Usage of SADDR Area and CALLT Instruction

CC-RL C Compiler for RL78 Family

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Introduction

- This document describes how to output a code that uses the SADDR area and CALLT instruction of the RL78 family when using the CC-RL C compiler for the RL78 family.
- Using the SADDR area and CALLT instruction reduces the code size.
- Each amount of code reduction shown in this document only applies to the corresponding example; the actual reduction will vary slightly between cases.
- The output assembly-language codes shown in this document are examples compiled with the medium model and the code size precedence option (-Osize) specified. Note that the output code will differ when a different type of optimization (default optimization or speed precedence optimization) is specified.

- This document uses the following tools and versions for description.
  - CC-RL C compiler for the RL78 family V.1.01.00
  - e^2 studio integrated development environment V.4.0.0.26
  - CS+ integrated development environment V.3.01.00

- How to Use the SADDR Area and CALLT Instruction
- Using the SADDR Area in a C Source File
- Using the CALLT Instruction in a C Source File
- Generating Variables/Functions Information File with Linker
- Using Variables/Functions Information File (e^2 studio)
- Using Variables/Functions Information File (CS+)

How to Use the SADDR Area and CALLT Instruction

- Use the following methods to specify the SADDR area and the CALLT instruction.
  - Declaring in C source files
    - __saddr declaration: SADDR area
    - #pragma saddr declaration: SADDR area
    - __callt declaration: CALLT instruction
    - #pragma callt declaration: CALLT instruction
  - Using the variables/functions information file
    - Use the linker option -vfinfo to statically analyze the reference frequencies and generate a variables/functions information file in which variables and functions with #pragma saddr or #pragma callt declarations added are listed in the order of reference frequency.
    - Specify the generated file in the -preinclude option at compilation.

Using the SADDR Area in a C Source File (1/2)

- Use __saddr declaration for the frequently used external variables and static variables inside functions.
- For a one-bit field especially, __saddr declaration can be expected to have a large effect.
- Declaring __saddr allocates variables to the SADDR area, and the variables are accessed with direct manipulation instructions or small-size instructions.
- Example:
  - C source program

Before Change	After Change

typedef struct {
unsigned char b0:1;
unsigned char b1:1;
unsigned char b2:1;
unsigned char b3:1;
unsigned char b4:1;
unsigned char b5:1;
unsigned char b6:1;
unsigned char b7:1;
} BITF;
BITF data0, data1;
 	
data0.b4 = data1.b1;
	typedef struct {
	unsigned char b0:1;
	unsigned char b1:1;
	unsigned char b2:1;
	unsigned char b3:1;
	unsigned char b4:1;
	unsigned char b5:1;
	unsigned char b6:1;
	unsigned char b7:1;
	} BITF;
	__saddr BITF data0, data1;
	
	data0.b4 = data1.b1;

Using the SADDR Area in a C Source File (2/2)

- Example:
  - Output assembly-language program

Before Change			After Change		
movw	**hl,#LOWW (_data1)**	3			
mov1	CY,[hl].1	2	mov1	CY,_data1.1	3
movw	**hl,#LOWW (_data0)**	3			
mov1	[hl].4,CY	2	mov1	_data0.4,CY	3
		10 bytes			6 bytes

- Note:
  - Alternatively, the variables/functions information file can be used to allocate variables to the SADDR area.

Using the CALLT Instruction in a C Source File (1/2)

- Use __callt declaration for frequently called functions.
- Declaring __callt stores the addresses of the functions to be called in the callt table area [80H - BFH], and the functions are called with a smaller-size code than that for direct function calls.
- Example:
  - C source program

Before Change	After Change

void func_sub(void)
{
;
}
void func()
{
func_sub();
;
func_sub();
}
	__**callt** void func_sub(void)
	{
	;
	}
	void func()
	{
	func_sub();
	;
	func_sub();
	}

Using the CALLT Instruction in a C Source File (2/2)

- Example:
  - Output assembly-language program

Before Change				After Change			
					.SECTION .callt0,CALLT0		
				@_func_sub:			
					.DB2 _func_sub		2
	.SECTION .textf,TEXTF				.SECTION .textf,TEXTF		
_func:				_func:			
	call	**!!_func_sub**	4		**callt**	**[@_func_sub]**	2
	call	**!!_func_sub**	4		**callt**	**[@_func_sub]**	2
			8 bytes				6 bytes

- Notes:
  - A table of addresses for function calls is generated (.callt0).
  - Due to generation of this table, code size reduction is not effective for a function called only once.
  - The CALLT instruction requires more clock cycles for execution than the CALL instruction.
  - Alternatively, the variables/functions information file can be used to specify declarations of the functions to be called through the CALLT instruction.

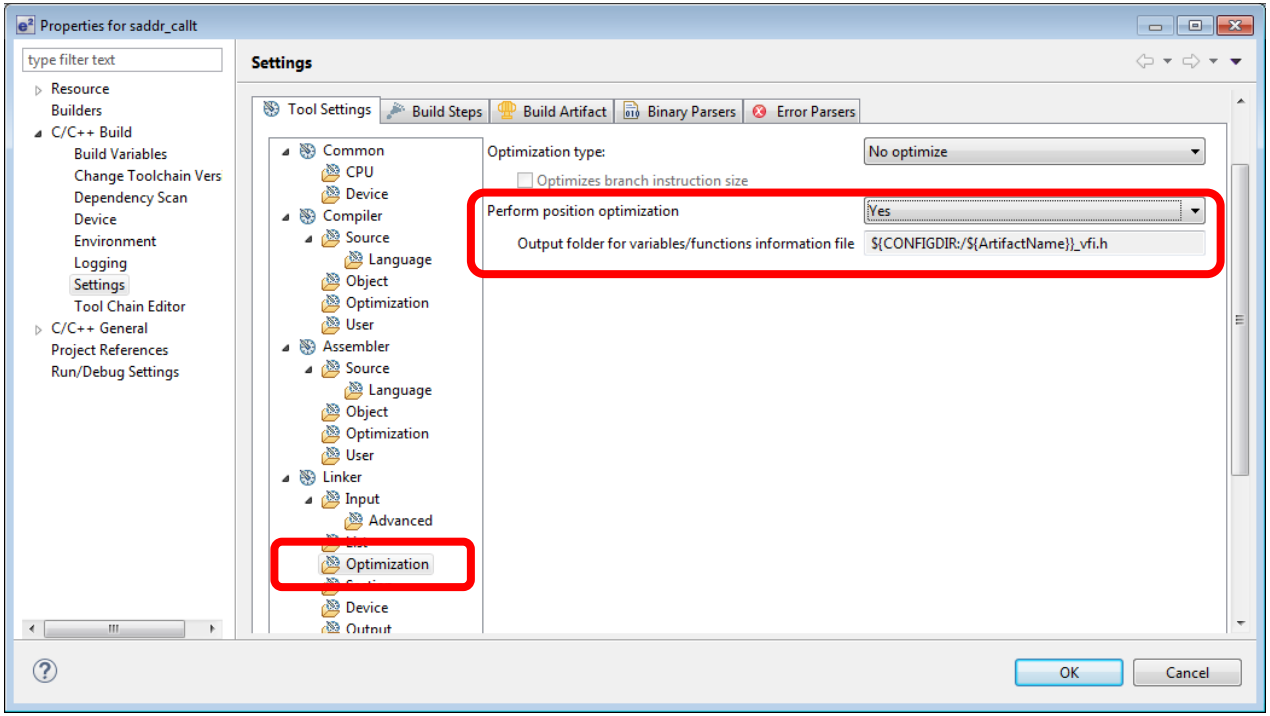
Generating Variables/Functions Information File with Linker

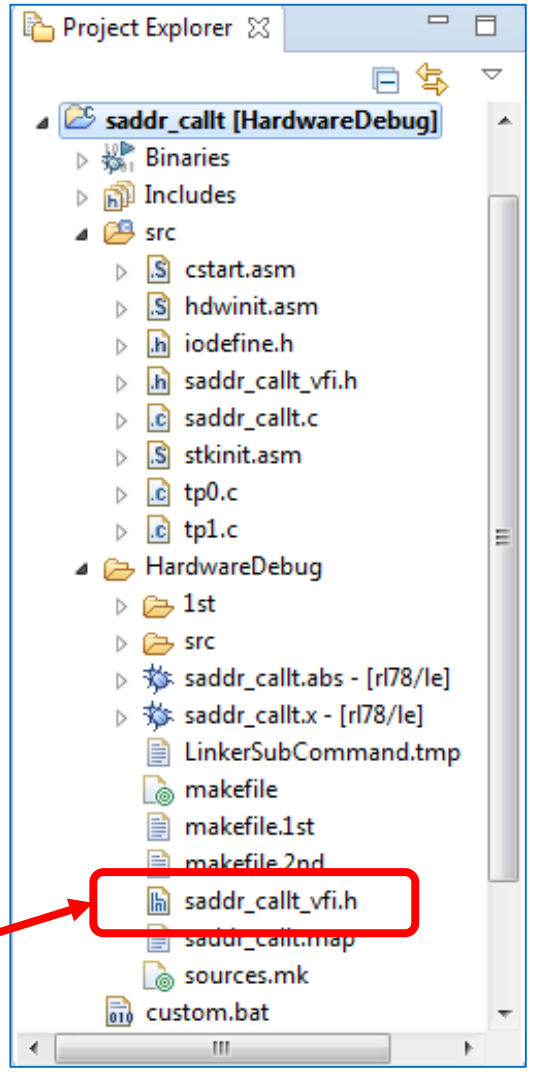
- Linker option -vfinfo
  - This option selects variables and functions for which code reduction works most effectively based on their reference frequencies, adds declarations of saddr variables and callt functions through #pragma directives to the selected variables and functions, and outputs them to a header file (variables/functions information file).
  - Example:

```
/* RENESAS OPTIMIZING LINKER GENERATED FILE yyyy.mm.dd */
/*** variable information ***/
#pragma saddr data0 /* count:10,size:1,near,tp0.obj */
#pragma saddr data1 /* count:5,size:1,near,tp0.obj */
            :
/* #pragma saddr datann */ /* count:1,size:1,near,tp1.obj */
            :
/*** function information ***/
#pragma callt func_sub0 /* count:4,far,tp0.obj */
#pragma callt func_sub1 /* count:1,far,tp0.obj */
            :
/* #pragma callt func0 */ /* count:1,far,tp1.obj */
            :
```

Using Variables/Functions Information File (e² studio) (1/2)

- Generating a variables/functions information file automatically
  - Enable position optimization in the linker.

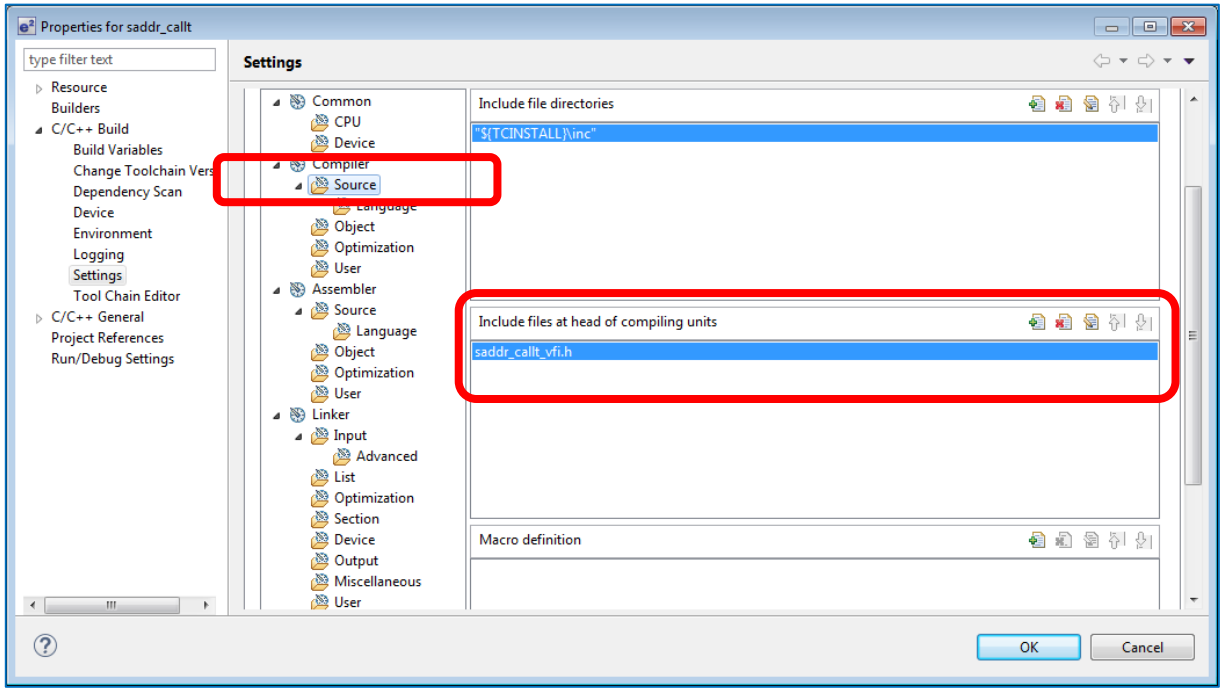




  - "Project name.h" is registered in the project tree.

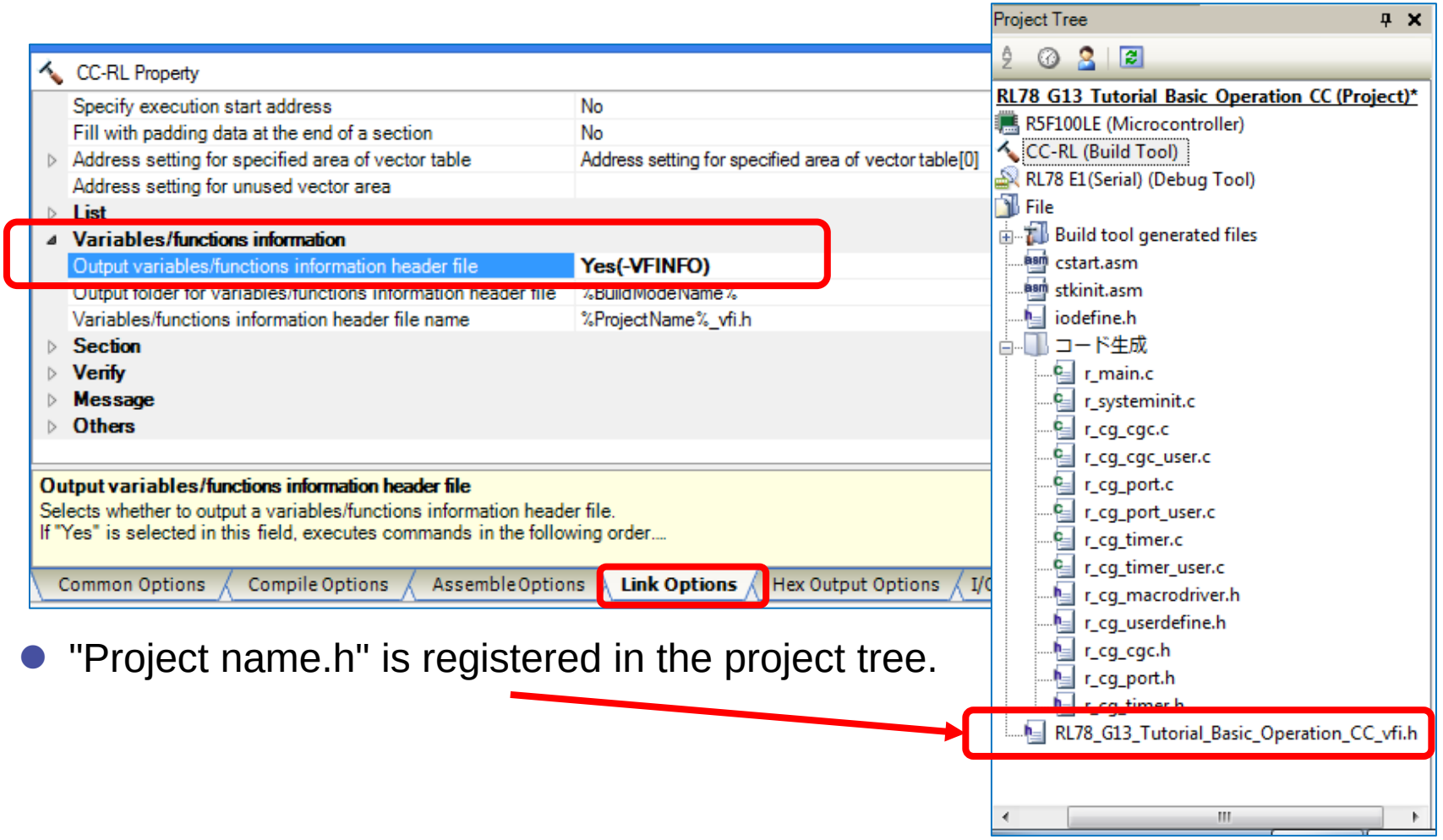
Using Variables/Functions Information File (e² studio) (2/2)

- Editing a variables/functions information file (after automatic generation)
  - Disable position optimization that was enabled in the step shown in the previous page in the linker.
  - Import the automatically generated "Project name.h" file to the src folder.
  - Register the "Project name.h" file in [Include files at head of compiling units].



Using Variables/Functions Information File (CS+) (1/2)

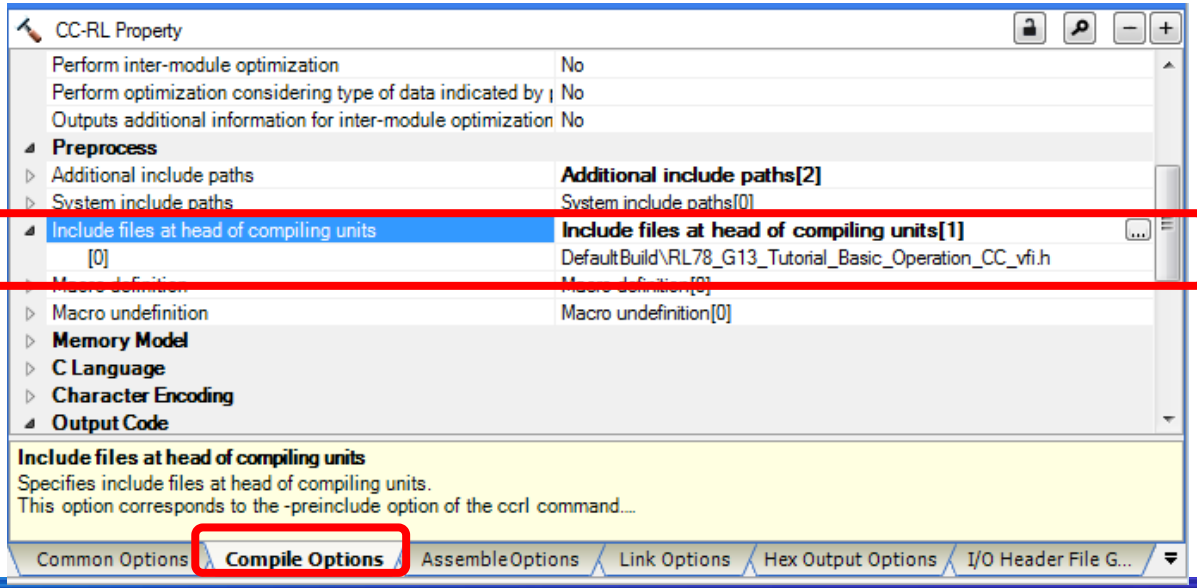
- Generating a variables/functions information file automatically
  - Enable output of a variables/functions information file.



  - "Project name.h" is registered in the project tree.

Using Variables/Functions Information File (CS+) (2/2)

- Editing a variables/functions information file (after automatic generation)
  - Disable output of a variables/functions information file that was enabled in the step shown in the previous page.
  - Copy the "Project name.h" file to another folder (such as the source folder). (Although it can be used without copying, when output of a variables/functions information file is enabled, the tool overwrites and deletes the file.)
  - Register the "Project name.h" file in [Include files at head of compiling units].



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