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April 1\(^{st}\), 2010
Renesas Electronics Corporation

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H8SX Series

Multiple Bit Shift

Introduction

As well as having an architecture that is upward-compatible with each CPU of the H8/300, H8/300H, and H8S series, so as to inherit a full complement of peripheral functions, the H8SX microcomputer series has a maximum operating frequency of 50 MHz and uses a 32-bit H8SX core CPU as well as an on-chip multiplier/divider to improve performance.

This H8SX series Application Note provides information you may be need during software and hardware design. This is a basic edition that provides operation examples that each use a single H8SX series on-chip peripheral function.

Although the operation of each program, circuit, and other aspects covered by this application note has been checked, make sure that you conduct your own operation checks before actually using the H8SX series.

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1. Overview

The H8SX series has an architecture that is upward-compatible with each CPU of the H8/300, H8/300H, and H8S series. Furthermore, in addition its instruction set has been enhanced to improve CPU performance. The enhancement of the instruction set has greatly improved coding efficiency compared to the conventional series. This improvement in the coding efficiency leads to benefits such as a reduction in the amount of ROM required to store programs, as well as the shortening of each instruction fetch cycle. This application note describes "multiple bit shift", which is an enhanced instruction set item.

2. Configuration

"Multiple bit shift" is described below. The conventional H8/300, H8/300H, and H8S series support only 1- or 2-bit shift instructions. With the H8SX series, however, 1-, 2-, 4-, 8-, and 16-bit shift instructions are supported as 2-byte code instructions. In addition, 32-bit shift instructions are added as 4-byte code instructions. For example, to perform a shift by 8 bits with the conventional H8S series, a 2-bit shift instruction is executed four times. With the H8SX series, an 8-bit shift instruction is executed once only. This is shown in Figure 1.

![Figure 1](image-url)
3. Sample Program

3.1 Flowchart

The sample program shown below is very simple, and will allow you to understand the description of "multiple bit shift", an enhanced instruction set item.

As a comparison with the H8S series, the results of compilation are shown. This example is for reference only because the instruction code length generated in the compilation of an application-level program greatly depends on the source program and the compile conditions. The flowchart for this sample program is shown below.

![Flowchart Image]
3.2 Program Listing

```c
/******************************************************************************
/* Include File                                                            */
******************************************************************************
#include <machine.h>

/******************************************************************************
/* Function Prototype                                                      */
******************************************************************************
void more_shift(void);

/******************************************************************************
/* RAM allocation                                                          */
******************************************************************************
static unsigned long lsrc;       // Shift Data
static unsigned long ldst;       // Execute Shift Data

/******************************************************************************
/* Function Definition(Main Program)                                       */
******************************************************************************
void more_shift(void)
{
    lsrc = 0x12345678;             // Initialize lsrc
    ldst = 0;                      // Initialize ldst

    ldst = (lsrc>>28)&0x0000000F;  // 28bit Write Shift
    ldst |= (lsrc>>20)&0x000000F0; // 20bit Write Shift
    ldst |= (lsrc>>12)&0x00000F00; // 12bit Write Shift
    ldst |= (lsrc>> 4)&0x0000F000; //  4bit Write Shift
    ldst |= (lsrc<< 4)&0x000F0000; //  4bit  Left Shift
    ldst |= (lsrc<<12)&0x00F00000; // 12bit  Left Shift
    ldst |= (lsrc<<20)&0x0F000000; // 20bit  Left Shift
    ldst |= (lsrc<<28)&0xF0000000; // 28bit  Left Shift
}
```

3.3 Comparison of the H8S Series with the H8SX Series

The result of compilation (assembly code) with the H8S series is shown below.

```
P                                                ; section
000000000   _more_shift:                      ; function: more_shift
000000000   PUSH.L  ER2
000000004   MOV.L   #305419896,ER0
00000000A   MOV.L   ER0,__$lsrc:32
000000012   SUB.L   ER0,ER0
000000014   MOV.L   ER0,__$ldst:32
00000001C   MOV.L   $__lsrc:32,ER0
000000024   MOV.W   #28,R1
000000028   L68:  
000000028   SHLR.L  #2,ER0
00000002A   DEC.W   #2,R1
00000002C   BGT    L68:8
```
0000002E  AND.L   #15,ER0
00000034  MOV.L   ER0,__$1dst:32
0000003C  MOV.W   @__$lsrc:32,R0
00000042  SUB.W   E0,ER0
00000044  SHLR.L  #2,ER0
00000046  SHLR.L  #2,ER0
00000048  AND.L   #240,ER0
0000004E  MOV.L   #__$ldst,ER1
00000054  MOV.L   @ER1,ER2
00000058  OR.L    ER0,ER2
0000005C  MOV.L   ER2,ER1
00000060  MOV.L   @__$lsrc:32,ER0
00000068  MOV.W   #12,R1
0000006C  L69:    
0000006E  AND.L   #2,ER0
00000070  BGT     L69:8
00000072  AND.L   #3840,ER0
00000078  MOV.L   @__$1dst,ER1
0000007E  MOV.L   @ER1,ER2
00000082  OR.L    ER0,ER2
00000086  MOV.L   ER2,ER1
0000008A  MOV.L   @__$lsrc:32,ER0
00000092  SHLR.L  #2,ER0
00000094  SHLR.L  #2,ER0
00000096  AND.L   #61440,ER0
0000009C  MOV.L   @ER1,ER2
000000A0  OR.L    ER0,ER2
000000A4  MOV.L   ER2,ER1
000000A8  MOV.L   @__$lsrc:32,ER0
000000B0  SHLL.L  #2,ER0
000000B2  SHLL.L  #2,ER0
000000B4  AND.L   #983040,ER0
000000BA  MOV.L   @ER1,ER2
000000BE  OR.L    ER0,ER2
000000C2  MOV.L   ER2,ER1
000000C6  MOV.L   @__$lsrc:32,ER0
000000CE  MOV.W   #12,R1
000000D2  L70:    
000000D4  DEC.W   #2,R1
000000D6  BGT     L70:8
000000D8  AND.L   #15728640,ER0
000000DE  MOV.L   @__$1dst,ER1
000000E4  MOV.L   @ER1,ER2
000000E8  OR.L    ER0,ER2
000000EC  MOV.L   ER2,ER1
000000F0  MOV.W   @__$lsrc+2:32,E0
000000F6  SUB.W   R0,R0
000000F8  SHLL.L  #2,ER0
000000FA  SHLL.L  #2,ER0
000000FC  AND.L   #251658240,ER0
00000102  MOV.L   @ER1,ER2
00000106  OR.L    ER0,ER2
The result of compilation (assembly code) with the H8SX series is shown below.

```
00000000  MOV.L   #305419896:32,@$lsrc:32
0000000C  MOV.L   #0:8,@$ldst:32
00000014  MOV.L   @$lsrc:32,ER0
00000020  AND.L   #15:16,ER0
00000024  MOV.L   ER0,@$ldst:32
0000002C  MOV.L   @$lsrc:32,ER0
00000034  SHLR.L  #16,ER0
00000036  SHLR.L  #4,ER0
00000038  AND.L   #240:16,ER0
00000044  OR.L    ER0,@$ldst:32
0000004C  SHLR.L  #8,ER0
0000004E  SHLR.L  #4,ER0
00000050  AND.L   #61440:16,ER0
00000054  OR.L    ER0,@$ldst:32
0000005C  MOV.L   @$lsrc:32,ER0
00000064  SHLR.L  #4,ER0
00000066  AND.L   #61440:16,ER0
0000006A  OR.L    ER0,@$ldst:32
00000072  MOV.L   @$lsrc:32,ER0
0000007A  SHLR.L  #4,ER0
0000007C  AND.L   #983040,ER0
00000082  OR.L    ER0,@$ldst:32
0000008A  MOV.L   @$lsrc:32,ER0
00000092  SHLR.L  #8,ER0
00000094  SHLR.L  #4,ER0
00000096  AND.L   #15728640,ER0
0000009C  OR.L    ER0,@$ldst:32
```
Table 1 lists the result of compilation with the H8S series, while Table 2 lists the result with the H8SX series.

### Table 1  Results of Compilation (H8S Series)

<table>
<thead>
<tr>
<th>Shift count</th>
<th>H8S series</th>
<th>Instruction length</th>
<th>Execution state count</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>MOV.W #28,R1</td>
<td>88</td>
<td>140</td>
</tr>
<tr>
<td></td>
<td>SHLR.L #2,ER0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DEC.W #2,R1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BGT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>MOV.W E0,R0</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>SUB.W E0,E0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SHLR.L #2,ER0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SHLR.L #2,ER0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>MOV.W #12,R1</td>
<td>40</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>L69:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SHLR.L #2,ER0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DEC.W #2,R1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BGT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>SHLR.L #2,ER0</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

B: ; section

00000000 __$lsrc ; static: lsrc
00000000 .RES.L 1
00000004 __$ldst ; static: ldst
00000004 .RES.L 1
### Table 2  Results of Compilation (H8SX Series)

<table>
<thead>
<tr>
<th>Shift count</th>
<th>H8SX series</th>
<th>Instruction length</th>
<th>Execution state count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>In bytes</td>
<td>Total</td>
</tr>
<tr>
<td>28</td>
<td>SHLR.L</td>
<td>#28:5,ER0</td>
<td>2</td>
</tr>
<tr>
<td>20</td>
<td>SHLR.L</td>
<td>#16,ER0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>SHLR.L</td>
<td>#4,ER0</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>SHLR.L</td>
<td>#8,ER0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>SHLR.L</td>
<td>#4,ER0</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>SHLR.L</td>
<td>#4,ER0</td>
<td>1</td>
</tr>
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### Revision Record

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<th>Date</th>
<th>Page</th>
<th>Summary</th>
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<td>1.00</td>
<td>Sept.19.03</td>
<td>—</td>
<td>First edition issued</td>
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