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April 1st, 2010
Renesas Electronics Corporation

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M16C/60 Series and M16C/20 Series

General-purpose Program for Multiplying 32 Bits

1. Abstract

This program performs a 32-bit unsigned multiplication using registers.

2. Introduction

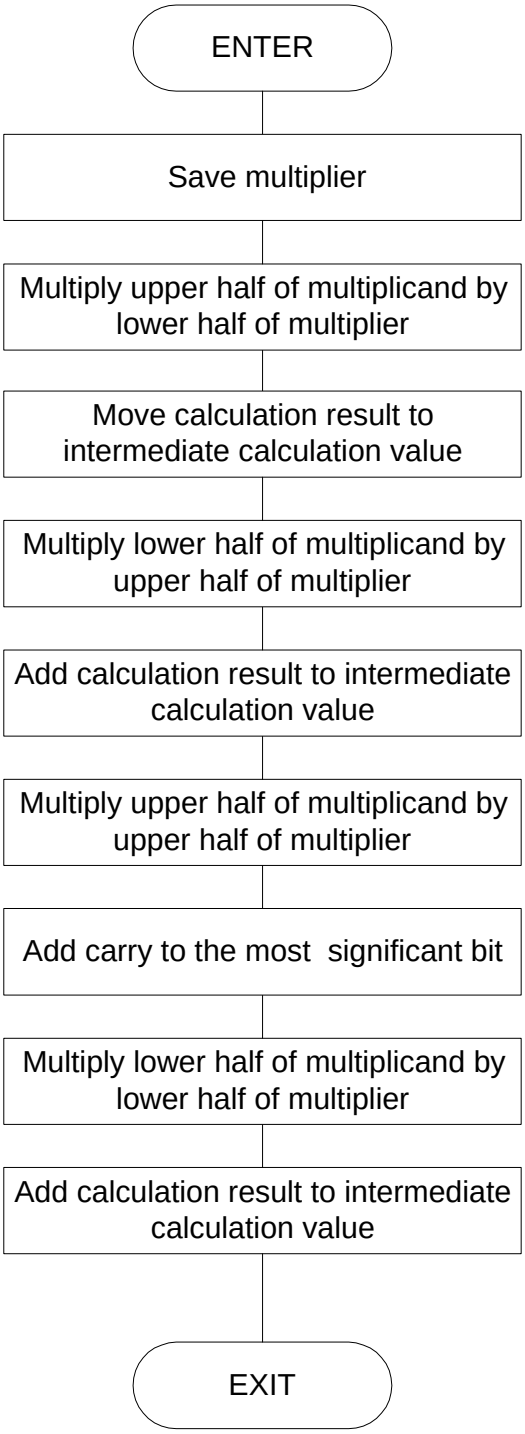
This program performs a 32-bit unsigned multiplication using registers. Set the multiplicand in R2 and R0 beginning with the upper half and the multiplier in R3 and R1, respectively. The multiplication result is output to R3, R1, R2, and R0 beginning with its most significant part.

In this program, both multiplier and multiplicand are divided into the upper and lower halves (16 bits each) as they are multiplied. The results are added to produce a 64-bit calculation result.

Subroutine name : MULTIPLE32	ROM capacity : 37 bytes
Interrupt during execution : Accepted	Number of stacks used : 6 bytes

Register/memory	Input	Output	Usage condition
R0	Lower half of multiplicand	Lower part of multiplication result	←
R1	Lower half of multiplier	Upper part of multiplication result	←
R2	Upper half of multiplicand	Middle part of multiplication result	←
R3	Upper half of multiplier	Most significant part of multiplication result	←
A0	-	Indeterminate	Used for storing data
A1	-	Indeterminate	Used for storing data
Usage precautions	The multiplication result is output to R3, R1, R2, and R0 beginning with its most significant part. Both multiplier and multiplicand are destroyed as a result of program execution.		

3. Flowchart


ENTER
Save multiplier
Multiply upper half of multiplicand by lower half of multiplier
Move calculation result to intermediate calculation value
Multiply lower half of multiplicand by upper half of multiplier
Add calculation result to intermediate calculation value
Multiply upper half of multiplicand by upper half of multiplier
Add carry to the most significant bit
Multiply lower half of multiplicand by lower half of multiplier
Add calculation result to intermediate calculation value
EXIT

4. The example of a reference program

```
;***********************************************************************
; *
; M16C General-purpose Programs *
; CPU : M16C *
; *
;***********************************************************************
VromTOP     .EQU     0F0000H             ; Declares start address of ROM
;                                        ;
;=============================================================
; Title     : Multiplying 32 bits
; Outline   : Multiplies 32-bit data together using registers
; Input     : ------------------------------> Output:
; R0 (Lower half of multiplicand) R0 (Lower part of multiplication result)
; R1 (Lower half of multiplier)   R1 (Upper part of multiplication result)
; R2 (Upper half of multiplicand) R2 (Middle part of multiplication result)
; R3 (Upper half of multiplier)   R3 (Most significant part of multiplication result)
; A0 ( ) A0 (Indeterminate)
; A1 ( ) A1 (Indeterminate)
; Stack amount used: 6 bytes
; Notes     : R2R0 X R3R1
;             Calculation result is output in order of R3, R1, R2,
;             and R0 beginning with the most significant bits.
;=============================================================
            .SECTION    PROGRAM,CODE
            .org     VromTOP        ; ROM area
MULTIPLE32:                         ;
   PUSH.W      R1                   ; Saves lower half of multiplier
   PUSH.W      R3                   ; Saves upper half of multiplier
   PUSH.W      R3                   ; Saves upper half of multiplier
   MULU.W      R2,R1                ; Multiplies upper half of multiplicand
                                    ; by lower half of multiplier
   MOV.W       R3,A1                ; Saves calculation result
   MOV.W       R1,A0                ;
   POP.W       R1                   ; Restores upper half of multiplier
   MULU.W      R0,R1                ; Multiplies lower half of multiplicand
                                    ; by upper half of multiplier
   ADD.W       R1,A0                ; Adds to intermediate calculation
                                    ; value and saves result
   ADC.W       R3,A1                ; Holds carry until next addition is
                                    ; made
   POP.W       R1                   ; Restores upper half of multiplier
   MULU.W      R2,R1                ; Multiplies upper half of multiplicand
                                    ; by upper half of multiplier
   ADCF.W      R3                   ; Adds carry to the most significant bit
   POP.W       R2                   ; Restores lower half of multiplier
   MULU.W      R2,R0                ; Multiplies lower half of multiplicand
                                    ; by lower half of multiplier
   ADD.W       A0,R2                ; Adds intermediate value to middle
                                    ; part
   ADC.W       A1,R1                ; Adds intermediate value to upper part
   ADCF.W      R3                   ; Adds carry to the most significant bit
   RTS                              ;
;                                   ;
            .END                    ;
```

5. Reference

SOFTWARE MANUAL
M16C/60 M16C/20 Series SOFTWARE MANUAL
(Acquire the most current version from Renesas web-site)

6. Web-site and contact for support

Renesas Web-site

http://www.renesas.com

Contact for Renesas technical support

Mail to : support_apl@renesas.com

REVISION HISTORY

Rev.	Date	Description	
		Page	Summary
1.00	Jul 08, 2002	-	First edition issued

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