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HEW

Stack Analysis of using HEW Call Walker (CallWalker)

Introduction

This application note provides:

1. A general view on stack information file (*.sni) or profile information file (*.pro) for new user
2. How to create stack information file (*.sni) or profile information file (*.pro)
3. Using call walker to display stack or profile information file
4. Usefulness and purpose of stack or profile information file

Call Walker is a stack analysis tool that reads a stack information file (*.sni), which has been output by an optimising linkage editor or a profile information file (*.pro), which has been output by a debugging interface and displays its stack amount used. The information can be added or modified by using the edit function.

Target Device

All

Contents

1. Overview

Call Walker opens stack or profile information file and displays call information (e.g. symbol classification), symbol details (e.g. symbol name, attribute, address, size, stack size and source).
Overview of linkage of each file related to Call Walker is shown below in Figure 1.

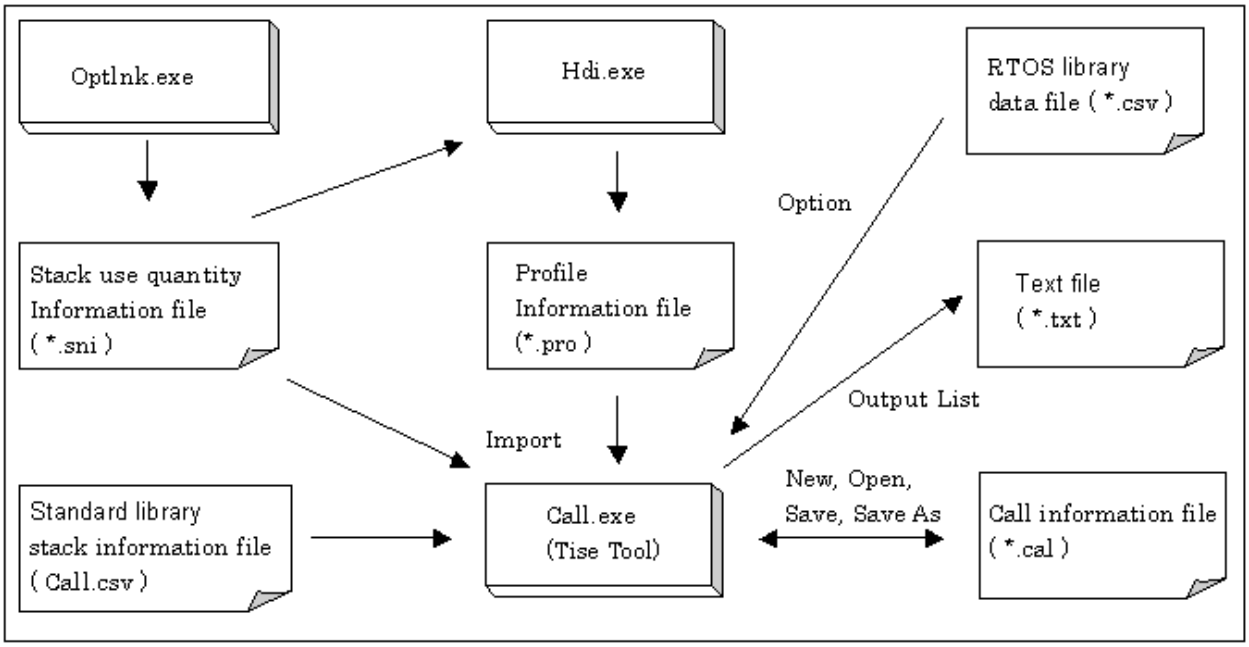

Figure 1 Linkage of each file related to Call Walker

2. How to Create a Stack or Profile Information File

There are two methods of creating a stack analysis file. Below explained how they can be obtained.

2.1 Creating a Stack Information File from HEW2

With existing working codes in a project in HEW2, by selecting [Options->Link/Library], for “Category:”, drop down list, and select “Other”. Click on “Stack information output” and “ok”. Build the project again, a stack information file will be created at the working project’s subfolder named Debug with an extension file of .sni.

2.2 Creating a Profile Information File from HDI/HEW2-Simulator

Making use of HDI or HEW2 Simulator from above project, after setting system Memory Resources found in Simulator Memory Resource, next download the compiled project file. In order to create profile Information file (*.pro), 1st select [view->Performance->Profile], or “shift + Crtl + F”, a Profile Window is displayed. Right click mouse on the profile display, click on “Enable Profiler”. Run the program, profile information will be displayed at the window. Right click mouse again to select “Output Profile Information files”, select the file that is displayed and click “save” then “close”. Profile information file had been created at the working project’s sub-folder named Debug with an extension of .pro.

3. Invoking Call Walker

In the “program” folder of the “start” menu of the Windows®, under Renesas High-performance Embedded Workshop, one of its submenus content display “Call Walker”, and click unto it.

The Call Walker will be invoked and the main frame will be opened. To view a stack or profile file, click [File->Import Stack file], “Ctrl + I” or  icon to select the directory where the stack or profile file is saved.

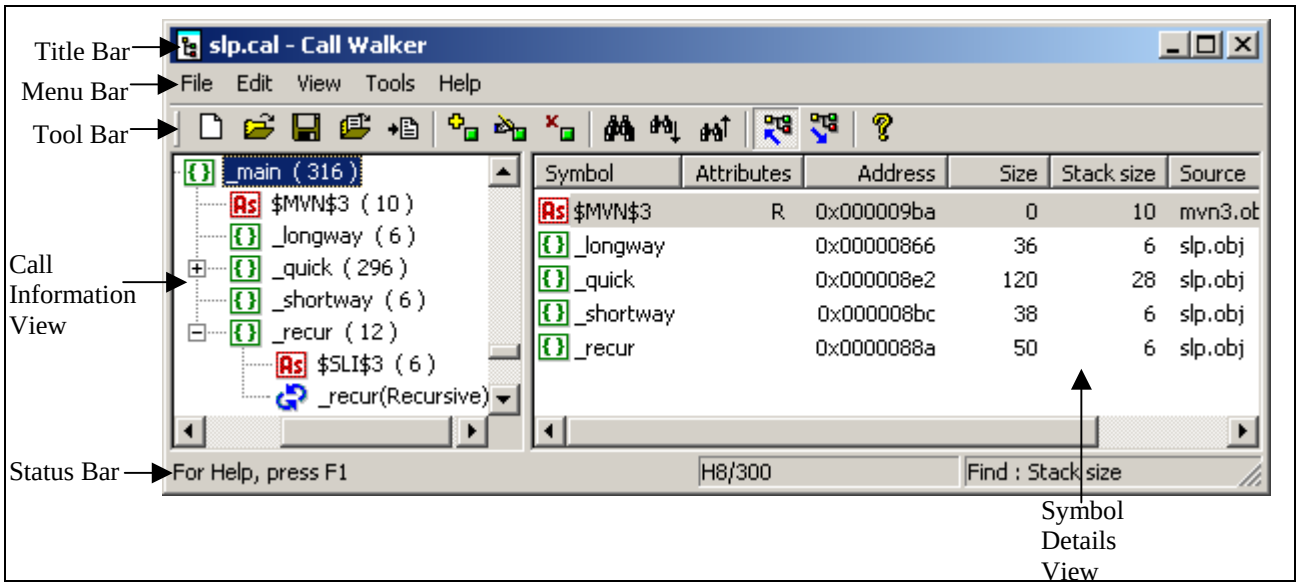

Figure 2 Call Walker Window

The above Call Walker window can only open one stack or profile file at a time.

Below explains the details of each information obtained from stack or profile information file.

3.1 Explanation on Usage of Call Information View

1. Symbol display

Display of the Symbol classification signs between link-level structure and symbols are explained below:

A. : Editing file

B. : Assembler label

C. : C/C++ function

D. : Recursive call function or a circulating function

E. : RTOS function

F. : Functions that the reference source is unknown

G. : Omitted symbol

The level structure can be edited by moving a symbol (drag and drop is used). That means, from the below Figure 3 shows that symbol '_main' contains 5 other symbols displayed on the right frame window (includes symbols '_longway', '_quick', '_shortway', '_recur' and 'MVN3').

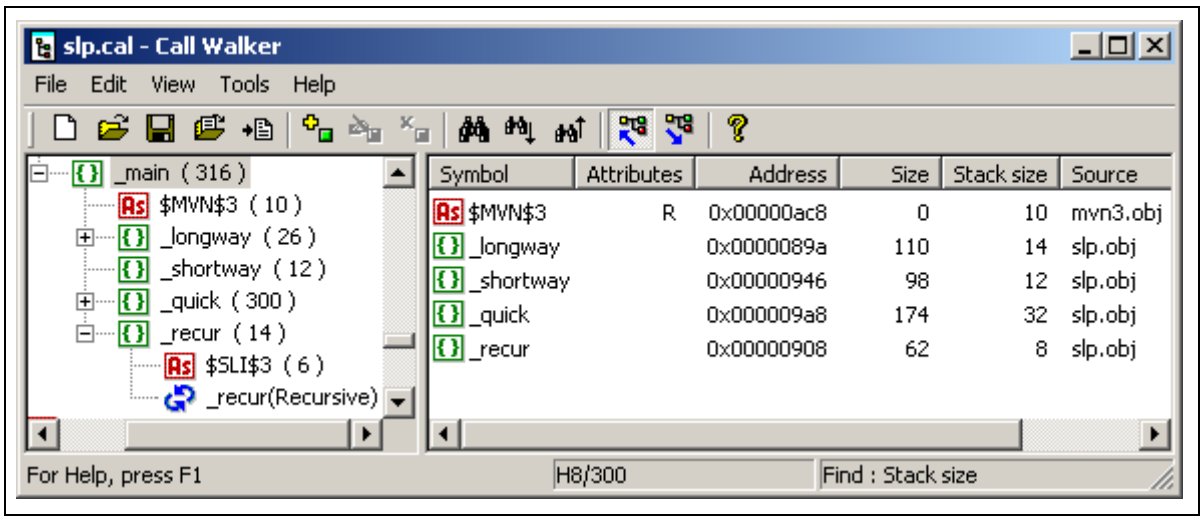

Figure 3 Call Walker Window

By dragging and then dropping '_recur' symbol to '_shortway' at the left frame window, the new linked-level structure becomes:

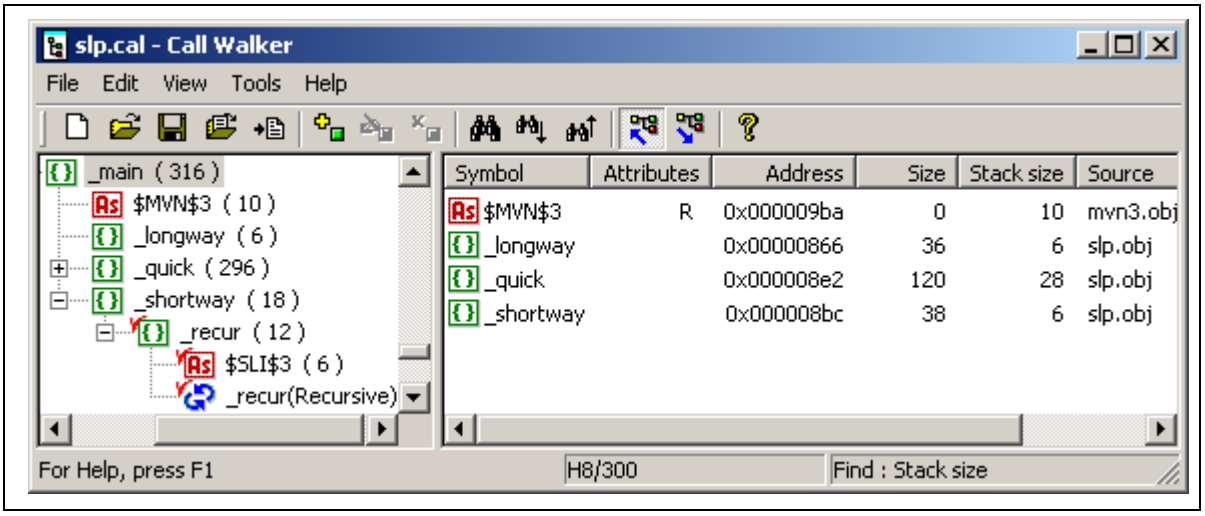

Figure 4 Call Walker Window After Dragging

Figure 4 shows that '_recur' symbol had moved to '_shortway' symbol. Notice that the numerical value within ( ) attached to '_shortway' symbol increase from 6 to 18 since '_recur' symbol stack size is 12.

However, symbols cannot be moved to the recursive call, cyclic function or omitted functions.

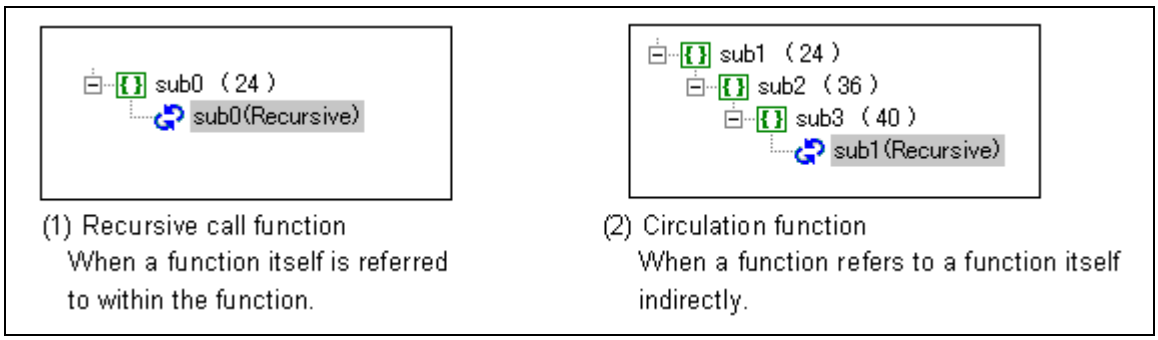

Figure 5 Recursive and Circulation Functions

How the above-mentioned figure 5 features may help in the development stage of a program?

In cases where stack size used maybe too large, e.g. when functions calling functions and so on. By dragging symbols to various locations could let the programmer to have a better view of estimating stack size allocation or maybe better idea of modifying the codes in saving stack size. E.g. reducing unnecessary multiple steps of functions calling functions will reduce stack size significantly.

2. Omitted Symbols

Symbols can be omitted when the program is very large. Below figure 6 shows the different types of display. Right side shows all symbols while left side shows simple symbols (as some symbols are omitted).

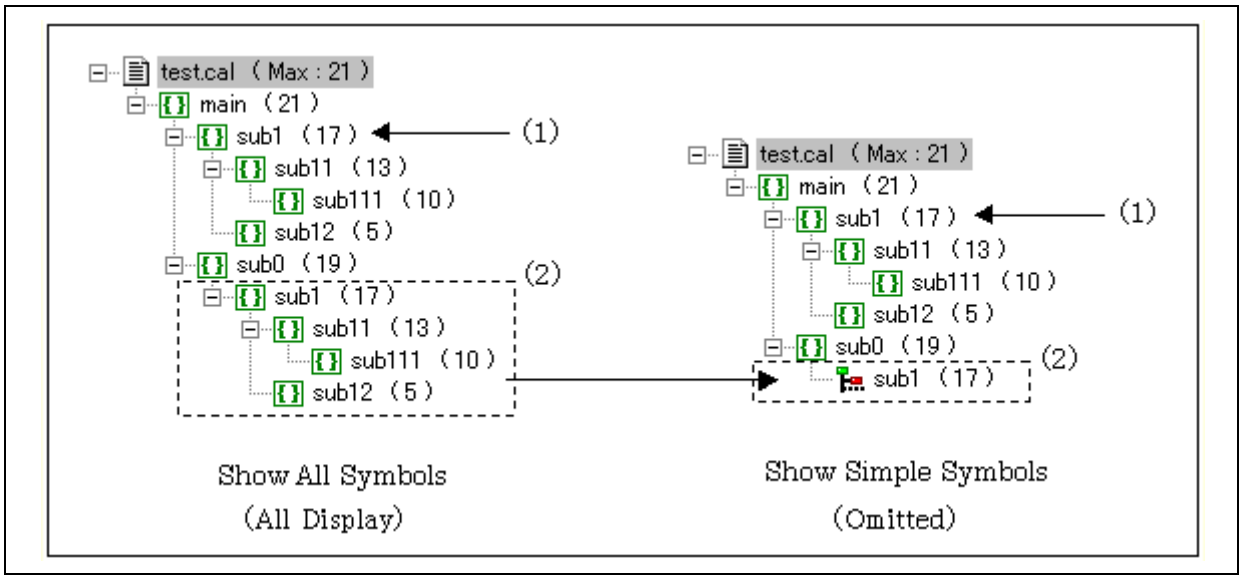

Figure 6 Display of All and Simple Symbols

To show all symbols, click [View->Show All Symbols]. To show simple symbols, click [View->Show Simple Symbols].

“Simple symbols” display is useful when the program is very large and an overview of whole structure is summarized.

“All symbols” display is useful when the viewer needs to look into the details of each symbol that are linked.

3. Stack size displays

Numerical values in ( ) attached to the symbol name specify the stack amount used. Stack size can be displayed in 2 types, namely Show Required Stack and Show Used Stack.

A. Understanding 'Show Required Stack'

Click on [View->Show Required Stack] or  icon to show required stack format. Values in ( ) in figure 7 on the left indicates the number of stack size required to execute the symbol that is attached to it.

Note: Stand-alone symbols without calling other function display the 'real', independent stack size value. In figure 7, 'sub1', 'sub21', 'sub22' and 'ext_sub' symbols display the 'real', exact stack size being used.

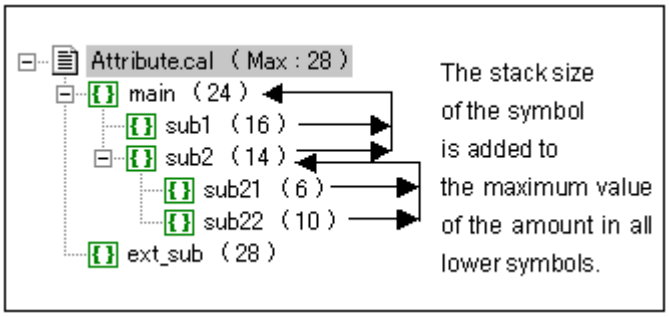

Figure 7 Show Required Stack Format

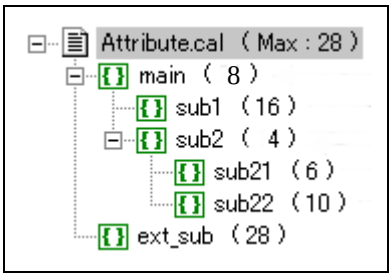

Figure 8 Individual Stack Size

How the values of stack size is obtained or calculated in the above figure 7?

Values in ( ) in Figure 8 displays the stack size that is only used by the symbol that is attached to it which can be found on symbol detail view on the right window, by clicking call/editing file (*.cal) on the top of call information view. Example stack size used by 'main' symbol is 8, 'sub1' is 16, 'sub2' is 4 and so on.

Figure 7 displays the 'Show Required Stack' format, lets start to view the values from the lowest symbol that is 'sub21' and 'sub22' which contain 6 and 10 stack size respectively. To calculate the stack size that is required to execute 'sub2' symbol, choosing the largest stack size value in its calling symbol, in this case is 'sub22' symbol stack size is 10, adding its own stack size value 4 (showed in figure 8) will obtain the result 14.

'main' symbol required stack size 24 is obtained by choosing from 'sub1' and 'sub2' symbols with larger stack value, which is 16 from 'sub1' symbol. Adding 'main' symbol stack value of 8 and 16 will get 24.

B. Understanding ‘Show Used Stack’

Click on [View->Show Used Stack] or  icon to show used stack format. Values in ( ) in figure 9 on the left indicates the total number of stack size needed to be used to execute that particular symbol.

Note: For easy reading, figure 10 is exactly same as figure 8.

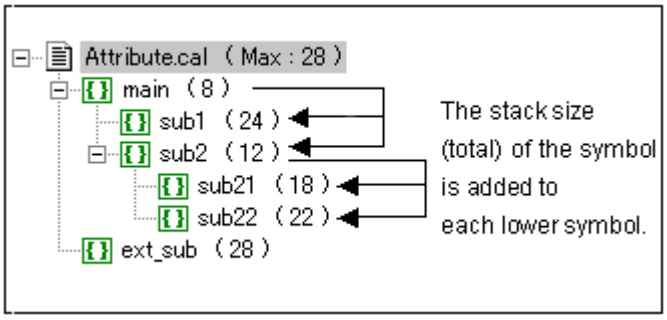

Figure 9 Show Stack Format

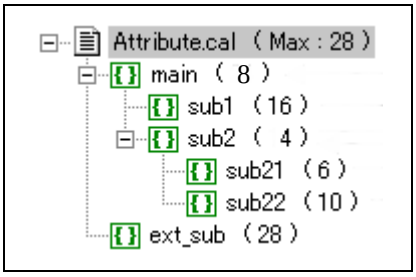

Figure 10 Individual Stack Size

How the values of stack size is obtained or calculated in the above figure 9?

Figure 9 displays the ‘Show Used Stack’ format, lets start to view the values from the top. To calculate the stack size that is used to execute ‘sub1’ symbol, where ‘sub1’ stack size is 16, adding ‘main’ symbol stack size 8, will obtain result 24.

Total stack size of 12 in ‘sub2’ symbol is obtained by adding ‘main’ value 8 and ‘sub2’ value 4 (from figure 10).

Total stack size of 18 in ‘sub21’ symbol is obtained by adding ‘sub2’ total value 12 and ‘sub21’ value 6 (from figure 10).

Total stack size of 22 in ‘sub22’ symbol is obtained by adding ‘sub2’ total value 12 and ‘sub22’ value 10 (from figure 10).

Note: For recursive call function or circulating function, the stack size is not displayed since it cannot be measured.

3.2 Explanation on Usage of Symbol Detail View

Symbol details view on the right window displays the symbol information that is being selected in the call information view, namely Symbol, Attribute, Address, Size, Stack size and Source.

1. Symbol:

   Displays its calling symbols that are same as those displayed in call information view.

   Advantage:

   - Clear view of the selected symbol's calling symbols/functions.

2. Attributes:

   Display of symbol attributes are explained below:

   A. R (Runtime Library) Runtime library

   B. O (Created by Optimization) Optimization-creating function

   C. I (Interrupt) Interrupt function

   D. S (Static) Static function

   E. V (Virtual) Virtual function

   F. L (Use Local Stack) Function used by local stack

   Advantage:

   - From the above information given, user can have an instant view of every symbol function type without looking through all the codes.

3. Address:

   Displaying symbol's address.

   Advantages:

   A. Able to amend values stored in particular symbol address without recompiling the codes again. E.g. changing initialise data section D's or could be constant data section C's specific variable's value.

   B. To have an overview of how section data are allocated in the memory area after compiling.

   C. Confirming that the symbols are stored in the correct address. E.g. Symbols not "overflow" to the unused area or being overlap to other undesired area.

   D. Able to create with a new section "close" or next to the existing one to save address space. E.g. In HEW2, under section assignment:

Address	Section
0x0000800	P
	C ← 0x0000980 (Information obtained from map file with starting given 'C' address added to given size)
0x0001000	D
	B
:	:
	:

4. Size:

   Displays symbol size.

   Advantages:

   A. Program optimization could then be focus on larger code size symbol.

   B. Have an overview of the size of sections ‘B’, ‘C’, ‘R’, ‘D’ etc. If size is too large at e.g. ‘D’ or ‘C’, unnecessary initialization can be omitted.

5. Stack size:

   Display stack size that is only used by the symbol that is attached to it. Figures 8 or 10 (above) are its display.

   Note: An empty space will be displayed if the stack size value is 0xffffffff.

   Advantages:

   - User can have an idea of how much stack size is being occupied to execute each symbol without tediously needed to trace/monitor every symbol’s stack size used manually (seeing the changes in the stack register, register R7 for H8 series and R15 for SH series).

6. Source:

   Display source file name that stores the symbolic source.

   Advantages:

   - Being able to know the calling function/symbol’s source file helps user to save time to search for it especially if the program is very large and contains many source files.

Notes:
1. The stack amount calculated in the stack information file, may be larger than the actual value when optimization option is used.
2. The stack amount for the interrupt function does not include the stack size used by the interrupt controller for saving context switchings when an interrupt occurs. Refer to the device hardware manual and calculate the required amount.
3. The stack amount for the interrupt function does not include the saved extended register (EXR).

4. "Stack Calculation" Selection in HEW2

4.1 Getting into "Stack Calculation"

Two ways to approach "Stack Calculation" dialog:

4.1.1 When Creating a New Project

Each time a new project is created, user will come to "Option Setting" dialog box shown below in Figure 11. A drop-down list from the "Stack Calculation" displays small, medium and large that specifies the stack size range.

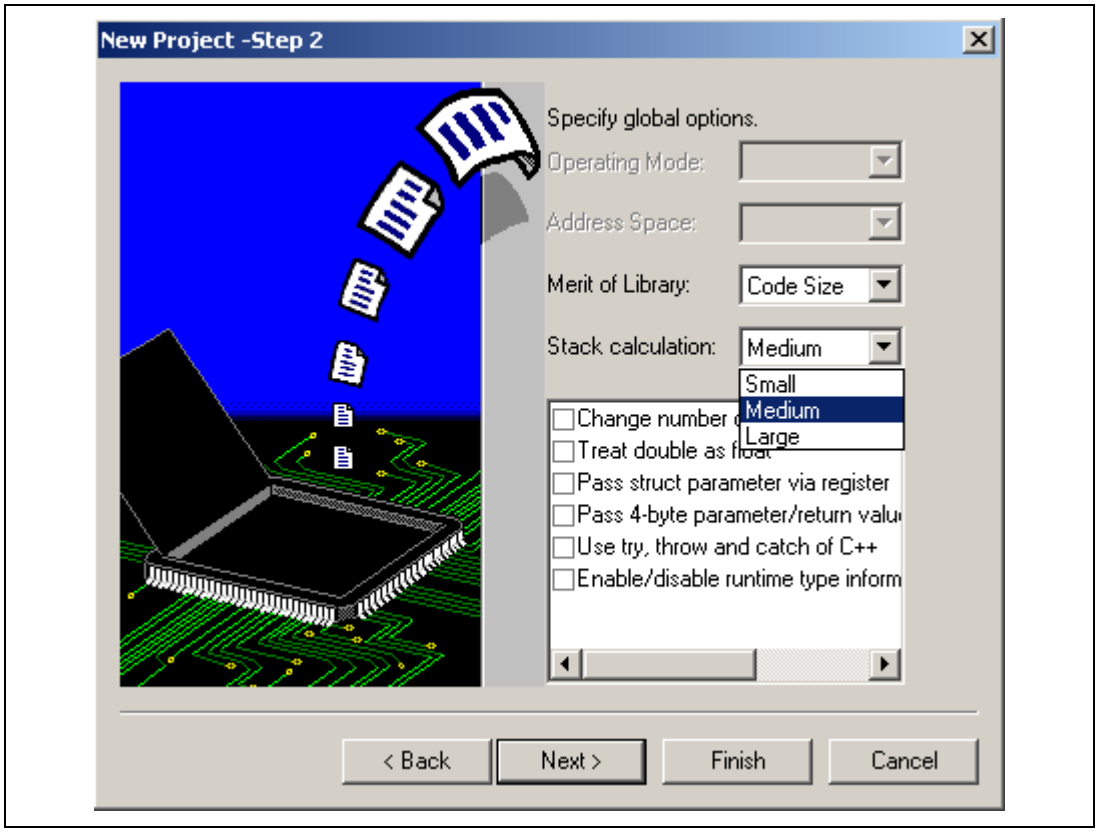

Figure 11 Stack Calculation Setting When Creating A New Project

4.1.2 Under Menu Bar Section

After a project had been built, to view or change “Stack Calculation” selection, click [Options->Hitachi H8 Tiny/SLP Toolchain->CPU], for “Stack Calculation:” drop-down list to select suitable size as shown below in Figure 12.

Note: Above Toolchain type is dependent on the type of CPU Series being chosen.

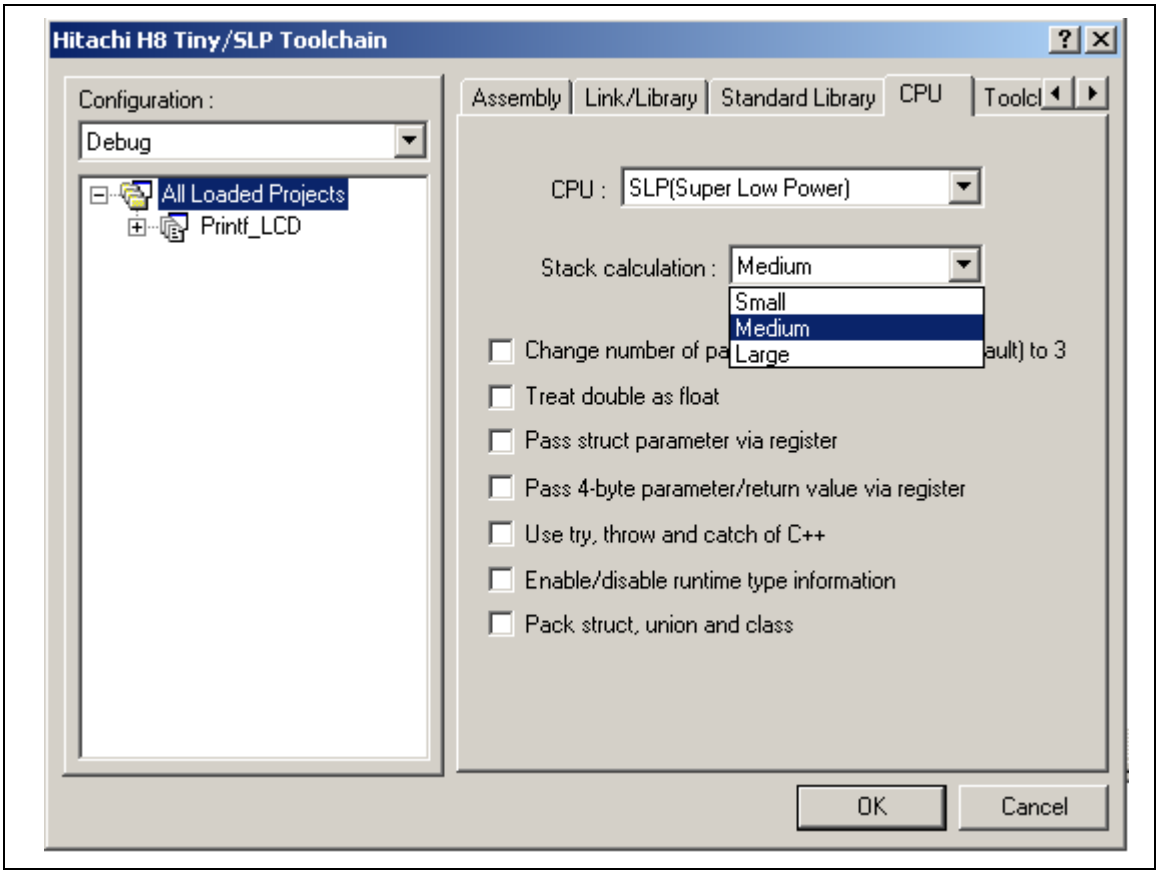

Figure 12 Stack Calculation Setting After A Project Been Built

4.2 Descriptions

When “Stack Calculation” is being selected as:

1. small: Stack addresses are operated in 1-byte units.
2. medium: Stack addresses are operated in 2-byte units.
3. large: Stack addresses are operated in 4-byte units.

The above option should be specified for the whole program.

If the stack address operation is performed with an address larger than the specified size, the program will not operate correctly, however the compiler does not output an error or warning.

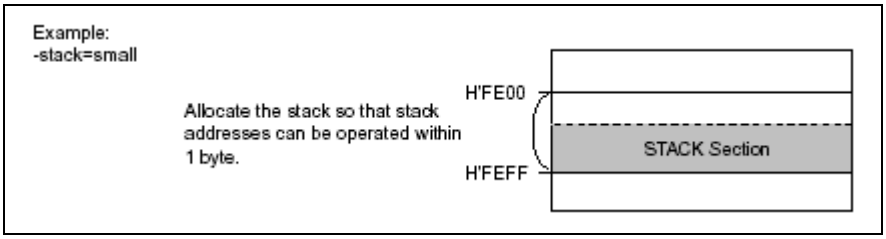

Figure 13 Stack Calculation = Small

4.3 Explanations on Data Memory Format

Memory data formats are classified into 3 types, mainly bytes, words and long words. Byte data can be accessed from any address. Word data can only be accessed from an even-numbered address of 2n. Long word data can be accessed only from an even-numbered address of 4n. Errors will occur if the above rules are not followed, also data accessed is not guaranteed.

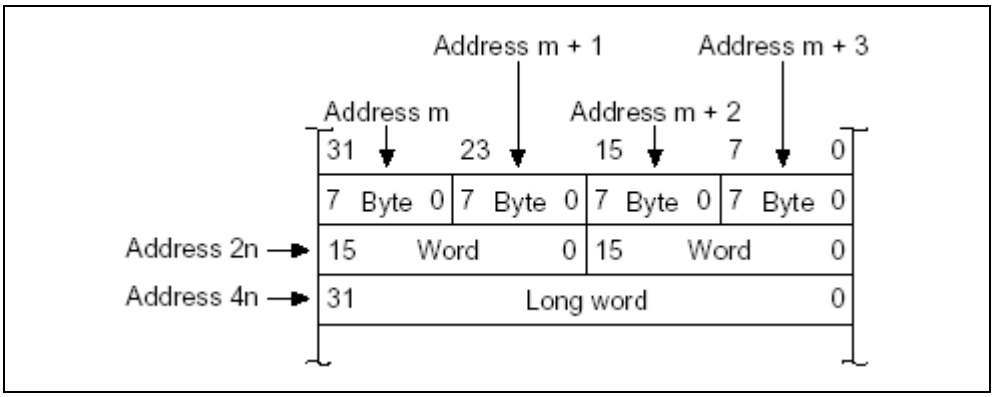

Figure 14 Memory Data Format

4.4 Information on Different Register being used as Stack Pointer in various CPU Series

Hardware stack area is referred to by hardware stack pointer, SP. One of the general registers will have dual functions, which means can be used as data register or stack pointer (SP). Depending on the CPU Series being chosen, eg. H8/SLP and Tiny Series CPU uses register R7 to also be function as SP while SH Series CPU uses R15 .

REFERENCE

1. *H8S, H8/300 Series C/C++ Compiler Assembler Optimizing Linker Editor User's Manual, Revision 4.0, HEW On-line Manual, Renesas Technology Corp.*

Revision Record

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	September .03	—	First edition issued

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