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Renesas Electronics Corporation

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H8/300L Super Low Power Series

Multiplication of 4-Digit BCD Numbers (MULD)

Introduction

The software MULD multiplies a 4-digit binary-coded decimal (BCD) number by another 4-digit BCD number and places the result (an 8-digit BCD number) in general-purpose registers.

Target Device

H8/38024

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1. Arguments

Description	Memory area	Data length (bytes)	
Input	Multiplicand	R1	2
	Multiplier	R0	2
Output	Result of multiplication	R2, R3	4

2. Changes to Internal Registers and Flags

R0	R1	R2	R3	R4	R5	R6	R7		
×	—	○	○	—	—	×	×	×	—
I	U	H	U	N	Z	V	C		
—	—	×	—	×	×	×	×		

Legend

- : No change
- ×: Undefined
- : Result

3. Specifications

Program memory (bytes)	62
Data memory (bytes)	0
Stack (bytes)	0
Clock cycle count	1192
Reentrant	Possible
Relocation	Possible
Interrupt	Possible

4. Notes

The clock cycle count (1192) in the specifications is for multiplication of 9999 by 9999.

5. Description

5.1 Details of functions

- The following arguments are used with the software MULD:
 - R0: Sets a 4-digit BCD multiplier (16 bits long) as an input argument.
 - R1: Sets a 4-digit BCD multiplicand (16 bits long) as an input argument.
 - R2: The upper 4 digits of the result (an 8-digit BCD, 32 bits long) are set here as an input argument.
 - R3: The lower 4 digits of the result (an 8-digit BCD, 32 bits long) are set here as an input argument.
- The following figure illustrates the execution of the software MULD. When the input arguments are set as shown in (1), the result of multiplication is placed in R2 and R3 as shown in (2).

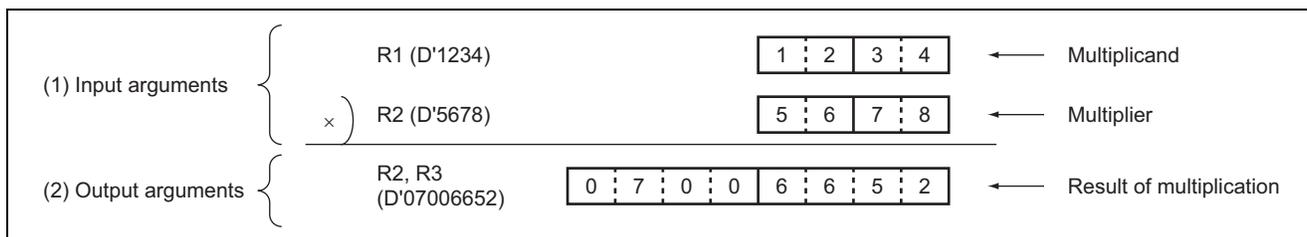


Figure 1 Example of Software MULD Execution

- Table 1 lists the result of multiplication with 0 placed in input arguments.

Table 1 Result of Multiplication with 0 Placed in Input Arguments

Input arguments		Output arguments
Multiplicand (R1)	Multiplier (R0)	Product (R2, R3)
H'****	H'0000	H'0000
H'0000	H'****	H'0000
H'0000	H'0000	H'0000

Note: H'**** is a hexadecimal number.

5.5 Operation

- Multiplication of decimal numbers can be done by performing a series of additions and shifts. Figure 3 shows an example of the multiplication (5678×1234).

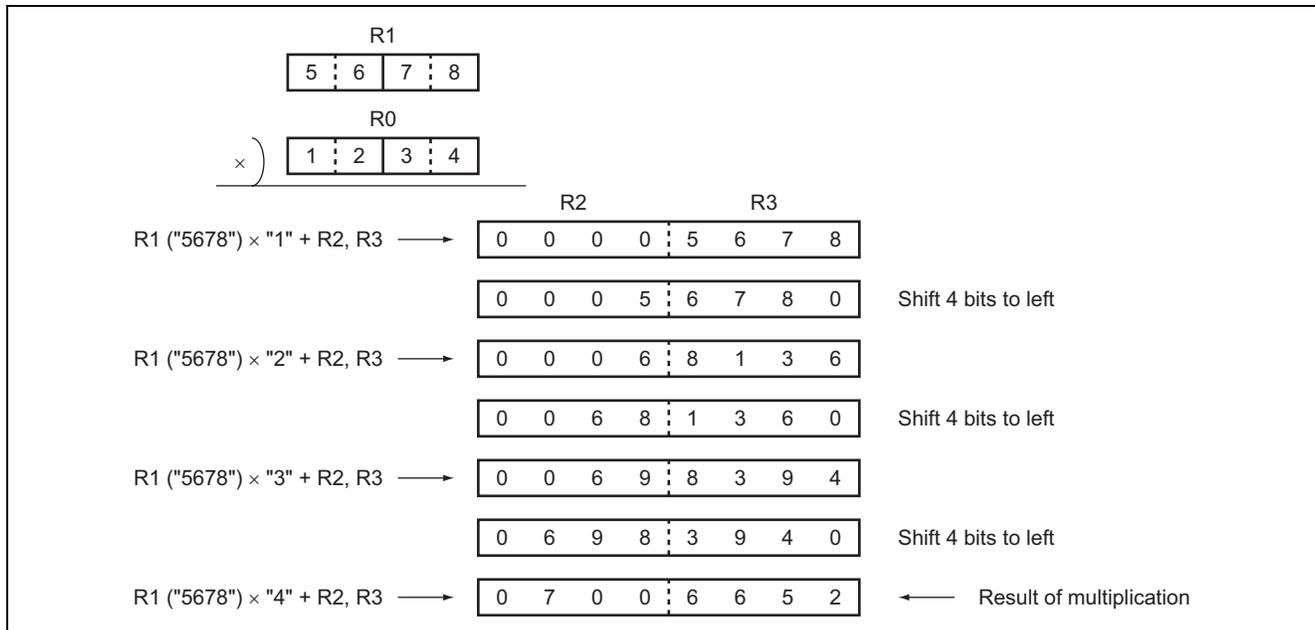


Figure 3 Example of Multiplication (5678 × 1234)

Figure 3 illustrates the method used to find the product by repeatedly adding the multiplicand, multiplied by the respective digits of the multiplier from the leftmost digit, to the result and then shifting the result.

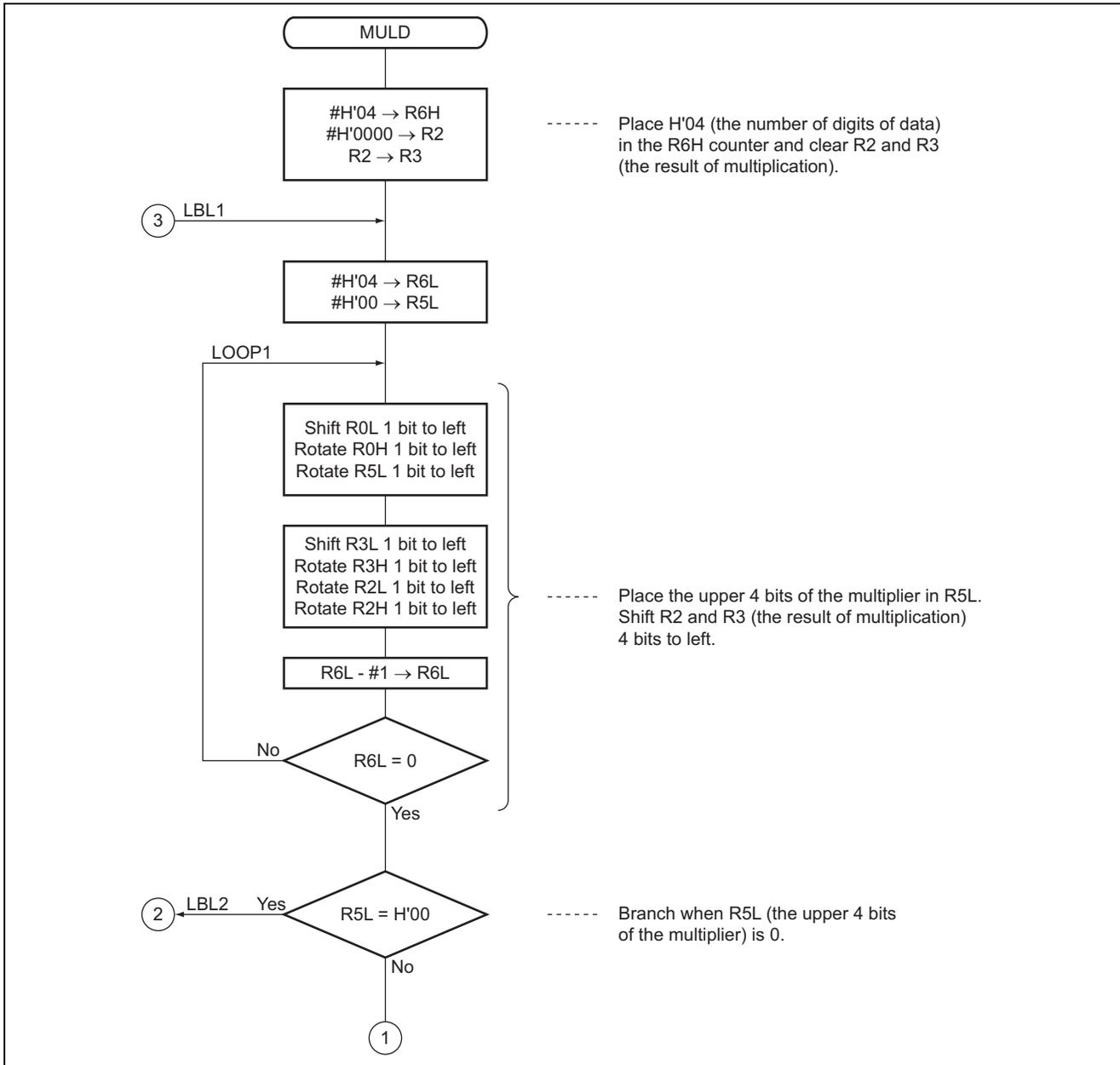
Firstly, the highest-order BCD digit (four bits) of the multiplier is taken, and the multiplicand is added this number of times. The result is then shifted four bits to left (one BCD digit). Next, the second highest digit is taken from the multiplier, the multiplicand is added to the preceding result this number of times, and so on. The final result is found by repeating the processes as many times as there are BCD digits (four times).

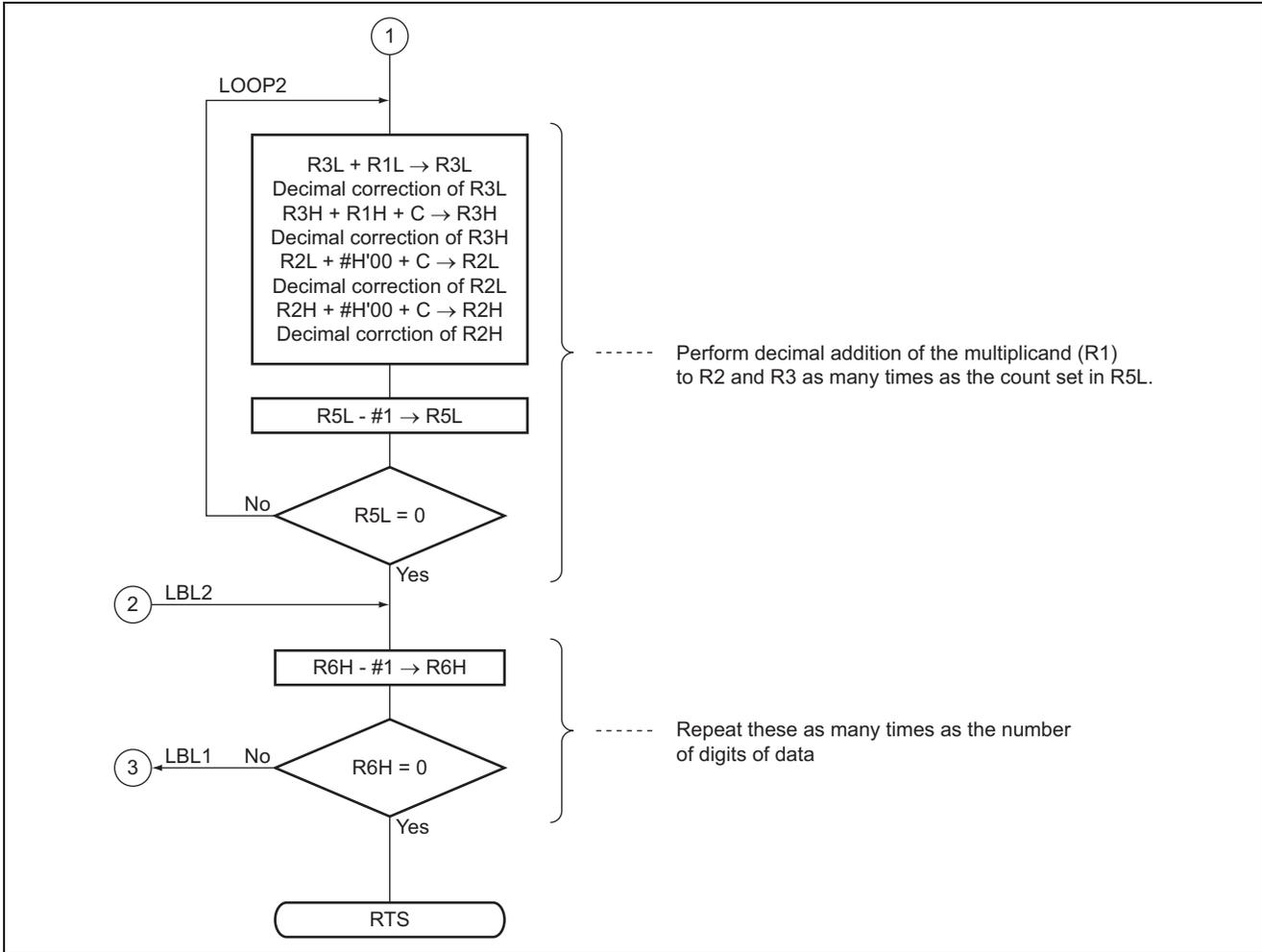
- Details of the program are given below.

The program:

- places H'04 in R6H as a counter that indicates the number of BCD digits in the data;
- clears R2 and R3, where the result of multiplication is to be stored;
- shifts R2 and R3 four bits (one BCD digit) to left;
- loads one BCD digit from the higher-order end of the multiplier to R5L, and branches to step g. when R5L is "0";
- BCD-adds the multiplicand to R2, R3 the same number of times as the value in R5L;
- decrements R6H; and
- repeats steps c to f above until R6H has become "0".

6. Flowchart





7. Program List

*** H8/300 ASSEMBLER VER 1.0B ** 08/18/92 10:01:29

```

PROGRAM NAME =
1          ;*****
2          ;*
3          ;*   00 - NAME :DECIMAL MULTIPLICATION
4          ;*           (MULD)
5          ;*
6          ;*****
7          ;*
8          ;*   ENTRY      :R1 (MULTIPLICAND)
9          ;*           R0 (MULTIPLIER)
10         ;*
11         ;*   RETURNS   :R2 (UPPER WORD OF RESULT)
12         ;*           R3 (LOWER WORD OF RESULT)
13         ;*
14         ;*****
15         ;
16 MULD_cod C    0000          .SECTION          MULD_code, CODE, ALIGN=2
17                                     .EXPORT  MULD
18         ;
19 MULD_cod C    00000000  MULD .EQU $          ;Entry point
20 MULD_cod C    0000 F604          MOV.B   #H'04,R6H   ;Set bit counter1
21 MULD_cod C    0002 79020000      MOV.W   #H'0000,R2  ;Clear R2
22 MULD_cod C    0006 0D23          MOV.W   R2,R3      ;Clear R3
23 MULD_cod C    0008          LBL1
24 MULD_cod C    0008 FE04          MOV.B   #H'04,R6L   ;Set bit counter2
25 MULD_cod C    000A FD00          MOV.B   #H'00,R5L   ;Clear R5L
26 MULD_cod C    000C          LOOP1
27 MULD_cod C    000C 1008          SHLL.B  R0L        ;Shift multiplier 1 bit left
28 MULD_cod C    000E 1200          ROTXL.B R0H
29 MULD_cod C    0010 120D          ROTXL.B R5L
30 MULD_cod C    0012 100B          SHLL.B  R3L        ;Shift result 1 bit left
31 MULD_cod C    0014 1203          ROTXL.B R3H
32 MULD_cod C    0016 120A          ROTXL.B R2L
33 MULD_cod C    0018 1202          ROTXL.B R2H
34 MULD_cod C    001A 1A0E          DEC.B   R6L        ;Decrement bit counter 2
35 MULD_cod C    001C 46EE          BNE     LOOP1      ;Branch if Z=0
36 MULD_cod C    001E AD00          CMP.B   #H'00,R5L
37 MULD_cod C    0020 4714          BEQ     LBL2      ;Branch if Z=1
38 MULD_cod C    0022          LOOP2
39 MULD_cod C    0022 089B          ADD.B   R1L,R3L    ;R1L + R3L -> R1L
40 MULD_cod C    0024 0F0B          DAA.B   R3L        ;Decimal adjust R3L
41 MULD_cod C    0026 0E13          ADDX.B  R1H,R3H    ;R1H + R3H + C -> R1H
42 MULD_cod C    0028 0F03          DAA.B   R3H        ;Decimal adjust R3H
43 MULD_cod C    002A 9A00          ADDX.B  #H'00,R2L  ;R2L + #H'00 + C -> R2L
44 MULD_cod C    002C 0F0A          DAA.B   R2L        ;Decimal adjust R2L
45 MULD_cod C    002E 9200          ADDX.B  #H'00,R2H  ;R2H + #H'00 + C -> R2H
46 MULD_cod C    0030 0F02          DAA.B   R2H        ;Decimal adjust R2H
47 MULD_cod C    0032 1A0D          DEC.B   R5L        ;Clear bit 0 of R5L
48 MULD_cod C    0034 46EC          BNE     LOOP2      ;Branch if Z=0

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```
49 MULD_cod C 0036 LBL2
50 MULD_cod C 0036 1A06 DEC.B R6H ;Decrement bit counter1
51 MULD_cod C 0038 46CE BNE LBL1 ;Branch if Z=0
52 ;
53 MULD_cod C 003A 5470 RTS
54 .END
*****TOTAL ERRORS 0
*****TOTAL WARNINGS 0
```

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