------

Description: W register is cleared. Zero bit (Z) is set.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process data	Write register 'W'

Example 1

CLRW

Before Instruction

W = 0x5A

After Instruction

W = 0x00

Z = 1

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## CLRWDT

Clear Watchdog Timer

Syntax: [ *label* ] CLRWDT

Operands: None

Operation: 00h → WDT  
0 → WDT prescaler count,  
1 →  $\overline{TO}$   
1 →  $\overline{PD}$

Status Affected:  $\overline{TO}$ ,  $\overline{PD}$

Encoding: 

00	0000	0110	0100
----	------	------	------

Description: CLRWDT instruction clears the Watchdog Timer. It also clears the prescaler count of the WDT. Status bits  $\overline{TO}$  and  $\overline{PD}$  are set.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	No operation	Process data	Clear WDT Counter

Example 1

CLRWDT

Before Instruction

WDT counter= x

WDT prescaler =1:128

After Instruction

WDT counter=0x00

WDT prescaler count=0

$\overline{TO}$  = 1

$\overline{PD}$  = 1

WDT prescaler =1:128

**Note:** The CLRWDT instruction does not affect the assignment of the WDT prescaler.

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## COMF Complement f

Syntax: [ *label* ] COMF f,d

Operands:  $0 \leq f \leq 127$   
 $d \in [0,1]$

Operation:  $(\bar{f}) \rightarrow \text{destination}$

Status Affected: Z

Encoding: 

00	1001	dfff	ffff
----	------	------	------

Description: The contents of register 'f' are 1's complemented. If 'd' is 0 the result is stored in W. If 'd' is 1 the result is stored back in register 'f'.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process data	Write to destination

Example 1            COMF    REG1, 0

Before Instruction  
REG1= 0x13  
After Instruction  
REG1= 0x13  
W = 0xEC

Example 2            COMF    INDF, 1

Before Instruction  
FSR = 0xC2  
Contents of Address (FSR)=0xAA  
After Instruction  
FSR = 0xC2  
Contents of Address (FSR)=0x55

Example 3            COMF    REG1, 1

Before Instruction  
REG1= 0xFF  
After Instruction  
REG1= 0x00  
Z = 1

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## DECF

Decrement f

Syntax: [ *label* ] DECF f,d

Operands:  $0 \leq f \leq 127$   
 $d \in [0,1]$

Operation:  $(f) - 1 \rightarrow \text{destination}$

Status Affected: Z

Encoding: 

00	0011	dfff	ffff
----	------	------	------

Description: Decrement register 'f'. If 'd' is 0 the result is stored in the W register. If 'd' is 1 the result is stored back in register 'f'.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process data	Write to destination

Example 1 DECF CNT, 1

Before Instruction

CNT = 0x01

Z = 0

After Instruction

CNT = 0x00

Z = 1

Example 2 DECF INDF, 1

Before Instruction

FSR = 0xC2

Contents of Address (FSR) = 0x01

Z = 0

After Instruction

FSR = 0xC2

Contents of Address (FSR) = 0x00

Z = 1

Example 3 DECF CNT, 0

Before Instruction

CNT = 0x10

W = x

Z = 0

After Instruction

CNT = 0x10

W = 0x0F

Z = 0

# PICmicro MID-RANGE MCU FAMILY

## DECFSZ

Decrement f, Skip if 0

Syntax: [ *label* ] DECFSZ f,d

Operands:  $0 \leq f \leq 127$   
 $d \in [0,1]$

Operation:  $(f) - 1 \rightarrow$  destination; skip if result = 0

Status Affected: None

Encoding: 

00	1011	dfff	ffff
----	------	------	------

Description: The contents of register 'f' are decremented. If 'd' is 0 the result is placed in the W register. If 'd' is 1 the result is placed back in register 'f'. If the result is 0, then the next instruction (fetched during the current instruction execution) is discarded and a NOP is executed instead, making this a 2 cycle instruction.

Words: 1

Cycles: 1(2)

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process data	Write to destination

If skip (2nd cycle):

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation

Example

```
HERE    DECFSZ  CNT, 1
        GOTO   LOOP
CONTINUE •
        •
        •
```

Case 1: Before Instruction  
PC = address HERE  
CNT = 0x01  
After Instruction  
CNT = 0x00  
PC = address CONTINUE

Case 2: Before Instruction  
PC = address HERE  
CNT = 0x02  
After Instruction  
CNT = 0x01  
PC = address HERE + 1

# Section 29. Instruction Set

## GOTO

### Unconditional Branch

Syntax: [ *label* ] GOTO *k*

Operands:  $0 \leq k \leq 2047$

Operation:  $k \rightarrow PC\langle 10:0 \rangle$   
 $PCLATH\langle 4:3 \rangle \rightarrow PC\langle 12:11 \rangle$

Status Affected: None

Encoding: 

10	1kkk	kkkk	kkkk
----	------	------	------

Description: GOTO is an unconditional branch. The eleven bit immediate value is loaded into PC bits  $\langle 10:0 \rangle$ . The upper bits of PC are loaded from PCLATH $\langle 4:3 \rangle$ . GOTO is a two cycle instruction.

Words: 1

Cycles: 2

Q Cycle Activity:

1st cycle:

Q1	Q2	Q3	Q4
Decode	Read literal 'k' $\langle 7:0 \rangle$	Process data	No operation

2nd cycle:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation

Example

GOTO THERE

After Instruction

PC =AddressTHERE

# PICmicro MID-RANGE MCU FAMILY

---

---

## INCF

Increment f

Syntax: [ *label* ] INCF f,d

Operands:  $0 \leq f \leq 127$   
 $d \in [0,1]$

Operation:  $(f) + 1 \rightarrow \text{destination}$

Status Affected: Z

Encoding: 

00	1010	dfff	ffff
----	------	------	------

Description: The contents of register 'f' are incremented. If 'd' is 0 the result is placed in the W register. If 'd' is 1 the result is placed back in register 'f'.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process data	Write to destination

Example 1            INCF    CNT, 1

Before Instruction

CNT = 0xFF

Z = 0

After Instruction

CNT = 0x00

Z = 1

Example 2            INCF    INDF, 1

Before Instruction

FSR = 0xC2

Contents of Address (FSR) = 0xFF

Z = 0

After Instruction

FSR = 0xC2

Contents of Address (FSR) = 0x00

Z = 1

Example 3            INCF    CNT, 0

Before Instruction

CNT = 0x10

W = x

Z = 0

After Instruction

CNT = 0x10

W = 0x11

Z = 0



## INCFSZ

Increment f, Skip if 0

Syntax: [ *label* ] INCFSZ f,d

Operands:  $0 \leq f \leq 127$   
 $d \in [0,1]$

Operation:  $(f) + 1 \rightarrow$  destination, skip if result = 0

Status Affected: None

Encoding: 

00	1111	dfff	ffff
----	------	------	------

Description: The contents of register 'f' are incremented. If 'd' is 0 the result is placed in the W register. If 'd' is 1 the result is placed back in register 'f'. If the result is 0, then the next instruction (fetched during the current instruction execution) is discarded and a NOP is executed instead, making this a 2 cycle instruction.

Words: 1

Cycles: 1(2)

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process data	Write to destination

If skip (2nd cycle):

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation

```

Example      HERE      INCFSZ  CNT, 1
              GOTO      LOOP
              CONTINUE  •
                  •
                  •
    
```

Case 1: Before Instruction

```

PC = address HERE
CNT = 0xFF
    
```

After Instruction

```

CNT = 0x00
PC = address CONTINUE
    
```

Case 2: Before Instruction

```

PC = address HERE
CNT = 0x00
    
```

After Instruction

```

CNT = 0x01
PC = address HERE + 1
    
```

# PICmicro MID-RANGE MCU FAMILY

## IORLW

Inclusive OR Literal with W

Syntax: [ *label* ] IORLW *k*

Operands:  $0 \leq k \leq 255$

Operation:  $(W).OR. k \rightarrow W$

Status Affected: Z

Encoding: 

11	1000	kkkk	kkkk
----	------	------	------

Description: The contents of the W register is OR'ed with the eight bit literal 'k'. The result is placed in the W register.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Process data	Write to W register

Example 1            IORLW 0x35  
Before Instruction  
W = 0x9A  
After Instruction  
W = 0xBF  
Z = 0

Example 2            IORLW MYREG  
Before Instruction  
W = 0x9A  
Address of MYREG † = 0x37  
† MYREG is a symbol for a data memory location  
After Instruction  
W = 0x9F  
Z = 0

Example 3            IORLW HIGH (LU\_TABLE)  
Before Instruction  
W = 0x9A  
Address of LU\_TABLE † = 0x9375  
† LU\_TABLE is a label for an address in program memory  
After Instruction  
W = 0x9B  
Z = 0

Example 4            IORLW 0x00  
Before Instruction  
W = 0x00  
After Instruction  
W = 0x00  
Z = 1

# Section 29. Instruction Set

## IORWF

Inclusive OR W with f

Syntax: [ *label* ] IORWF f,d

Operands:  $0 \leq f \leq 127$   
 $d \in [0,1]$

Operation: (W).OR. (f) → destination

Status Affected: Z

Encoding: 

00	0100	dfff	ffff
----	------	------	------

Description: Inclusive OR the W register with register 'f'. If 'd' is 0 the result is placed in the W register. If 'd' is 1 the result is placed back in register 'f'.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process data	Write to destination

Example 1 IORWF RESULT, 0

Before Instruction  
RESULT=0x13  
W = 0x91  
After Instruction  
RESULT=0x13  
W = 0x93  
Z = 0

Example 2 IORWF INDF, 1

Before Instruction  
W = 0x17  
FSR = 0xC2  
Contents of Address (FSR) = 0x30  
After Instruction  
W = 0x17  
FSR = 0xC2  
Contents of Address (FSR) = 0x37  
Z = 0

Example 3 IORWF RESULT, 1

Case 1: Before Instruction  
RESULT=0x13  
W = 0x91  
After Instruction  
RESULT=0x93  
W = 0x91  
Z = 0

Case 2: Before Instruction  
RESULT=0x00  
W = 0x00  
After Instruction  
RESULT=0x00  
W = 0x00  
Z = 1

# PICmicro MID-RANGE MCU FAMILY

## MOVLW

Move Literal to W

Syntax: [ *label* ] MOVLW *k*

Operands:  $0 \leq k \leq 255$

Operation:  $k \rightarrow W$

Status Affected: None

Encoding: 

11	00xx	kkkk	kkkk
----	------	------	------

Description: The eight bit literal 'k' is loaded into W register. The don't cares will assemble as 0's.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Process data	Write to W register

Example 1            MOVLW    0x5A  
                          After Instruction  
                          W    =    0x5A

Example 2            MOVLW    MYREG  
                          Before Instruction  
                          W    =    0x10  
                          Address of MYREG † = 0x37  
                          † MYREG is a symbol for a data memory location  
                          After Instruction  
                          W    =    0x37

Example 3            MOVLW    HIGH (LU\_TABLE)  
                          Before Instruction  
                          W    =    0x10  
                          Address of LU\_TABLE † = 0x9375  
                          † LU\_TABLE is a label for an address in program memory  
                          After Instruction  
                          W    =    0x93

## MOVF

Move f

Syntax: [ *label* ] MOVF f,d

Operands:  $0 \leq f \leq 127$   
 $d \in [0,1]$

Operation: (f) → destination

Status Affected: Z

Encoding: 

00	1000	dfff	ffff
----	------	------	------

Description: The contents of register 'f' is moved to a destination dependent upon the status of 'd'. If 'd' = 0, destination is W register. If 'd' = 1, the destination is file register 'f' itself. 'd' = 1 is useful to test a file register since status flag Z is affected.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process data	Write to destination

Example 1            MOVF    FSR, 0

Before Instruction

W = 0x00  
 FSR = 0xC2

After Instruction

W = 0xC2  
 Z = 0

Example 2            MOVF    INDF, 0

Before Instruction

W = 0x17  
 FSR = 0xC2  
 Contents of Address (FSR) = 0x00

After Instruction

W = 0x17  
 FSR = 0xC2  
 Contents of Address (FSR) = 0x00  
 Z = 1

Example 3            MOVF    FSR, 1

Case 1: Before Instruction

FSR = 0x43

After Instruction

FSR = 0x43  
 Z = 0

Case 2: Before Instruction

FSR = 0x00

After Instruction

FSR = 0x00  
 Z = 1

# PICmicro MID-RANGE MCU FAMILY

---

---

## MOVWF

Move W to f

Syntax: [ *label* ] MOVWF f

Operands:  $0 \leq f \leq 127$

Operation: (W) → f

Status Affected: None

Encoding: 

00	0000	1fff	ffff
----	------	------	------

Description: Move data from W register to register 'f'.

Words: 1

Cycles: 1

Q Cycle Activity:

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

Example 1            MOVWF    OPTION\_REG

Before Instruction

OPTION\_REG=0xFF

W = 0x4F

After Instruction

OPTION\_REG=0x4F

W = 0x4F

Example 2            MOVWF    INDF

Before Instruction

W = 0x17

FSR = 0xC2

Contents of Address (FSR) = 0x00

After Instruction

W = 0x17

FSR = 0xC2

Contents of Address (FSR) = 0x17

# Section 29. Instruction Set

## NOP

No Operation

Syntax: [ *label* ] NOP

Operands: None

Operation: No operation

Status Affected: None

Encoding: 

00	0000	0xx0	0000
----	------	------	------

Description: No operation.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	No operation	No operation	No operation

Example

HERE NOP

:

Before Instruction

PC = address HERE

After Instruction

PC = address HERE + 1

# PICmicro MID-RANGE MCU FAMILY

---

---

## OPTION

### Load Option Register

Syntax: [ *label* ] OPTION

Operands: None

Operation: (W) → OPTION

Status Affected: None

Encoding: 

00	0000	0110	0010
----	------	------	------

Description: The contents of the W register are loaded in the OPTION register. This instruction is supported for code compatibility with PIC16C5X products. Since OPTION is a readable/writable register, the user can directly address it.

Words: 1

Cycles: 1

**To maintain upward compatibility with future PIC16CXX products, do not use this instruction.**



# Section 29. Instruction Set

## RETFIE

Return from Interrupt

Syntax: [ *label* ] RETFIE

Operands: None

Operation: TOS → PC,  
1 → GIE

Status Affected: None

Encoding: 

00	0000	0000	1001
----	------	------	------

Description: Return from Interrupt. The 13-bit address at the Top of Stack (TOS) is loaded in the PC. The Global Interrupt Enable bit, GIE (INTCON<7>), is automatically set, enabling Interrupts. This is a two cycle instruction.

Words: 1

Cycles: 2

Q Cycle Activity:

1st cycle:

Q1	Q2	Q3	Q4
Decode	No operation	Process data	No operation

2nd cycle:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation

Example

RETFIE

After Instruction

PC = TOS

GIE = 1

# PICmicro MID-RANGE MCU FAMILY

## RETLW

Return with Literal in W

Syntax: [ *label* ] RETLW *k*

Operands:  $0 \leq k \leq 255$

Operation:  $k \rightarrow W$ ;  
TOS  $\rightarrow$  PC

Status Affected: None

Encoding: 

11	01xx	kkkk	kkkk
----	------	------	------

Description: The W register is loaded with the eight bit literal 'k'. The program counter is loaded 13-bit address at the Top of Stack (the return address). This is a two cycle instruction.

Words: 1

Cycles: 2

Q Cycle Activity:

1st cycle:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Process data	Write to W register

2nd cycle:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation

```
Example      HERE      CALL TABLE      ; W contains table
                                     ; offset value
                                     ;
                                     ; W now has table value
                                     ;
TABLE        ADDWF PC      ;W = offset
              RETLW k1     ;Begin table
              RETLW k2     ;
                                     ;
                                     ;
              RETLW kn     ; End of table
```

Before Instruction

W = 0x07

After Instruction

W = value of k8

PC = TOS = Address Here + 1

# Section 29. Instruction Set

## RETURN

Return from Subroutine

Syntax: [ *label* ] RETURN

Operands: None

Operation: TOS → PC

Status Affected: None

Encoding: 

00	0000	0000	1000
----	------	------	------

Description: Return from subroutine. The stack is POPed and the top of the stack (TOS) is loaded into the program counter. This is a two cycle instruction.

Words: 1

Cycles: 2

Q Cycle Activity:

1st cycle:

Q1	Q2	Q3	Q4
Decode	No operation	Process data	No operation

2nd cycle:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation

Example

HERE RETURN

After Instruction

PC = TOS

# PICmicro MID-RANGE MCU FAMILY

## RLF

Rotate Left f through Carry

Syntax: [ *label* ] RLF f,d

Operands:  $0 \leq f \leq 127$   
 $d \in [0,1]$

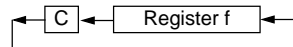
Operation: See description below

Status Affected: C

Encoding: 

00	1101	dfff	ffff
----	------	------	------

Description: The contents of register 'f' are rotated one bit to the left through the Carry Flag. If 'd' is 0 the result is placed in the W register. If 'd' is 1 the result is stored back in register 'f'.



Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process data	Write to destination

Example 1

RLF REG1,0

Before Instruction

REG1= 1110 0110  
 C = 0

After Instruction

REG1=1110 0110  
 W =1100 1100  
 C =1

Example 2

RLF INDF, 1

Case 1: Before Instruction

W = xxxx xxxx  
 FSR = 0xC2  
 Contents of Address (FSR) = 0011 1010  
 C = 1

After Instruction

W = 0x17  
 FSR = 0xC2  
 Contents of Address (FSR) = 0111 0101  
 C = 0

Case 2: Before Instruction

W = xxxx xxxx  
 FSR = 0xC2  
 Contents of Address (FSR) = 1011 1001  
 C = 0

After Instruction

W = 0x17  
 FSR = 0xC2  
 Contents of Address (FSR) = 0111 0010  
 C = 1

# Section 29. Instruction Set

## RRF

Rotate Right f through Carry

Syntax: [label] RRF f,d

Operands:  $0 \leq f \leq 127$   
 $d \in [0,1]$

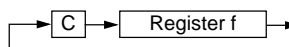
Operation: See description below

Status Affected: C

Encoding: 

00	1100	dfff	ffff
----	------	------	------

Description: The contents of register 'f' are rotated one bit to the right through the Carry Flag. If 'd' is 0 the result is placed in the W register. If 'd' is 1 the result is placed back in register 'f'.



Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process data	Write to destination

Example 1                    RRF                    REG1,0

Before Instruction

REG1= 1110 0110  
W = xxxx xxxx  
C = 0

After Instruction

REG1= 1110 0110  
W = 0111 0011  
C = 0

Example 2                    RRF                    INDF, 1

Case 1: Before Instruction

W = xxxx xxxx  
FSR = 0xC2  
Contents of Address (FSR) = 0011 1010  
C = 1

After Instruction

W = 0x17  
FSR = 0xC2  
Contents of Address (FSR) = 1001 1101  
C = 0

Case 2: Before Instruction

W = xxxx xxxx  
FSR = 0xC2  
Contents of Address (FSR) = 0011 1001  
C = 0

After Instruction

W = 0x17  
FSR = 0xC2  
Contents of Address (FSR) = 0001 1100  
C = 1

# PICmicro MID-RANGE MCU FAMILY

---

---

## SLEEP

---

Syntax: [ *label* ] SLEEP

Operands: None

Operation: 00h → WDT,  
0 → WDT prescaler count,  
1 →  $\overline{TO}$ ,  
0 →  $\overline{PD}$

Status Affected:  $\overline{TO}$ ,  $\overline{PD}$

Encoding: 

00	0000	0110	0011
----	------	------	------

Description: The power-down status bit,  $\overline{PD}$  is cleared. Time-out status bit,  $\overline{TO}$  is set. Watchdog Timer and its prescaler count are cleared. The processor is put into SLEEP mode with the oscillator stopped.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	No operation	No operation	Go to sleep

Example: SLEEP

**Note:** The SLEEP instruction does not affect the assignment of the WDT prescaler

# Section 29. Instruction Set

## SUBLW

Subtract W from Literal

Syntax: [ *label* ] SUBLW *k*

Operands:  $0 \leq k \leq 255$

Operation:  $k - (W) \rightarrow W$

Status Affected: C, DC, Z

Encoding: 

11	110x	kkkk	kkkk
----	------	------	------

Description: The W register is subtracted (2's complement method) from the eight bit literal 'k'. The result is placed in the W register.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Process data	Write to W register

Example 1: SUBLW 0x02

Case 1: Before Instruction

W = 0x01  
C = x  
Z = x

After Instruction

W = 0x01  
C = 1 ; result is positive  
Z = 0

Case 2: Before Instruction

W = 0x02  
C = x  
Z = x

After Instruction

W = 0x00  
C = 1 ; result is zero  
Z = 1

Case 3: Before Instruction

W = 0x03  
C = x  
Z = x

After Instruction

W = 0xFF  
C = 0 ; result is negative  
Z = 0

Example 2 SUBLW MYREG

Before Instruction

W = 0x10

Address of MYREG † = 0x37

† MYREG is a symbol for a data memory location

After Instruction

W = 0x27

C = 1 ; result is positive

# PICmicro MID-RANGE MCU FAMILY

## SUBWF

Subtract W from f

Syntax: [ *label* ] SUBWF f,d

Operands:  $0 \leq f \leq 127$   
 $d \in [0,1]$

Operation:  $(f) - (W) \rightarrow \text{destination}$

Status Affected: C, DC, Z

Encoding: 

00	0010	dfff	ffff
----	------	------	------

Description: Subtract (2's complement method) W register from register 'f'. If 'd' is 0 the result is stored in the W register. If 'd' is 1 the result is stored back in register 'f'.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process data	Write to destination

Example 1: SUBWF REG1,1

Case 1: Before Instruction

REG1= 3  
W = 2  
C = x  
Z = x

After Instruction

REG1= 1  
W = 2  
C = 1 ; result is positive  
Z = 0

Case 2: Before Instruction

REG1= 2  
W = 2  
C = x  
Z = x

After Instruction

REG1= 0  
W = 2  
C = 1 ; result is zero  
Z = 1

Case 3: Before Instruction

REG1= 1  
W = 2  
C = x  
Z = x

After Instruction

REG1= 0xFF  
W = 2  
C = 0 ; result is negative  
Z = 0



# Section 29. Instruction Set

## SWAPF

Swap Nibbles in f

Syntax: [ *label* ] SWAPF f,d

Operands:  $0 \leq f \leq 127$   
 $d \in [0,1]$

Operation: (f<3:0>) → destination<7:4>,  
(f<7:4>) → destination<3:0>

Status Affected: None

Encoding: 

00	1110	dfff	ffff
----	------	------	------

Description: The upper and lower nibbles of register 'f' are exchanged. If 'd' is 0 the result is placed in W register. If 'd' is 1 the result is placed in register 'f'.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process data	Write to destination

Example 1 SWAPF REG, 0

Before Instruction

REG1= 0xA5

After Instruction

REG1= 0xA5

W = 0x5A

Example 2 SWAPF INDF, 1

Before Instruction

W = 0x17

FSR = 0xC2

Contents of Address (FSR) = 0x20

After Instruction

W = 0x17

FSR = 0xC2

Contents of Address (FSR) = 0x02

Example 3 SWAPF REG, 1

Before Instruction

REG1= 0xA5

After Instruction

REG1= 0x5A

# PICmicro MID-RANGE MCU FAMILY

---

---

## TRIS

### Load TRIS Register

Syntax:	[ <i>label</i> ] TRIS f				
Operands:	$5 \leq f \leq 7$				
Operation:	(W) → TRIS register f;				
Status Affected:	None				
Encoding:	<table border="1"><tr><td>00</td><td>0000</td><td>0110</td><td>0fff</td></tr></table>	00	0000	0110	0fff
00	0000	0110	0fff		
Description:	The instruction is supported for code compatibility with the PIC16C5X products. Since TRIS registers are readable and writable, the user can directly address them.				
Words:	1				
Cycles:	1				

### Example

**To maintain upward compatibility with future PIC16CXX products, do not use this instruction.**

# Section 29. Instruction Set

## XORLW

Exclusive OR Literal with W

Syntax: [ *label*] XORLW *k*

Operands:  $0 \leq k \leq 255$

Operation: (W).XOR. *k* → W

Status Affected: Z

Encoding: 

11	1010	kkkk	kkkk
----	------	------	------

Description: The contents of the W register are XOR'ed with the eight bit literal 'k'. The result is placed in the W register.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Process data	Write to W register

Example 1

```
XORLW 0xAF ; 1010 1111 (0xAF)
Before Instruction ; 1011 0101 (0xB5)
W = 0xB5 ; -----
After Instruction ; 0001 1010 (0x1A)
W = 0x1A
Z = 0
```

Example 2

```
XORLW MYREG
Before Instruction
W = 0xAF
Address of MYREG † = 0x37
† MYREG is a symbol for a data memory location
After Instruction
W = 0x18
Z = 0
```

Example 3

```
XORLW HIGH (LU_TABLE)
Before Instruction
W = 0xAF
Address of LU_TABLE † = 0x9375
† LU_TABLE is a label for an address in program memory
After Instruction
W = 0x3C
Z = 0
```

# PICmicro MID-RANGE MCU FAMILY

## XORWF

Exclusive OR W with f

Syntax: [label] XORWF f,d

Operands:  $0 \leq f \leq 127$   
 $d \in [0,1]$

Operation: (W).XOR. (f) → destination

Status Affected: Z

Encoding: 

00	0110	dfff	ffff
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Description: Exclusive OR the contents of the W register with register 'f'. If 'd' is 0 the result is stored in the W register. If 'd' is 1 the result is stored back in register 'f'.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process data	Write to destination

**Example 1**

```
XORWF  REG, 1           ; 1010 1111  (0xAF)
Before Instruction      ; 1011 0101  (0xB5)
                        REG= 0xAF    ; -----
                        W  = 0xB5    ; 0001 1010  (0x1A)
After Instruction
                        REG= 0x1A
                        W  = 0xB5
```

**Example 2**

```
XORWF  REG, 0           ; 1010 1111  (0xAF)
Before Instruction      ; 1011 0101  (0xB5)
                        REG= 0xAF    ; -----
                        W  = 0xB5    ; 0001 1010  (0x1A)
After Instruction
                        REG= 0xAF
                        W  = 0x1A
```

**Example 3**

```
XORWF  INDF, 1
Before Instruction
W      = 0xB5
FSR   = 0xC2
Contents of Address (FSR) = 0xAF
After Instruction
W      = 0xB5
FSR   = 0xC2
Contents of Address (FSR) = 0x1A
```

## 29.6 Design Tips

**Question 1:** *How can I modify the value of W directly? I want to decrement W.*

**Answer 1:**

There are a few possibilities, two are:

1. For the midrange devices, there are several instructions that work with a literal and W. For instance, if it were desired to decrement W, this can be done with an `ADDLW 0xFF` (the `0x` prefix denotes hex to the assembler)
2. Notice that all of the instructions can modify a value right where it sits in the file register. This means you can decrement it right where it is. You do not even need to move it to W. If you want to decrement it AND move it somewhere else, then you make W the DESTINATION of the decrement (`DECF register,W`) then put it where you want it. It is the same number of instructions as a straight move, but it gets decremented along the way.

**Question 2:** *Is there any danger in using the TRIS instruction for the PIC16CXXX since there is a warning in the Data book suggesting it not be used?*

**Answer 2:**

For code compatibility and upgrades to later parts, the use of the TRIS instruction is not recommended. You should note the TRIS instruction is limited to ports A, B and C. Future devices may not support these instructions.

**Question 3:** *Do I have to switch to Bank1 of data memory before using the TRIS instruction (for parts with TRIS registers in the memory map)?*

**Answer 3:**

No. The TRIS instruction is Bank independent. Again the use of the TRIS instruction is not recommended.

**Question 4:** *I have seen references to "Read-Modify-Write" instructions in your data sheet, but I do not know what that is. Can you explain what it is and why I need to know this?*

**Answer 4:**

An easy example of a Read-Modify-Write (R-M-W) instruction is the bit clear instruction `BCF`. You might think that the processor just clears the bit, which on a port output pin would clear the pin. What actually happens is the whole port (or register) is first read, THEN the bit is cleared, then the new modified value is written back to the port (or register). Actually, any instruction that depends on a value currently in the register is going to be a Read-Modify-Write instruction. This includes `ADDWF`, `SUBWF`, `BCF`, `BSF`, `INCF`, `XORWF`, etc... Instructions that do not depend on the current register value, like `MOVWF`, `CLRF`, and so on are not R-M-W instructions.

One situation where you would want to consider the affects of a R-M-W instruction is a port that is continuously changed from input to output and back. For example, say you have `TRISB` set to all outputs, and write all ones to the `PORTB` register, all of the `PORTB` pins will go high. Now, say you turn pin RB3 into an input, which happens to go low. A `BCF PORTB, 6` is then executed to drive pin RB6 low. If you then turn RB3 back into an output, it will now drive low, even though the last value you put there was a one. What happened was that the `BCF` of the other pin (RB6) caused the whole port to be read, including the zero on RB3 when it was an input. Then, bit 6 was changed as requested, but since RB3 was read as a zero, zero will also be placed back into that port latch, overwriting the one that was there before. When the pin is turned back into an output, the new value was reflected.

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**Question 5:** *When I perform a BCF other pins get cleared in the port. Why?*

**Answer 5:**

There are a few possibilities, two are:

1. Another case where a R-M-W instruction may seem to change other pin values unexpectedly can be illustrated as follows: Suppose you make PORTC all outputs and drive the pins low. On each of the port pins is an LED connected to ground, such that a high output lights it. Across each LED is a 100  $\mu$ F capacitor. Let's also suppose that the processor is running very fast, say 20 MHz. Now if you go down the port setting each pin in order; `BSF PORTC, 0` then `BSF PORTC, 1` then `BSF PORTC, 2` and so on, you may see that only the last pin was set, and only the last LED actually turns on. This is because the capacitors take a while to charge. As each pin was set, the pin before it was not charged yet and so was read as a zero. This zero is written back out to the port latch (R-M-W, remember) which clears the bit you just tried to set the instruction before. This is usually only a concern at high speeds and for successive port operations, but it can happen so take it into consideration.
2. If this is on a PIC16C7X device, you may not have configured the I/O pins properly in the ADCON1 register. If a pin is configured for analog input, any read of that pin will read a zero, regardless of the voltage on the pin. This is an exception to the normal rule that the pin state is always read. You can still configure an analog pin as an output in the TRIS register, and drive the pin high or low by writing to it, but you will always read a zero. Therefore if you execute a Read-Modify-Write instruction (see previous question) all analog pins are read as zero, and those not directly modified by the instruction will be written back to the port latch as zero. A pin configured as analog is expected to have values that may be neither high nor low to a digital pin, or floating. Floating inputs on digital pins are a no-no, and can lead to high current draw in the input buffer, so the input buffer is disabled.

# Section 29. Instruction Set

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## 29.7 Related Application Notes

This section lists application notes that are related to this section of the manual. These application notes may not be written specifically for the Mid-Range MCU family (that is they may be written for the Base-Line, or High-End families), but the concepts are pertinent, and could be used (with modification and possible limitations). The current application notes related to the instruction set are:

**Currently No related Application Notes**

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## 29.8 Revision History

### Revision A

This is the initial released revision of the Instruction Set description.