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April 1st, 2010
Renesas Electronics Corporation

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

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H8S Family
15-Phase PWM Output

Introduction
A 15-phase PWM waveform with variable duty cycle is output with the desired cycle.

Target Device
H8S/2339

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1. Specifications

(1) Outputs 15-phase PWM waveforms with variable duty cycles, as shown in figure 1.
(2) In operation at 19.6608 MHz, the period of the output PWM signal can be set to any desired value from about 50.86 ns to 3.33 ms by the value set in pwm_cyc.

![Figure 1 Example of PWM-Waveform Output](image-url)
2. Description of Module Usage

(1) TPU0 to TPU5 operate in synchronization to produce 15 PWM waveforms with different phases.

(a) Figure 2 is a block diagram of how the TPUs are used in this sample task, which demonstrates how up to 15 PWM waveforms with different phases can be output through synchronized operation of the TPU functions (PWM mode 2).
3. Principles of Operation

The principle of operation for 15-phase PWM output is shown in figure 3. As the figure shows, the pulse trains are output on the PWM-output pins, TPU0 to TPU5, through a combination of hardware and software processing.

![Principle of Operation for 15-Phase PWM Output](image)

**Figure 3** Principle of Operation for 15-Phase PWM Output

Note: Waveforms of low width:high width = 2:3 are created in the sample program. This figure is an example of operation.
4. Software Description

(1) Function

<table>
<thead>
<tr>
<th>Function</th>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main routine</td>
<td>pwrn15mn</td>
<td>Settings for simultaneous clearing of channels 0 to 5 and PWM output</td>
</tr>
</tbody>
</table>

(2) Arguments

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
<th>Data Type</th>
<th>Used in</th>
<th>I/O</th>
</tr>
</thead>
<tbody>
<tr>
<td>pwm[0] to PWM[14]</td>
<td>The timer-counter settings for low pulse width. The following expression governs pulse width. Low pulse width (ns) = timer-counter value x ( \phi ) period (50.86 ns in operation at 19.66 MHz) x frequency divisor for the input clock on each channel</td>
<td>unsigned short</td>
<td>Main routine</td>
<td>Input</td>
</tr>
<tr>
<td>pwm_cyc</td>
<td>The timer-counter setting for PWM period. The following expression governs PWM period. PWM period (ns) = timer-counter value x ( \phi ) period (50.86 ns in operation at 19.66 MHz) x frequency divisor for the input clock on each channel</td>
<td>unsigned short</td>
<td>Main routine</td>
<td>Input</td>
</tr>
</tbody>
</table>

(3) Internal Registers

<table>
<thead>
<tr>
<th>Register</th>
<th>Description</th>
<th>Used in</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSTR</td>
<td>Starts and stops counting by the timer counters of TPU0 to TPU5.</td>
<td>Main routine</td>
</tr>
<tr>
<td>TSYR</td>
<td>Selects synchronous operation for the timer counters of TPU0 to TPU5</td>
<td>Main routine</td>
</tr>
<tr>
<td>TCR0</td>
<td>Sets compare-match with TGR0A as the source for clearing the timer counters</td>
<td>Main routine</td>
</tr>
<tr>
<td>TCR1 to TCR5</td>
<td>Sets synchronous clearing as the source for clearing of the timer counters</td>
<td>Main routine</td>
</tr>
<tr>
<td>TIOR0 to TIOR5</td>
<td>Sets output on each of the PWM output pins</td>
<td>Main routine</td>
</tr>
<tr>
<td>TMDR0 to TMDR5</td>
<td>Selects PWM mode 2</td>
<td>Main routine</td>
</tr>
<tr>
<td>TGR0A</td>
<td>Sets the PWM cycle</td>
<td>Main routine</td>
</tr>
<tr>
<td>TGR0B to TGR5B</td>
<td>Sets the timer-counter values at which the levels on the PWM output pins go high</td>
<td>Main routine</td>
</tr>
<tr>
<td>MSTPCR</td>
<td>Takes the TPU out of module-stopped mode</td>
<td>Main routine</td>
</tr>
</tbody>
</table>

(4) RAM Usage

<table>
<thead>
<tr>
<th>Label</th>
<th>Set value of the sample task</th>
</tr>
</thead>
<tbody>
<tr>
<td>pwm_cyc</td>
<td>H’0FFF</td>
</tr>
</tbody>
</table>

5. PAD

(1) Main routine

- Take the TPU out of module-stopped mode.
- Set the sources for clearing of the timer-counters of TPU0 to TPU5 as follows:
  - TPU0: Compare-match with TGR0A
  - TPU1 to TPU5: Synchronous clearing
- Set the output configuration for each PWM output pin:
  - initial value = 0, and output on compare-match = 1.
- Set the value for PWM period in TGR0A, and the values for duty cycle in the other TGRs
- Select synchronized clearing of TPU1 to TPU5.
- Select the PWM mode 2 as the operating mode for TPU0 to TPU5.
- Start counting by TPU0 to TPU5.

while (1)
## Revision Record

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<th>Date</th>
<th>Description</th>
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<tr>
<td>1.00</td>
<td>Feb.17.05</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>First edition issued</td>
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