PIC Microcontroller and Embedded Systems

Branch, Call and Delay Loop

1

OUTLINE

- Looping in PIC
- Loop inside loop
- Other conditional jumps
- All conditional branches are short jumps
-
- Unconditional branch instruction

2

Looping in PIC

- Repeat a sequence of instructions or a certain number of times
- Two ways to do looping
  - Using DECFSZ instruction
  - Using BNZ\BZ instructions

3

DECFSZ instruction

Decrement file register, skip the next instruction if the result is equal 0

- DECFSZ fileRef, d
- GOTO instruction follows DECFSZ

- Write a program to a)Clear WREG
- b)Add 3 to WREG ten times and place the result in SFR PORTB

```
COUNT   EQU 0x25
        MOVLW  d'10'
        MOVWF  COUNT
        MOVLW  0
AGAIN   ADDLW  3
        DECFSZ COUNT,F
        GOTO   AGAIN
        MOVWF  PORTB
```

4

Using BNZ\BZ instructions

- Supported by PIC18 families
  - Early families such as PIC16 and PIC12 doesn't support these instruction
- These instructions check the status flag

Back

DECF fileReg, f

BNZBack

5

Example

Write a program to

- a)Clear WREG
- b)Add 3 to WREG ten times and place the result in SFR PORTB

- Solution

```
            COUNT EQU0x25
            MOVLWd'10'
            MOVWFCOUNT
            MOVLW 0
AGAIN       ADDLW3
            DECF COUNT,F
            BNZ AGAIN
            MOVWFPORTB
```

6

Loop inside a loop

Write a program to
a)Load the PORTB SFR register with the value 55H
b)Complement PORTB **700times**
Solution

```
                R1 EQU0x25
                R2 EQU0x26
                COUNT_1 EQUd'10'
                COUNT_2 EQUd'70'
                MOVLW0x55
                MOVWFPORTB
                MOVLWCOUNT_1
                MOVWFR1
LOP_1           MOVLWCOUNT_2
                MOVWFR2
LOP_2           COMPFPORTB, F
                DECFR2, F
                BNZLOP_2
                DECFR1, F
                BNZLOP_1
```

7

Other conditional jumps

- All of the 10 conditional jumps are 2-byte instructions
- They requires the target address
  - 1 byte address (short branch address)
  - Relative address
- Recall: MOVF will affect the status Reg.
- In the BZ instruction, the Z flag is checked. If it is high, that is equal 1, it jumps to the target address

8

Flag Bits and Decision Making

BC	k	Branch relative if Carry
BNC	k	Branch relative if Not Carry
BN	k	Branch relative if Negative
BNN	k	Branch relative if Not Negative
BOV	k	Branch relative if Overflow
BNOV	k	Branch relative if Not Overflow
BZ	k	Branch relative if Zero
BNZ	k	Branch relative if Not Zero

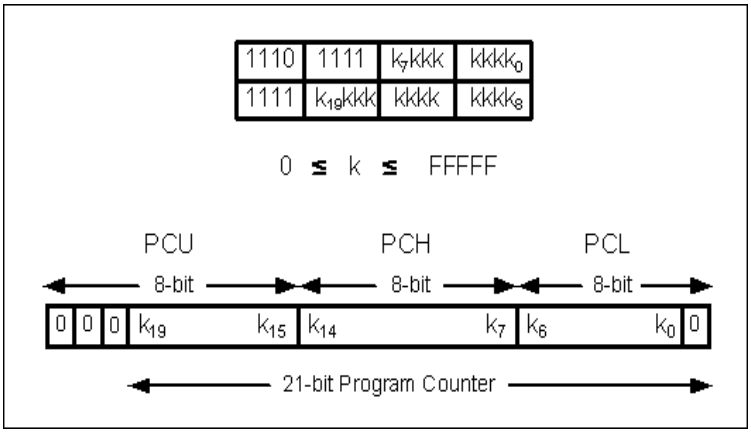
9

Unconditional branch instruction

- Control is transferred unconditionally to the target location (at ROM)
- Two unconditional branches
  - GOTO
  - BRA

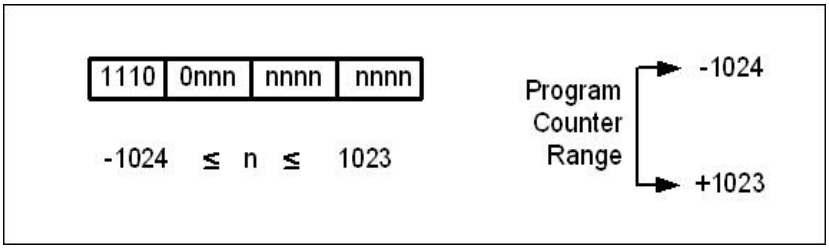
10

GOTO Instruction



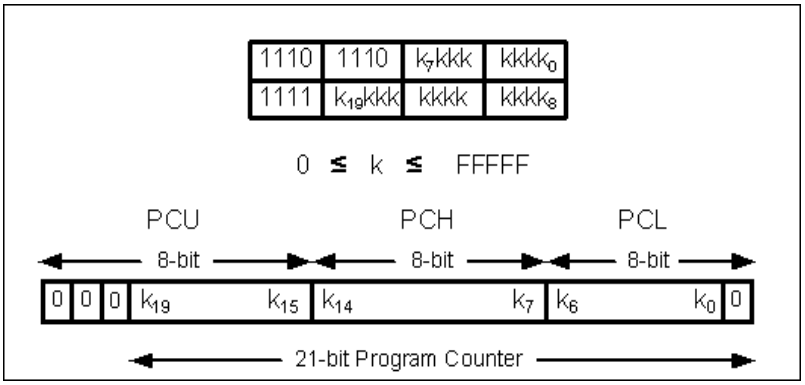
11

BRA Instruction



12

Call instruction



13

CALL Instruction

- Control is transferred to subroutine
- Current PC value, the instruction address just below the CALL instruction, is stored in the stack
  - push onto the stack
- Return instruction is used to transfer the control back to the caller,
  - the previous PC is popped from the stack

14

Stack and Stack Pointer (SP)

- Read/Write Memory
- Store the PC Address
  - 21-bit (000000 to 1FFFFF)
- 5-bit stack, total of 32 locations
- SP points to the last used location of the stack
  - Location 0 doesn't used
  - Incremented pointer

15

RCALL (Relative Call)

- 2-Byte instruction
- The target address must be within 2K
  - 11 bits of the 2 Byte is used
- Save a number of bytes.

16

Delay Calculating for PIC18

- Two factors can affect the accuracy of the delay

1. The duration of the clock period, which is function of the Crystal freq Connected to OSC! And OSC2

2. The instruction cycle duration
   - Most of the PIC18 instructions consumes 1 cycle
     - Use Harvard Architecture
     - Use RISC Architecture
     - Use the pipeline concept between fetch and execute

17

Instruction Cycle time for the PIC

- What is the Instruction Cycle ?
- Most instructions take one or tow cycles
  - BTFSS can take up to 3 cycles
- Instruction Cycle depends on the freq. of oscillator
- Clock source: Crystal oscillator and on-chip circuitry
- One instruction cycle consists of four oscillator period

18

Example

- Find the period of the instruction cycle you chose 4 MHz crystal? And what is required time for fetching an instruction?
- Solution

  4 MHz/4 =1 MHz
  Instruction Cycle = 1/1MHz = 1 usec
  Fetch cycle = 4 * 1 usec = 4 usec

19

Example

Find how long it take to execute each of the following instructions for a PIC18 with 4 MHz

- MOVLW
- ADDLW
- CALL
- DECF
- GOTO
- NOP
- BNZ
- MOVWF

20

Delay calculation for PIC18Example

- Find the size of the delay in the following program if the crystal freq. is 4MHz.

```
DELAY   MOVLW0xFF
        MOVWFMYREG
AGAIN   NOP
        NOP
        DECFMYREG, F
        BNZAGAIN
        RETERN
```

21

Example

```
        MYREGEQU0x08
        ORG0
BACK    MOVLW  0x55
        MOVWF  PORTB
        CALL   DELAY
        MOVLW  0xAA
        MOVWF  PORTB
        CALL   DELAY
        GOTO   BACK

        ORG    300H
DELAY   MOVLW  0xFA
        MOVWF  MYREG
AGAIN   NOP
        NOP
        NOP
        DECF   MYREG, F
        BNZ    AGAIN
        RETURN
```

22

Example

```
        R2      EQU0x2
        R3      EQU0x3
        R4      EQU0x4
        MOVLW   0x55
        MOVWF   PORTB
BACK
        CALL
        DELAY_500MS
        COMF    PORTB
        GOTO    BACK
```

```
DELAY_500MS
        MOVLW   D'20'
        MOVWF   R4
BACK
        MOVLW   D'100'
        MOVWF   R3
AGAIN
        MOVLW   D'250'
        MOVWF   R2
HERE    NOP
        NOP
        DECF    R2, F
        BNZ     HERE
        DECF    R3, F
        BNZ     AGAIN
        DECF    R4, F
        BNZ     BACK
        RETURN
```

23