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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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M16C/60 Series and M16C/20 Series
General-purpose Program for Dividing 32 Bits

1. Abstract
This program performs a 32-bit unsigned division using registers.

2. Introduction
This program performs a 32-bit unsigned division using registers. Set the dividend in R2 and R0 and the divisor in R3 and R1 beginning with the upper half, respectively. The quotient and the remainder are output to R2 and R3, and to A1 and A0 beginning with the upper half, 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 : DIVIDE32                   ROM capacity : 48 bytes
Interrupt during execution : Accepted        Number of stacks used : 3 bytes

<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 dividend</td>
<td>Lower half of quotient</td>
<td>←</td>
</tr>
<tr>
<td>R1</td>
<td>Lower half of divisor</td>
<td>Does not change</td>
<td>←</td>
</tr>
<tr>
<td>R2</td>
<td>Upper half of dividend</td>
<td>Upper half of quotient</td>
<td>←</td>
</tr>
<tr>
<td>R3</td>
<td>Upper half of divisor</td>
<td>Does not change</td>
<td>←</td>
</tr>
<tr>
<td>A0</td>
<td>-</td>
<td>Lower half of remainder</td>
<td>←</td>
</tr>
<tr>
<td>A1</td>
<td>-</td>
<td>Upper half of remainder</td>
<td>←</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 is allocated in a stack area by configuring a stack frame as a temporary variable area in the program. Therefore, the value of CNT when program execution is completed is 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?
  Yes
  No

Division succeeded
Clear Z flag

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

;************************************************************************
; * M16C General-purpose Programs *
; CPU : M16C *
; *
;************************************************************************
VromTOP .EQU 0F0000H ; Declares start address of ROM
FBcnst .EQU 001000H ; Assumed FB register value

;=============================================
; Title : Dividing 32 bits
; Outline : Divides 32-bit data together using registers
; Input : -----------------------------------------> Output:
; R0 (Lower half of dividend) R0 (Lower half of quotient)
; R1 (Lower half of divisor) R1 (Lower half of divisor)
; R2 (Upper half of dividend) R2 (Upper half of quotient)
; R3 (Upper half of divisor) R3 (Upper half of divisor)
; A0 ( ) A0 (Lower half of remainder)
; A1 ( ) A1 (Upper half of remainder)
; Stack amount used: 3 bytes
; Notes : R2R0 ÷ R3R1
; Division by zero is returned by Z flag.
;=============================================

.SECTION PROGRAM,CODE
.ORG VromTOP ; ROM area
.FB FBcnst ; Assumes FB register value

DIVIDE32: ;
; Declaration of temporary variable
;---------------------------------------------
CNT .EQU -1 ; Shift count counter
ENTER #1 ; Sets stack frame
MOV.B #0,A0 ; Initializes remainder area
MOV.B #0,A1 ;
CMP.W #0,R1 ;
JNE DIVIDE32_10 ;
CMP.W #0,R3 ;
JEQ DIVIDE32exit ; -- Division by zero
DIVIDE32_10: ;
MOV.B #32,CNT[FB] ; Sets number of shifts performed
; (32 times)
DIVIDE32_20: ;
SHL.W #1,R0 ; Pushes dividend and carry quotient
ROL.W R2 ;
ROL.W A0 ; Creates dividend
ROL.W A1 ;
SUB.W R1,A0 ; Subtracts divisor
SBB.W R3,A1 ;
BMC 0,R0 ; Sets quotient
JC DIVIDE32_30 ; -- Subtraction of divisor succeeded
ADD.W R1,A0  ; Restored to original data because
ADC.W R3,A1  ; subtraction of divisor failed
DIVIDE32_30:
ADJNZ.B #-1,CNT[FB],DIVIDE32_20  ; --> Executes next digit
FCLR Z  ; Division succeeded
DIVIDE32exit:
EXITD  ; Clears stack frame
;
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>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>Jul 08, 2002</td>
<td>First edition issued</td>
</tr>
</tbody>
</table>
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