To our customers,

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Old Company Name in Catalogs and Other Documents

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Renesas Electronics website: http://www.renesas.com

April 1\textsuperscript{st}, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (http://www.renesas.com)

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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.

<table>
<thead>
<tr>
<th>Subroutine name</th>
<th>ROM capacity</th>
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<tbody>
<tr>
<td>MULTIPLE32</td>
<td>37 bytes</td>
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</table>

<table>
<thead>
<tr>
<th>Interrupt during execution</th>
<th>Number of stacks used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accepted</td>
<td>6 bytes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Register/memory</th>
<th>Input</th>
<th>Output</th>
<th>Usage condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>R0</td>
<td>Lower half of multiplicand</td>
<td>Lower part of multiplication result</td>
<td>←</td>
</tr>
<tr>
<td>R1</td>
<td>Lower half of multiplier</td>
<td>Upper part of multiplication result</td>
<td>←</td>
</tr>
<tr>
<td>R2</td>
<td>Upper half of multiplicand</td>
<td>Middle part of multiplication result</td>
<td>←</td>
</tr>
<tr>
<td>R3</td>
<td>Upper half of multiplier</td>
<td>Most significant part of multiplication result</td>
<td>←</td>
</tr>
<tr>
<td>A0</td>
<td>-</td>
<td>Indeterminate</td>
<td>Used for storing data</td>
</tr>
<tr>
<td>A1</td>
<td>-</td>
<td>Indeterminate</td>
<td>Used for storing data</td>
</tr>
</tbody>
</table>

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 *
************************************************************************

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 ;
PUSH.W R1 ; Saves 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
ADCF.W R3 ; Adds carry to the most significant bit
POP.W R1 ; Restores upper 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
ADCF.W A1,R1 ; Adds intermediate value to upper part
ADD.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

<table>
<thead>
<tr>
<th>Rev.</th>
<th>Date</th>
<th>Description</th>
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<tbody>
<tr>
<td>1.00</td>
<td>Jul 08, 2002</td>
<td>First edition issued</td>
</tr>
</tbody>
</table>
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