Old Company Name in Catalogs and Other Documents

On April 1st, 2010, NEC Electronics Corporation merged with Renesas Technology Corporation, and Renesas Electronics Corporation took over all the business of both companies. Therefore, although the old company name remains in this document, it is a valid Renesas Electronics document. We appreciate your understanding.

Renesas Electronics website: http://www.renesas.com

April 1st, 2010 Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (http://www.renesas.com)

Send any inquiries to http://www.renesas.com/inquiry.

Notice

- 1. All information included in this document is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas Electronics products listed herein, please confirm the latest product information with a Renesas Electronics sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas Electronics such as that disclosed through our website.
- Renesas Electronics does not assume any liability for infringement of patents, copyrights, or other intellectual property rights of third parties by or arising from the use of Renesas Electronics products or technical information described in this document. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
- 3. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part.
- 4. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.
- 5. When exporting the products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. You should not use Renesas Electronics products or the technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. Renesas Electronics products and technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations.
- 6. Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors in or omissions from the information included herein.
- 7. Renesas Electronics products are classified according to the following three quality grades: "Standard", "High Quality", and "Specific". The recommended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below. You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application categorized as "Specific" without the prior written consent of Renesas Electronics. Further, you may not use any Renesas Electronics. Renesas Electronics shall not be in any way liable for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for an application categorized as "Specific" or for which the product is not intended where you have failed to obtain the prior written consent of Renesas Electronics. The quality grade of each Renesas Electronics product is "Standard" unless otherwise expressly specified in a Renesas Electronics data sheets or data books, etc.
 - "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; and industrial robots.
 - "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anticrime systems; safety equipment; and medical equipment not specifically designed for life support.
 - "Specific": Aircraft; aerospace equipment; submersible repeaters; nuclear reactor control systems; medical equipment or systems for life support (e.g. artificial life support devices or systems), surgical implantations, or healthcare intervention (e.g. excision, etc.), and any other applications or purposes that pose a direct threat to human life.
- 8. You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damages arising out of the use of Renesas Electronics products beyond such specified ranges.
- 9. Although Renesas Electronics endeavors to improve the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please be sure to implement safety measures to guard them against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas Electronics product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.
- 10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. Please use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
- 11. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written consent of Renesas Electronics.
- 12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products, or if you have any other inquiries.
- (Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its majorityowned subsidiaries.
- (Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.



H8/300L Super Low Power Series

Multiplication of 16-Bit Binary Numbers (MUL)

Introduction

The software MUL multiplies a 16-bit binary number by another 16-bit binary number and places the result (a 32-bit binary number) in a general-purpose register.

Target Device

H8/38024

Contents

1.	Arguments	2
2.	Changes to Internal Registers and Flags	2
3.	Specifications	2
4.	Description	3
5.	Flowchart	7
6.	Program List	8



1. Arguments

Description		Memory area	Data length (bytes)
Input	Multiplicand	R1	2
	Multiplier	R0	2
Output	Result of multiplication	R1, R2	4

2. Changes to Internal Registers and Flags

R0	R1	R2	R3	R4	R5	R6	R7
×	0	0	×	×	×	×	—
<u> </u>	U	Н	U	Ν	Z	V	С
		×		×	×	×	×

Legend

—: No change

×: Undefined

o: Result

3. Specifications

Program memory (bytes)
32
Data memory (bytes)
0
Stack (bytes)
0
Clock cycle count
86
Reentrant
Possible
Relocation
Possible
Interrupt
Possible



4. Description

4.1 Details of functions

- 1. The following arguments are used with the software MUL:
 - R0: Sets a 16-bit binary multiplier as an input argument.
 - R1: Sets a 16-bit binary multiplicand as an input argument. The upper 2 bytes of the result are placed in this register after execution of the software MUL.
 - R2: The lower 2 bytes of the result is placed in this register as an output argument.

R0	16-bit binary multiplier
R1	16-bit binary multiplicand

Figure 1 Input Argument Setting

2. The following figure illustrates the execution of the software MUL. When the input arguments are set as shown in (1), the result of multiplication is placed in R1 and R2 as shown in (2).

	R1 (H'A0B6) A 0 B 6	_ ← Multiplicand
(1) Input arguments) R0 (H'1F6A) <u>1 F 6 A</u>	Multiplier
(2) Output arguments $\left\{ \begin{array}{c} (H' 13) \end{array} \right.$	R1, R2 B8955C) 1 3 B 8 9 5 5 C	Result of multiplication

Figure 2 Example of Software MUL Execution

3. Table 1 lists the results of multiplication with 0 placed in the input arguments.

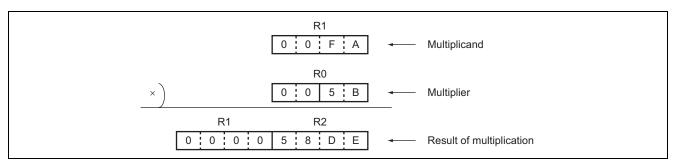
Table 1 Results of Multiplication with 0 Placed in Input Arguments

	Input argument	Output argument
Multiplicand (R1)	Multiplier (R0)	Product (R1, R2)
H'****	H'0000	H'0000 0000
H'0000	H'***	H'0000 0000
H'0000	H'0000	H'0000 0000

Note: H'**** is any given hexadecimal number.

4.2 Notes on usage

1. When upper bits are not used (see figure 3), set them to 0; otherwise, a correct result cannot be obtained because multiplication is made on the numbers including indeterminate data.





2. After execution of the software MUL, the multiplicand will be lost because the result is placed in R1. If the multiplicand is still needed after software MUL execution, save it in memory.

4.3 Data memory

The software MUL uses no data memory.

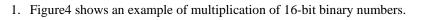
4.4 Example of usage

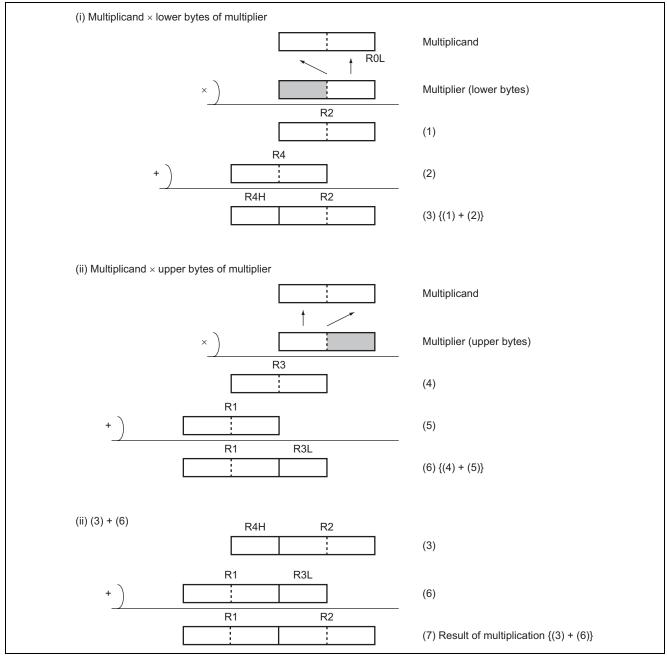
Set a multiplicand and a multiplier in the input arguments and call the software MUL as a subroutine.

WORK1	. RES. W	1	Reserve a data memory area in which the user program places a 16-bit binary multiplicand.
WORK2	. RES. W	1	Reserve a data memory area in which the user program places a 16-bit binary multiplier.
WORK 3	. RES. W	2	Reserve a data memory area for storage of the result of multiplication (a 32-bit binary number).
	Mov. W	@WORK1, R1	Place the 16-bit binary multiplicand set by the user program in the input arguments (R1).
	MOV. W	@WORK2, RO	$\begin{array}{c} \\ \\ \end{array} \left(\begin{array}{c} \text{Place the 16-bit binary multiplier set by the user program} \\ \\ \\ \text{in the input arguments (R0).} \end{array} \right) \end{array}$
[JSR	@MUL	$\cdots \cdots $ (Call the software MUL as a subroutine.
	MOV. W R1, MOV. W R2,	@WORK3 @WORK3+2	Place the result of multiplication (a 32-bit binary number set in the output arguments) in the data memory of the user program.
	•		



4.5 Operation







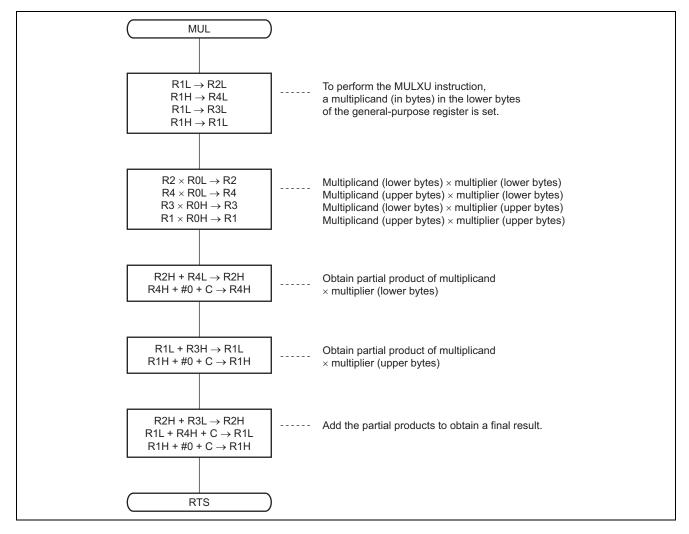


Multiplication of 16-bit binary numbers consists of two stages as shown in figure 4: finding two partial products (3) and (6) by using the MULXU instruction and adding them.

- 2. The program runs in the following steps:
 - a. The MULXU instruction is used to obtain the result of the multiplicand (lower byte) × the multiplier (lower byte) ((1) in figure 4) and the result of the multiplicand (upper byte) × the multiplier (lower byte) ((2) in figure 4). Then these two results are added to obtain a partial product, that is, the multiplicand × the multiplier (lower byte) ((3) in figure 4).
 - b. The MULXU instruction is used to obtain another partial product, that is, the multiplicand × the multiplier (upper byte) ((6) in figure 4).
 - c. The two partial products found in steps a and b are added to obtain the result of multiplication ((7) in figure 4).



5. Flowchart





6. Program List

* * *	H8/300 ASSEM	BLER V	ER 1.0B **	08/18/9	2 09:54:0	3		
PRC	GRAM NAME =							
1				;*****	********	******	******	******
2				; *				
3				; *	00 - NAM	E :16	BIT MU	LTIPLICATION (MUL)
4				; *				
5				;*****	********	******	******	******
6				; *				
7				; *	ENTRY	:R0	(MULTI	PLIER)
8				; *		R1	(MULTI	PLICAND)
9				; *				
10				; *	RETURNS	:R1	(UPPER	WORD OF RESULT)
11				; *		R2	(LOWER	WORD OF RESULT)
12				; *				
13				;*****	********	******	******	******
14				;				
15	MUL_code C	0000			.SECTION			MUL_code,CODE,ALIGN=2
16					.EXPORT			MUL
17				;				
18	MUL_code C		00000000	MUL	.EQU \$;Entry point
19	MUL_code C	0000	0C9A		MOV.B	R1L,R21	L	;R1L -> R2L
20	MUL_code C	0002	0C1C		MOV.B	R1H,R41	L	;R1H -> R4L
21	MUL_code C	0004	0C9B		MOV.B	R1L,R31	L	;R1L -> R3L
22	MUL_code C	0006	0C19		MOV.B	R1H,R1	L	;R1H -> R1L
23				;				
24	MUL_code C	0008	5082		MULXU	ROL,R2		;R0L * R2L -> R2
25	MUL_code C	A000	5084		MULXU	R0L,R4		;R0L * R4L -> R4
26	MUL_code C	000C	5003		MULXU	R0H,R3		;ROH * R3L -> R3
27	MUL_code C	000E	5001		MULXU	R0H,R1		;ROH * R1L -> R1
28				;				
29	MUL_code C	0010	08C2		ADD.B	R4L,R2E	H	;R2H + R4L -> R2H
30	MUL_code C	0012	9400		ADDX.B	#H'00,H	R4H	;R4H + #H'00 + C -> R4H
31	MUL_code C	0014	0839		ADD.B	R3H,R11	L	;R3H + R1L -> R1L
32	MUL_code C	0016	9100		ADDX.B	#H'00,H	R1H	;R1H + #H'00 + C -> R1H
33				;				
34	MUL_code C	0018	08B2		ADD.B	R3L,R2E	H	;R3L + R2H -> R2H
35	MUL_code C	001A	0E49		ADDX.B	R4H,R11	L	;R4H + R1L + C -> R1L
36	MUL_code C	001C	9100		ADDX.B	#H'00,H	R1H	;R1H + #H'00 + C -> R1H
37				;				
38	MUL_code C	001E	5470		RTS			
39				;				
40					.END			
* * *	**TOTAL ERRORS	S 0						
* * *	**TOTAL WARNII	NGS 0						



Website and Support

Renesas Technology Website <u>http://www.renesas.com/</u>

Inquiries

http://www.renesas.com/inquiry csc@renesas.com

Revision Record

		Description				
Rev.	Date	Page	Summary			
1.00	Sep.18.03	_	First edition issued			
2.00	Nov.30.06	All pages	Content correction			

Notes regarding these materials

- This document is provided for reference purposes only so that Renesas customers may select the appropriate Renesas products for their use. Renesas neither makes warranties or representations with respect to the accuracy or completeness of the information contained in this document nor grants any license to any intellectual property rights or any other rights of Renesas or any third party with respect to the information in this document.
- 2. Renesas shall have no liability for damages or infringement of any intellectual property or other rights arising out of the use of any information in this document, including, but not limited to, product data, diagrams, charts, programs, algorithms, and application circuit examples.
- 3. You should not use the products or the technology described in this document for the purpose of military applications such as the development of weapons of mass destruction or for the purpose of any other military use. When exporting the products or technology described herein, you should follow the applicable export control laws and regulations, and procedures required by such laws and regulations.
- 4. All information included in this document such as product data, diagrams, charts, programs, algorithms, and application circuit examples, is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas products listed in this document, please confirm the latest product information with a Renesas sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas such as that disclosed through our website. (http://www.renesas.com)
- 5. Renesas has used reasonable care in compiling the information included in this document, but Renesas assumes no liability whatsoever for any damages incurred as a result of errors or omissions in the information included in this document.
- 6. When using or otherwise relying on the information in this document, you should evaluate the information in light of the total system before deciding about the applicability of such information to the intended application. Renesas makes no representations, warranties or guaranties regarding the suitability of its products for any particular application and specifically disclaims any liability arising out of the application and use of the information in this document or Renesas products.
- 7. With the exception of products specified by Renesas as suitable for automobile applications, Renesas products are not designed, manufactured or tested for applications or otherwise in systems the failure or malfunction of which may cause a direct threat to human life or create a risk of human injury or which require especially high quality and reliability such as safety systems, or equipment or systems for transportation and traffic, healthcare, combustion control, aerospace and aeronautics, nuclear power, or undersea communication transmission. If you are considering the use of our products for such purposes, please contact a Renesas sales office beforehand. Renesas shall have no liability for damages arising out of the uses set forth above.
- 8. Notwithstanding the preceding paragraph, you should not use Renesas products for the purposes listed below: (1) artificial life support devices or systems
 - (2) surgical implantations
 - (3) healthcare intervention (e.g., excision, administration of medication, etc.)
 - (4) any other purposes that pose a direct threat to human life

Renesas shall have no liability for damages arising out of the uses set forth in the above and purchasers who elect to use Renesas products in any of the foregoing applications shall indemnify and hold harmless Renesas Technology Corp., its affiliated companies and their officers, directors, and employees against any and all damages arising out of such applications.

- 9. You should use the products described herein within the range specified by Renesas, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas shall have no liability for malfunctions or damages arising out of the use of Renesas products beyond such specified ranges.
- 10. Although Renesas endeavors to improve the quality and reliability of its products, IC products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Please be sure to implement safety measures to guard against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other applicable measures. Among others, since the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.
- 11. In case Renesas products listed in this document are detached from the products to which the Renesas products are attached or affixed, the risk of accident such as swallowing by infants and small children is very high. You should implement safety measures so that Renesas products may not be easily detached from your products. Renesas shall have no liability for damages arising out of such detachment.
- 12. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written approval from Renesas.
- 13. Please contact a Renesas sales office if you have any questions regarding the information contained in this document, Renesas semiconductor products, or if you have any other inquiries.

© 2006. Renesas Technology Corp., All rights reserved.