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H8/300L Series

Addition of 32-Bit Binary Numbers (ADD1)

Introduction

1. The software ADD1 adds a 32-bit binary number to another 32-bit binary number and places the result (a 32-bit binary number) in general-purpose registers.
2. The arguments used with the software ADD1 are unsigned integers.
3. All data is manipulated in general-purpose registers.

Target Device

H8/300L Series

Contents

1. Arguments

Description		Memory area	Data length (bytes)
Input	Augend	R0, R1	4
	Addend	R2, R3	4
Output	Result of addition	RO, R1	4
	Carry	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
•	•	×	•	×	×	×	↕

• : No change
× : Undefined
↕ : Result

3. Specifications

Program memory (bytes)
8
Data memory (bytes)
0
Stack (bytes)
0
Clock cycle count
14
Reentrant
Possible
Relocation
Possible
Interrupt
Possible

4. Description

4.1 Details of functions

1. The following arguments are used with the software ADD1:
   R0, R1: Sets a 32-bit binary augend as an input argument. The result of addition is placed in these registers after execution of the software ADD1.
   R2, R3: Sets a 32-bit binary addend as an input argument.
   C flag (CCR): Determines the presence or absence of a carry as an output argument after execution of the software ADD1.
   C flag = 1: A carry occurred in the result (see figure 4.1).
   C flag = 0: No carry occurred in the result.

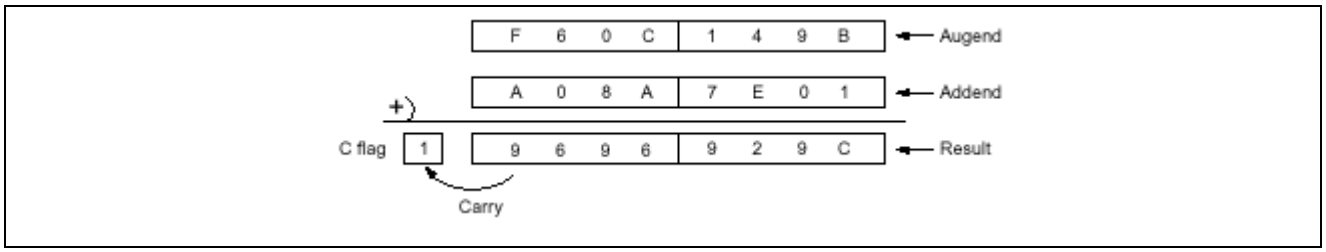


Figure 4.1 Example of Addition with a Carry

2. The following figure illustrates the execution of the software ADD1. When the input arguments are set as shown in (1), the result of addition is placed in R0 and R1 as shown in (2).

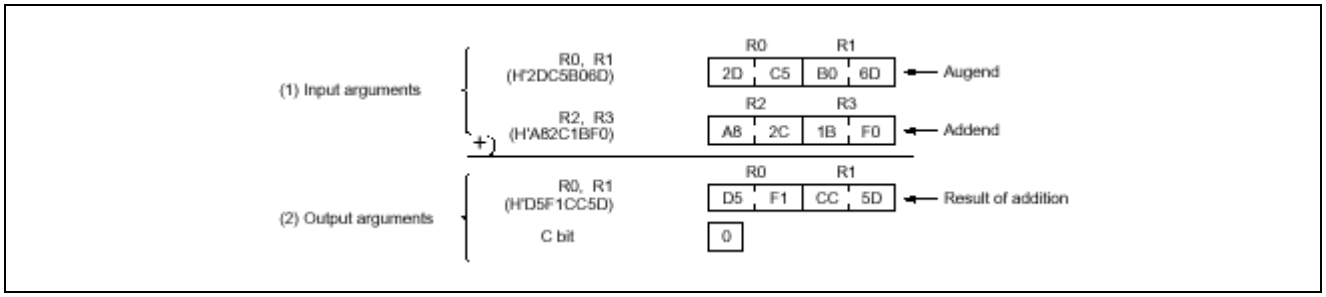


Figure 4.2 Example of Software ADD1 Execution

4.2 Notes on usage

1. When upper bits are not used (see figure 4.3), set them to 0; otherwise, a correct result cannot be obtained because addition is done on the numbers including indeterminate data.

Figure 4.3 Example of Addition with Upper Bits Unused

2. After execution of the software ADD1, the augend will be lost because the result is placed in R0 and R1. If the augend is still needed after software ADD1 execution, save it in memory.

4.3 Data memory

The software ADD1 uses no data memory.

4.4 Example of use

Set an augend and an addend in the input arguments and call the software ADD1 as a subroutine.

```
WORK1   .RES. W   2          ..... Reserves a data memory area in which the
                             ..... user program places a 32-bit binary
                             ..... augend.
WORK2   .RES. W   2          ..... Reserves a data memory area in which the
                             ..... user program places a 32-bit binary
                             ..... addend.
WORK3   .RES. W   2          ..... Reserves a data memory area for storage
                             ..... of the result of addition.
        MOV. W  @WORK1, R0   ..... Places in the input arguments (R0 and R1)
        MOV. W  @WORK1+2, R1 ..... the 32-bit binary augend set by the user
                             ..... program.
        MOV. W  @WORK2, R2   ..... Places in the input arguments (R2 and R3)
        MOV. W  @WORK2+2, R3 ..... the 32-bit binary addend set by the user
                             ..... program.
        JSR     @ADD1        ..... Calls the software ADD1 as a subroutine.
        BCS     OVER         ..... Branches to the carry processing routine if
                             ..... a carry has occurred in the result.
        MOV. W  R0, @WORK3   ..... Places the result (set in the output
        MOV. W  R1, @WORK3+2 ..... arguments (R3 and R4)) in the data
                             ..... memory of the user program.
OVER    Carry processing routine
```

4.5 Operation

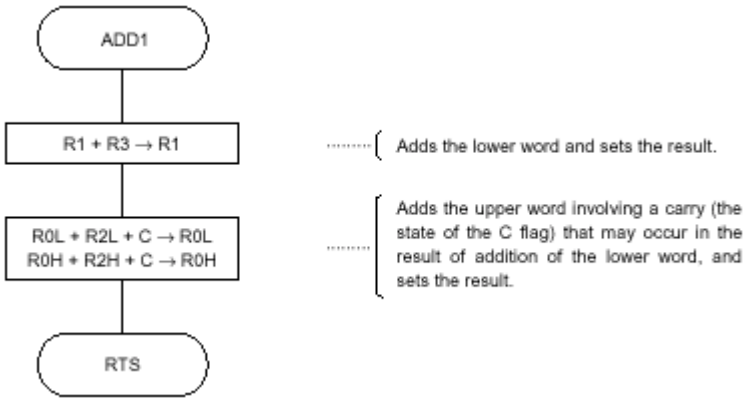
1. Addition of 3 bytes or more can be done by repeating 1-byte additions.
2. A 1-word add instruction (ADD.W), which does not consider the state of the C flag, is used to add the lower word as shown by equation 1. The C flag is set if a carry occurs after execution of the equation.

   $R1 + R3 \rightarrow R1$ ..... equation 1
3. A 1-byte add instruction (ADDX.B), which considers the state of the C flag, is used twice to add the upper word as shown by equation 2.

   $$\left.\begin{array}{l} R0L + R2L + C \rightarrow R0L \\ R0H + R2H + C \rightarrow R0H \end{array}\right\} \cdots\cdots\cdots \text{equation 1}$$

   The C flag indicates a carry that may occur as a result of addition of the lower word executed in step 2 and the addition of the lower bytes of the upper word.

5. Flowchart


ADD1
R1 + R3 → R1
R0L + R2L + C → R0L
R0H + R2H + C → R0H
RTS
Adds the lower word and sets the result.
Adds the upper word involving a carry (the state of the C flag) that may occur in the result of addition of the lower word, and sets the result.

6. Program List

```
*** H8/300 ASSEMBLER VER 1.0B ** 08/18/92 09:53:09
PROGRAM NAME =
 1                                          ;*******************************************************************************
 2                                          ;*
 3                                          ;*      00-NAME                 :32 BIT ADDITION (ADD1)
 4                                          ;*
 5                                          ;*******************************************************************************
 6                                          ;*
 7                                          ;*      ENTRY                   :R0,R1 (SUMMAND)
 8                                          ;*                               R2,R3 (ADDEND)
 9                                          ;*
10                                          ;*      RETURNS                 :R0,R1 (SUM)
11                                          ;*                               C flag OF CCR (C = 0;TRUE , C = 1;OVERFLOW)
12                                          ;*
13                                          ;*******************************************************************************
14                                          ;
15        ADD1_cod C       0000                      .SECTION                ADD1_code,CODE,ALIGN=2
16                                                   .EXPORT                 ADD1
17                                          ;
18       ADD1_cod C               00000000   ADD1    .EQU $                  ;Entry point
19       ADD1_cod C       0000    0931               ADD.W   R3,R1           ;Adjust lower word
20       ADD1_cod C       0002    0EA8               ADDX.B  R2L,R0L         ;Adjust upper word
21       ADD1_cod C       0004    0E20               ADDX.B  R2H,R0H         ;
22       ADD1_cod C       0006    5470               RTS
23                                          ;
24                                                   .END
*****TOTAL ERRORS 0
*****TOTAL WARNINGS 0
```

Revision Record

		Description	
Rev.	Date	Page	Summary
1.00	Sep.18.03	—	First edition issued

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