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SH7000 Series

64 Bit + 64 Bit = 64 Bit (Unsigned)

Label: ADDU64

Functions Used: ADDC Instruction

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1. Function

Adds the augend (unsigned 64 bits) and addend (unsigned 64 bits), and determines the sum (unsigned 64 bits). At this time, whether or not any carry is generated is set in the T bit.

2. Arguments

Description		Storage Location	Data Length (Bytes)
Input	Upper 32 bits of augend (unsigned 64 bits)	R0	4
	Lower 32 bits of augend (unsigned 64 bits)	R1	4
	Upper 32 bits of addend (unsigned 64 bits)	R2	4
	Lower 32 bits of addend (unsigned 64 bits)	R3	4
Output	Upper 32 bits of sum (unsigned 64 bits)	R0	4
	Lower 32 bits of sum (unsigned 64 bits)	R1	4
	With/without carry (with: T = 1, without: T = 0)	T bit (SR)	4

3. Internal Register Changes and Flag Changes

	(Before Execution)	→	(After Execution)
R0	Upper 32 bits of augend	→	Upper 32 bits of sum
R1	Lower 32 bits of augend	→	Lower 32 bits of sum
R2	Upper 32 bits of addend	→	No change
R3	Lower 32 bits of addend	→	No change
R4			
R5			
R6			
R7			
R8			
R9			
R10			
R11			
R12			
R13			
R14			
R15	(SP)		

- T bit * — : No change
 * : Change
 0 : Fixed 0
 1 : Fixed 1

4. Programming Specifications

Program memory (bytes)	8
Data memory (bytes)	0
Stack (bytes)	0
Number of states	5
Reentrant	Yes
Relocation	Yes
Intermediate interrupt	Yes

5. Description

(1) Function

Details of the arguments are as follows.

- R0: Set the upper 32 bits of the augend (unsigned 64 bits) as the input argument.
 Holds the upper 32 bits of the sum (unsigned 64 bits) as the output argument.
- R1: Set the lower 32 bits of the augend (unsigned 64 bits) as the input argument.
 Holds the lower 32 bits of the sum (unsigned 64 bits) as the output argument.
- R2: Set the upper 32 bits of the addend (unsigned 64 bits) as the input argument.
- R3: Set the lower 32 bits of the addend (unsigned 64 bits) as the input argument.
- T bit (SR): Indicates the presence or absence of a carry after execution of the software instruction ADDU64.
 T bit = 1: Indicates a carry was generated.
 T bit = 0: Indicates no carry was generated.

Figure 1 shows a software ADDU64 execution example.

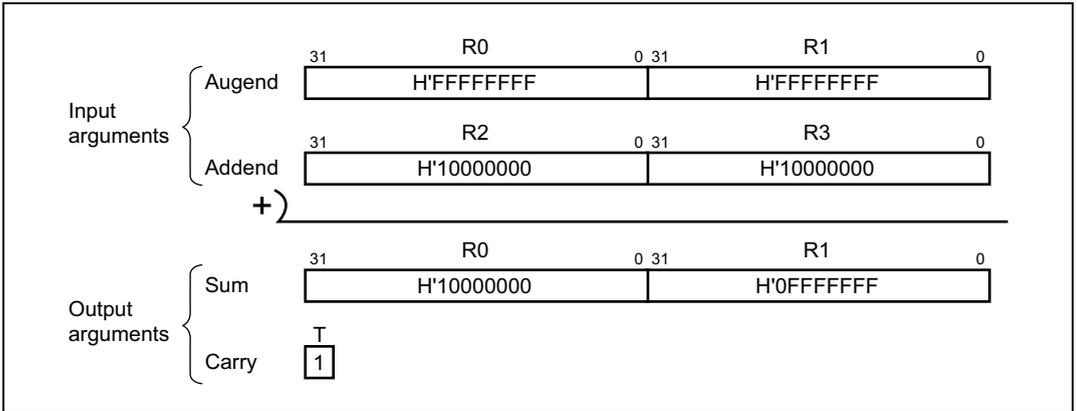


Figure 1 Software ADDU64 Execution Example

(2) Usage Notes

Since the sum is set in R1 and R2, which contained the augend settings, the augend data is destroyed. If the value for the augend will be needed after the software ADDU64 instruction is executed, it should be saved beforehand.

(3) RAM Used

No RAM is used by the software ADDU64 instruction.

(4) Usage Example

After the augend and addend are set in input arguments, the software instruction ADDU64 is executed by a subroutine call.

```

MOV.L DATA1,R0    . . . . Sets augend (upper 32 bits) in input argument
MOV.L DATA2,R1    . . . . Sets augend (lower 32 bits) in input argument
MOV.L DATA3,R2    . . . . Sets addend (upper 32 bits) in input argument
BSR  ADDU64        . . . . Subroutine call to ADDU64
MOV.L DATA4,R3    . . . . Sets addend (lower 32 bits) in input argument
BT   ERROR         . . . . Branches to error-processing subroutine if carry occurs
.
.
.
.align 4
DATA1 .data.l H'FFFFFFFF
DATA2 .data.l H'FFFFFFFF
DATA3 .data.l H'10000000
DATA4 .data.l H'10000000
    
```

(5) Operating Principle

As shown in figure 2, the add with carry instruction (ADDC) is used repeatedly to perform addition in 32-bit units, starting from the LSB.

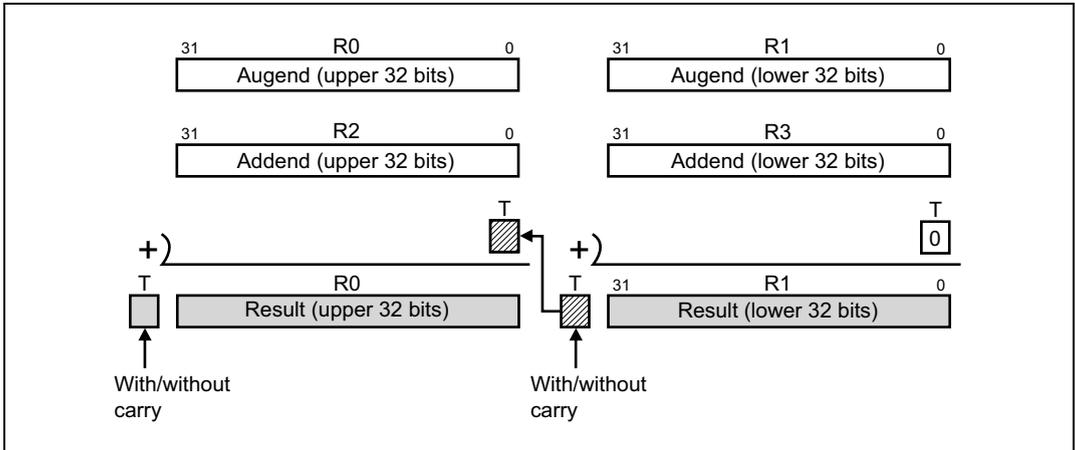
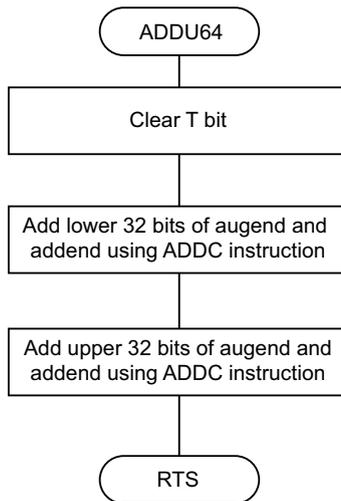


Figure 2 Unsigned Addition

6. Flowchart



7. Program Listing

```

1          1  ;*****
2          2  ;*
3          3  ;*          NAME ; 64 BIT UNSIGNED BINARY ADDITION (ADDU64)
4          4  ;*
5          5  ;*****
6          6  ;*
7          7  ;*          ENTRY : R0          (UPPER 32 BIT AUGEND)
8          8  ;*          R1          (LOWER 32 BIT AUGEND)
9          9  ;*          R2          (UPPER 32 BIT ADDEND)
10         10 ;*          R3          (LOWER 32 BIT ADDEND)
11        11 ;*          RETURNS : R0         (UPPER 32 BIT SUM)
12        12 ;*          R1          (LOWER 32 BIT SUM)
13        13 ;*          T BIT (CARRY -> TRUE;T=1,FALSE;T=0)
14        14 ;*
15        15 ;*****
16 00001000 16          .SECTION A, CODE, LOCATE=H'1000
17          17          ADDU64 .EQU $          ; Entry point
18 00001000 0008 18          CLRT          ; Clear T bit
19 00001002 313E 19          ADDC   R3,R1          ; Lower 32 bit augend + Lower
                                         ; 32 bit addend
20 00001004 000B 20          RTS          ;
21 00001006 302E 21          ADDC   R2,R0          ; Upper 32 bit augend + Upper
                                         ; 32 bit addend
22          22          .END
*****TOTAL ERRORS      0
*****TOTAL WARNINGS    0

```

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