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April 1st, 2010
Renesas Electronics Corporation

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H8/300L Super Low Power Series

Conversion from 5-Digit BCD to 2-Byte Hexadecimal (BCD)

Introduction

The software BCD converts a 5-digit BCD (binary-coded decimal) number (3 bytes, placed in general-purpose registers) to a 2-byte hexadecimal number and places the result in a general-purpose register.

Target Device

H8/38024

Contents

1. Arguments

Description		Memory area	Data length (bytes)
Input	5-digit BCD number (upper 1 digit)	R0L	1
	5-digit BCD number (lower 4 digits)	R1	2
Output	2-byte hexadecimal number	R2	2

2. Changes to Internal Registers and Flags

R0H	R0L	R1	R2	R3	R4	R5H	R5L	R6	R7
×	—	—	○	×	—	—	×	×	—

I	U	H	U	N	Z	V	C
—	—	×	—	×	×	×	×

Legend
—: No change
×: Undefined
○: Result

3. Specifications

Program memory (bytes)
64
Data memory (bytes)
0
Stack (bytes)
2
Clock cycle count
210
Reentrant
Possible
Relocation
Possible
Interrupt
Possible

4. Description

4.1 Details of functions

1. The following arguments are used with the software BCD:
   R0L: Sets the upper 1 digit (1 byte) of a 5-digit BCD number as an input argument.
   R1: Sets the lower 4 digits (2 bytes) of a 5-digit BCD number as an input argument.
   R2: The 2-byte hexadecimal number is placed here as an output argument.
   Figure 1 shows the formats of the input and output arguments.

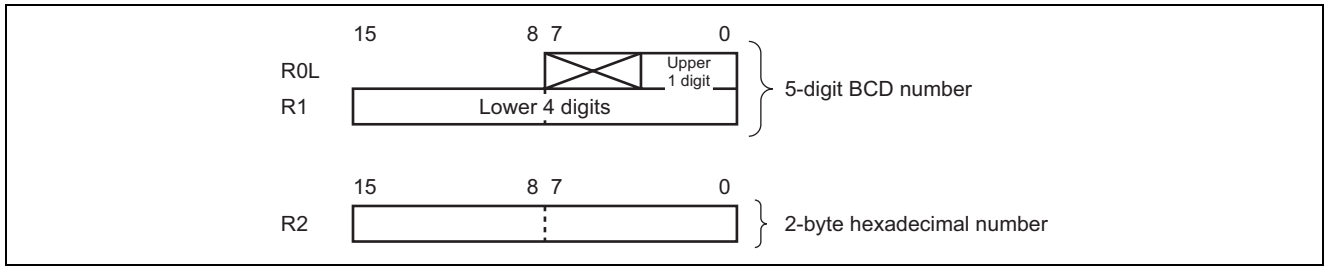


Figure 1 Formats of Input and Output Arguments

2. Figure 2 illustrates the execution of the software BCD. When the input argument is set as shown in (1), the 2-byte hexadecimal number is placed in R2 as shown in (2).

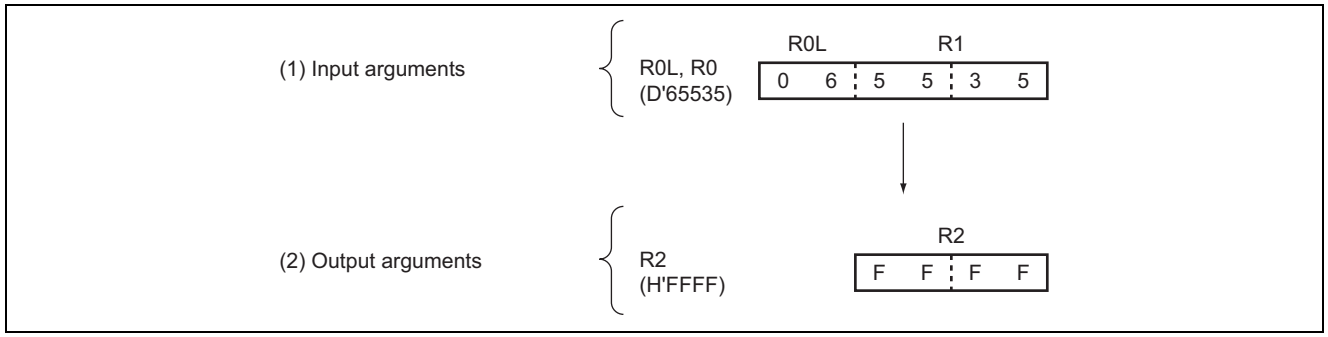


Figure 2 Example of Software BCD Execution

4.2 Notes on usage

1. The software BCD does not convert the values of bits 4 through 7 of R0L, in which the upper 1 digit of the 5-digit BCD number is placed. They are cleared to "0" during execution of the software BCD.
2. The maximum value of specifiable 5-digit BCD numbers is H'65535.
3. When the upper bits are not used, set them to 0; otherwise, a correct result cannot be obtained because computation is made on numbers including indeterminate data placed in the upper bits.

4.3 Description of data memory

The software BCD does not use the data memory.

4.4 Example of usage

Set a 5-digit BCD number in the input argument and call the software BCD as a subroutine.

```
WORK1    . RES. B    3     ---------  Reserves a data memory area in which the user program places
                               a 5-digit BCD number (3 bytes).

WOEK2    . RES. B    2     ---------  Reserves a data memory area in which the user program places
                               a 2-byte hexadecimal number.
           .
           .
           .
         MOV. B      @WORK1, R0L
         MOV. B      @WORK1+1, R1H  -------  Places in the input argument the 5-digit BCD number
         MOV. B      @WORK1+2, R1L           set by the user program.

         JSR         @BCD           -------  Calls the software BCD as a subroutine.

         MOV. B      @WORK2, R2H
         MOV. B      @WORK2+1, R2L  -------  Places the 2-byte hexadecimal number
                                             set in the output argument in the data memory
           .                                 area of the user program.
           .
           .
```

4.5 Operation

1. The software BCD consists of two processes:
   a. Extraction of the individual digits from the five-digit BCD number.
   b. Conversion of the extracted data to hexadecimal in four-bit units.
2. The processing of one digit (four bits) of input data is described below with reference to figure 3.

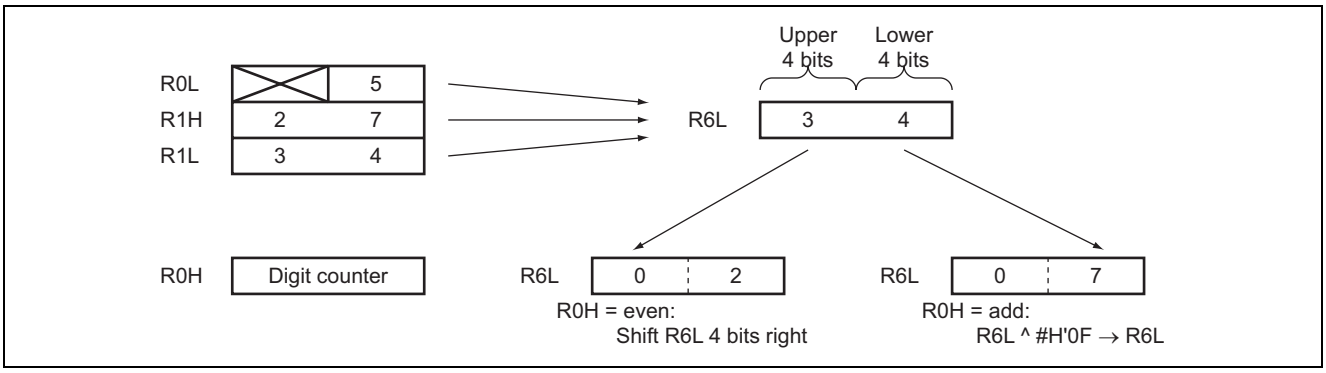


Figure 3 Dividing One Byte of Data in a General-Purpose Register into Two

   a. H'04 is set to count the execution of processing for 5 digits.
   b. The 5-digit BCD number (in R0L, R1H, and R1L) is sequentially transferred to R6L starting with the most significant byte. Then the upper or lower 4 bits of the byte are selected in the manner described in step d.
   c. R0H is decremented each time step b is performed.
   d. When step c is performed, the software checks whether the counter (R0H) is even or odd.
      When R0H is odd, R6L is ANDed with H'0F to extract the lower 4 bits.
      When R0H is even, R6L is shifted 4 bits to right to extract the upper 4 bits.
3. The BCD number is converted to a hexadecimal number in the following steps:
   a. A 4-digit BCD "$D_3D_2D_1D_0$" is represented by equations 1 and 2 below:

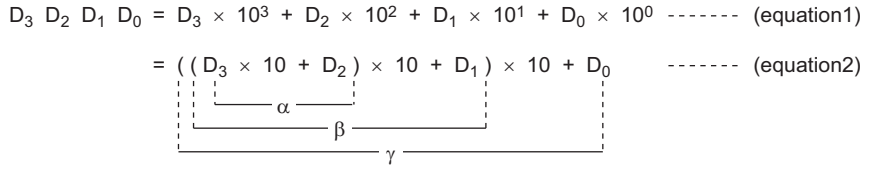
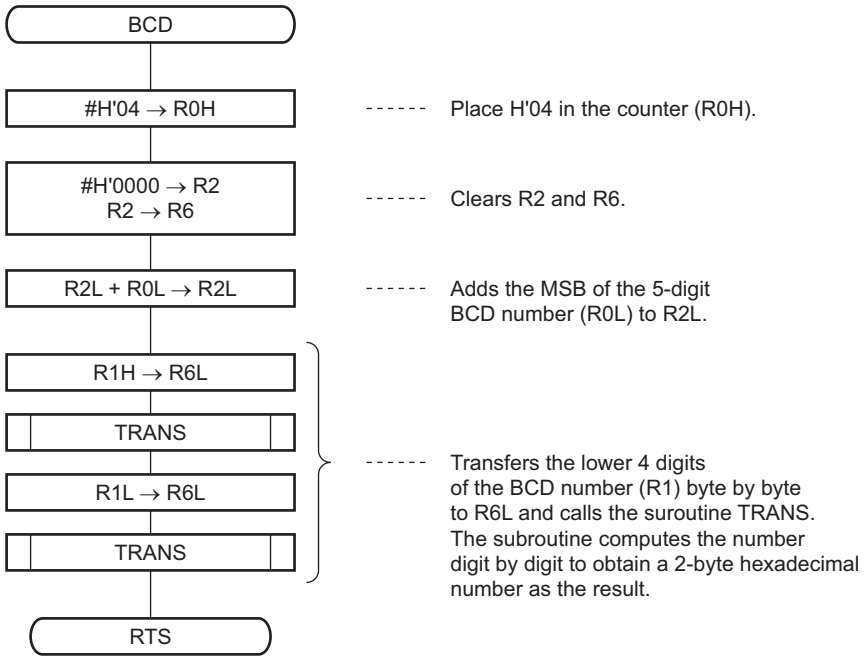
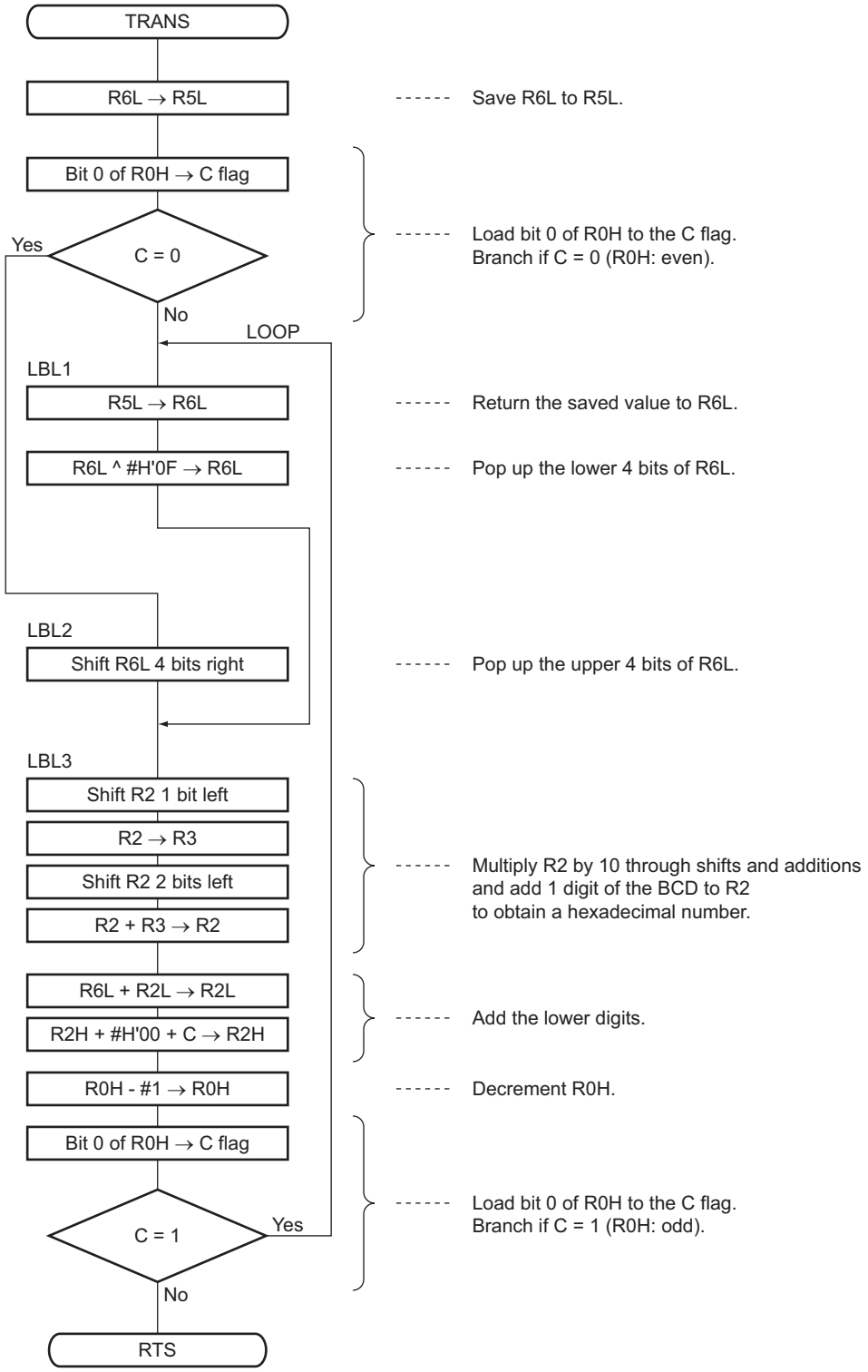


Figure 4 Converting 4-Digit BCD Number ($D_3D_2D_1D_0$) to a Hexadecimal Number

   b. First, equation 2 is used to compute $\alpha = D_3 \times 10 + D_2$ (see figure 4). Next, a series of operations, $\beta = \alpha \times 10 + D_1$, $\gamma = \beta \times 10 + D_0$, etc., are performed to produce a hexadecimal number.
   c. Equations 3 and 4 are used to compute $D_3 \times 10$:
      $D_3 \times 10 = D_3 \times (2 + 8)$..... (equation 3)
      $= D_3 \times 2 \times (1 + 2^2)$..... (equation 4)
   d. The software BCD uses R2 and R3 to compute equation 4 by taking the following steps:
      (1) Places D_3 in R2 and shifts it 1 bit to left.
      (2) Transfers R2 to R3 and shifts it 1 bit to left.
      (3) Adds R3 to R2.
4. The two-byte hexadecimal number is obtained by repeating steps (2) and (3) five times.

5. Flowchart


BCD
#H'04 → R0H
Place H'04 in the counter (R0H).
#H'0000 → R2
R2 → R6
Clears R2 and R6.
R2L + R0L → R2L
Adds the MSB of the 5-digit
BCD number (R0L) to R2L.
R1H → R6L
TRANS
R1L → R6L
TRANS
Transfers the lower 4 digits
of the BCD number (R1) byte by byte
to R6L and calls the suroutine TRANS.
The subroutine computes the number
digit by digit to obtain a 2-byte hexadecimal
number as the result.
RTS


TRANS
R6L → R5L
Save R6L to R5L.
Bit 0 of R0H → C flag
C = 0
Yes
No
Load bit 0 of R0H to the C flag.
Branch if C = 0 (R0H: even).
LOOP
LBL1
R5L → R6L
Return the saved value to R6L.
R6L ^ #H'0F → R6L
Pop up the lower 4 bits of R6L.
LBL2
Shift R6L 4 bits right
Pop up the upper 4 bits of R6L.
LBL3
Shift R2 1 bit left
R2 → R3
Shift R2 2 bits left
R2 + R3 → R2
Multiply R2 by 10 through shifts and additions
and add 1 digit of the BCD to R2
to obtain a hexadecimal number.
R6L + R2L → R2L
R2H + #H'00 + C → R2H
Add the lower digits.
R0H - #1 → R0H
Decrement R0H.
Bit 0 of R0H → C flag
C = 1
Yes
No
Load bit 0 of R0H to the C flag.
Branch if C = 1 (R0H: odd).
RTS

6. Program List

```
*** H8/300 ASSEMBLER VER 1.0B ** 08/22/92 11:09:49
PROGRAM NAME =
 1                              ;*****************************************************************
 2                              ;*
 3                              ;*      00 - NAME :           CHANGE 5 CHARACTER
 4                              ;*                            TO 2 BYTE HEXADECIMAL (BCD)
 5                              ;*
 6                              ;*****************************************************************
 7                              ;*
 8                              ;*      ENTRY :               R0L (UPPER 1 CHAR (BY BCD))
 9                              ;*                            R1 (LOWER 4 CHAR (BY BCD))
10                              ;*
11                              ;*      RETURN :              R2 (2 BYTE HEXADECIMAL)
12                              ;*
13                              ;*****************************************************************
14                              ;
15  BCD_code C    0000                      .SECTION              BCD_code,CODE,ALIGN=2
16                                          .EXPORT  BCD
17                              ;
18  BCD_code C          00000000  BCD       .EQU $                ;Entry point
19  BCD_code C    0000  F004                MOV.B    #H'04,R0H    ;Set bit counter
20  BCD_code C    0002  79020000            MOV.W    #H'0000,R2   ;Clear R2
21  BCD_code C    0006  0D26                MOV.W    R2,R6        ;Clear R6
22                              ;
23  BCD_code C    0008  088A                ADD.B    R0L,R2L      ;R2L + R0L -> R2L
24  BCD_code C    000A  0C1E                MOV.B    R1H,R6L      ;R1H -> R6L
25  BCD_code C    000C  5506                BSR      TRANS
26  BCD_code C    000E  0C9E                MOV.B    R1L,R6L      ;R1L -> R6L
27  BCD_code C    0010  5502                BSR      TRANS
28  BCD_code C    0012  5470                RTS
29                              ;
30                              ;---------------------------------------------------------------
31                              ;
32  BCD_code C    0014              TRANS                          ;Change BCD to hexadecimal
33  BCD_code C    0014  0CED                MOV.B    R6L,R5L      ;R6L -> R5L
34  BCD_code C    0016  7700                BLD      #0,R0H       ;load bit 0 of R0H
35  BCD_code C    0018  4406                BCC      LBL2         ;Branch if C = 0
36  BCD_code C    001A              LBL1
37  BCD_code C    001A  0CDE                MOV.B    R5L,R6L      ;R5l -> R6L
38  BCD_code C    001C  EE0F                AND.B    #H'0F,R6L    ;Clear bit 7-4 of R6L
39  BCD_code C    001E  4008                BRA      LBL3         ;Branch always
40  BCD_code C    0020              LBL2
41  BCD_code C    0020  110E                SHLR.B   R6L          ;Shift R6L 4 bit left
42  BCD_code C    0022  110E                SHLR.B   R6L
43  BCD_code C    0024  110E                SHLR.B   R6L
44  BCD_code C    0026  110E                SHLR.B   R6L
45  BCD_code C    0028              LBL3
46  BCD_code C    0028  100A                SHLL.B   R2L          ;Shift Hexadecimal 1 bit left
47  BCD_code C    002A  1202                ROTXL.B  R2H
48  BCD_code C    002C  0D23                MOV.W    R2,R3        ;R2 -> R3
49  BCD_code C    002E  100A                SHLL.B   R2L          ;Shift Hexadecimal 2 bit left
50  BCD_code C    0030  1202                ROTXL.B  R2H
```

```
51  BCD_code C    0032  100A            SHLL.B   R2L
52  BCD_code C    0034  1202            ROTXL.B  R2H
53  BCD_code C    0036  0932            ADD.W    R3,R2        ;R3 + R2 -> R2
54  BCD_code C    0038  08EA            ADD.B    R6L,R2L
55  BCD_code C    003A  9200            ADDX.B   #0,R2H
56  BCD_code C    003C  1A00            DEC.B    R0H          ;Decrement bit counter
57  BCD_code C    003E  7700            BLD      #0,R0H       ;load bit 0 of R0H
58  BCD_code C    0040  45D8            BCS      LBL1         ;Branch if C=!
59  BCD_code C    0042  5470            RTS
60                                  ;
61                                      .END
*****TOTAL ERRORS 0
*****TOTAL WARNINGS 0
```

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