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Renesas Electronics Corporation

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H8/300H Tiny Series

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

Introduction

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

H8/300H Tiny Series

Contents

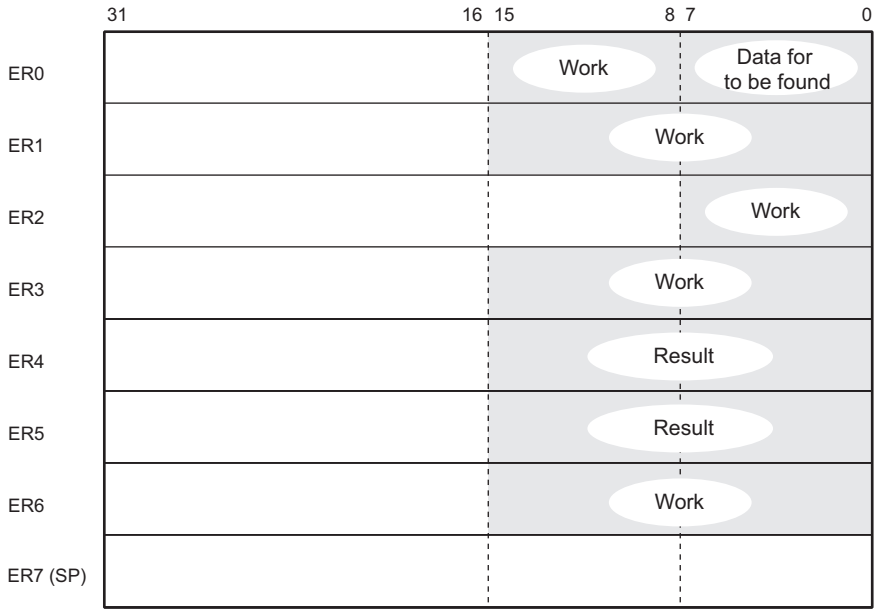
1. Function

1. Searches an array for an element with the specified value; if such an element is found, outputs its address, x-index, and y-index.
2. The data to be found is an unsigned 1-byte integer.
3. Array elements are unsigned 1-byte integers.
4. The array should be no larger than 255 bytes × 255 bytes.

2. Arguments

Contents		Storage Location	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
	Existence of matching data	C flag (CCR)	—

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)
46
Data memory (bytes)
0
Stack (bytes)
0
Number of cycles
1986
Re-entrant
Yes
Relocatable
Yes
Interrupts during execution
Yes

5. Notes

The number of cycles given in the programming specifications is the value for the example of figure 1.

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

6. Descriptions

6.1 Description of Functions

1. The arguments are listed below.
   1) Set the input arguments as below.
      R0L: data to be found
      R4: first address of the array
      R2: array size (X)
      R3L: array size (Y)
   2) The ARRAY subroutine sets the following 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: Indicates that matching data was found.
      - C flag = 0: Indicates that matching data was not found.

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

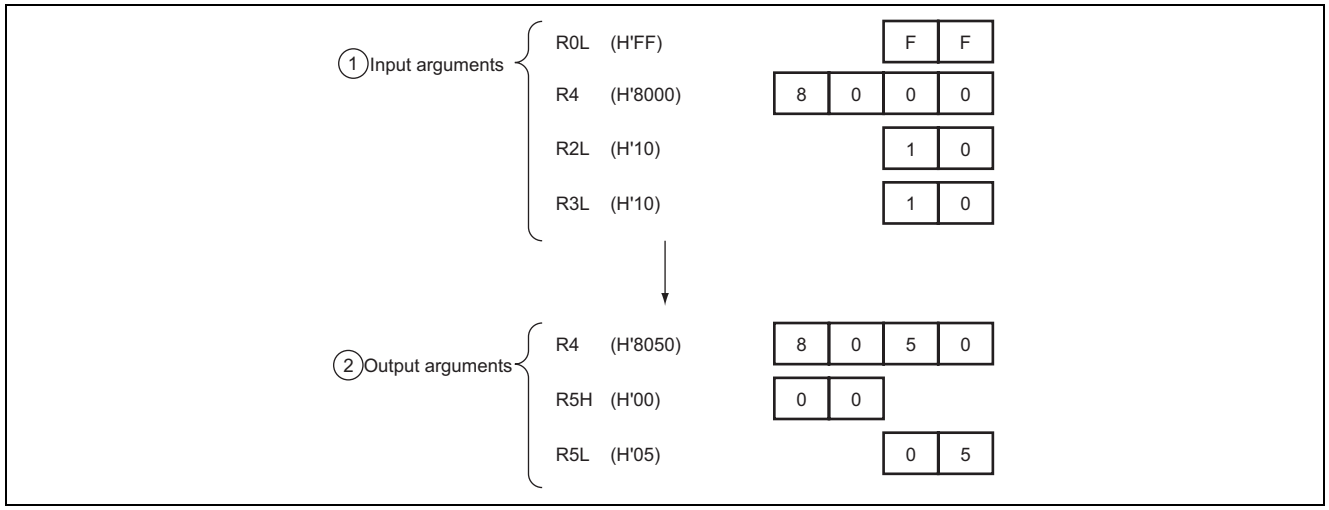


Figure 1 Example of ARRAY Execution

3. The execution of ARRAY requires the existence of an array such as that shown in figure 2.

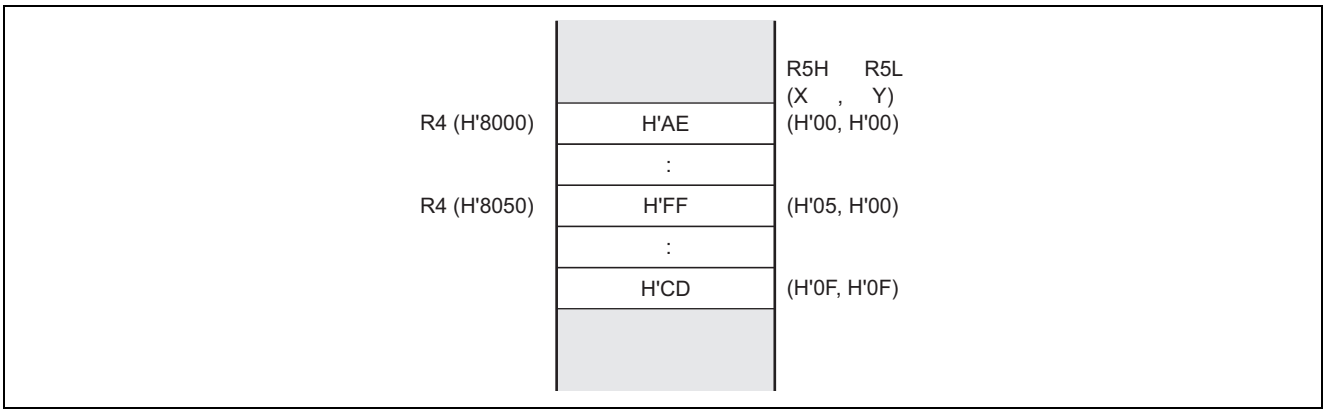


Figure 2 Array Space

4. Details of the array are given below with reference to figure 6.3.

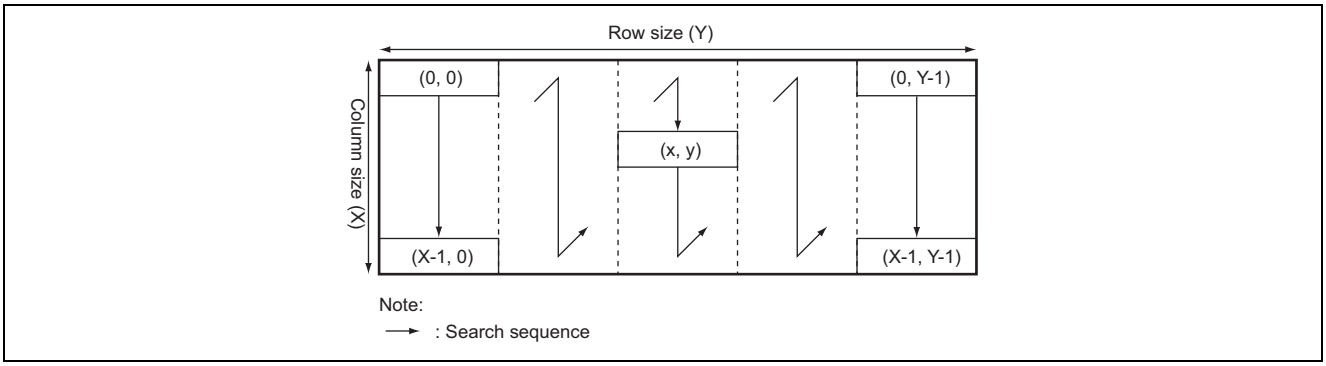


Figure 3 Two-Dimensional Array

1) The size of the array is specified by the numbers of rows (X) and columns (Y).
2) 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).
3) 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.

6.2 Usage Notes

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.

6.3 Description of Data Memory

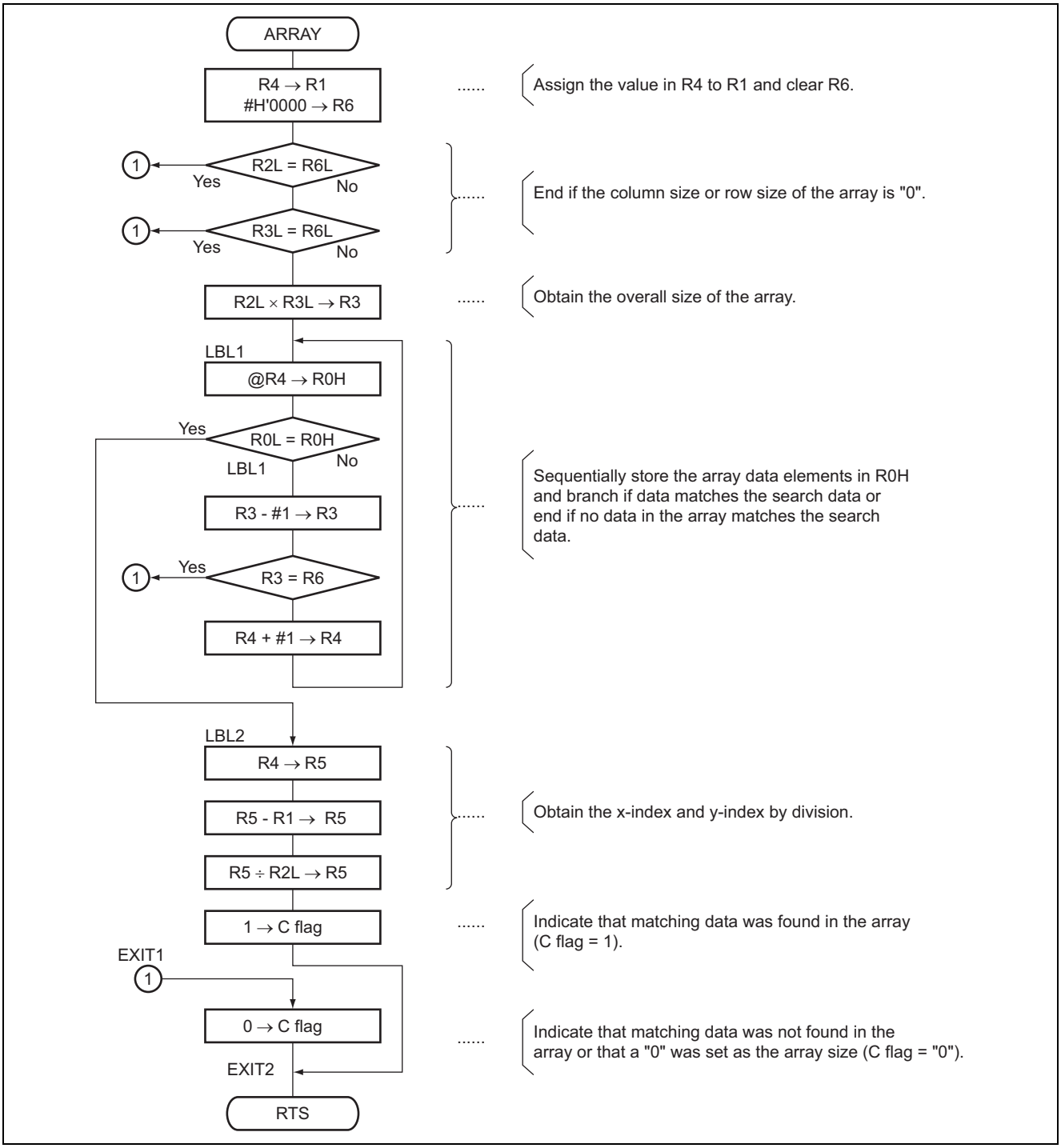
No data memory is used by the ARRAY subroutine.

6.4 Example of Usage

After setting the data to be found, and the first address, column size, and row size of the array, call the ARRAY subroutine.

```
I-WORK1   . RES. W 1          ..... Data memory area for storage of the first address of the array.
I-WORK2   . RES. B 1          ..... Data memory area for storage of  the array size (X).
I-WORK3   . RES. B 1          ..... Data memory area for storage of  the array size (Y).
I-WORK4   . RES. B 1          ..... Data memory area for storage of  the data to be found.
            .
            .
            .
O-WORK1   . RES. W 1          ..... Data memory area where the address of the matching data will be stored.
O-WORK2   . RES. B 1          ..... Data memory area where the x-index of the matching data will be stored.
O-WORK3   . RES. B 1          ..... Data memory area where the y-index of the matching data will be stored.
            .
            .
            .
          MOV. B @I-WORK4, R0L ..... Set the search data.
          MOV. W @I-WORK1, R4  ..... Set the first address of the array.
          MOV. B @I-WORK2, R2H ..... Set the array size (X).
          MOV. B @I-WORK3, R2L ..... Set the array size (Y).
          JSR    @ARRAY        ..... Subroutine call of ARRAY.
          MOV. W R4, @O-WORK1  ..... Stores the address of the matched data.
          MOV. B R2H, @O-WORK2 ..... Stores the x-index of the matched data.
          MOV. B R2L, @O-WORK3 ..... Stores the y-index of the matched data.
            .
            .
            .
```

7. Flowchart


ARRAY
R4 → R1
#H'0000 → R6
Assign the value in R4 to R1 and clear R6.
1
R2L = R6L
Yes
No
1
R3L = R6L
Yes
No
End if the column size or row size of the array is "0".
R2L × R3L → R3
Obtain the overall size of the array.
LBL1
@R4 → R0H
Yes
R0L = R0H
No
LBL1
R3 - #1 → R3
1
Yes
R3 = R6
R4 + #1 → R4
Sequentially store the array data elements in R0H and branch if data matches the search data or end if no data in the array matches the search data.
LBL2
R4 → R5
R5 - R1 → R5
R5 ÷ R2L → R5
Obtain the x-index and y-index by division.
1 → C flag
Indicate that matching data was found in the array (C flag = 1).
EXIT1
1
0 → C flag
Indicate that matching data was not found in the array or that a "0" was set as the array size (C flag = "0").
EXIT2
RTS

8. Program Listing

```
                                ;***********************************************************
                                ;*                                                         *
                                ;*          NAME : 2-DIMENSIONAL ARRAY (ARRAY)             *
                                ;*                                                         *
                                ;***********************************************************
                                ;*                                                         *
                                ;*        ENTRY:   R0L      (REFERENCE DATA)               *
                                ;*                 R2L      (NUMBER OF COLUMNS [X])        *
                                ;*                 R3L      (NUMBER OF ROWS [Y])           *
                                ;*                 R4       (ARRAY START ADDR)             *
                                ;*                                                         *
                                ;*       RETURNS:  R5H    (ARRAY ELEMENT: COLUMN INDEX [x]) *
                                ;*                 R5L    (ARRAY ELEMENT: ROW INDEX [y])    *
                                ;*                 R4       (MATCHING DATA ADDR.)          *
                                ;*                 C flag OF CCR (C=1:TRUE , C=0:FALSE)    *
                                ;*                                                         *
                                ;***********************************************************
                                ;
                                        .CPU        300HN
0000                            .SECTION    ARRAY_code,CODE,ALIGN=2
                                .EXPORT     ARRAY
                                ;
      00000000                  ARRAY   .EQU        $           ;Entry point
0000 0D41                       LBL1    MOV.W       R4,R1
0002 79060000                           MOV.W       #H'0000,R6  ;Clear R6
0006 1CAE                               CMP.B       R2L,R6L
0008 4720                               BEQ         EXIT1       ;Branch to exit if Z=1
000A 1CBE                               CMP.B       R3L,R6L
000C 471C                               BEQ         EXIT1       ;Branch to exit if Z=1
000E 50A3                               MULXU       R2L,R3      ;Get total no. of array elements (R3)
0010                            LBL2
0010 6840                               MOV.B       @R4,R0H     ;Load array data
0012 1C80                               CMP.B       R0L,R0H
0014 470A                               BEQ         LBL2        ;Branch if data found
0016 1B03                               SUBS        #1,ER3      ;Decrement R3
0018 1D36                               CMP.W       R3,R6
001A 4710                               BEQ         EXIT2       ;Branch if false
001C 0B04                               ADDS        #1,ER4      ;Increment data pointer
001E 40F0                               BRA         LBL1        ;Branch always
0020                            EXIT1
0020 0D45                               MOV.W       R4,R5
0022 1915                               SUB.W       R1,R5       ;Found data: distance from 1st addr.
0024 51A5                               DIVXU       R2L,R5      ;Get array index [x,y]
0026 0401                               ORC.B       #H'01,CCR   ;Set C flag of CCR
0028 4002                               BRA         EXIT2       ;Branch always
                                ;
002A                            EXIT2
002A 06FE                               ANDC.B      #H'FE,CCR   ;Clear C flag of CCR
002C                                    RTS
002C 5470                       ;
                                        .END
```

```
*****TOTAL ERRORS       0
*****TOTAL WARNINGS     0
```

Revision Record

Rev.	Date	Description	
		Page	Summary
2.00	Feb.28.06	—	Format has been changed from Hitachi version to Renesas version.

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