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Renesas Electronics Corporation

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H8/300L Super Low Power Series

Subtraction of Multiple-Precision Binary Numbers (SUB2)

Introduction

The software SUB2 subtracts a multiple-precision binary number from another multiple-precision binary number and places the result in the data memory where the minuend was set.

Target Device

H8/38024

Contents

1. Arguments

Description		Memory area	Data length (bytes)
Input	Minuend and subtrahend byte count	R0L	1
	Start address of minuend	R3	2
	Start address of subtrahend	R4	2
Output	Start address of result	R3	2
	Error	Z flag (CCR)	—
	Borrow	C flag (CCR)	—

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)
42
Data memory (bytes)
0
Stack (bytes)
0
Clock cycle count
7170
Reentrant
Possible
Relocation
Possible
Interrupt
Possible

4. Notes

The clock cycle count (7170) in the specifications for subtraction of 255 bytes from 255 bytes.

5. Description

5.1 Details of functions

1. The following arguments are used with the software SUB2:
   - R0L: Sets, as an input argument, the byte count of a minuend and the byte count of a subtrahend in 2-digit hexadecimals.
   - R3: Sets, as an input argument, the start address of the data memory area where the minuend is placed. After execution of the software SUB2, the start address of the result is placed in this register.
   - R4: Sets, as an input argument, the start address of the data memory area where the subtrahend is placed.
   - Z flag (CCR): Indicates an error in data length as an output argument.
     - Z flag = 0: The data byte count (R0L) was not 0.
     - Z flag = 1: The data byte count (R0L) was 0, indicating an error.
   - C flag (CCR): Determines the presence or absence of a borrow after software SUB2 execution as an output argument.
     - C flag = 0: No borrow occurred in the result.
     - C flag = 1: A borrow occurred in the result. (See figure 2)

2. The following figure illustrates the execution of the software SUB2. When the input arguments are set as shown in (1), the result of subtraction is placed in the data memory area as shown in (2).

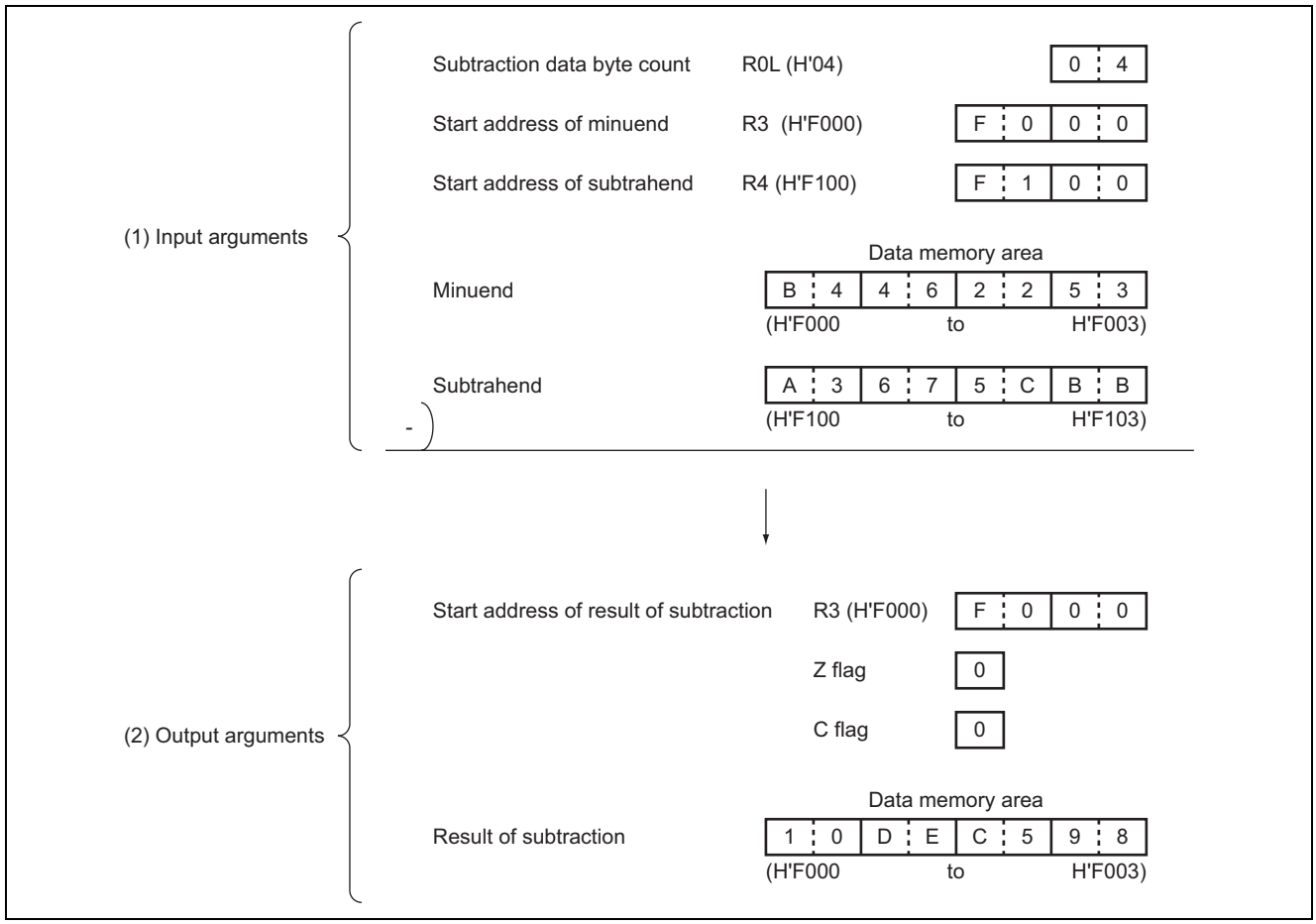


Figure 1 Example of Software SUB2 Execution

Figure 2 shows an example of subtraction with a borrow that has occurred in the result.

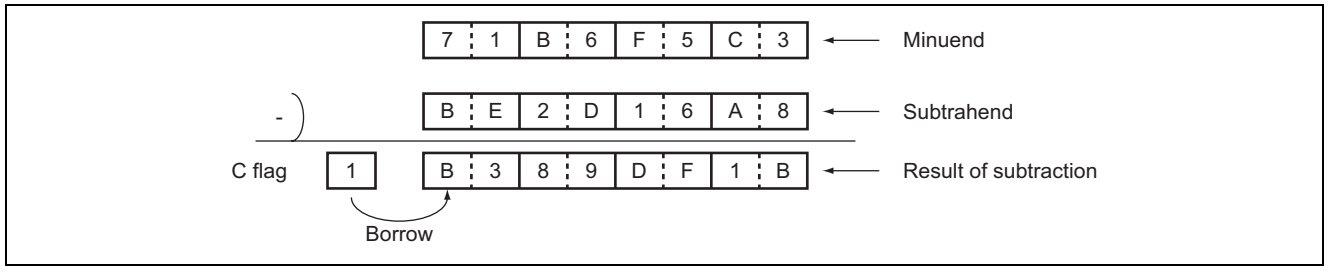


Figure 2 Example of Subtraction with a Borrow

5.2 Notes on usage

1. When the upper bits are not used (see figure 3), set them to 0. The software SUB2 performs byte-based subtraction; when 0 are not set in the unused upper bits, a correct result cannot be obtained because the subtraction is done on the numbers including indeterminate data.

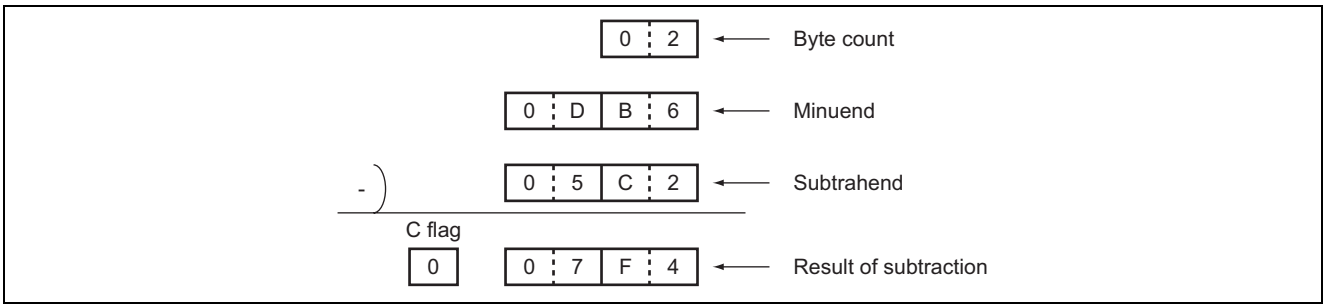


Figure 3 Example of Subtraction with Upper Bits Unused

2. After execution of the software SUB2, the minuend will be lost because the result is placed in the data memory area where the minuend was set. When the minuend is still needed after software SUB2 execution, save it in memory.

5.3 Data memory

The software SUB2 uses no data memory.

5.4 Example of usage

This is an example of subtracting 8 bytes of data. Set the start addresses of a byte count, a minuend and a subtrahend in the registers and call the software SUB2 as a subroutine.

```
WORK1     .RES.B     1           ---------- Reserve a data memory area in which the user program places
                                            a byte count.

WORK2     .RES.B     8           ---------- Reserve a data memory area in which the user program places
                                            an 8-byte binary minuend.

WORK3     .RES.B     8           ---------- Reserve a data memory area in which the user program places
             .                              an 8-byte binary minuend.
             .
             .
          MOV.B      @WORK1, R0L   ------- Place the byte count set by the user program
                                           in the input argument (R0L).

          MOV.W      #WORK2, R3    ------- Place the start address of the minuend set
                                           by the user program in the input argument (R3).

          MOV.W      #WORK3, R4    ------- Place the start address of the subtrahend set
                                           by the user program in the input argument (R4).

          JSR        @SUB2         ------- Call the software SUB2 as a subroutine.

          BCS        BORROW        ------- Branch to the borrow processing routine
             .                             when a borrow has occurred in the result of subtraction.
             .
             .
BORROW    Borrow processing routine
```

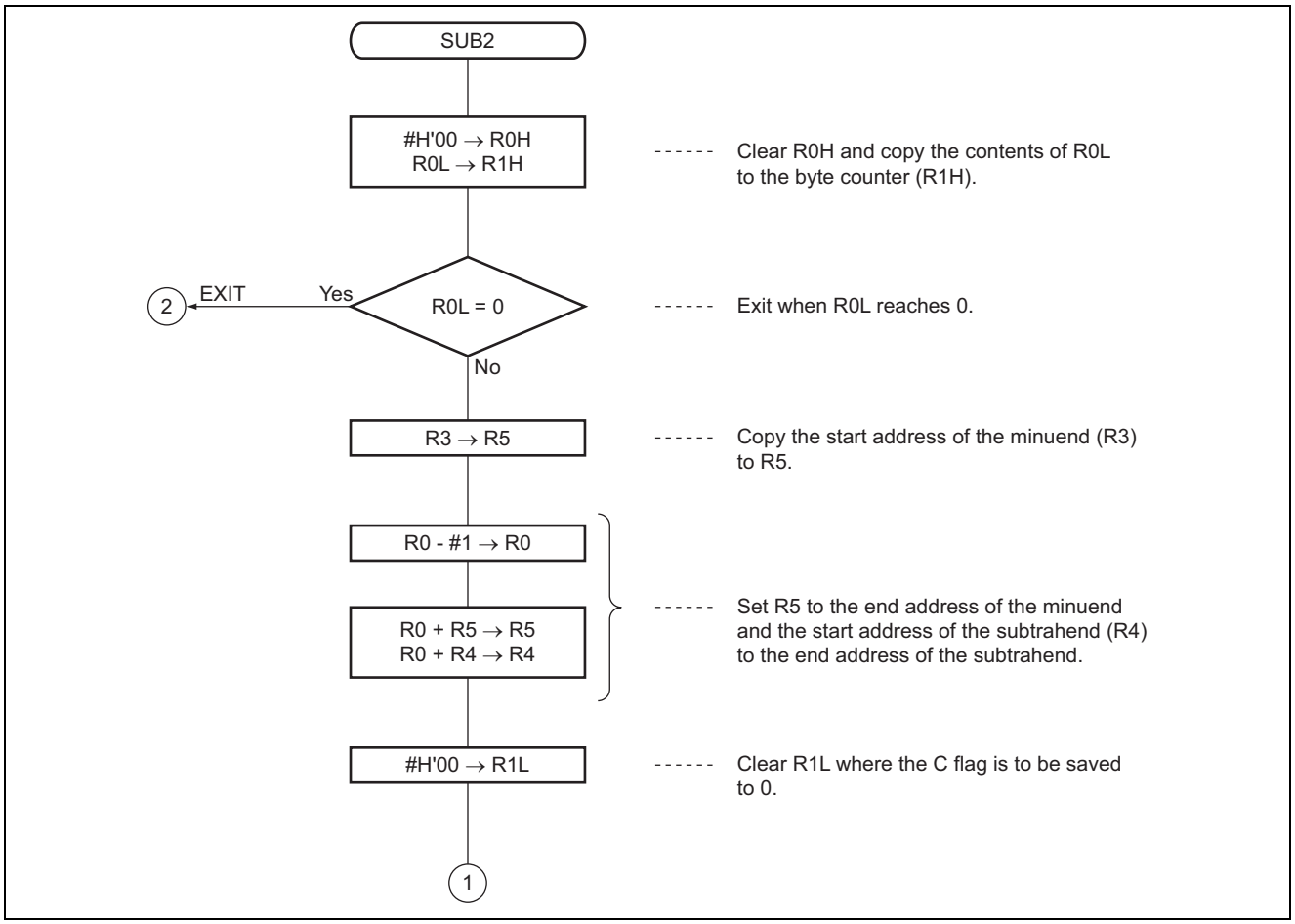
5.5 Operation

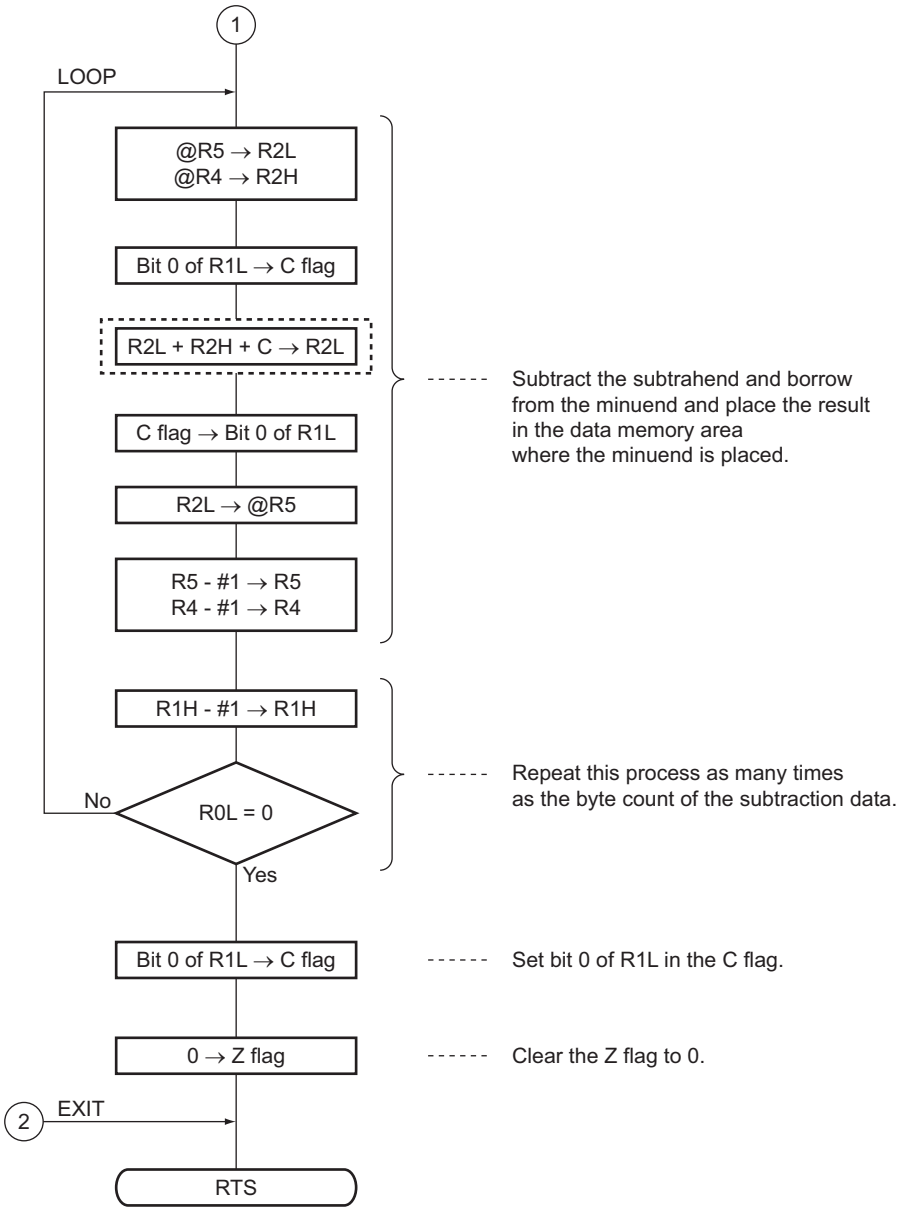
1. Subtraction of multiple-precision binary numbers can be done by repeating a subtract instruction with a carry flag (SUBX.B) as the minuend and subtrahend data are placed in registers on a byte basis.
2. The end address of the data memory area containing the minuend is placed in R3, and the end address of the data memory area containing the subtrahend is placed in R4.
3. R1L is cleared so that the C flag can be saved there.
4. The minuend and subtrahend are loaded in R2L and R2H respectively, byte by byte, starting at their end address and equation 1 is executed:

$$\left.\begin{array}{r}\text{Minuend - subtrahend - C} \rightarrow \text{R2L}\\ \text{R2L} \rightarrow \text{@R3}\end{array}\right\} \text{------- equation 1}$$

   where the C flag indicates a carry that may occur in the result of subtraction of the lower bytes.
5. The result of step 4 is placed in the data memory area for the minuend.
6. R3, R4, and R0L are decremented each time the operation of steps 4 and 5 has been finished. This processing is repeated until R0L reaches 0.

6. Flowchart


SUB2
#H'00 → R0H
R0L → R1H
Clear R0H and copy the contents of R0L to the byte counter (R1H).
2
EXIT
Yes
R0L = 0
Exit when R0L reaches 0.
No
R3 → R5
Copy the start address of the minuend (R3) to R5.
R0 - #1 → R0
R0 + R5 → R5
R0 + R4 → R4
Set R5 to the end address of the minuend and the start address of the subtrahend (R4) to the end address of the subtrahend.
#H'00 → R1L
Clear R1L where the C flag is to be saved to 0.
1



Note: SUB2 is the same as ADD2, ADDD2 and SUBD2 except for the stop surrounded by dotted lines.

7. Program List

```
*** H8/300 ASSEMBLER VER 1.0B ** 08/18/92 10:00:06
PROGRAM NAME =
 1                              ;*************************************************************
 2                              ;*
 3                              ;*      00 - NAME     :MULTIPLE-PRECISION BINARY SUBTRACTION
 4                              ;*                     (SUB2)
 5                              ;*
 6                              ;*************************************************************
 7                              ;*
 8                              ;*      ENTRY         :R0L (BYTE LENGTH OF DATA)
 9                              ;*                     R3 (START ADDRESS OF MINUEND)
10                              ;*                     R4 (START ADDRESS OF SUBTRAHEND)
11                              ;*
12                              ;*      RETURNS       :R3 (START ADDRESS OF RESULT)
13                              ;*                     Z flag OF CCR (Z=0;TRUE , Z=1;FALSE)
14                              ;*                     C flag OF CCR (C = 0;TRUE , C = 1;BORROW)
15                              ;*
16                              ;*************************************************************
17                              ;
18  SUB2_cod C    0000                      .SECTION            SUB2_code,CODE,ALIGN=2
19                                          .EXPORT             SUB2
20                ;
21  SUB2_cod C          00000000  SUB2      .EQU $              ;Entry point
22  SUB2_cod C    0000  F000                MOV.B     #H'00,R0H ;Clear R0H
23  SUB2_cod C    0002  0C81                MOV.B     R0L,R1H   ;Set byte counter(R1H)
24  SUB2_cod C    0004  4722                BEQ       EXIT      ;Branch if R0L=0
25  SUB2_cod C    0006  0D35                MOV.W     R3,R5     ;R3 -> R5
26  SUB2_cod C    0008              MAIN
27  SUB2_cod C    0008  1B00                SUBS.W    #1,R0     ;Decrement R0
28  SUB2_cod C    000A  0905                ADD.W     R0,R5     ;Adjust minuend start address(R5)
29  SUB2_cod C    000C  0904                ADD.W     R0,R4     ;Adjust subtrahend start address(R4)
30  SUB2_cod C    000E  F900                MOV.B     #H'00,R1L ;Clear R1L
31  SUB2_cod C    0010              LOOP
32  SUB2_cod C    0010  685A                MOV.B     @R5,R2L   ;Load minuend
33  SUB2_cod C    0012  6842                MOV.B     @R4,R2H   ;Load subtrahend
34  SUB2_cod C    0014  7709                BLD       #0,R1L    ;Load bit 0 of R1L to C flag
35  SUB2_cod C    0016  1E2A                SUBX.B    R2H,R2L   ;Subtruction
36  SUB2_cod C    0018  6709                BST       #0,R1L    ;Store C flag to bit 0 of R1L
37  SUB2_cod C    001A  68DA                MOV.B     R2L,@R5   ;Store result
38  SUB2_cod C    001C  1B05                SUBS.W    #1,R5     ;Decrement minuend address
39  SUB2_cod C    001E  1B04                SUBS.W    #1,R4     ;Decrement subtrahend address
40  SUB2_cod C    0020  1A01                DEC.B     R1H       ;Decrement byte counter
41  SUB2_cod C    0022  46EC                BNE       LOOP      ;Branch if not R0L=0
42                                          ;
43  SUB2_cod C    0024  7709                BLD       #0,R1L    ;Load bit 0 of R1L to C flag
44  SUB2_cod C    0026  06FB                ANDC      #H'FB,CCR ;Clear Z flag
45  SUB2_cod C    0028              EXIT
46  SUB2_cod C    0028  5470                RTS
47                                          ;
48                                          .END
*****TOTAL ERRORS 0
*****TOTAL WARNINGS 0
```

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