

To our customers,

Old Company Name in Catalogs and Other Documents

On April 1st, 2010, NEC Electronics Corporation merged with Renesas Technology Corporation, and Renesas Electronics Corporation took over all the business of both companies. Therefore, although the old company name remains in this document, it is a valid Renesas Electronics document. We appreciate your understanding.

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

April 1st, 2010
Renesas Electronics Corporation

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

Send any inquiries to <http://www.renesas.com/inquiry>.

Notice

1. All information included in this document is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas Electronics products listed herein, please confirm the latest product information with a Renesas Electronics sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas Electronics such as that disclosed through our website.
2. Renesas Electronics does not assume any liability for infringement of patents, copyrights, or other intellectual property rights of third parties by or arising from the use of Renesas Electronics products or technical information described in this document. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
3. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part.
4. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.
5. When exporting the products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. You should not use Renesas Electronics products or the technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. Renesas Electronics products and technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations.
6. Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors in or omissions from the information included herein.
7. Renesas Electronics products are classified according to the following three quality grades: “Standard”, “High Quality”, and “Specific”. The recommended applications for each Renesas Electronics product depends on the product’s quality grade, as indicated below. You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application categorized as “Specific” without the prior written consent of Renesas Electronics. Further, you may not use any Renesas Electronics product for any application for which it is not intended without the prior written consent of Renesas Electronics. Renesas Electronics shall not be in any way liable for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for an application categorized as “Specific” or for which the product is not intended where you have failed to obtain the prior written consent of Renesas Electronics. The quality grade of each Renesas Electronics product is “Standard” unless otherwise expressly specified in a Renesas Electronics data sheets or data books, etc.
 - “Standard”: Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; and industrial robots.
 - “High Quality”: Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; safety equipment; and medical equipment not specifically designed for life support.
 - “Specific”: Aircraft; aerospace equipment; submersible repeaters; nuclear reactor control systems; medical equipment or systems for life support (e.g. artificial life support devices or systems), surgical implantations, or healthcare intervention (e.g. excision, etc.), and any other applications or purposes that pose a direct threat to human life.
8. You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damages arising out of the use of Renesas Electronics products beyond such specified ranges.
9. Although Renesas Electronics endeavors to improve the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please be sure to implement safety measures to guard them against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas Electronics product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.
10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. Please use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
11. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products, or if you have any other inquiries.

(Note 1) “Renesas Electronics” as used in this document means Renesas Electronics Corporation and also includes its majority-owned subsidiaries.

(Note 2) “Renesas Electronics product(s)” means any product developed or manufactured by or for Renesas Electronics.

SH7000 Series

Quotient of 32 Bit ÷ 32 Bit (Signed)

Label: DIVS32Q

Functions Used: DIV0S Instruction
DIV1 Instruction

Contents

1. Function	2
2. Arguments.....	2
3. Internal Register Changes and Flag Changes.....	3
4. Programming Specifications	4
5. Notes	4
6. Description	5
7. Flowchart.....	9
8. Program Listing	10

1. Function

Divides the dividend (signed 32 bits) by the divisor (signed 32 bits), and determines the quotient (signed 32 bits). Also indicates errors (division by 0) in the T bit.

2. Arguments

Description	Storage Location	Data Length (Bytes)
Input	Dividend (signed 32 bits)	R1
	Divisor (signed 32 bits)	R0
Output	Quotient (signed 32 bits)	R1
	Error (division by 0) generated/not generated (generated: T = 1, not generated: T = 0)	T bit (SR)

3. Internal Register Changes and Flag Changes

(Before Execution) → (After Execution)

R0	Divisor (signed 32 bits) → No change
R1	Dividend (signed 32 bits) → Quotient (signed 32 bits)
R2	Work
R3	Work
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)
166
Data memory (bytes)
0
Stack (bytes)
8
Number of states
80
Reentrant
Yes
Relocation
Yes
Intermediate interrupt
Yes

5. Notes

The number of states indicated in the programming specifications is the value when H'80000000 ÷ H'7FFFFFFF is calculated.

6. Description

(1) Function

Details of the arguments are as follows.

- R0: Set the divisor (signed 32 bits) as the input argument.
- R1: Set the dividend (signed 32 bits) as the input argument.
Holds the quotient (signed 32 bits) as the output argument.
- T bit (SR): Indicates whether an error (division by 0) has occurred.
T bit = 1: Indicates an error (division by 0) has occurred.
T bit = 0: Indicates no error (division by 0) has occurred.

Figure 1 shows a software DIVS32Q execution example.

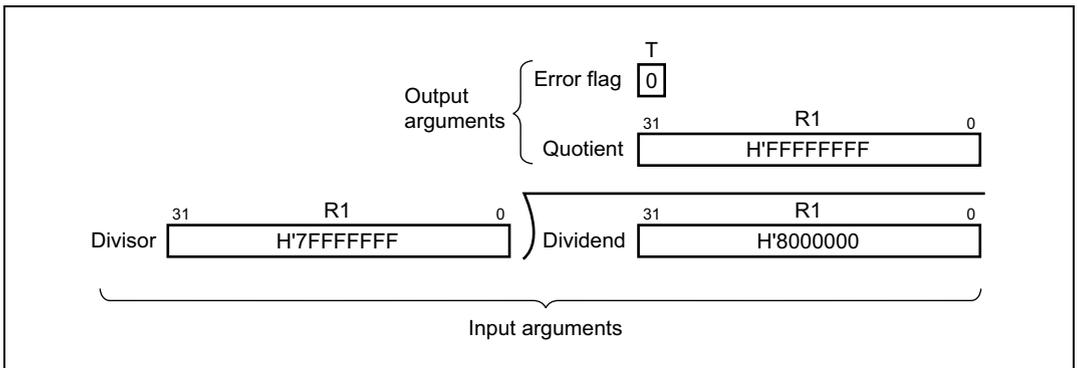


Figure 1 Software DIVS32Q Execution Example

(2) Usage Notes

After execution of software instruction DIVS32Q, the quotient is set in R1, which previously contained the dividend, and the dividend is destroyed. If the value for the dividend will be needed after the software DIVS32Q instruction is executed, it should be saved beforehand.

In addition, although $H'80000000 \div H'7FFFFFFF$ results in an overflow, this overflow is not detected by software instruction DIVS32Q.

(3) RAM Used

No RAM is used by the software DIVS32Q instruction.

(4) Usage Example

After the dividend and divisor are set in the input arguments, the software instruction DIVS32Q is executed by a subroutine call.

```

MOV.L DATA1,R1    ... Sets dividend (signed 32 bits) in input argument (R1)
BSR   DIVS32Q     ... Subroutine call to software instruction DIVS32Q
MOV.L DATA2,R0    ... Sets divisor (signed 32 bits) in input argument (R0)
BT    ERROR       ... Branches to error processing subroutine if error (division by 0) occurs
      .
      .
      .
.align 4
DATA1 .data.l H'80000000
DATA2 .data.l H'7FFFFFFF
    
```

(5) Operating Principle

- (a) Before division, the following initial settings are carried out.
 - (i) R2 is used for the upper 32 bits to sign extend the dividend to 64 bits. (Figure 2-(1))
 - (ii) If the dividend is negative, it is converted to a complement of 1 for handling by the one-step division instruction. (Figure 2-(2))
 - (iii) The M, Q, and T bits used in one-step division are set to signed division values (M = divisor sign, Q = dividend sign, T = quotient sign). (Figure 2-(3))

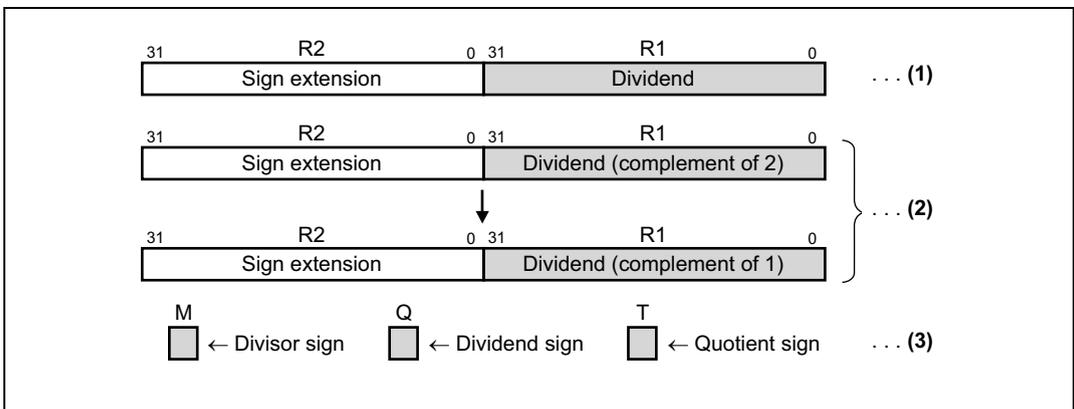


Figure 2 Initial Settings

(b) As shown in figure 3, the division operation is repeated through the number of divisor bits (32 times) using the ROTCL and DIV1 instructions.

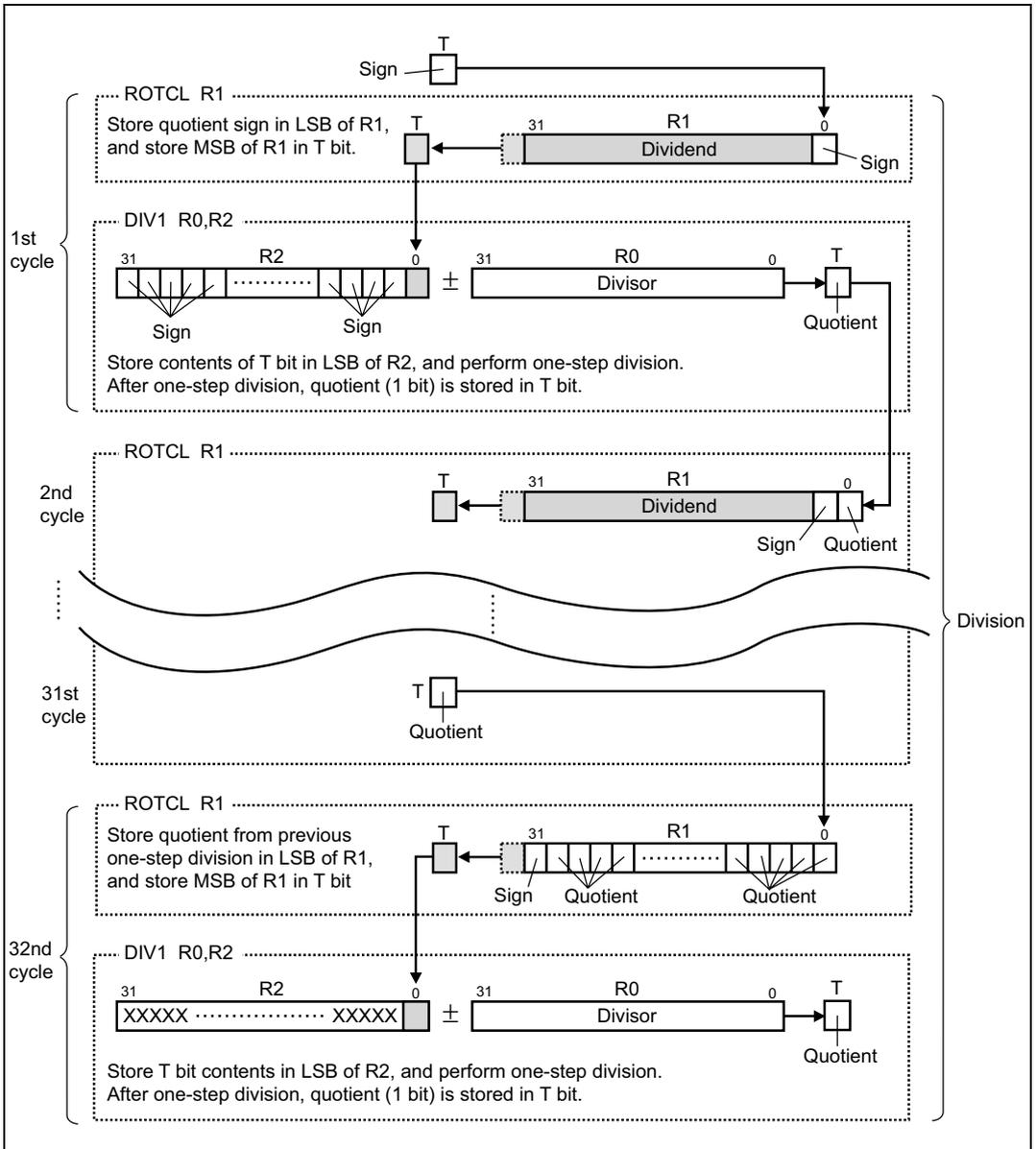


Figure 3 Operation Example

(c) - (i) As shown in figure 4, the 32nd quotient of one-step division is stored in the T bit, and the quotient sign in the MSB of R1, at the end of division. If the quotient is positive, it becomes the contents of R1, which stores the T bit (32nd quotient of one-step division) in the LSB. If the quotient is negative, it becomes a complement of 1 of the T bit (32nd quotient of one-step division) stored in the LSB of R1, which in turn is converted into a complement of 2.

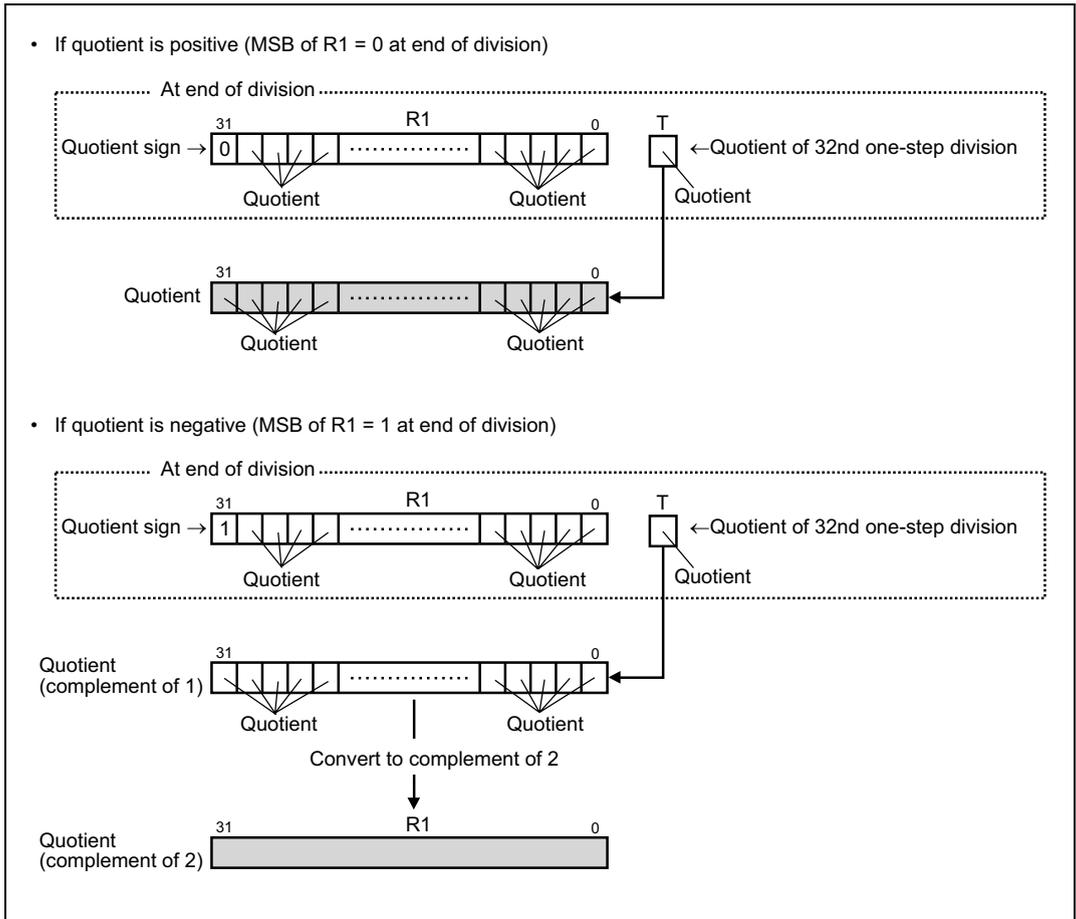
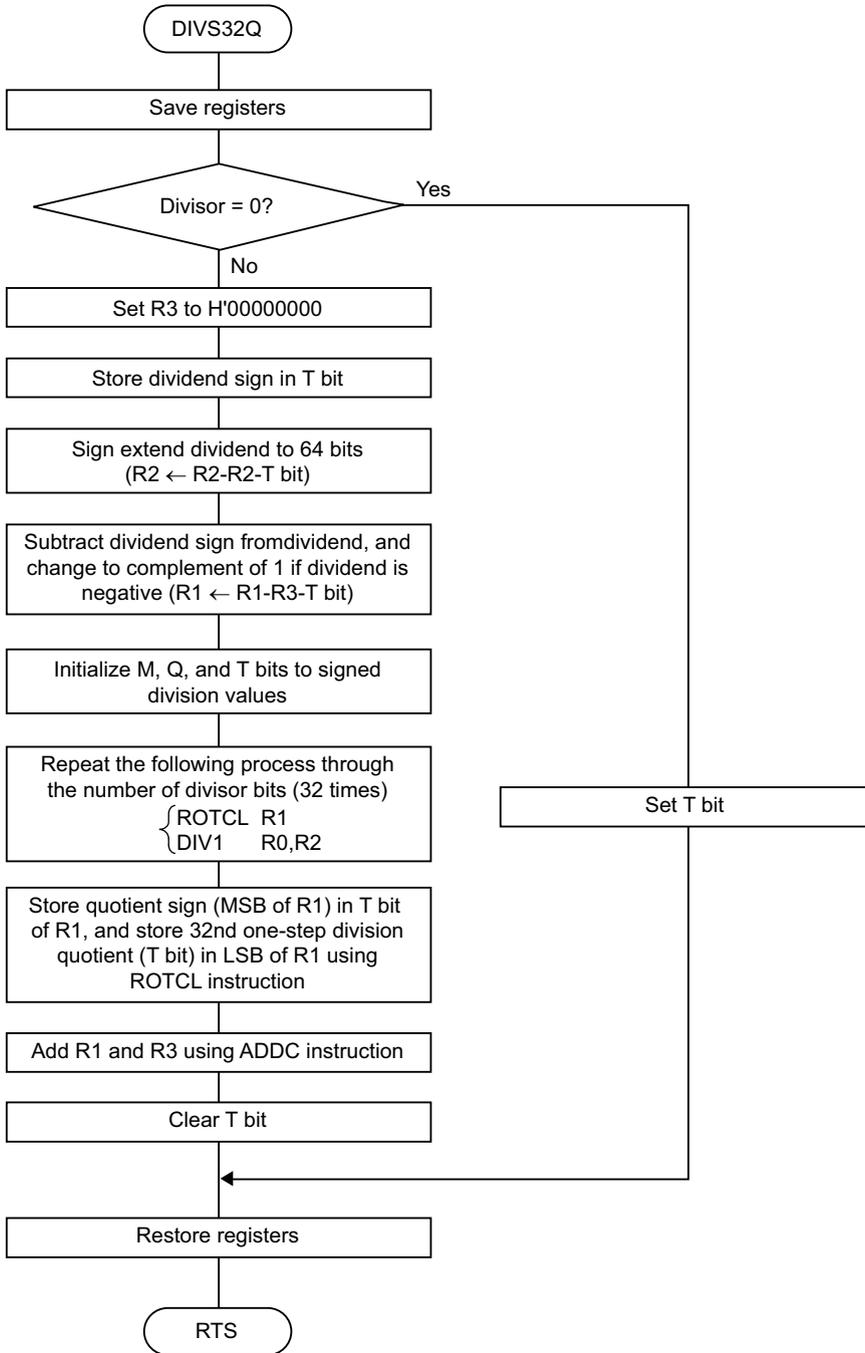


Figure 4 Quotient

(ii) The software instruction DIVS32Q performs the processing described in (i) as follows. Note that R3 stores H'00000000.

- ROTCL R1 : Stores quotient sign in T bit, and saves T bit quotient to LSB of R1.
- ADDC R3, R1 : If quotient is positive, T bit = 0, so there is no change of value. If quotient is negative, T bit = 1, so 1 is added to make it complement of 2.

7. Flowchart



8. Program Listing

```

1          1          ;*****
2          2          ;*
3          3          ;*      NAME ; QUOTIENT OF 32 BIT SIGNED DIVISION (DIVS32Q)
4          4          ;*
5          5          ;*****
6          6          ;*
7          7          ;*      ENTRY : R1 (DIVIDEND)
8          8          ;*      R0 (DIVISOR)
9          9          ;*      RETURNS : R1 (QUOTIENT)
10         10         ;*      T BIT (ERROR -> TRUE;T=1,FALSE;T=0
11         11         ;*
12         12         ;*****
13 00001000      13          .SECTION A, CODE, LOCATE=H'1000
14          14         DIVS32Q .EQU      $          : Entry point
15 00001000 2F26      15         MOV.L   R2,@-R15      ; Escape register
16 00001002 2F36      16         MOV.L   R3,@-R15      ;
17 00001004 2008      17         TST    R0,R0          ; Divisor = 0 ?
18 00001006 894A      18         BT     DIVS32Q1      ; Yes
19 00001008 233A      19         XOR    R3,R3          ; R3 <- H'00000000
20 0000100A 2137      20         DIVOS  R3,R1          ; T bit <- Sign of dividend
21 0000100C 322A      21         SUBC   R2,R2          ; R2 sign extend
22 0000100E 313A      22         SUBC   R3,R1          ;
23 00001010 2207      23         DIVOS  R0,R2          ; Divide as signed
24          24         ;
25 00001012 4124      25         ROTCL  R1          ;
26 00001014 3204      26         DIV1   R0,R2          ;
27 00001016 4124      27         ROTCL  R1          ;
28 00001018 3204      28         DIV1   R0,R2          ;
29 0000101A 4124      29         ROTCL  R1          ;
30 0000101C 3204      30         DIV1   R0,R2          ;
31 0000101E 4124      31         ROTCL  R1          ;
32 00001020 3204      32         DIV1   R0,R2          ;
33 00001022 4124      33         ROTCL  R1          ;
34 00001024 3204      34         DIV1   R0,R2          ;
35 00001026 4124      35         ROTCL  R1          ;
36 00001028 3204      36         DIV1   R0,R2          ;
37 0000102A 4124      37         ROTCL  R1          ;
38 0000102C 3204      38         DIV1   R0,R2          ;
39 0000102E 4124      39         ROTCL  R1          ;
40 00001030 3204      40         DIV1   R0,R2          ;
41          41         ;
42 00001032 4124      42         ROTCL  R1          ;
43 00001034 3204      43         DIV1   R0,R2          ;
44 00001036 4124      44         ROTCL  R1          ;
45 00001038 3204      45         DIV1   R0,R2          ;
46 0000103A 4124      46         ROTCL  R1          ;
47 0000103C 3204      47         DIV1   R0,R2          ;
48 0000103E 4124      48         ROTCL  R1          ;
49 00001040 3204      49         DIV1   R0,R2          ;

```

50	00001042	4124	50	ROTCL	R1	;
51	00001044	3204	51	DIV1	R0,R2	;
52	00001046	4124	52	ROTCL	R1	;
53	00001048	3204	53	DIV1	R0,R2	;
54	0000104A	4124	54	ROTCL	R1	;
55	0000104C	3204	55	DIV1	R0,R2	;
56	0000104E	4124	56	ROTCL	R1	;
57	00001050	3204	57	DIV1	R0,R2	;
58			58			;
59	00001052	4124	59	ROTCL	R1	;
60	00001054	3204	60	DIV1	R0,R2	;
61	00001056	4124	61	ROTCL	R1	;
62	00001058	3204	62	DIV1	R0,R2	;
63	0000105A	4124	63	ROTCL	R1	;
64	0000105C	3204	64	DIV1	R0,R2	;
65	0000105E	4124	65	ROTCL	R1	;
66	00001060	3204	66	DIV1	R0,R2	;
67	00001062	4124	67	ROTCL	R1	;
68	00001064	3204	68	DIV1	R0,R2	;
69	00001066	4124	69	ROTCL	R1	;
70	00001066	3204	70	DIV1	R0,R2	;
71	0000106A	4124	71	ROTCL	R1	;
72	0000106C	3204	72	DIV1	R0,R2	;
73	0000106E	4124	73	ROTCL	R1	;
74	00001070	3204	74	DIV1	R0,R2	;
75			75			;
76	00001072	4124	76	ROTCL	R1	;
77	00001074	3204	77	DIV1	R0,R2	;
78	00001076	4124	78	ROTCL	R1	;
79	00001078	3204	79	DIV1	R0,R2	;
80	0000107A	4124	80	ROTCL	R1	;
81	0000107C	3204	81	DIV1	R0,R2	;
82	0000107E	4124	82	ROTCL	R1	;
83	00001080	3204	83	DIV1	R0,R2	;
84	00001082	4124	84	ROTCL	R1	;
85	00001084	3204	85	DIV1	R0,R2	;
86	00001086	4124	86	ROTCL	R1	;
87	00001088	3204	87	DIV1	R0,R2	;
88	0000108A	4124	88	ROTCL	R1	;
89	0000108C	3204	89	DIV1	R0,R2	;
90	0000108E	4124	90	ROTCL	R1	;
91	00001090	3204	91	DIV1	R0,R2	;
92			92			;
93	00001092	4124	93	ROTCL	R1	;
94	00001094	313E	94	ADDC	R3,R1	;
95	00001096	0008	95	CLRT		; T bit <- No error
96	00001098	63F6	96	MOV.L	@R15+,R3	; Return register
97	0000109A	000B	97	RTS		;
98	0000109C	62F6	98	MOV.L	@R15+,R2	;
99	0000109E		99	DIVS32Q1		;
100	0000109E	0018	100	SETT		; T bit <- Error

```
101 000010A0 63F6      101      MOV.L  @R15+,R3      ; Return register
102 000010A2 000B      102      RTS                    ;
103 000010A4 62F6      103      MOV.L  @R15+,R2      ;
104                                104      .END
****TOTAL ERRORS      0
****TOTAL WARNINGS    0
```

Keep safety first in your circuit designs!

1. Renesas Technology Corp. puts the maximum effort into making semiconductor products better and more reliable, but there is always the possibility that trouble may occur with them. Trouble with semiconductors may lead to personal injury, fire or property damage.
Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (i) placement of substitutive, auxiliary circuits, (ii) use of nonflammable material or (iii) prevention against any malfunction or mishap.

Notes regarding these materials

1. These materials are intended as a reference to assist our customers in the selection of the Renesas Technology Corp. product best suited to the customer's application; they do not convey any license under any intellectual property rights, or any other rights, belonging to Renesas Technology Corp. or a third party.
2. Renesas Technology Corp. assumes no responsibility for any damage, or infringement of any third-party's rights, originating in the use of any product data, diagrams, charts, programs, algorithms, or circuit application examples contained in these materials.
3. All information contained in these materials, including product data, diagrams, charts, programs and algorithms represents information on products at the time of publication of these materials, and are subject to change by Renesas Technology Corp. without notice due to product improvements or other reasons. It is therefore recommended that customers contact Renesas Technology Corp. or an authorized Renesas Technology Corp. product distributor for the latest product information before purchasing a product listed herein.
The information described here may contain technical inaccuracies or typographical errors. Renesas Technology Corp. assumes no responsibility for any damage, liability, or other loss rising from these inaccuracies or errors.
Please also pay attention to information published by Renesas Technology Corp. by various means, including the Renesas Technology Corp. Semiconductor home page (<http://www.renesas.com>).
4. When using any or all of the information contained in these materials, including product data, diagrams, charts, programs, and algorithms, please be sure to evaluate all information as a total system before making a final decision on the applicability of the information and products. Renesas Technology Corp. assumes no responsibility for any damage, liability or other loss resulting from the information contained herein.
5. Renesas Technology Corp. semiconductors are not designed or manufactured for use in a device or system that is used under circumstances in which human life is potentially at stake. Please contact Renesas Technology Corp. or an authorized Renesas Technology Corp. product distributor when considering the use of a product contained herein for any specific purposes, such as apparatus or systems for transportation, vehicular, medical, aerospace, nuclear, or undersea repeater use.
6. The prior written approval of Renesas Technology Corp. is necessary to reprint or reproduce in whole or in part these materials.
7. If these products or technologies are subject to the Japanese export control restrictions, they must be exported under a license from the Japanese government and cannot be imported into a country other than the approved destination.
Any diversion or reexport contrary to the export control laws and regulations of Japan and/or the country of destination is prohibited.
8. Please contact Renesas Technology Corp. for further details on these materials or the products contained therein.