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

April 1st, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (http://www.renesas.com)
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R8C/Tiny Series
General-purpose Program for Dividing 64 Bits

1. Abstract

This program performs an unsigned division on a 64-bit dividend and a 32-bit divisor using registers.

2. Introduction

This program performs an unsigned division on a 64-bit dividend and a 32-bit divisor using registers. Set the dividend in R3, R1, R2, and R0 beginning with the most significant part, and the divisor in A1 and A0 beginning with the upper half. The quotient and the remainder are output to R3, R1, R2, and R0, and A1 and A0, respectively. The zero divide information is output to the Z flag.

In this program, the dividend is pushed out one bit at a time beginning with the most significant bit as the program creates a dividend for calculation purposes and the divisor is subtracted from that data to get the quotient beginning with the most significant bit. The quotient and the remainder are obtained by repeating this operation as many times as the number of bits in the dividend.

<table>
<thead>
<tr>
<th>Z</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Quotient and remainder are valid.</td>
</tr>
<tr>
<td>1</td>
<td>Quotient and remainder are invalid because division by zero is attempted.</td>
</tr>
</tbody>
</table>

Subroutine name : DIVIDE64

Interrupt during execution : Accepted

Number of stacks used : 8 bytes

<table>
<thead>
<tr>
<th>Register/memory</th>
<th>Input Description</th>
<th>Output Description</th>
<th>Usage condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>R0</td>
<td>Lower part of dividend</td>
<td>Lower part of quotient</td>
<td>←</td>
</tr>
<tr>
<td>R1</td>
<td>Upper part of dividend</td>
<td>Upper part of quotient</td>
<td>←</td>
</tr>
<tr>
<td>R2</td>
<td>Middle part of dividend</td>
<td>Middle part of quotient</td>
<td>←</td>
</tr>
<tr>
<td>R3</td>
<td>Most significant part of dividend</td>
<td>Most significant part of quotient</td>
<td>←</td>
</tr>
<tr>
<td>A0</td>
<td>Lower half of divisor</td>
<td>Lower half of remainder</td>
<td>←</td>
</tr>
<tr>
<td>A1</td>
<td>Upper half of divisor</td>
<td>Upper half of remainder</td>
<td>←</td>
</tr>
<tr>
<td>JYOUYO</td>
<td>-</td>
<td>Indeterminate</td>
<td>Shift dividend used for calculation</td>
</tr>
<tr>
<td>CNT</td>
<td>-</td>
<td>Indeterminate</td>
<td>Number of shifts performed</td>
</tr>
<tr>
<td>Z flag</td>
<td>-</td>
<td>Zero divide information</td>
<td>←</td>
</tr>
</tbody>
</table>

Usage precautions: CNT and JYOUYO are allocated in a stack area by configuring stack frames as temporary variable areas in the program. Therefore, the values of CNT and JYOUYO when program execution is completed are indeterminate. The dividend is destroyed as a result of program execution.
3. Flowchart

```
ENTER

Initialize remainder area

Zero division? Yes

No

Sets number of shifts to be performed

Create shift dividend and carry quotient

Shift dividend - divisor --> Shift dividend

Set quotient

Could be subtracted? Yes

No

Shift dividend + divisor --> Shift dividend

Number of shifts set completed? No

Yes

Set remainder

Division succeeded
Clear Z flag

EXIT
```
4. The example of a reference program

```
.include apl.inc ; special page include file

;---------------------------------------------------------------------------------
; Title: Dividing 64 bits
; Outline: Divides 64-bit dividend by 32-bit divisor
; Input:  ------------------> Output:
; R0 (Lower part of dividend)  R0 (Lower part of quotient)
; R1 (Upper part of dividend)  R1 (Upper part of quotient)
; R2 (Middle part of dividend) R2 (Middle part of quotient)
; R3 (Most significant part of dividend) R3 (Most significant part of quotient)
; A0 (Lower half of divisor)  A0 (Lower half of remainder)
; A1 (Upper half of divisor)  A1 (Upper half of remainder)
; Stack amount used: 8 bytes
; Notes: Division by zero is returned by Z flag.
; R3R1R2R0 / A1A0 = R3R1R2R0 remainder A1A0
;---------------------------------------------------------------------------------

.SECTION PROGRAM, CODE

.ORC VromTOP ; ROM area
.FB FBcnst ; Assumes FB register value

DIVIDE64:

; Declaration of temporary variables

JYOUYO .EQU -6 ; Used for remainder calculation
CNT .EQU -1 ; Shift count counter

ENTER #6 ; Sets stack frame
MOV.W #0,JYOUYO[FB] ; Initializes remainder area
MOV.W #0,JYOUYO+2[FB] ;
MOV.B #0,JYOUYO+4[FB] ;
CMP.W #0,A0 ;
JNE DIVIDE64_10 ;
CMP.W #0,A1 ;
JEQ DIVIDE64exit ; --> Division by zero
DIVIDE64_10:

MOV.B #64,CNT[FB]; Sets number of shifts performed (64 times)
DIVIDE64_20:

SHL.W #1,R0 ; Pushes divided and carry quotient
ROL.W R2 ;
ROL.W R1 ;
ROL.W R3 ;
ROL.W JYOUYO[FB] ; Creates dividend
```

Outline: Divides 64-bit dividend by 32-bit divisor

Input:

- R0 (Lower part of dividend)
- R1 (Upper part of dividend)
- R2 (Middle part of dividend)
- R3 (Most significant part of dividend)
- A0 (Lower half of divisor)
- A1 (Upper half of divisor)

Output:

- R0 (Lower part of quotient)
- R1 (Upper part of quotient)
- R2 (Middle part of quotient)
- R3 (Most significant part of quotient)
- A0 (Lower half of remainder)
- A1 (Upper half of remainder)

Stack amount used: 8 bytes

Notes: Division by zero is returned by Z flag.

R3R1R2R0 / A1A0 = R3R1R2R0 remainder A1A0
General-purpose Program for Dividing 64 Bits

ROLC.W JYOUYO+2[FB] ;
ROLC.B JYOUYO+4[FB] ;
SUB.W A0, JYOUYO[FB] ; Subtracts divisor
SBB.W A1, JYOUYO+2[FB] ;
SBB.B #0, JYOUYO+4[FB] ;
BMC 0, R0 ; Sets quotient
JC DIVIDE64_30 ; --> Subtraction of divisor succeeded
ADD.W A0, JYOUYO[FB] ; Restored to original data because subtraction of divisor failed
ADC.W A1, JYOUYO+2[FB] ;
ADCF.B JYOUYO+4[FB] ;
DIVIDE64_30:
ADJNZ.B #-1, CNT[FB], DIVIDE64_20 ; --> Executes next digit
MOV.W JYOUYO[FB], A0 ; Sets lower half of remainder
MOV.W JYOUYO+2[FB], A1 ; Sets upper half of remainder
FCLR Z ; Division succeeded
DIVIDE64exit:
EXITD ; Clears stack frame
; .END ;
5. Reference

SOFTWARE MANUAL
R8C/Tiny 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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</thead>
<tbody>
<tr>
<td>1.00</td>
<td>Dec 24, 2003</td>
<td>First edition issued</td>
</tr>
</tbody>
</table>
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