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Renesas Electronics Corporation

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H8/300L Super Low Power Series

Find an Element in a Two-dimensional Array (ARRAY)

Introduction

The software ARRAY searches a two-dimensional array (hereinafter simply called an array) for an element with the specified value; if a matching element is found, outputs its address, x-index, and y-index.

Target Device

H8/38024

Contents

1. Arguments

Description		Memory area	Data length (bytes)
Input	Data to be found	R0L	1
	First address of the array	R4	2
	Array size = X (number of columns)	R2L	1
	Array size = Y (number of rows)	R3L	1
Output	Address of the matching data	R4	2
	x-index of the matching data	R5H	1
	y-index of the matching data	R5L	1
	Presence of matching data	C flag (CCR)	

2. Changes to Internal Registers and Flags

R0H	R0L	R1	R2H	R2L	R3H	R3L	R4	R5H	R5L	R6	R7
×	—	—	×	×	×	×	○	○	○	×	—

I	U	H	U	N	Z	V	C
—	—	×	—	×	×	×	○

Legend
—: No change
×: Undefined
○: Result

3. Specifications

Program memory (bytes)
46
Data memory (bytes)
0
Stack (bytes)
0
Clock cycle count
1986
Reentrant
Possible
Relocation
Possible
Interrupt
Possible

4. Note

The clock cycle count (1986) in the specifications is for the example shown in figure 1.

If either of the array-size arguments is 0, execution ends immediately after clearing of the C flag.

5. Description

5.1 Details of functions

1. The following arguments are used with the software ARRAY:
   a. Input arguments:
      R0L: Data to be found
      R4: First address of the array
      R2L: Array size (x)
      R3L: Array size (y)
   b. Output arguments:
      R4: Address of the matching data
      R5H: x-index of the matching data
      R5L: y-index of the matching data
      C flag (CCR): Indicates the state when the ARRAY subroutine has ended.
         C flag = 1: Matching data was found in the array.
         C flag = 0: Matching data was not found in the array.

2. The following figure illustrates the execution of the software ARRAY. When the input arguments are set as shown in (1), the software ARRAY searches the array (16 × 16) in figure 2, finds the matching data, then sets its address in R4, x-index in R5H, and y-index in R5L as shown in (2).

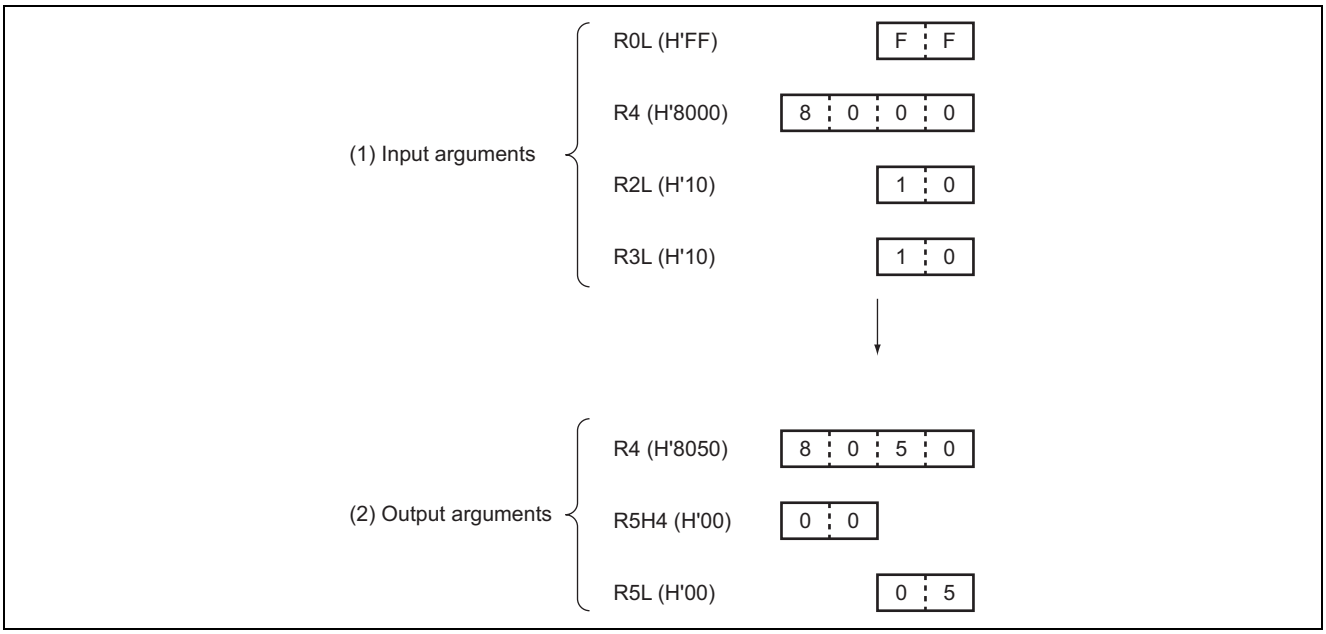


Figure 1 Example of Software ARRAY Execution

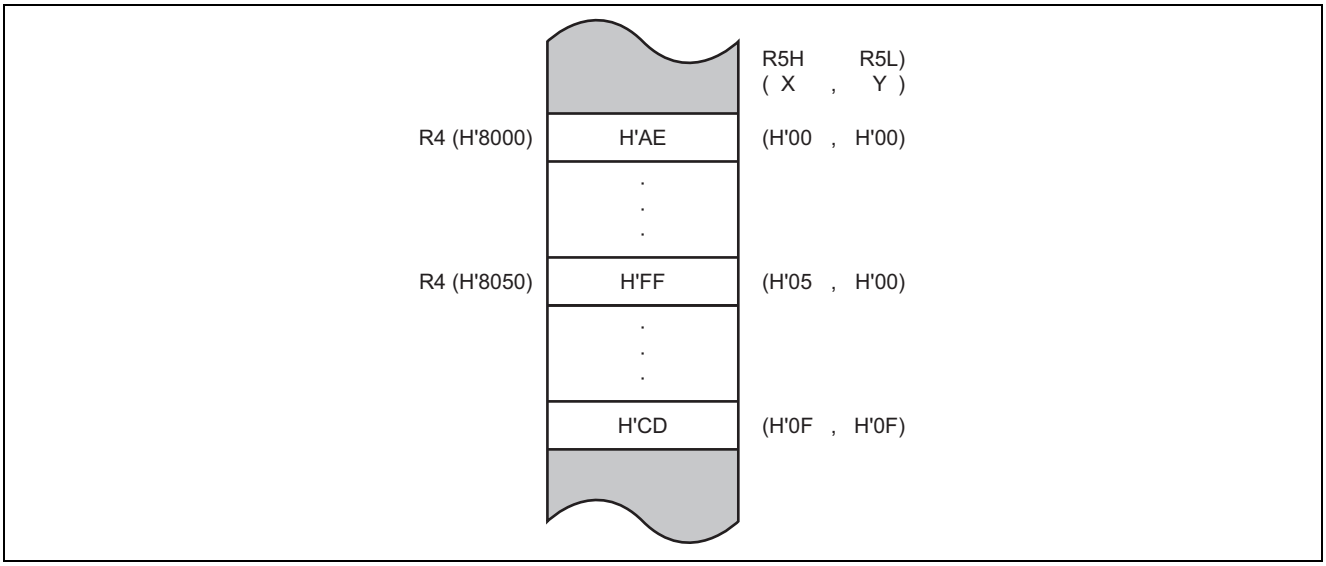


Figure 2 Array Space

3. Execution of the software ARRAY requires the existence of an array such as that shown in figure 3. Details of the array are explained below with reference this figure.

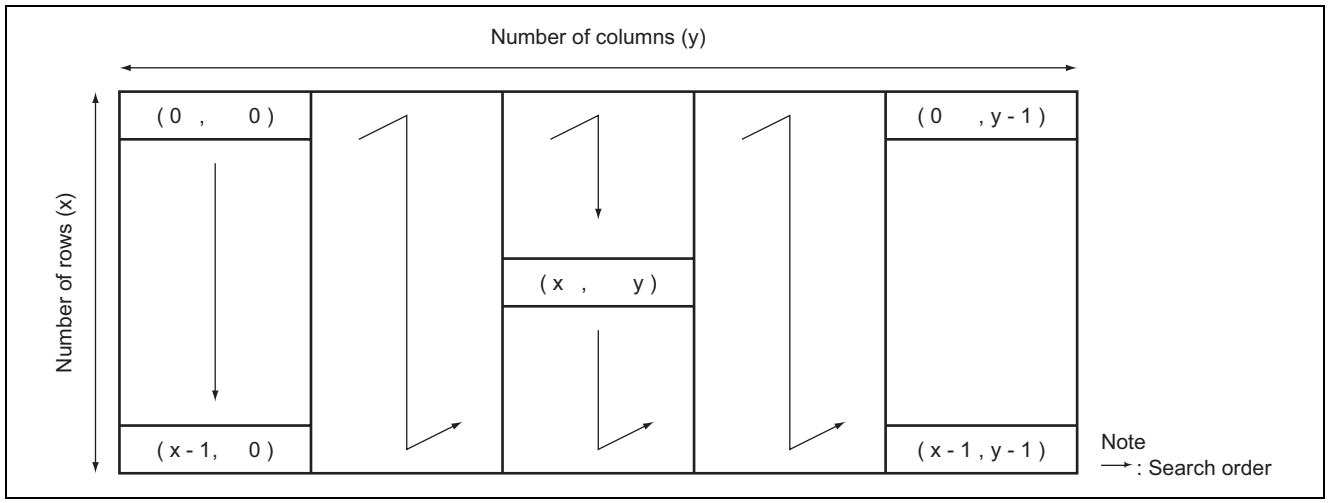


Figure 3 2-Dimensional Array

a. The size of an array is specified by the number of rows (X) and the number of columns (Y).
b. An array element is indicated as an x-index and y-index where (x, y) = (x^{th} row, y^{th} column), with values in the range from (0, 0) to (X-1, Y-1).
c. Element (0, 0) is regarded as being at the first address of the array, and the data search follows the sequence shown in figure 3.

5.2 Notes on usage

Zero is not specifiable as the column (X) or row size (Y) of an array. If 0 is specified here, the ARRAY subroutine simply clears the C flag in the CCR and ends without searching.

5.3 Description of data memory

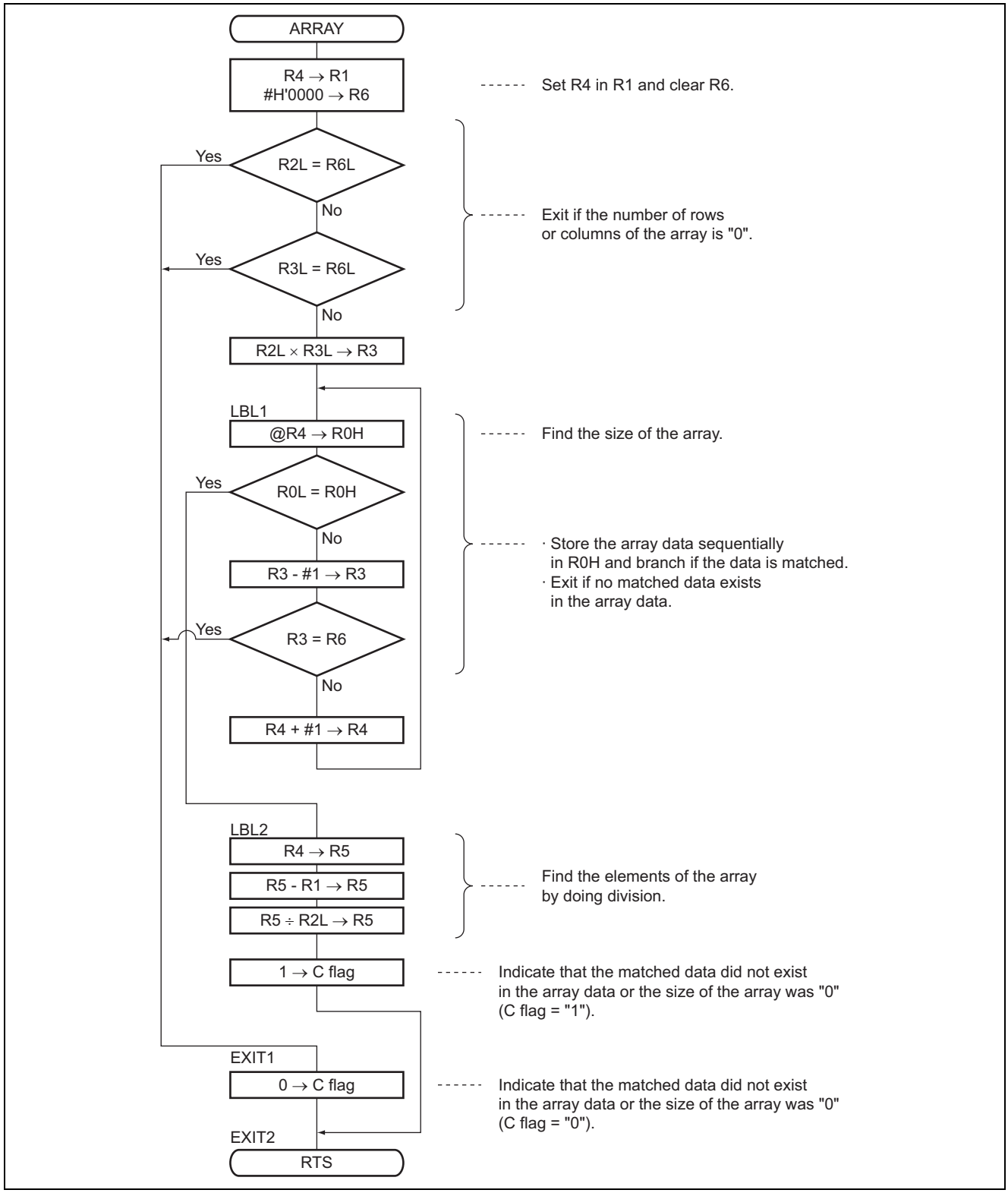
The software ARRAY uses no data memory.

5.4 Example of usage

Set the data to be found and the first address, column size, and row size of the array, and call the software ARRAY as a subroutine.

```
I-WORK1    . RES. W      1     ---------- ( Reserves a data memory area for the start address of the array.

I-WORK2    . RES. B      1     ---------- ( Reserves a data memory area for the number of rows
                                            of the array (x).

I-WORK3    . RES. B      1     ---------- ( Reserves a data memory area for the number of columns
                                            of the array (y).

I-WORK4    . RES. B      1     ---------- ( Reserves a data memory area for the data to be retrieved.
             .
             .
             .
O-WORK1    . RES. W      1     ---------- ( Reserves a data memory area for the address of the matched data.

O-WORK2    . RES. B      1     ---------- ( Reserves a data memory area for the element (x) of the array
                                            when the data is matched.

O-WORK3    . RES. B      1     ---------- ( Reserves a data memory area for the element (y) of the array
                                            when the data is matched.
             .
             .
             .
           MOV. B        @I_WORK4, R0L  ------- ( Places the data to be retrieved.

           MOV. W        @I_WORK1, R4   ------- ( Places the start address of the array.

           MOV. B        @I_WORK2, R2H  ------- ( Places the number of rows of the array (x).

           MOV. B        @I_WORK3, R2L  ------- ( Places the number of columns of the array (y).

         | JSR           @ARRAY       |  ------- ( Calls the software MOVE2 as a subroutine.

           MOV. W        R4, @O_WORK1   ------- ( Stores the address of the matched data.

           MOV. B        R2H, @O_WORK2  ------- ( Stores the element of the array (x) when the data is matched.

           MOV. B        R2L, @O_WORK3  ------- ( Stores the element of the array (y) when the data is matched.

             .
             .
             .
```

6. Flowchart


ARRAY
R4 → R1
#H'0000 → R6
Set R4 in R1 and clear R6.
Yes
R2L = R6L
No
Yes
R3L = R6L
No
Exit if the number of rows
or columns of the array is "0".
R2L × R3L → R3
LBL1
@R4 → R0H
Find the size of the array.
Yes
R0L = R0H
No
R3 - #1 → R3
Yes
R3 = R6
No
R4 + #1 → R4
· Store the array data sequentially
in R0H and branch if the data is matched.
· Exit if no matched data exists
in the array data.
LBL2
R4 → R5
R5 - R1 → R5
R5 ÷ R2L → R5
Find the elements of the array
by doing division.
1 → C flag
Indicate that the matched data did not exist
in the array data or the size of the array was "0"
(C flag = "1").
EXIT1
0 → C flag
Indicate that the matched data did not exist
in the array data or the size of the array was "0"
(C flag = "0").
EXIT2
RTS

7. Program List

```
*** H8/300 ASSEMBLER VER 1.0B ** 08/18/92 10:26:53
PROGRAM NAME =
 1                              ;*************************************************************
 2                              ;*
 3                              ;*      00 - NAME :    2-DIMENSIONAL ARRAY (ARRAY)
 4                              ;*
 5                              ;*************************************************************
 6                              ;*
 7                              ;*      ENTRY :        R0L (REFERENCE DATA)
 8                              ;*                     R2L (NUMBER OF COLUM [X])
 9                              ;*                     R3L (NUMBER OF ROW [Y])
10                              ;*                     R4 (ARRAY START ADDR)
11                              ;*
12                              ;*      RETURNS :      R5H (ARRAY ELEMENT OF COLUM [x])
13                              ;*                     R5L (ARRAY ELEMENT OF LOW [y])
14                              ;*                     R4 (MATCH DATA ADDR)
15                              ;*                     C flag OF CCR (C = 1;TRUE , C = 0;FALSE)
16                              ;*
17                              ;*************************************************************
18                              ;
19  ARRAY_co C    0000                      .SECTION              ARRAY_code,CODE,ALIGN=2
20                                          .EXPORT  ARRAY
21                              ;
22  ARRAY_co C          00000000  ARRAY     .EQU $                ;Entry point
23  ARRAY_co C    0000  0D41                MOV.W    R4,R1
24  ARRAY_co C    0002  79060000            MOV.W    #H'0000,R6   ;Clear R6
25  ARRAY_co C    0006  1CAE                CMP.B    R2L,R6L
26  ARRAY_co C    0008  4720                BEQ      EXIT1        ;Branch if Z=1 then exit
27  ARRAY_co C    000A  1CBE                CMP.B    R3L,R6L
28  ARRAY_co C    000C  471C                BEQ      EXIT1        ;Branch if Z=1 then exit
29  ARRAY_co C    000E  50A3                MULXU    R2L,R3       ;Get total number of array(R3)
30  ARRAY_co C    0010              LBL1
31  ARRAY_co C    0010  6840                MOV.B    @R4,R0H      ;Load array data
32  ARRAY_co C    0012  1C80                CMP.B    R0L,R0H
33  ARRAY_co C    0014  470A                BEQ      LBL2         ;Branch if data find
34  ARRAY_co C    0016  1B03                SUBS.W   #1,R3        ;Decrement R3
35  ARRAY_co C    0018  1D36                CMP.W    R3,R6
36  ARRAY_co C    001A  4710                BEQ      EXIT2        ;Branch if false
37  ARRAY_co C    001C  0B04                ADDS.W   #1,R4        ;Increment data pointer
38  ARRAY_co C    001E  40F0                BRA      LBL1         ;Branch always
39  ARRAY_co C    0020              LBL2
40  ARRAY_co C    0020  0D45                MOV.W    R4,R5
41  ARRAY_co C    0022  1915                SUB.W    R1,R5        ;Get count number of find data
42  ARRAY_co C    0024  51A5                DIVXU    R2L,R5       ;Get array element [x,y]
43  ARRAY_co C    0026  0401                ORC.B    #H'01,CCR    ;Set C flag of CCR
44  ARRAY_co C    0028  4002                BRA      EXIT2        ;Branch always
45  ARRAY_co C    002A              EXIT1
46  ARRAY_co C    002A  06FE                ANDC.B   #H'FE,CCR    ;Clear C flag of CCR
47  ARRAY_co C    002C              EXIT2
48  ARRAY_co C    002C  5470                RTS
49                              ;
50                                          .END
*****TOTAL ERRORS 0
*****TOTAL WARNINGS 0
```

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