To our customers,

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April 1\textsuperscript{st}, 2010
Renesas Electronics Corporation

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

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This manual explains the sample program functions of the 16-bit interval timer (TMM) for the V850E/IA4 microcontroller.

The explanations are based on usage with the V850E/IA4 microcontroller. Refer to this manual when using the V850E/IA3, V850ES/IK1, and V850ES/IE2 microcontrollers.

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This sample program is provided for reference purposes only and operations are therefore not subject to guarantee by NEC Electronics Corporation. When using this sample program, customers are kindly advised to sufficiently evaluate this product based on their system before usage.
NOTES FOR CMOS DEVICES

① VOLTAGE APPLICATION WAVEFORM AT INPUT PIN
   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between \( V_{IL} \) (MAX) and \( V_{IH} \) (MIN) due to noise, etc., the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between \( V_{IL} \) (MAX) and \( V_{IH} \) (MIN).

② HANDLING OF UNUSED INPUT PINS
   Unconnected CMOS device inputs can be cause of malfunction. If an input pin is unconnected, it is possible that an internal input level may be generated due to noise, etc., causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using pull-up or pull-down circuitry. Each unused pin should be connected to \( V_{DD} \) or GND via a resistor if there is a possibility that it will be an output pin. All handling related to unused pins must be judged separately for each device and according to related specifications governing the device.

③ PRECAUTION AGAINST ESD
   A strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it when it has occurred. Environmental control must be adequate. When it is dry, a humidifier should be used. It is recommended to avoid using insulators that easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors should be grounded. The operator should be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with mounted semiconductor devices.

④ STATUS BEFORE INITIALIZATION
   Power-on does not necessarily define the initial status of a MOS device. Immediately after the power source is turned ON, devices with reset functions have not yet been initialized. Hence, power-on does not guarantee output pin levels, I/O settings or contents of registers. A device is not initialized until the reset signal is received. A reset operation must be executed immediately after power-on for devices with reset functions.

⑤ POWER ON/OFF SEQUENCE
   In the case of a device that uses different power supplies for the internal operation and external interface, as a rule, switch on the external power supply after switching on the internal power supply. When switching the power supply off, as a rule, switch off the external power supply and then the internal power supply. Use of the reverse power on/off sequences may result in the application of an overvoltage to the internal elements of the device, causing malfunction and degradation of internal elements due to the passage of an abnormal current. The correct power on/off sequence must be judged separately for each device and according to related specifications governing the device.

⑥ INPUT OF SIGNAL DURING POWER OFF STATE
   Do not input signals or an I/O pull-up power supply while the device is not powered. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Input of signals during the power off state must be judged separately for each device and according to related specifications governing the device.
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Cautions 1. Download the program used in this manual from the NEC Electronics Website (http://www.necel.com/).

2. When using this sample program, reference the following startup file and link directive file and adjust them if as necessary.
   • Startup file: IA4_start.s
   • Link directive file: IA4_link.dir
Conventions

The function lists are structured as follows.

### Hardware name (symbol)

<table>
<thead>
<tr>
<th>[Function]</th>
<th>Function description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Function name]</td>
<td>Name of sample function</td>
</tr>
<tr>
<td>[Argument(s)]</td>
<td>Type and overview of argument(s)</td>
</tr>
<tr>
<td>[Processing content]</td>
<td>Processing content of sample function</td>
</tr>
<tr>
<td>[Starting method]</td>
<td>Conditions for calling a function</td>
</tr>
<tr>
<td>[SFR(s) used]</td>
<td>Register name and setting content</td>
</tr>
<tr>
<td>[call function(s)]</td>
<td>Name and function of call function(s)</td>
</tr>
<tr>
<td>[Variable(s)]</td>
<td>Type, name, and overview of variable(s) used in sample function</td>
</tr>
<tr>
<td>[Interrupt(s)]</td>
<td>Name of function</td>
</tr>
<tr>
<td>[Interrupt source(s)]</td>
<td>Name</td>
</tr>
<tr>
<td>[File name]</td>
<td>Name of corresponding sample program file</td>
</tr>
<tr>
<td>[Caution(s)]</td>
<td>Caution(s) upon function usage</td>
</tr>
</tbody>
</table>

### Interrupt function

<table>
<thead>
<tr>
<th>[Function name]</th>
<th>Name of interrupt function</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Overview]</td>
<td>Processing content</td>
</tr>
<tr>
<td>[Factor(s)]</td>
<td>Name of interrupt and conditions for occurrence</td>
</tr>
<tr>
<td>[call function(s)]</td>
<td>None</td>
</tr>
<tr>
<td>[Variable(s)]</td>
<td>Name of variable, function</td>
</tr>
<tr>
<td>[File name]</td>
<td>Name of corresponding sample program file</td>
</tr>
<tr>
<td>[Caution(s)]</td>
<td>None</td>
</tr>
</tbody>
</table>

### Product Differences

The differences between the V850E/IA4 and the V850E/IA3, V850ES/IK1, and V850ES/IE2 related to the 16-bit interval timer (TMM) are shown below.

<table>
<thead>
<tr>
<th>Item</th>
<th>V850E/IA4</th>
<th>V850E/IA3</th>
<th>V850ES/IK1</th>
<th>V850ES/IE2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count clock</td>
<td>fxx/2, fxx/4, fxx/8, fxx/16, fxx/32, fxx/64, fxx/128, fxx/256</td>
<td>fxx/2, fxx/4, fxx/8, fxx/16, fxx/32, fxx/64, fxx/128, fxx/256</td>
<td>fxx, fxx/2, fxx/4, fxx/8, fxx/16, fxx/32, fxx/64, fxx/128</td>
<td>fxx/128</td>
</tr>
</tbody>
</table>

**Remark**

fxx: Peripheral clock frequency
Related Documents

The related documents indicated in this publication may include preliminary versions. However, preliminary versions are not marked as such.

Documents related to the V850E/IA3, V850E/IA4, V850ES/IK1, and V850ES/IE2

<table>
<thead>
<tr>
<th>Document Name</th>
<th>Document No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>V850E1 Architecture User’s Manual</td>
<td>U14559E</td>
</tr>
<tr>
<td>V850E/IA3, V850E/IA4 Hardware User’s Manual</td>
<td>U16543E</td>
</tr>
<tr>
<td>V850ES Architecture User’s Manual</td>
<td>U15943E</td>
</tr>
<tr>
<td>V850ES/IK1 Hardware User’s Manual</td>
<td>U16910E</td>
</tr>
<tr>
<td>V850ES/IE2 Hardware User’s Manual</td>
<td>U17716E</td>
</tr>
<tr>
<td>Inverter Control by V850 Series Vector Control by Hole Sensor Application Note</td>
<td>U17338E</td>
</tr>
<tr>
<td>Inverter Control by V850 Series Vector Control by Encoder Application Note</td>
<td>U17324E</td>
</tr>
<tr>
<td>Inverter Control by V850 Series 120° Excitation Method Control by Zero-Cross Detection Application Note</td>
<td>U17209E</td>
</tr>
<tr>
<td>Manual for Using Sample Program Functions DMA Functions (V850E/IA3, V850E/IA4) Application Note</td>
<td>U18235E</td>
</tr>
<tr>
<td>Manual for Using Sample Program Functions Timer M (V850E/IA3, V850E/IA4, V850ES/IK1, V850ES/IE2) Application Note</td>
<td>This manual</td>
</tr>
<tr>
<td>Manual for Using Sample Program Functions Timer ENC (V850E/IA3, V850E/IA4) Application Note</td>
<td>U18240E</td>
</tr>
<tr>
<td>Manual for Using Sample Program Functions Clock Generator (V850E/IA3, V850E/IA4, V850ES/IK1, V850ES/IE2) Application Note</td>
<td>U18242E</td>
</tr>
</tbody>
</table>
16-bit interval timer (TMM0)

Startup

[Function] Clears 16-bit counter if values of 16-bit counter and TM0CMP0 register match, and an interrupt request signal is generated.

[Function name] timer_interval

[Arguments] unsigned char set_TM0CTL0 Sets count clock.
unsigned short set_TM0CMP0 Sets compare register.

[Processing content] Calls an interrupt function every millisecond.

[Starting method] Starts by calling timerm_interval_st function.

[SFRs used] TM0CTL0 Controls mode of 16-bit counter.
TM0CMP0 Compare register of 16-bit counter

[call function] main main function

[Variable] None

[Interrupt] timerm_interval_int

[Interrupt source] INTTM0EQ0

[File name] timerm_interval\timerm_1.c,
timerm_interval\MAIN.C

[Cautions]
• Call when operation of 16-bit counter is stopped.
• Operate in clock-through mode (8 MHz).
• Set port 1 before calling.
• Set TM0CTL0 (count clock setting) when TMM0 is stopped.
• Bits 3 to 6 of TM0CTL0 must be set to 0.
• Rewriting of TM0CMP0 (compare register) during operation of TMM0 is prohibited.

The setting time is determined by the following formula (during clock-through mode (8 MHz)).

Synchronizing clock: 8 MHz = 1/8 ⇒ 0.125 μs
Count clock frequency (for fxx/32): 0.125 μs × 32 ⇒ 4 μs
Value of compare register when generating an interrupt every millisecond: 1000 μs/4 μs ⇒ 250 – 1 = 249
### Starting function of timerm_interval

<table>
<thead>
<tr>
<th>Function name</th>
<th>timerm_interval_st</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argument</td>
<td>None</td>
</tr>
<tr>
<td>Processing content</td>
<td>Starting function of timerm_interval</td>
</tr>
<tr>
<td>Starting method</td>
<td>Call after timerm_interval function.</td>
</tr>
<tr>
<td>SFR used</td>
<td>TM0CTL0.TM0CE</td>
</tr>
<tr>
<td></td>
<td>Operation control of 16-bit counter.</td>
</tr>
<tr>
<td>Call function</td>
<td>None</td>
</tr>
<tr>
<td>Variable</td>
<td>None</td>
</tr>
<tr>
<td>Caution</td>
<td>None</td>
</tr>
</tbody>
</table>

### User definition

<table>
<thead>
<tr>
<th>Function name</th>
<th>timerm_interval_int</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>User definition</td>
</tr>
<tr>
<td>Factor</td>
<td>INTTM0EQ0</td>
</tr>
<tr>
<td></td>
<td>Match between count value of 16-bit counter and TM0CMP0</td>
</tr>
<tr>
<td>Call function</td>
<td>None</td>
</tr>
<tr>
<td>Variable</td>
<td>None</td>
</tr>
<tr>
<td>File name</td>
<td>timerm_interval/timerm_1.c</td>
</tr>
<tr>
<td>Caution</td>
<td>None</td>
</tr>
</tbody>
</table>
16-bit interval timer (TMM0)

Startup

- Enables interrupt
- TMM0 interval timer (setting)
- TMM0 interval timer (start)

- TM0EQMK0 ← 0
- Enables INTTM0EQ0 interrupt
- TMM0 interval timer
- ret

- Timerm_interval
- ret

- TM0CE ← 1
  Enables TMM0 operation (TM0CTL0: bit 7 of TM0CTL0 register)
- ret

- INTTM0EQ0 (Match between count value of 16-bit counter and TM0CMP0)
- Timerm_interval_int
  reti

- EI
  Enables interrupt
- Timerm_interval_init
  Timerm_interval_start
  Timerm_interval_int
For further information, please contact:

NEC Electronics Corporation
1753, Shimonumabe, Nakahara-ku, Kawasaki, Kanagawa 211-8668, Japan
Tel: 044-435-5111
http://www.necel.com/

[America]
NEC Electronics America, Inc.
2880 Scott Blvd.
Santa Clara, CA 95050-2554, U.S.A.
Tel: 408-588-6000
800-368-9782
http://www.am.necel.com/

[Europe]
NEC Electronics (Europe) GmbH
Arcadiastrasse 10
40472 Düsseldorf, Germany
Tel: 0211-65030
http://www.eu.necel.com/

- Hanover Office
  Podbielskiestr 166 B
  30177 Hannover
  Tel: 0 511 33 40 2-0

- Munich Office
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  81829 München
  Tel: 0 89 92 10 03-0

- Stuttgart Office
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  Tel: 0 711 99 01 0-0

- United Kingdom Branch
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  Linford Wood, Milton Keynes
  MK14 6NP, U.K.
  Tel: 01908-691-133

- Succursale Française
  9, rue Paul Dautier, B.P. 52
  78142 Velizy-Villacoublay Cédex
  France
  Tel: 01-3067-5800

- Succursal en España
  Juan Esplandiu, 15
  28007 Madrid, Spain
  Tel: 091-504-2787

- Tyskland Filial
  Täby Centrum
  Entrance S (7th floor)
  18322 Täby, Sweden
  Tel: 08 638 72 00

- Filiale Italiana
  Via Fabio Filzi, 25/A
  20124 Milano, Italy
  Tel: 02-667541

- Branch The Netherlands
  Steigerweg 6
  5616 HS Eindhoven
  The Netherlands
  Tel: 040 265 40 10

[Asia & Oceania]
NEC Electronics (China) Co., Ltd
7th Floor, Quantum Plaza, No. 27 ZhiChunLu Haidian District, Beijing 100083, P.R.China
Tel: 010-8235-1155
http://www.cn.necel.com/

NEC Electronics Hong Kong Ltd.
12/F., Cityplaza 4,
12 Tai Kok Wan Road, Hong Kong
Tel: 2886-9318
http://www.hk.necel.com/

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Taipei, Taiwan, R. O. C.
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NEC Electronics Singapore Pte. Ltd.
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#12-08 Novena Square,
Singapore 307684
Tel: 6253-8311
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NEC Electronics Korea Ltd.
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