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April 1st, 2010
Renesas Electronics Corporation

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April 1, 2003

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APPLICATION NOTE

Conversion from Two-Byte Hexadecimal to Five-Digit BCD (HEX)

Introduction

Converts a two-byte hexadecimal number in a general register to five-digit BCD (binary coded decimal), and places the result in other general registers.

Target Devices

H8/300H Tiny Series

Contents

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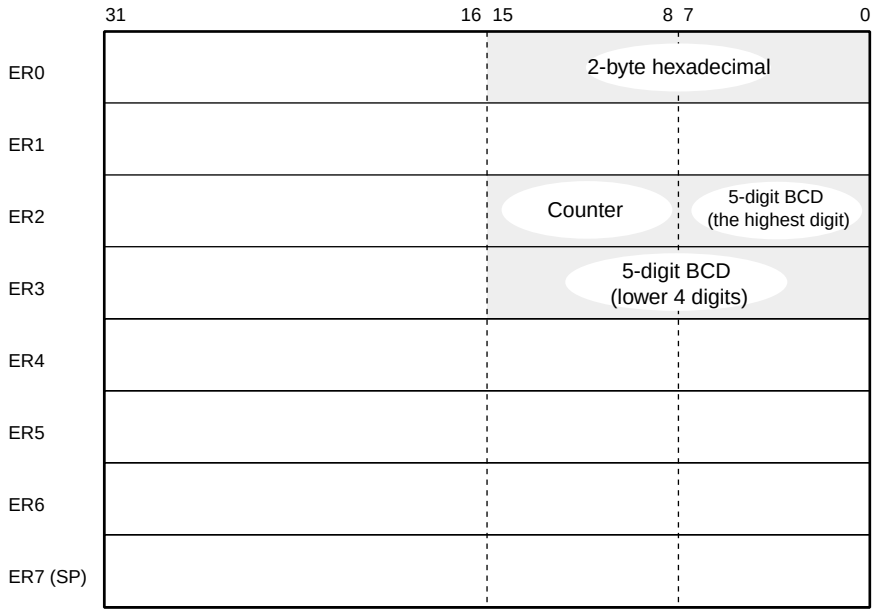
1. Function

Converts the two-byte hexadecimal number in a general register to five-digit BCD (binary coded decimal), and places the result in other general registers. The arguments are all unsigned integers. Data operations are entirely on general registers.

2. Arguments

Contents		Storage Location	Data Length (Bytes)
Input	2-byte hexadecimal number	R0	2
Output	5-digit BCD (highest-order digit)	R2L	1
	5-digit BCD (4 lower-order digits)	R3	2

3. Changes to Internal Registers and Flags



I	UI	H	U	N	Z	V	C
–	–	↕	–	↕	↕	↕	↕

– : No change
↕ : Varies
0 : Fixed to 0
1 : Fixed to 1

4. Programming Specifications

Program memory (bytes)
30
Data memory (bytes)
0
Stack (bytes)
0
Number of cycles
368
Re-entrant
Yes
Relocatable
Yes
Interrupts during execution
Yes

5. Description

5.1 Description of Functions

1. The arguments are as follows.

   R0: Set a two-byte hexadecimal number as an input argument.

   R2L: The highest digit (1 byte) of the five-digit BCD number is placed here as part of the output argument.

   R3: The lower-order four digits (two bytes) of the five-digit BCD number is placed here as part of the output argument.

   Figure 5.1 shows the format of the input and output arguments.

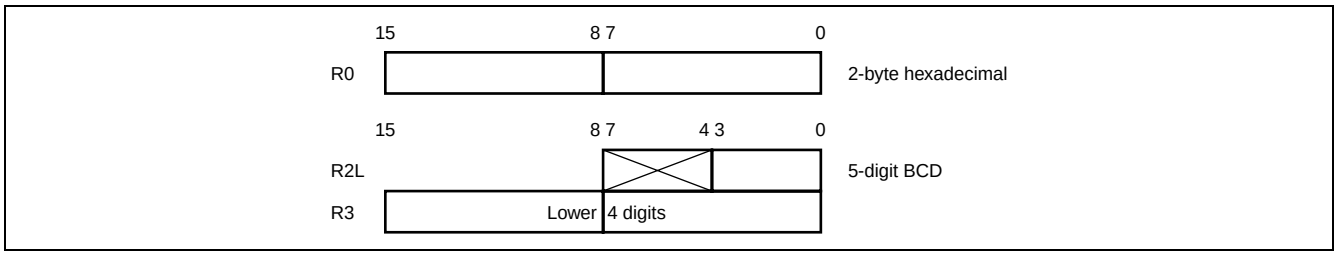


Figure 5.1 Input and Output Arguments

2. Figure 5.2 illustrates the execution of the HEX subroutine. With the input argument set as shown below, the subroutine places the corresponding five-digit BCD number in R2L, R3.

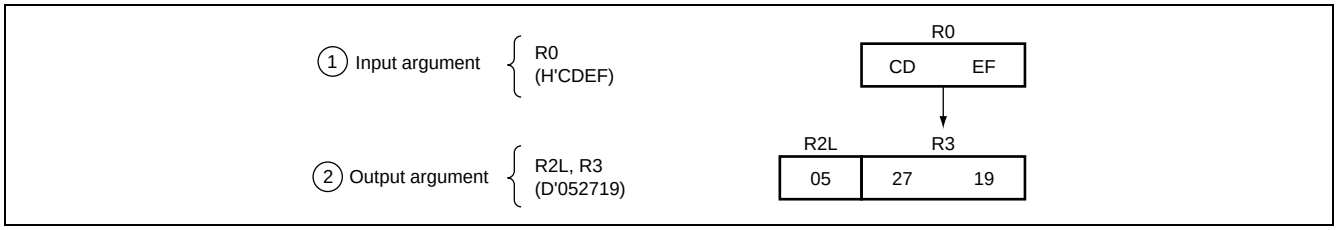


Figure 5.2 Example of HEX Execution

5.2 Usage Notes

Any higher-order bits of the two-byte hexadecimal number that are not used must be explicitly set to “0”. Otherwise, the correct result might not be obtained because the undefined data in the higher-order bits is included in the operation.
Example: When converting the two-byte hexadecimal number H’9AB, the higher-order four bits should be set to 0 as shown in the figure below.

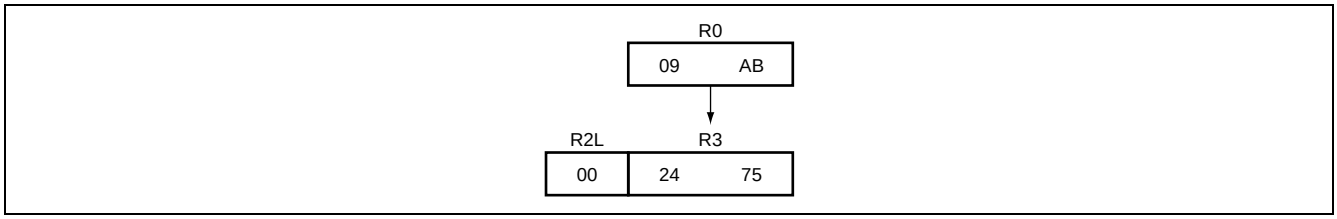


Figure 5.3 Example of the Case when Higher-Order Bits are not Used

5.3 Description of Data Memory

No data memory is used by HEX.

5.4 Example of Usage

Set the two-byte hexadecimal number, then call the HEX subroutine.

```
WORK1   . RES. W 1          ..... Reservation of the data memory area for setting of a 2-byte hexadecimal number by the user
                                  program.
WORK2   . RES. B 3          ..... Reservation of the data memory area where the 5-digit BCD number (3 bytes) will be set for the
          .                       user program.
          .
          .
        MOV. W @WORK1, R0   ..... Sets, as the input argument, the 2-byte hexadecimal number specified by the user program.

        JSR    @HEX         ..... Subroutine call of HEX.

        MOV. B R2L, @WORK2  ..... Transfers the 5-digit BCD number from the output argument to the data memory area of the user
                                  program.
        MOV. B R3H, @WORK2+1

        MOV. B R3L, @WORK2+2
```

5.5 Principles of Operation

1. A four-bit binary number of the form $B_3B_2B_1B_0$ may be expressed in the following ways.

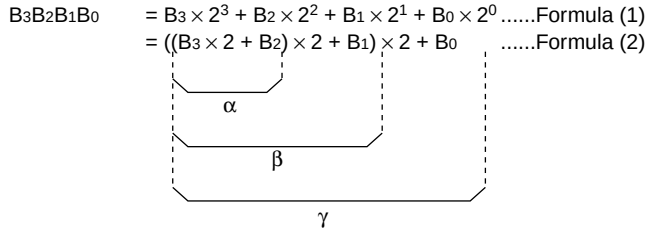


Figure 5.4 Concept of Four-Bit Binary Number $B_3B_2B_1B_0$

2. Formula (2) in the above figure is applied to convert a four-bit binary number to five-digit BCD in the following way.
   Start by using the addition (ADD.B) and decimal correction (DAA) instructions to find $\alpha = B_3 \times 2 + B_2$. After that, successively calculate $\beta = \alpha \times 2 + B_1$ and $\gamma = \beta \times 2 + B_0$ in the same way to get the five-digit BCD number.

3. In the HEX subroutine, R0, R2L, and R3 are used to calculate $B_3 \times 2 + B_2$.
   1) R2H is used to count the bit shifts of R0, which holds the two-byte hexadecimal input argument. R2H is set to D'16 for 16 shift operations.
   2) R0 is shifted one-bit to the left, placing its MSB in the C bit.
   3) Next, the following operations are applied to R2L and R3, where the five-digit BCD output is to be stored, in sequence from the lowest-order byte.

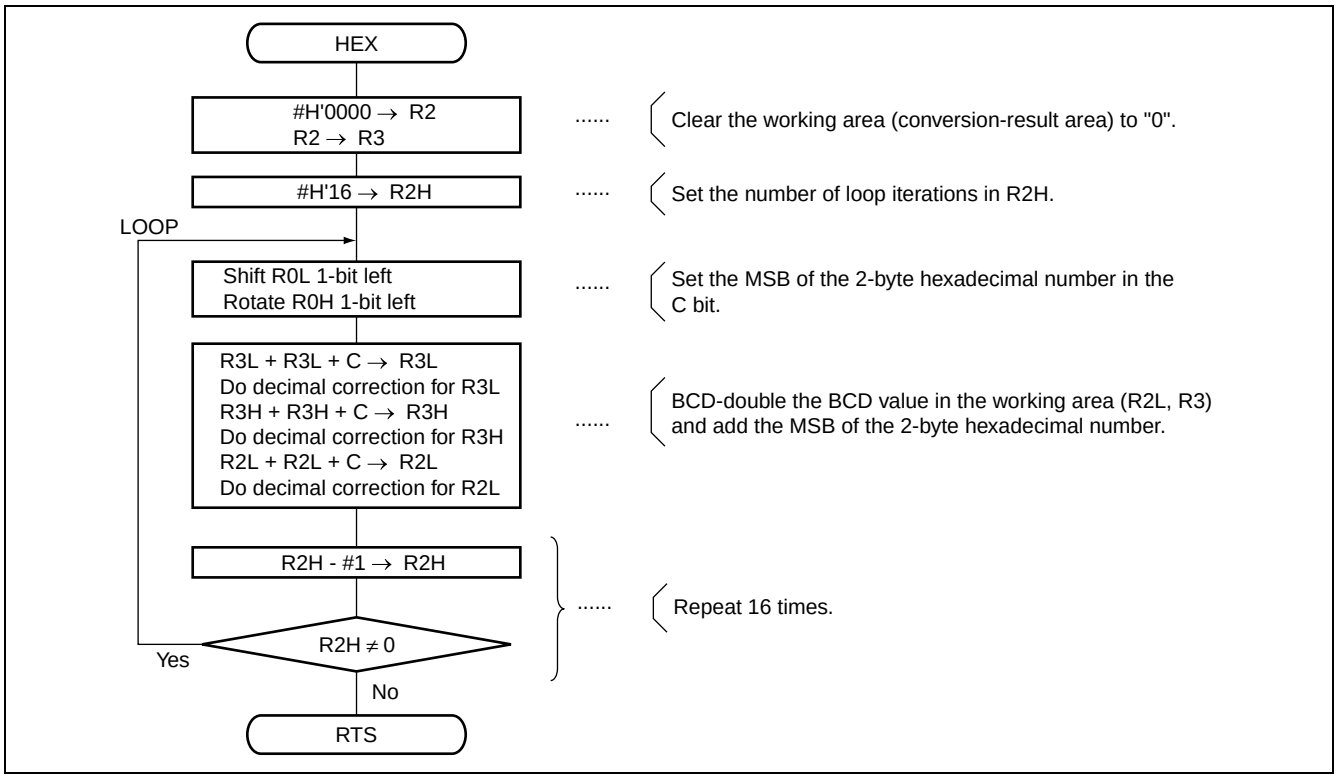
      R3L + R3L + C → R3L, decimal correction of R3L

      R3H + R3H + C → R3H, decimal correction of R3H

      R2L + R2L + C → R2L, decimal correction of R2L

      As a result, $\alpha = B_3 \times 2 + B_2$ is found.
   4) In the HEX subroutine, R2H is decremented each time steps 2) and 3) areis performed; this process is repeated until R2H reaches "0".

6. Flowchart



7. Program Listing

```
 1                                1     ;*************************************************************
 2                                2     ;*                                                           *
 3                                3     ;*          NAME : CHANGE 2 BYTE HEXADECIMAL TO BCD (HEX)    *
 4                                4     ;*                                                           *
 5                                5     ;*                                                           *
 6                                6     ;*************************************************************
 7                                7     ;*                                                           *
 8                                8     ;*         ENTRY: R0       (HEXADECIMAL)                     *
 9                                9     ;*                                                           *
10                               10     ;*        RETURN: R2L      (HIGHER DIGIT (BCD))              *
11                               11     ;*                R3       (LOWER 4 DIGITS (BCD))            *
12                               12     ;*                                                           *
13                               13     ;*************************************************************
14                               14     ;
15                               15             .CPU        300HN
16   0000                        16             .SECTION    HEX_code,CODE,ALIGN=2
17                               17             .EXPORT     HEX
18                               18     ;
19        00000000               19     HEX     .EQU        $           ;Entry point
20   0000 79020000               20             MOV.W       #H'0000,R2  ;Clear R2
21   0004 0D23                   21             MOV.W       R2,R3       ;Clear R3
22   0006 F210                   22             MOV.B       #D'16,R2H   ;Set bit counter
23   0008                        23     LOOP
24   0008 1008                   24             SHLL.B      R0L
25   000A 1200                   25             ROTXL.B     R0H
26                               26     ;
27   000C 0EBB                   27             ADDX.B      R3L,R3L
28   000E 0F0B                   28             DAA         R3L
29   0010 0E33                   29             ADDX.B      R3H,R3H
30   0012 0F03                   30             DAA         R3H
31   0014 0EAA                   31             ADDX.B      R2L,R2L
32   0016 0F0A                   32             DAA         R2L
33                               33     ;
34   0018 1A02                   34             DEC.B       R2H
35   001A 46EC                   35             BNE         LOOP
36   001C 5470                   36             RTS
37                               37     ;
38                               38             .END
*****TOTAL ERRORS       0
*****TOTAL WARNINGS     0
```