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Implementing Long Calls

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INTRODUCTION

This application note discusses how to implement “long calls” in the PIC16C5X architecture. The use of long call can simplify the partitioning of the application program with minimal software overhead.

In the PIC16C5X architecture, the program memory page size is 512 words. Depending on the device, the program memory may be as large as 2K words (as in the PIC16C57 or PIC16C58 devices). The program counter (and stack) width range from 9- to 11-bits, depending on the amount of program memory. Table 1 shows the width of the Program Counter (PC) and Stack for the various devices.

The low order 8-bits of the program counter are accessible by the user program. These bits are contained in the PC register.

TABLE 1: PC AND STACK WIDTH

DEVICE	Width (bits)		Program Memory (Words)
	Program Counter	Stack	
PIC16C54 / PIC16C55	9	9	512
PIC16C56	10	10	1K
PIC16C57 / PIC16C58	11	11	2K

Figure 1 shows the structure of the PC. Since A8 is forced to 0 by `CALL` instructions, the start address of subroutines must be in the first 256 words of each program memory page. Depending on the size and number of called subroutines, this limitation may become a burden to the software developer. The implementation of a “long call” eases this, by allowing the subroutine to be anywhere in the program memory page. The three important concepts for understanding the implementation of the long call are:

1. A `CALL` instruction loads the entire PC onto the Stack.
2. A `GOTO` instruction does not affect the Stack.
3. A `GOTO` instruction can branch to any location in a program memory page.

Also to select the desired page, the PA1 and PA0 bits (STATUS<6:5>) must be programmed accordingly. These bits do not get loaded into A10:A9, of the PC, until one of the following occurs:

- A `CALL` instruction
- A `GOTO` instruction
- An instruction that modifies the PC register (PC<:7:0>), such as `ADDWF PC,F.`

So a `CALL` instruction followed by a `GOTO` instruction will always remain in the same page as the intended call. This allows the developer to place “call vectors” at the first 256 words of each page. The instruction at the “call vector” then executes a `GOTO` instruction to the subroutine anywhere in that page. The `RETLW` instruction, of the subroutine, will then POP the stack. The Stack contains the PUSHed PC value from the `CALL` instruction.

Figure 2 shows an example of a “long call” sequence in a device with 2K-words.

FIGURE 1: PROGRAM COUNTER STRUCTURE

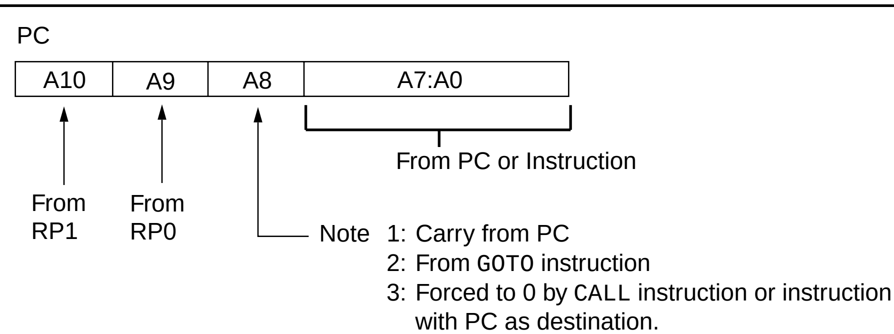
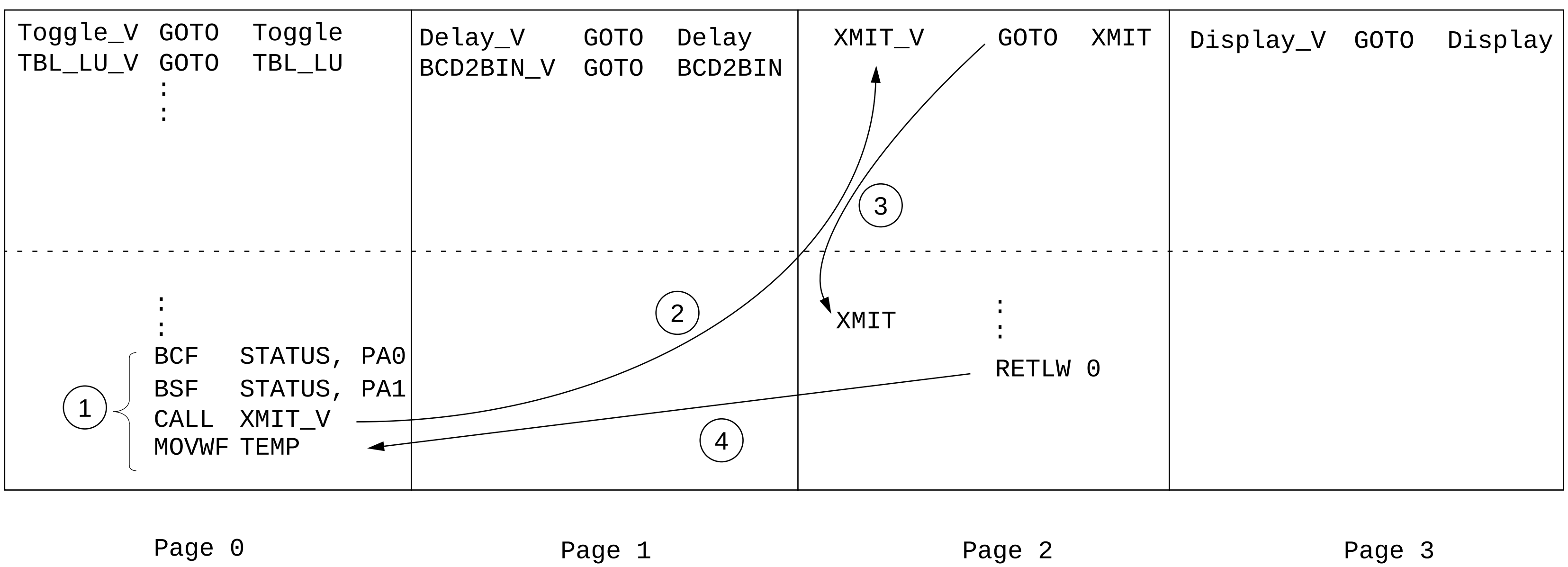


FIGURE 2: EXAMPLE OF A "LONG CALL" SEQUENCE



The flow that occurs in Figure 2 is as follows:

1. Select the program memory page of the desired subroutine and execute the call to that subroutine.
2. The program loads the Stack with the PC + 1 address, branches to the selected page and specified address of the “call vector” (must be in the first 256 locations of the page).
3. Executes a `GOTO` instruction, to have access to the entire program memory page. Then executes the subroutine.
4. Executes the `RETLW` instruction, which POPs the new PC value from the Stack. This causes program execution to continue at the instruction after the `CALL` instruction.

The use of “long calls” could be used to place all the subroutines in selected page(s), since the entire page can contain the subroutines (not restricted to the top half of the page). The placing of all subroutines in fewer program memory pages can reduce the overhead of specifying the required pages, since they are changed less frequently.

Use of the MPASM assembler can ease in verifying that `CALL` vectors and the CALL routine are in the same program memory page. Example 1 shows the use of assembler directives to print user defined warning or error messages in the listing file. These are shown as the shaded conditional statements. These messages are only printed in the listing file, and no indication of these messages is shown at the completion of assembly.

EXAMPLE 1: USE OF ASSEMBLER DIRECTIVES

```
;
P1_TOP            EQU      0x0000     ; First address in page 0
P2_TOP            EQU      0x0200     ; First address in page 1
P3_TOP            EQU      0x0400     ; First address in page 2
P4_TOP            EQU      0x0600     ; Reset vector address in page 1
RESET_V           EQU      0x07FF
;
     org    P1_TOP
;
     :
     :
     :
;
     org    P3_TOP
;
My_Subroutine_V     GOTO    My_Subroutine     ; Vector for My_Subroutine
     :
     :
     :
;
My_Subroutine                                 ; My_Subroutine routine
;
    if ( ( My_Subroutine_V & 0x0600 ) != ( My_Subroutine & 0x0600 ) )
       MESSG   "ERROR - User Defined: CALL VECTOR and CALL routine NOT in same page"
       endif
;
     :
     :
     :
;
My_Subroutine_END    RETURN
;
    if ( ( My_Subroutine_V & 0x0600) != (My_Subroutine_END & 0x0600) )
       MESSG   "Warning - User Defined: Call routine crosses page boundry"
    endif
;
     :
     :
     :
;
        org   RESET_V                         ; Program memory address for the reset vector
;
                 GOTO          START          ; Goto the beginning of the program
```

CONCLUSION

The use of "long calls" may ease the development of application programs. For minimal overhead, the application program can execute a subroutine from anywhere in the program memory, and return to the desired location. This eases the development of the application program by reducing the mapping of subroutine in the first 256 words of each program memory page. The use of "long calls" is possible in any of the PIC16C5X devices, but is most useful in devices with more than one program memory page. For devices with more than one page of program memory, the assembler directives can be used to verify that the subroutines are in the program memory page.

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