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>
<thead>
<tr>
<th>DEVICE</th>
<th>Width</th>
<th>Program Memory (Words)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(bits)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PC</td>
<td>Stack</td>
</tr>
<tr>
<td>PIC16C54 / PIC16C55</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>PIC16C56</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>PIC16C57 / PIC16C58</td>
<td>11</td>
<td>11</td>
</tr>
</tbody>
</table>

The following concepts are important for understanding the implementation of the long call:

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 2: EXAMPLE OF A "LONG CALL" SEQUENCE

Toggle_V GOTO Toggle
TBL_LU_V GOTO TBL_LU

Delay_V GOTO Delay
BCD2BIN_V GOTO BCD2BIN

XMIT_V GOTO XMIT

BCF STATUS, PA0
BSF STATUS, PA1
CALL XMIT_V
MOVWF TEMP

XMIT

RETLW 0

Display_V GOTO Display

Page 0  Page 1  Page 2  Page 3
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 \texttt{GOTO} instruction, to have access to the entire program memory page. Then executes the subroutine.
4. Executes the \texttt{RETLW} instruction, which POPs the new PC value from the Stack. This causes program execution to continue at the instruction after the \texttt{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 \texttt{CALL} vectors and the \texttt{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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WORLDWIDE SALES AND SERVICE

AMERICAS
Corporate Office
2335 West Chandler Blvd.
Chandler, AZ  85224-6199
Tel: 480-792-7200  Fax: 480-792-7277
Technical Support: 480-792-7627
Web Address: http://www.microchip.com

Rocky Mountain
2335 West Chandler Blvd.
Chandler, AZ  85224-6199
Tel: 480-792-7966  Fax: 480-792-7456

Atlanta
500 Sugar Mill Road, Suite 200B
Atlanta, GA  30350
Tel: 770-640-0034  Fax: 770-640-0307

Boston
2 Lan Drive, Suite 120
Westford, MA 01886
Tel: 978-692-3848  Fax: 978-692-3821

Chicago
333 Pierce Road, Suite 180
Itasca, IL  60143
Tel: 630-285-0071 Fax: 630-285-0075

Dallas
4570 Westgrove Drive, Suite 160
Addison, TX 75001
Tel: 972-818-7924  Fax: 972-818-2924

Detroit
Tri-Atria Office Building
32255 Northwestern Highway, Suite 190
Farmington Hills, MI 48334
Tel: 248-538-2050 Fax: 248-538-2260

Kokomo
2767 S. Albright Road
Kokomo, Indiana 46902
Tel: 765-864-8360 Fax: 765-864-8387

Los Angeles
18201 Von Karman, Suite 1090
Irvine, CA  92612
Tel: 949-263-1888 Fax: 949-263-1338

New York
150 Motor Parkway, Suite 202
Hauppauge, NY 11788
Tel: 631-273-5050 Fax: 631-273-5305

San Jose
Microchip Technology Inc.
2107 North First Street, Suite 590
San Jose, CA 95131
Tel: 408-436-7950 Fax: 408-436-7955

Toronto
6285 Northaven Drive, Suite 108
Mississauga, Ontario L4V 1X5, Canada
Tel: 905-673-0699 Fax: 905-673-6509

ASIA/PACIFIC
Australia
Microchip Technology Australia Pty Ltd
Suite 22, 41 Lawson Street
Epping 2121, NSW
Australia
Tel: 61-2-9868-6733 Fax: 61-2-9868-6755

China - Beijing
Microchip Technology Consulting (Shanghai) Co., Ltd., Beijing Liaison Office
Unit 915
Bei Hai Wan Tai Bldg.
No. 6 Chaoyangmen Beidajie
Beijing, 100027, No. China
Tel: 86-10-85282100 Fax: 86-10-85282104

China - Chengdu
Microchip Technology Consulting (Shanghai) Co., Ltd., Chengdu Liaison Office
Rm. 2401, 24th Floor,
Ming Xing Financial Tower
No. 88 TIDU Street
Chengdu 610016, China
Tel: 86-28-6766200 Fax: 86-28-6766599

China - Fuzhou
Microchip Technology Consulting (Shanghai) Co., Ltd., Fuzhou Liaison Office
Unit 701 World Trade Plaza
No. 71 Wuzi Road
Fuzhou 350001, China
Tel: 86-591-7503506 Fax: 86-591-7503521

China - Shanghai
Microchip Technology Consulting (Shanghai) Co., Ltd.
Room 701, Bldg. B
Far East International Plaza
No. 317 Xian Xia Road
Shanghai, 200005
Tel: 86-21-6275-5700 Fax: 86-21-6275-5060

China - Shenzhen
Microchip Technology Consulting (Shanghai) Co., Ltd., Shenzhen Liaison Office
Rm. 1301, 13/F, Shenzhen Kerry Centre,
Renminnan Lu
Shenzhen 518001, China
Tel: 86-755-2350361 Fax: 86-755-2366086

Hong Kong
Microchip Technology Hong Kong Ltd.
Unit 901-6, Tower 2, Metroplaza
223 Hing Fong Road
Kwai Fong, N.T., Hong Kong
Tel: 852-2401-1200 Fax: 852-2401-3431

India
Microchip Technology Inc.
India Liaison Office
Divyagiri Chambers
1 Floor, Wing A (A3/A4)
No. 11, O'Shaugnessy Road
Bangalore, 560 025, India
Tel: 91-80-2290061 Fax: 91-80-2290062

Japan
Microchip Technology Japan K.K.
Benex S-1 6F
3-18-20, Shinyokohama
Kohoku-Ku, Yokohama-shi
Kanagawa, 222-0033, Japan
Tel: 81-45-471-6166 Fax: 81-45-471-6122

Korea
Microchip Technology Korea
168-1, Youngbo Bldg. 3 Floor
Samsung-Dong, Kangnam-Ku
Seoul, Korea 135-882
Tel: 82-2-554-7200 Fax: 82-2-558-5934

Singapore
Microchip Technology Singapore Pte Ltd.
200 Middle Road
#07-02 Prime Centre
Singapore, 189890
Tel: 65-334-8870 Fax: 65-334-8850

Taiwan
Microchip Technology Taiwan
11F-3, No. 207
Tung Hua North Road
Taipei, 105, Taiwan
Tel: 886-2-2717-7175 Fax: 886-2-2545-0139

EUROPE
Denmark
Microchip Technology Nordic ApS
Regus Business Centre
Lautrup høj 1-3
Ballerup DK-2750 Denmark
Tel: 45 4420 9895 Fax: 45 4420 9910

France
Microchip Technology SARL
Parc d’Activite du Moulin de Massy
43 Rue du Saule Trapu
Batiment A - 1er Etage
91900 Massy, France
Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79

Germany
Microchip Technology GmbH
Gustav-Heinemann Ring 125
D-81739 Munich, Germany
Tel: 49-89-6275-7000 Fax: 49-89-6275-7001

Italy
Microchip Technology SRL
Centro Direzionale Colleoni
Palazzo Taurus 1 V. Le Colleoni 1
20041 Agrate Brianza
Milan, Italy
Tel: 39-039-65791-1 Fax: 39-039-6899883

United Kingdom
Arizona Microchip Technology Ltd.
505 Eskdale Road
Winnersh Triangle
Wokingham
Berkshire, England RG41 5TU
Tel: 44 118 921 5869 Fax: 44-118 921-5820

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