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_________________________
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April 1st, 2010
Renesas Electronics Corporation

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SH7000 Series
Multi-Bit Shift of 32-Bit Data (Logical Right Shift)

Label:    SHLRN

Functions Used:    SHLR2 Instruction
                   SHLR8 Instruction
                   SHLR16 Instruction

Contents

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

Performs a multi-bit (0–31) logical right shift of 32-bit data.

2. **Arguments**

<table>
<thead>
<tr>
<th>Description</th>
<th>Storage Location</th>
<th>Data Length (Bytes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>R0</td>
<td>4</td>
</tr>
<tr>
<td>Number of shift bits (0–31)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32-bit data before shift</td>
<td>R1</td>
<td>4</td>
</tr>
<tr>
<td>Output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32-bit data after shift</td>
<td>R1</td>
<td>4</td>
</tr>
</tbody>
</table>

3. **Internal Register Changes and Flag Changes**

<table>
<thead>
<tr>
<th>Register</th>
<th>(Before Execution)</th>
<th>(After Execution)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R0</td>
<td>Number of shift bits</td>
<td>No change</td>
</tr>
<tr>
<td>R1</td>
<td>32-bit data before shift</td>
<td>32-bit data after shift</td>
</tr>
<tr>
<td>R2</td>
<td>Work</td>
<td></td>
</tr>
<tr>
<td>R3</td>
<td>Work</td>
<td></td>
</tr>
<tr>
<td>R4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R15</td>
<td>(SP)</td>
<td></td>
</tr>
</tbody>
</table>

T bit

- : No change
* : Change
0 : Fixed 0
1 : Fixed 1
4. **Programming Specifications**

<table>
<thead>
<tr>
<th>Program memory (bytes)</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data memory (bytes)</td>
<td>0</td>
</tr>
<tr>
<td>Stack (bytes)</td>
<td>0</td>
</tr>
<tr>
<td>Number of states</td>
<td>19</td>
</tr>
<tr>
<td>Reentrant</td>
<td>Yes</td>
</tr>
<tr>
<td>Relocation</td>
<td>Yes</td>
</tr>
<tr>
<td>Intermediate interrupt</td>
<td>Yes</td>
</tr>
</tbody>
</table>

5. **Notes**

The number of states indicated in the programming specifications is the value when a 31-bit shift is performed.
6. Description

(1) Function

Details of the arguments are as follows.

R0: As the input argument, set the number of shift bits (0–31).
R1: Set the 32-bit data before the shift as the input argument.
    Holds the 32-bit data after the shift as the output argument.

Figure 1 shows a software SHLRN execution example.

<table>
<thead>
<tr>
<th>Input arguments</th>
<th>Output argument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of shift bits</td>
<td>31 R0 0</td>
</tr>
<tr>
<td>32-bit data before shift</td>
<td>H'0000001F (D'31)</td>
</tr>
<tr>
<td>32-bit data after shift</td>
<td>31 R1 0</td>
</tr>
<tr>
<td></td>
<td>H'80000000</td>
</tr>
<tr>
<td></td>
<td>H'00000001</td>
</tr>
</tbody>
</table>

Figure 1  Software SHLRN Execution Example

(2) Usage Notes

The contents of R1, which holds the 32-bit data before the shift, are destroyed after the shift when the 32-bit data after the shift is stored there. If the value for the 32-bit data before the shift will be needed after the software SHLRN instruction is executed, it should be saved beforehand.

(3) RAM Used

No RAM is used by the software SHLRN instruction.
(4) Usage Example

After the number of shift bits and the 32-bit data before the shift have been set in the input arguments, the software SHLRN instruction is executed by a subroutine call.

```assembly
MOV #H'05, R0 .... Sets number of shift bits in input argument (R0)
BSR SHARN .... Subroutine call to software SHLRN
MOV.L DATA, R1 .... Sets 32-bit data before shift in input argument (R1)
```

(5) Operating Principle

Bits 4 to 0 in R0, which is set to the number of shift bits, are tested. If any of them have a value of 1, a shift corresponding to the weighting of the bits in question is performed using the 16-bit logical right shift command (SHLR16), the 8-bit logical right shift command (SHLR8), the 2-bit logical right shift command (SHLR2), and the 1-bit logical right shift command (SHLR).

<table>
<thead>
<tr>
<th>Bit Number</th>
<th>Weighting</th>
<th>Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit 4</td>
<td>$2^4 = 16$</td>
<td>SHLR16</td>
</tr>
<tr>
<td>Bit 3</td>
<td>$2^3 = 8$</td>
<td>SHLR8</td>
</tr>
<tr>
<td>Bit 2</td>
<td>$2^2 = 4$</td>
<td>SHLR2 (twice)</td>
</tr>
<tr>
<td>Bit 1</td>
<td>$2^1 = 2$</td>
<td>SHLR2</td>
</tr>
<tr>
<td>Bit 0</td>
<td>$2^0 = 1$</td>
<td>SHLR</td>
</tr>
</tbody>
</table>
7. Flowchart

```
SHLRN

Bit 4 of R0 = 1?  
No

Yes

16-bit logical right shift of R1
by SHLR16 instruction

Bit 3 of R0 = 1?  
No

Yes

8-bit logical right shift of R1
by SHLR8 instruction

Bit 2 of R0 = 1?  
No

Yes

4-bit logical right shift of R1
by SHLR2 instruction (twice)

Bit 1 of R0 = 1?  
No

Yes

2-bit logical right shift of R1
by SHLR2 instruction

Bit 0 of R0 = 1?  
No

Yes

1-bit logical right shift of R1
by SHLR instruction

RTS
```
8. Program Listing

```assembly
;***************************************************************
; * NAME n BITS SHIFT LOGICAL RIGHT (SHLRN) *
;***************************************************************
; ENTRY : R0 (NUMBER OF BIT SHIFTED) *
; R1 (32 BIT DATA) *
; RETURNS : R1 (SHIFT RESULT) *
;***************************************************************

00001000 .SECTION A, CODE, LOCATE=H'1000
00001000 SHLRN .EQU $ ; Entry point
14 00001000 SHLRN1
15 00001000 C810 TST #B'00010000, R0 ; Bit 4 = 1?
16 00001002 4129 SHLR16 R1 ; 16 bit shift logical right
17 00001004 C808 TST #B'00001000, R0 ; Bit 3 = 1?
18 00001006 4119 SHLR8 R1 ; 8 bit shift logical right
19 00001008 C804 TST #B'00000100, R0 ; Bit 2 = 1?
20 0000100A 4109 SHLR2 R1 ; 4 bit shift logical right
21 0000100C C802 TST #B'00000010, R0 ; Bit 1 = 1?
22 00001010 4101 SHLR R1 ; 1 bit shift logical right
23 00001012 27 SHLRN4
24 00001014 C800 TST #B'00000010, R0 ; Bit 1 = 1?
25 00001010 8900 BT SHLR5
26 00001012 31 SHLR5
27 00001014 C801 TST #B'00000010, R0 ; Bit 0 = 1?
28 00001016 8900 BT SHLR_END
29 00001018 33 SHLR_END
30 00001020 35 SHLR_END
31 00001022 000B RTS
32 38 .END

*****TOTAL ERRORS 0
*****TOTAL WARNINGS 0
```
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