

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.

Manual for Using Sample Program Functions Timer P (V850E/IA3, V850E/IA4, V850ES/IK1, V850ES/IE2)

This manual explains the sample program functions of the 16-bit timer/event counter P (TMP) 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.

Caution

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.

These commodities, technology or software, must be exported in accordance with the export administration regulations of the exporting country. Diversion contrary to the law of that country is prohibited.

• **The information in this document is current as of July, 2006. The information is subject to change without notice. For actual design-in, refer to the latest publications of NEC Electronics data sheets or data books, etc., for the most up-to-date specifications of NEC Electronics products. Not all products and/or types are available in every country. Please check with an NEC Electronics sales representative for availability and additional information.**

• No part of this document may be copied or reproduced in any form or by any means without the prior written consent of NEC Electronics. NEC Electronics assumes no responsibility for any errors that may appear in this document.

• NEC 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 NEC Electronics products listed in this document or any other liability arising from the use of such products. No license, express, implied or otherwise, is granted under any patents, copyrights or other intellectual property rights of NEC Electronics or others.

• Descriptions of circuits, software and other related information in this document are provided for illustrative purposes in semiconductor product operation and application examples. The incorporation of these circuits, software and information in the design of a customer's equipment shall be done under the full responsibility of the customer. NEC Electronics assumes no responsibility for any losses incurred by customers or third parties arising from the use of these circuits, software and information.

• While NEC Electronics endeavors to enhance the quality, reliability and safety of NEC Electronics products, customers agree and acknowledge that the possibility of defects thereof cannot be eliminated entirely. To minimize risks of damage to property or injury (including death) to persons arising from defects in NEC Electronics products, customers must incorporate sufficient safety measures in their design, such as redundancy, fire-containment and anti-failure features.

• NEC Electronics products are classified into the following three quality grades: "Standard", "Special" and "Specific".

The "Specific" quality grade applies only to NEC Electronics products developed based on a customer-designated "quality assurance program" for a specific application. The recommended applications of an NEC Electronics product depend on its quality grade, as indicated below. Customers must check the quality grade of each NEC Electronics product before using it in a particular application.

"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.

"Special": 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, life support systems and medical equipment for life support, etc.

The quality grade of NEC Electronics products is "Standard" unless otherwise expressly specified in NEC Electronics data sheets or data books, etc. If customers wish to use NEC Electronics products in applications not intended by NEC Electronics, they must contact an NEC Electronics sales representative in advance to determine NEC Electronics' willingness to support a given application.

(Note)

(1) "NEC Electronics" as used in this statement means NEC Electronics Corporation and also includes its majority-owned subsidiaries.

(2) "NEC Electronics products" means any product developed or manufactured by or for NEC Electronics (as defined above).

INTRODUCTION

- 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)

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

Interrupt function(s)

[Function name]	Name of interrupt function
[Overview]	Processing content
[Factor(s)]	Name of interrupt and conditions for occurrence
[call function(s)]	None
[Variable(s)]	Name of variable, function
[File name]	Name of corresponding sample program file
[Caution(s)]	None

Product Differences The differences between the V850E/IA4 and the V850E/IA3, V850ES/IK1, and V850ES/IE2 related to the 16-bit timer/event counter P (TMP) are shown below.

Item	V850E/IA4	V850E/IA3	V850ES/IK1	V850ES/IE2
TOP31 pin	Provided	Provided	Provided	
Count clock	fxx/2, fxx/4, fxx/8, fxx/16, fxx/32, fxx/64, fxx/128, fxx/256	fxx/2, fxx/4, fxx/8, fxx/16, fxx/32, fxx/64, fxx/128, fxx/256	fxx, fxx/2, fxx/4, fxx/8, fxx/16, fxx/32, fxx/64, fxx/128	

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 V850E/IA3, V850E/IA4, V850ES/IK1, and V850ES/IE2

Document Name	Document No.
V850E1 Architecture User's Manual	U14559E
V850E/IA3, V850E/IA4 Hardware User's Manual	U16543E
V850ES Architecture User's Manual	U15943E
V850ES/IK1 Hardware User's Manual	U16910E
V850ES/IE2 Hardware User's Manual	U17716E
Inverter Control by V850 Series Vector Control by Hole Sensor Application Note	U17338E
Inverter Control by V850 Series Vector Control by Encoder Application Note	U17324E
Inverter Control by V850 Series 120° Excitation Method Control by Zero-Cross Detection Application Note	U17209E
Manual for Using Sample Program Functions Serial Communication (UARTA) (V850E/IA3, V850E/IA4, V850ES/IK1, V850ES/IE2) Application Note	U18233E
Manual for Using Sample Program Functions Serial Communication (CSIB) (V850E/IA3, V850E/IA4, V850ES/IK1, V850ES/IE2) Application Note	U18234E
Manual for Using Sample Program Functions DMA Functions (V850E/IA3, V850E/IA4) Application Note	U18235E
Manual for Using Sample Program Functions Timer M (V850E/IA3, V850E/IA4, V850ES/IK1, V850ES/IE2) Application Note	U18236E
Manual for Using Sample Program Functions Watchdog Timer (V850E/IA3, V850E/IA4, V850ES/IK1, V850ES/IE2) Application Note	U18237E
Manual for Using Sample Program Functions Timer P (V850E/IA3, V850E/IA4, V850ES/IK1, V850ES/IE2) Application Note	This manual
Manual for Using Sample Program Functions Timer Q (V850E/IA3, V850E/IA4, V850ES/IK1, V850ES/IE2) Application Note	U18239E
Manual for Using Sample Program Functions Timer ENC (V850E/IA3, V850E/IA4) Application Note	U18240E
Manual for Using Sample Program Functions Port Functions (V850E/IA3, V850E/IA4, V850ES/IK1, V850ES/IE2) Application Note	U18241E
Manual for Using Sample Program Functions Clock Generator (V850E/IA3, V850E/IA4, V850ES/IK1, V850ES/IE2) Application Note	U18242E
Manual for Using Sample Program Functions Standby Functions (V850E/IA3, V850E/IA4, V850ES/IK1, V850ES/IE2) Application Note	U18243E
Manual for Using Sample Program Functions Interrupt Functions (V850E/IA3, V850E/IA4, V850ES/IK1, V850ES/IE2) Application Note	U18244E
Manual for Using Sample Program Functions A/D Converters 0 and 1 (V850E/IA3, V850E/IA4, V850ES/IK1, V850ES/IE2) Application Note	U18245E
Manual for Using Sample Program Functions A/D Converter 2 (V850E/IA3, V850E/IA4) Application Note	U18246E

CONTENTS

16-bit timer/event counter P (TMPn) (n = 0 to 3)	
Interval timer mode	8
16-bit timer/event counter P (TMPk) (k = 0, 2)	
External event counter mode	12
16-bit timer/event counter P (TMPm) (m = 0, 2, 3)	
External trigger pulse output mode	15
16-bit timer/event counter P (TMPm) (m = 0, 2, 3)	
One-shot pulse output mode.....	19
16-bit timer/event counter P (TMPm) (m = 0, 2, 3)	
PWM output mode	23
16-bit timer/event counter P (TMPn) (n = 0 to 3)	
Free-running timer mode	27
16-bit timer/event counter P (TMPk) (k = 0, 2)	
Pulse width measurement mode.....	32

16-bit timer/event counter P (TMPn) (n = 0 to 3)
Interval timer mode

(1/2)

[Functions]	<p>Outputs a PWM waveform with a duty factor of 50% from the TOP00 pin at an interval set by the TP0CCR0 register.</p> <p>Inverts the TOP01 pin output when the value set by the TP0CCR1 register and the count value of the 16-bit counter match.</p> <p>Can be implemented with TMP0 to TMP3.</p>
[Function name]	timerp_interval
[Argument]	None
[Processing content]	<p>Performs count operation of an f_{xx}/32 count clock, generates an interrupt by inverting the TOP00 pin output upon the count subsequent to the count whose value matches the value of the TP0CCR0 register, and clears the counter.</p> <p>Generates an interrupt by inverting the TOP01 pin output upon the count subsequent to the count whose value matches the value of the TP0CCR1 register.</p> <p>The TOP00 and TOP01 pins start output at high level.</p>
[Starting method]	Starts by calling the timerp_interval_st function.
[SFRs used]	<p>TP0CTL0 Selects the count clock.</p> <p>TP0CTL1 Selects the timer mode.</p> <p>TP0IOC0 • Sets the TOP00 and TOP01 pin outputs. • Sets the TOP00 and TOP01 pin output levels.</p> <p>TP0CCR0 Compare register of the 16-bit counter</p> <p>TP0CCR1 Compare register of the 16-bit counter</p>
[call function]	main main function
[Variable]	None
[Interrupts]	<p>timerp_TP0CC0_int</p> <p>timerp_TP0CC1_int</p>
[Interrupt sources]	<p>INTTP0CC0</p> <p>INTTP0CC1</p>
[File name]	<p>timerp_interval\timerp_1.c,</p> <p>timerp_interval\MAIN.C</p>

[Cautions]	<p>The following care must be exercised for setting the registers.</p> <p>TPnCTL1(n = 0 to 3)</p> <p>Bit 7: Only TMP0 and TMP1 are settable. TMP2 and TMP3 must be set to 0.</p> <p>Bit 6: Only TMP0, TMP2, and TMP3 are settable. TMP1 must be set to 0.</p> <p>Bit 5: Only TMP0 and TMP2 are settable. TMP1 and TMP3 must be set to 0.</p> <p>TPmIOC0 (m = 0, 2, 3)</p> <p>Bits 1 and 0: Only TMP0 is valid. TMP2 and TMP3 must be set to 0.</p>
------------	--

The interval time can be calculated by the following formula.

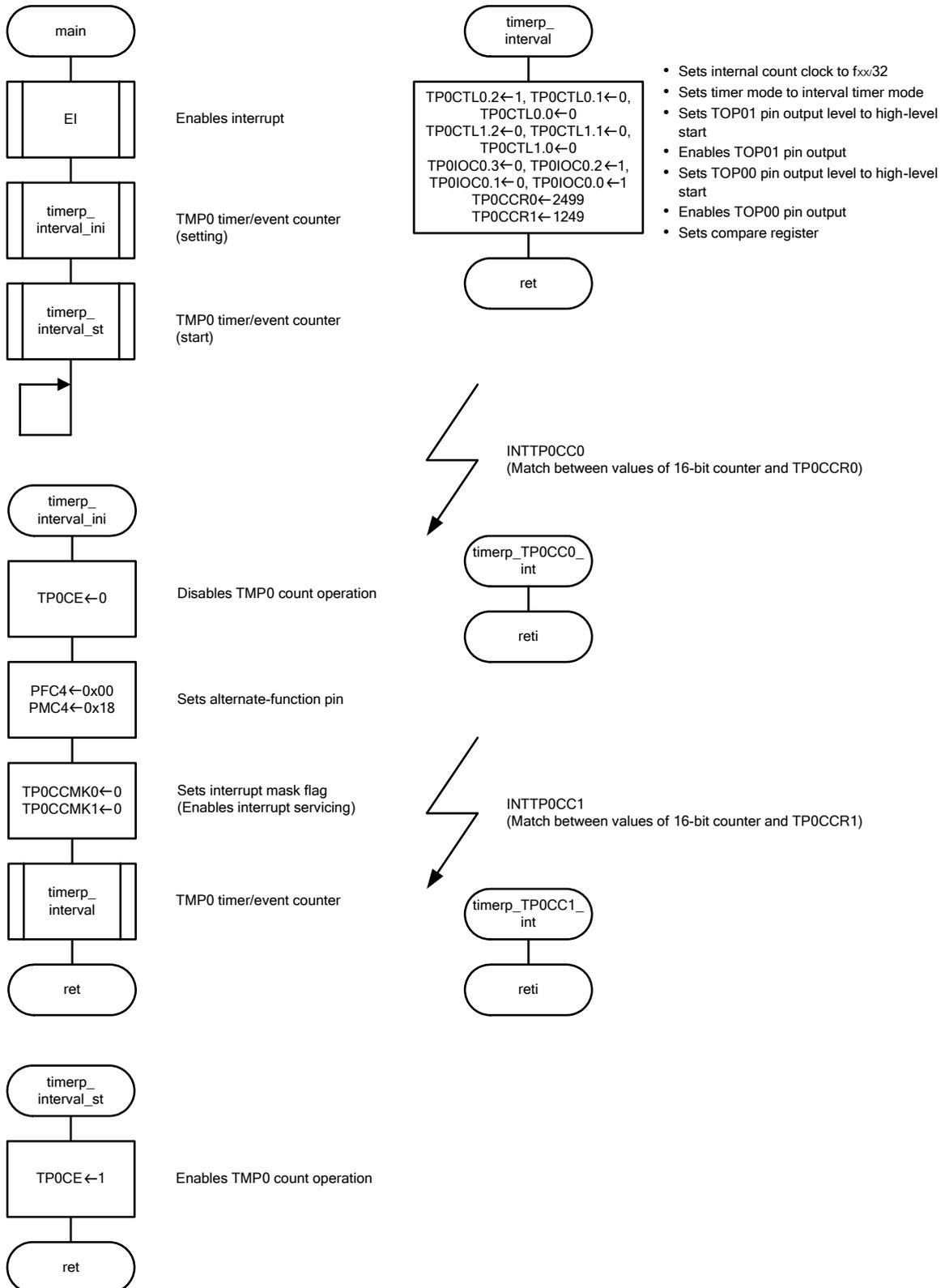
$\text{Interval} = (\text{Set value of TP0CCR0 register} + 1) \times \text{Count clock cycle}$
--

[Function name]	timerp_interval_st
[Argument]	None
[Processing content]	Starting function of timerp_interval
[Starting method]	Call this function after calling the timerp_interval function.
[SFR used]	TP0CTL0.TP0CE Controls TMP0 operation.
[call function]	None
[Variable]	None
[File name]	timerp_interval/timerp_1.c
[Caution]	None

Interrupt functions

[Function name]	timerp_TP0CC0_int
[Overview]	Defined by the user.
[Factor]	INTTP0CC0 Match between the count value of the 16-bit counter and TP0CCR0
[call function]	None
[Variable]	None
[File name]	timerp_interval/timerp_1.c
[Caution]	None

[Function name]	timerp_TP0CC1_int
[Overview]	Defined by the user.
[Factor]	INTTP0CC1 Match between the count value of the 16-bit counter and TP0CCR1
[call function]	None
[Variable]	None
[File name]	timerp_interval/timerp_1.c
[Caution]	None



16-bit timer/event counter P (TMPk) (k = 0, 2) External event counter mode

[Functions]	<p>Counts the valid edge of the external event count input (TIP00 pin) and generates an interrupt request signal (INTTP0CC0) for each count set to the TP0CCR0 register. (Clears the 16-bit counter simultaneously.)</p> <p>Generates an interrupt request signal (INTTP0CCR1) upon a compare match between the count value of the 16-bit counter and the value of the TP0CCR1 register.</p> <p>Can be implemented with TMP0 and TMP2.</p>
[Function name]	timerp_event_count
[Argument]	None
[Processing content]	<p>Counts the valid edge of the external event count input, generates an interrupt upon the count subsequent to the count whose value matches the value of the TP0CCR0 register, and clears the counter.</p> <p>Generates an interrupt upon the count subsequent to the count whose value matches the value of the TP0CCR1 register.</p>
[Starting method]	Starts by calling the timerp_event_count_st function.
[SFRs used]	<p>TP0CTL0 Selects the count clock.</p> <p>TP0CTL1 Selects the timer mode.</p> <p>TP0IOC2</p> <ul style="list-style-type: none"> • Sets the valid edge of the external event count input signal (TIP00 pin). • Sets the valid edge of the external trigger input signal (TIP00 pin). <p>TP0CCR0 Compare register of the 16-bit counter</p> <p>TP0CCR1 Compare register of the 16-bit counter</p>
[call function]	main main function
[Variable]	None
[Interrupts]	<p>timerp_TP0CC0_int</p> <p>timerp_TP0CC1_int</p>
[Interrupt sources]	<p>INTTP0CC0</p> <p>INTTP0CC1</p>
[File name]	<p>timerp_event_count\timerp_2.c,</p> <p>timerp_event_count\MAIN.C</p>
[Cautions]	<ul style="list-style-type: none"> • The TP0CCR0 and TP0CCR1 registers must not be set to 0x0000. • The following care must be exercised for setting the registers. <p>TPkCTL1</p> <p style="padding-left: 20px;">Bit 7: Only TMP0 settable. TMP2 must be set to 0.</p> <p>TPkIOC0</p> <p style="padding-left: 20px;">Set to 0x00.</p>

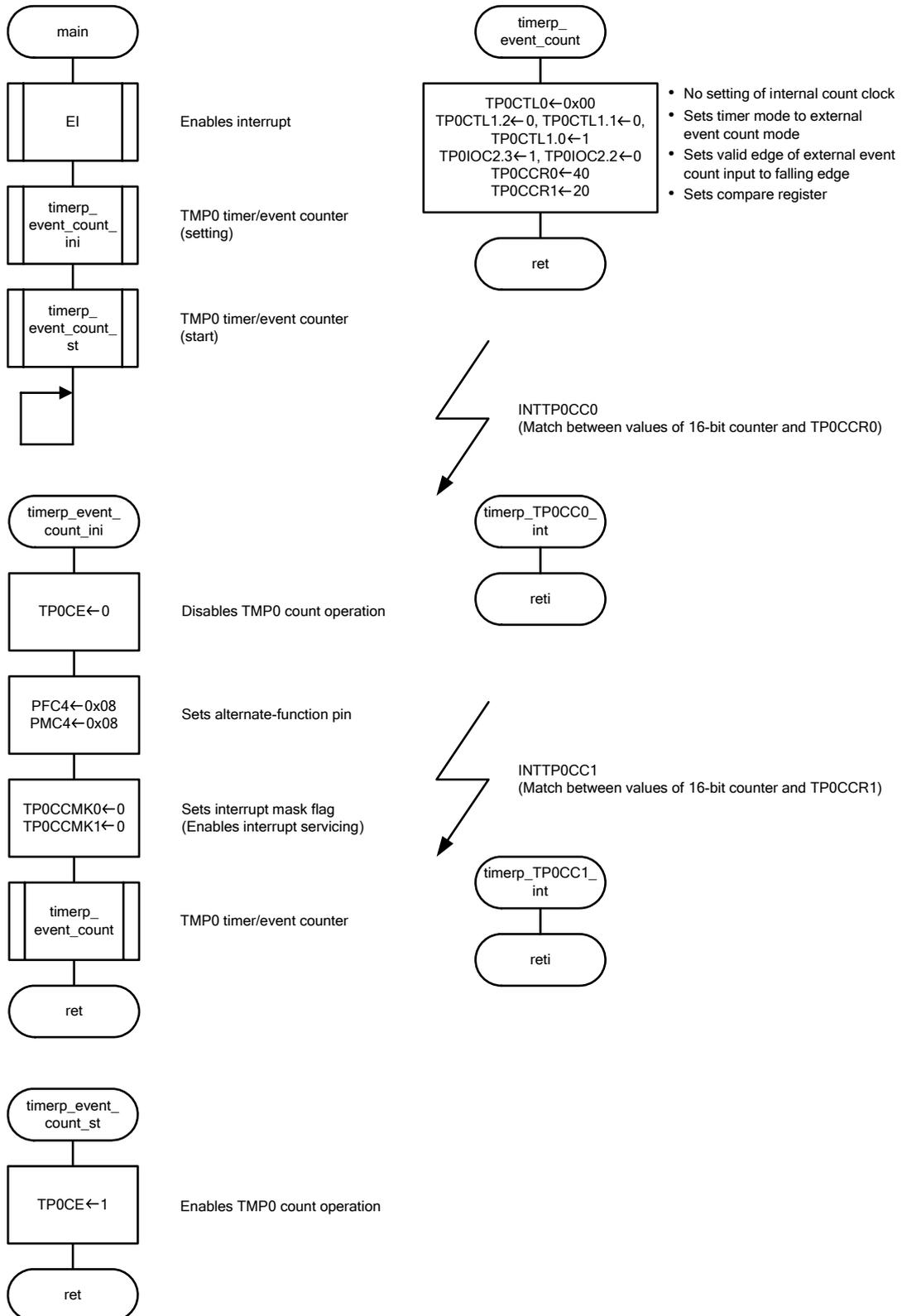
[Function name]	timerp_event_count_st
[Argument]	None
[Processing content]	Starting function of timerp_event_count
[Starting method]	Call this function after calling the timerp_event_count function.
[SFR used]	TP0CTL0.TP0CE Controls TMP0 operation.
[call function]	None
[Variable]	None
[File name]	timerp_event_count\timerp_2.c
[Caution]	None

Interrupt functions

[Function name]	timerp_TP0CC0_int
[Overview]	Defined by the user.
[Factor]	INTTP0CC0 Match between the count value of the 16-bit counter and TP0CCR0
[call function]	None
[Variable]	None
[File name]	timerp_event_count\timerp_2.c
[Caution]	None

[Function name]	timerp_TP0CC1_int
[Overview]	Defined by the user.
[Factor]	INTTP0CC1 Match between the count value of the 16-bit counter and TP0CCR1
[call function]	None
[Variable]	None
[File name]	timerp_event_count\timerp_2.c
[Caution]	None

16-bit timer/event counter P (TMPk)
External event counter mode



16-bit timer/event counter P (TMPm) (m = 0, 2, 3)
 External trigger pulse output mode

(1/2)

[Functions]	<p>Starts operation of the 16-bit counter when the valid edge of the external trigger input (TIP00) is detected.</p> <p>Clears the 16-bit counter upon a compare match with the TP0CCR0 register.</p> <p>Inverts the TOP01 pin output upon a match between the value set by the TP0CCR1 register and the count value of the 16-bit counter.</p> <p>Inverts the TOP01 pin output when the 16-bit counter is cleared.</p> <p>Can be implemented with TMP0, TMP2, and TMP3 (software trigger only for TMP3).</p>
[Function name]	timerp_trigger_pulse
[Argument]	None
[Processing content]	<p>Starts count operation of an fxx/32 count clock when the valid edge of the external trigger input is detected, generates an interrupt upon the count subsequent to the count whose value matches the value of the TP0CCR0 register, and clears the counter.</p> <p>Generates an interrupt by inverting the TOP01 pin output upon the count subsequent to the count whose value matches the value of the TP0CCR1 register.</p> <p>TOP01 pin starts output at high level.</p>
[Starting method]	Starts by calling the timerp_trigger_pulse_st function.
[SFRs used]	<p>TP0CTL0 Selects the count clock.</p> <p>TP0CTL1 Selects the timer mode.</p> <p>TP0IOC0</p> <ul style="list-style-type: none"> • Sets the TOP00 and TOP01 pin outputs. • Sets the TOP00 and TOP01 pin output levels. <p>TP0IOC2</p> <ul style="list-style-type: none"> • Sets the valid edge of the external event count input signal (TIP00 pin). • Sets the valid edge of the external trigger input signal (TIP00 pin). <p>TP0CCR0 Compare register of the 16-bit counter</p> <p>TP0CCR1 Compare register of the 16-bit counter</p>
[call function]	main main function
[Variable]	None
[Interrupts]	<p>timerp_TP0CC0_int</p> <p>timerp_TP0CC1_int</p>
[Interrupt sources]	<p>INTTP0CC0</p> <p>INTTP0CC1</p>
[File name]	<p>timerp_trigger_pulse\timerp_3.c,</p> <p>timerp_trigger_pulse\MAIN.C</p>

[Cautions]

- The compare register is written in batch write mode.
When changing the value of the compare register during timer operation, change the value of the TP0CCR1 register at the end.
- The following care must be exercised for setting the registers.
TPmCTL1
 Bit 7: Only TMP0 is settable. TMP2 and TMP3 must be set to 0.
 Bit 5: Only TMP0 and TMP2 are settable. TMP3 must be set to 0
 TPmIOC0
 Bits 1 and 0: Only TMP0 is valid. TMP2 and TMP3 must be set to 0.

The active level width, cycle and duty factor of the PWM waveform can be calculated by the following formula.

Active level width = (Set value of TP0CCR1 register) × Count clock cycle

Cycle = (Set value of TP0CCR0 register + 1) × Count clock cycle

Duty factor = (Set value of TP0CCR1 register)/(Set value of TP0CCR0 register + 1)

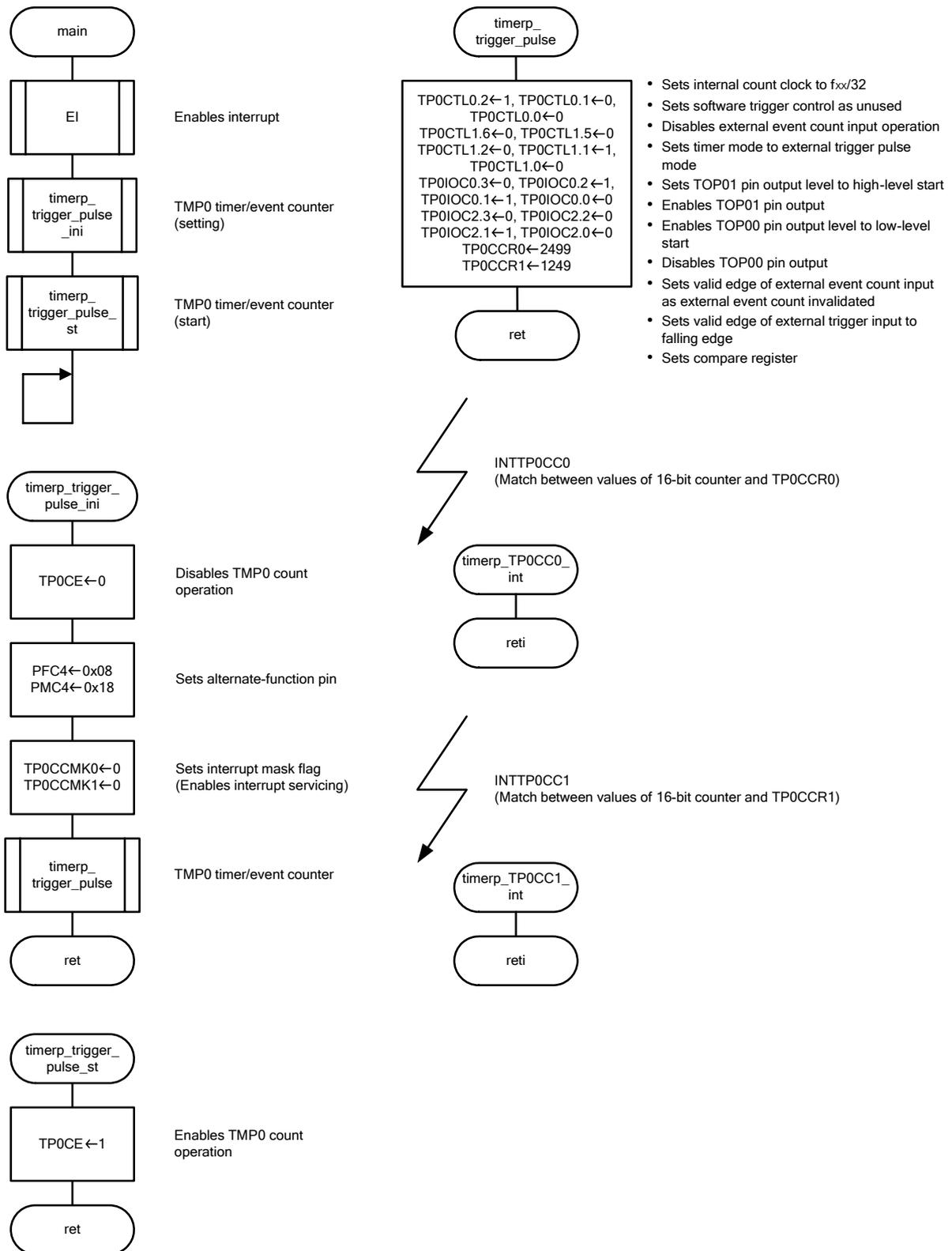
[Function name]	timerp_trigger_pulse_st
[Argument]	None
[Processing content]	Starting function of timerp_trigger_pulse
[Starting method]	Call this function after calling the timerp_trigger_pulse function.
[SFR used]	TP0CTL0.TP0CE Controls TMP0 operation.
[call function]	None
[Variable]	None
[File name]	timerp_trigger_pulse\timerp_3.c
[Caution]	None

Interrupt functions

[Function name]	timerp_TP0CC0_int
[Overview]	Defined by the user.
[Factor]	INTTP0CC0 Match between the count value of the 16-bit counter and TP0CCR0
[call function]	None
[Variable]	None
[File name]	timerp_trigger_pulse\timerp_3.c
[Caution]	None

[Function name]	timerp_TP0CC1_int
[Overview]	Defined by the user.
[Factor]	INTTP0CC1 Match between the count value of the 16-bit counter and TP0CCR1
[call function]	None
[Variable]	None
[File name]	timerp_trigger_pulse\timerp_3.c
[Caution]	None

16-bit timer/event counter P (TMPm)
External trigger pulse output mode



16-bit timer/event counter P (TMPm) (m = 0, 2, 3)
 One-shot pulse output mode

(1/2)

[Functions]	<p>Starts operation of the 16-bit counter when the valid edge of the external trigger input (TIP00 pin) is detected.</p> <p>Stops the count when the 16-bit counter is cleared upon a compare match with the TP0CCR0 register.</p> <p>Inverts the TOP01 pin output upon a match between the value set by the TP0CCR1 register and the count value of the 16-bit counter.</p> <p>Inverts the TOP01 pin output when the 16-bit counter is cleared.</p> <p>Can be implemented with TMP0, TMP2, and TMP3 (software trigger only for TMP3).</p>
[Function name]	timerp_1shot_pulse
[Argument]	None
[Processing content]	<p>Starts count operation of an f_{xx}/32 count clock upon valid edge detection of the external trigger input, generates an interrupt by inverting the TOP01 pin output upon the count subsequent to the count whose value matches the value of the TP0CCR0 register, clears the counter, and stops count operation.</p> <p>Generates an interrupt by inverting the TOP01 pin output upon the count subsequent to the count whose value matches the value of the TP0CCR1 register.</p> <p>TOP01 pin starts output at high level.</p>
[Starting method]	Starts by calling the timerp_1shot_pulse_st function.
[SFRs used]	<p>TP0CTL0 Selects the count clock.</p> <p>TP0CTL1 Selects the timer mode.</p> <p>TP0IOC0</p> <ul style="list-style-type: none"> • Sets the TOP00 and TOP01 pin outputs. • Sets the TOP00 and TOP01 pin output levels. <p>TP0IOC2</p> <ul style="list-style-type: none"> • Sets the valid edge of the external event count input signal (TIP00 pin). • Sets the valid edge of the external trigger input signal (TIP00 pin). <p>TP0CCR0 Compare register of the 16-bit counter</p> <p>TP0CCR1 Compare register of the 16-bit counter</p>
[call function]	main main function
[Variable]	None
[Interrupts]	<p>timerp_TP0CC0_int</p> <p>timerp_TP0CC1_int</p>
[Interrupt sources]	<p>INTTP0CC0</p> <p>INTTP0CC1</p>
[File name]	<p>timerp_1shot_pulse\timerp_4.c,</p> <p>timerp_1shot_pulse\MAIN.C</p>

[Caution]	<ul style="list-style-type: none"> The following care must be exercised for setting the registers.
	<p>TPmCTL1</p> <p>Bit 7: Only TMP0 is settable. TMP2 and TMP3 must be set to 0.</p> <p>Bit 5: Only TMP0 and TMP2 are settable. TMP3 must be set to 0</p>
	<p>TPmIOC0</p> <p>Bits 1 and 0: Only TMP0 is valid. TMP2 and TMP3 must be set to 0.</p>

The output delay period and the active level width of the one-shot pulse can be calculated from the following formula.

Output delay period = (Set value of TP0CCR1 register) × Count clock cycle

Active level width = (Set value of TP0CCR0 register – Set value of TP0CCR1 register + 1) × Count clock cycle

[Function name]	timerp_1shot_pulse_st
[Argument]	None
[Processing content]	Starting function of timerp_1shot_pulse
[Starting method]	Call this function after calling the timerp_1shot_pulse function.
[SFR used]	TP0CTL0.TP0CE Controls TMP0 operation.
[call function]	None
[Variable]	None
[File name]	timerp_1shot_pulse\timerp_4.c
[Cautions]	None

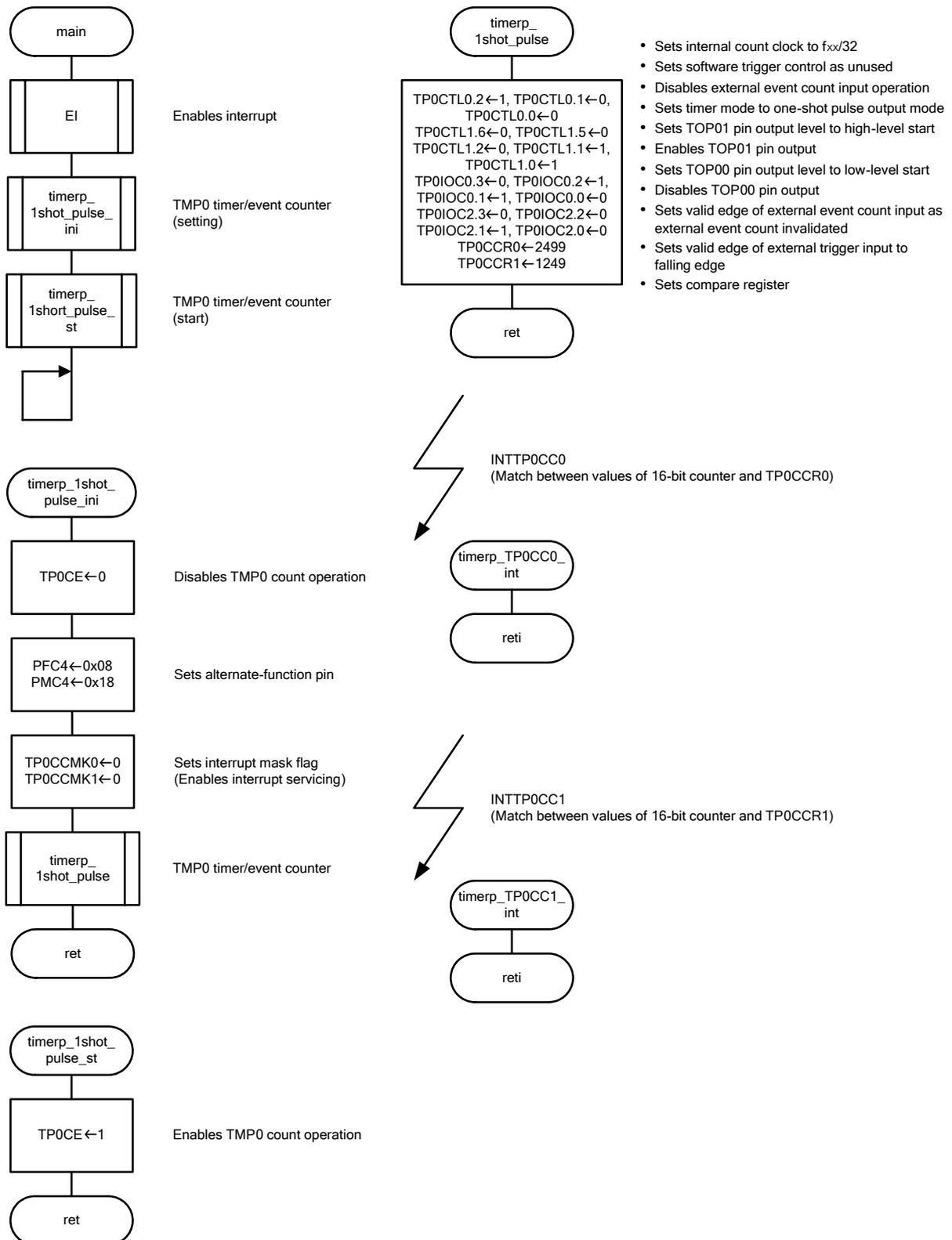
Interrupt functions

[Function name]	timerp_TP0CC0_int
[Overview]	Defined by the user.
[Factor]	INTTP0CC0 Match between the count value of the 16-bit counter and TP0CCR0
[call function]	None
[Variable]	None
[File name]	timerp_1shot_pulse\timerp_4.c
[Caution]	None

[Function name]	timerp_TP0CC1_int
[Overview]	Defined by the user.
[Factor]	INTTP0CC1 Match between the count value of the 16-bit counter and TP0CCR1
[call function]	None
[Variable]	None
[File name]	timerp_1shot_pulse\timerp_4.c
[Caution]	None

16-bit timer/event counter P (TMPm)

One-shot pulse output mode



16-bit timer/event counter P (TMPm) (m = 0, 2, 3)
 PWM output mode

(1/2)

[Functions]	<p>Starts operation of the 16-bit counter by setting the TP0CE bit.</p> <p>Outputs a PWM waveform with a 50% duty factor whose half cycle is equal to the set value of the TP0CCR0 register + 1, by clearing the 16-bit counter upon a compare match with the TP0CCR0 register and inverting the TOP00 pin.</p> <p>Inverts the TOP01 pin output upon a match between the value set by the TP0CCR1 register and the count value of the 16-bit counter.</p> <p>Inverts the TOP01 pin output when the 16-bit counter is cleared.</p> <p>Can be implemented with TMP0, TMP2, and TMP3.</p>
[Function name]	timerp_pwm_output
[Argument]	None
[Processing content]	<p>Performs count operation of an fxx/32 count clock, generates an interrupt by inverting the TOP00 and TOP01 pin outputs upon the count subsequent to the count whose value matches the value of the TP0CCR0 register, and clears the counter.</p> <p>Generates an interrupt by inverting the TOP01 pin output upon the count subsequent to the count whose value matches the value of the TP0CCR1 register.</p> <p>The TOP00 and TOP01 pins start output at high level.</p>
[Starting method]	Starts by calling the timerp_pwm_output_st function.
[SFRs used]	<p>TP0CTL0 Selects the count clock.</p> <p>TP0CTL1 Selects the timer mode.</p> <p>TP0IOC0 • Sets the TOP00 and TOP01 pin outputs. • Sets the TOP00 and TOP01 pin output levels.</p> <p>TP0IOC2 • Sets the valid edge of the external event counter input signal (TIP00 pin). • Sets the valid edge of the external trigger input signal (TIP00 pin).</p> <p>TP0CCR0 Compare register of the 16-bit counter</p> <p>TP0CCR1 Compare register of the 16-bit counter</p>
[call function]	main main function
[Variable]	None
[Interrupts]	<p>timerp_TP0CC0_int</p> <p>timerp_TP0CC1_int</p>
[Interrupt sources]	<p>INTTP0CC0</p> <p>INTTP0CC1</p>
[File name]	<p>timerp_pwm_output\timerp_5.c,</p> <p>timerp_pwm_output\MAIN.C</p>

[Cautions]

- The compare register is written in batch write mode.
When changing the value of the compare register during timer operation, change the value of the TP0CCR1 register at the end.
- The following care must be exercised for setting the registers.
TPmCTL1
Bit 7: Only TMP0 is settable. TMP2 and TMP3 must be set to 0.
Bit 5: Only TMP0 and TMP2 are settable. TMP3 must be set to 0
TPmIOC0
Bits 1 and 0: Only TMP0 is valid. TMP2 and TMP3 must be set to 0.

The active level width, cycle, and duty factor of the PWM waveform output from the TOP01 pin can be calculated from the following formula.

Active level width = (Set value of TP0CCR1 register) × Count clock cycle

Cycle = (Set value of TP0CCR0 register + 1) × Count clock cycle

Duty factor = (Set value of TP0CCR1 register)/(Set value of TP0CCR0 register + 1)

[Function name] timerp_pwm_output_st

[Argument] None

[Processing content] Starting function of timerp_pwm_output

[Starting method] Call this function after calling the timerp_pwm_output function.

[SFR used] TP0CTL0.TP0CE Controls TMP0 operation.

[call function] None

[Variable] None

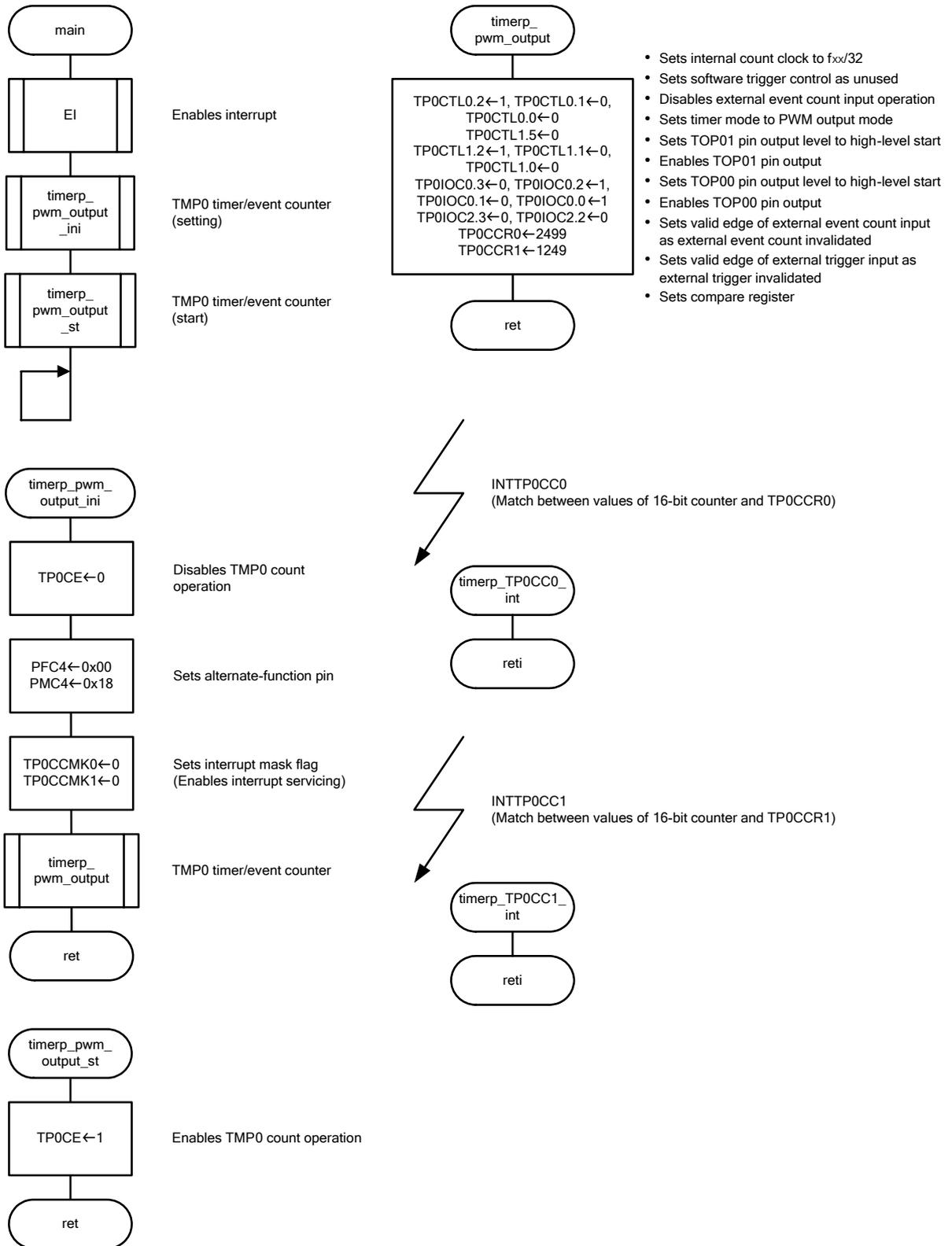
[File name] timerp_pwm_output\timerp_5.c

[Caution] None

Interrupt functions

[Function name]	timerp_TP0CC0_int
[Overview]	Defined by the user.
[Factor]	INTTP0CC0 Match between the count value of the 16-bit counter and TP0CCR0
[call function]	None
[Variable]	None
[File name]	timerp_pwm_output\timerp_5.c
[Caution]	None

[Function name]	timerp_TP0CC1_int
[Overview]	Defined by the user.
[Factor]	INTTP0CC1 Match between the count value of the 16-bit counter and TP0CCR1
[call function]	None
[Variable]	None
[File name]	timerp_pwm_output\timerp_5.c
[Caution]	None



16-bit timer/event counter P (TMPn) (n = 0 to 3)
 Free-running timer mode

(1/2)

[Functions]	<p>Inverts the TOP00 pin output upon a compare match between the TP0CCR0 register and the count value of the 16-bit counter (compare function).</p> <p>Stores the count value of the 16-bit counter when the valid edge of the capture trigger input (TIP01 pin) is detected (capture function).</p> <p>The compare function can be implemented with TMP0 to TMP3.</p> <p>The capture function can be implemented with TMP0 and TMP2.</p>
[Function name]	timerp_free_running
[Argument]	None
[Processing content]	<p>Performs count operation of an fxx/32 count clock, generates an interrupt by inverting the TOP00 pin output upon the count subsequent to the count whose value matches the value of the TP0CCR0 register, and clears the counter.</p> <p>Generates an interrupt by capturing the count value to the TP0CCR1 register when the valid edge from the TIP01 pin is detected.</p> <p>Generates an INTTP0OV interrupt when a counter overflow is detected.</p> <p>The TOP00 pin starts output at high level.</p>
[Starting method]	Starts by calling the timerp_free_running_st function.
[SFRs used]	<p>TP0CTL0 Selects the count clock.</p> <p>TP0CTL1 Selects the timer mode.</p> <p>TP0IOC0</p> <ul style="list-style-type: none"> • Sets the TOP00 and TOP01 pin outputs. • Sets the TOP00 and TOP01 pin output levels. <p>TP0IOC1 Sets the valid edge of the capture trigger input signal (TIP00 and TIP01 pins)</p> <p>TP0IOC2</p> <ul style="list-style-type: none"> • Sets the valid edge of the external event count input signal (TIP00 pin). • Sets the valid edge of the external trigger input signal (TIP00 pin). <p>TP0OPT0 Selects the capture/compare functions of the TP0CCR0 and TP0CCR1 registers.</p> <p>TP0CCR0 Compare register of the 16-bit counter</p> <p>TP0CCR1 Compare register of the 16-bit counter</p>
[call function]	main main function
[Variable]	None
[Interrupts]	<p>timerp_TP0CC0_int</p> <p>timerp_TP0CC1_int</p> <p>timerp_TP0OV_int</p>
[Interrupt sources]	<p>INTTP0CC0</p> <p>INTTP0CC1</p> <p>INTTP0OV</p>

[File name]	timerp_free_running\timerp_6.c, timerp_free_running\MAIN.C
[Caution]	<ul style="list-style-type: none"> The following care must be exercised for setting the registers. <p>TPnCTL1</p> <p>Bit 7: Only TMP0 and TMP1 are settable. TMP2 and TMP3 must be set to 0.</p> <p>Bit 6: Only TMP0, TMP2, and TMP3 are settable. TMP1 must be set to 0.</p> <p>Bit 5: Only TMP0 and TMP2 are settable. TMP1 and TMP3 must be set to 0.</p> <p>TPmIOC0 (m = 0, 2, 3)</p> <p>Bits 1 and 0: Only TMP0 is valid. TMP2 and TMP3 must be set to 0.</p> <p>TPnOPT0</p> <p>Bits 5 and 4: Only TMP0 and TMP2 are valid. TMP1 and TMP3 must be set to 0.</p>

[Function name]	timerp_free_running_st
[Argument]	None
[Processing content]	Starting function of timerp_free_running
[Starting method]	Call this function after calling the timerp_free_running function.
[SFR used]	TP0CTL0.TP0CE Controls TMP0 operation.
[call function]	None
[Variable]	None
[File name]	timerp_free_running\timerp_6.c
[Caution]	None

Interrupt functions

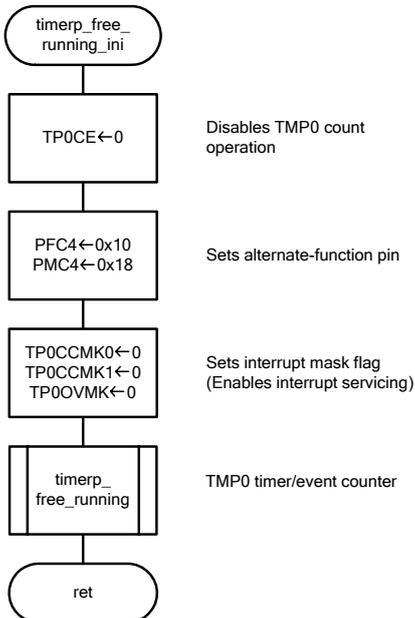
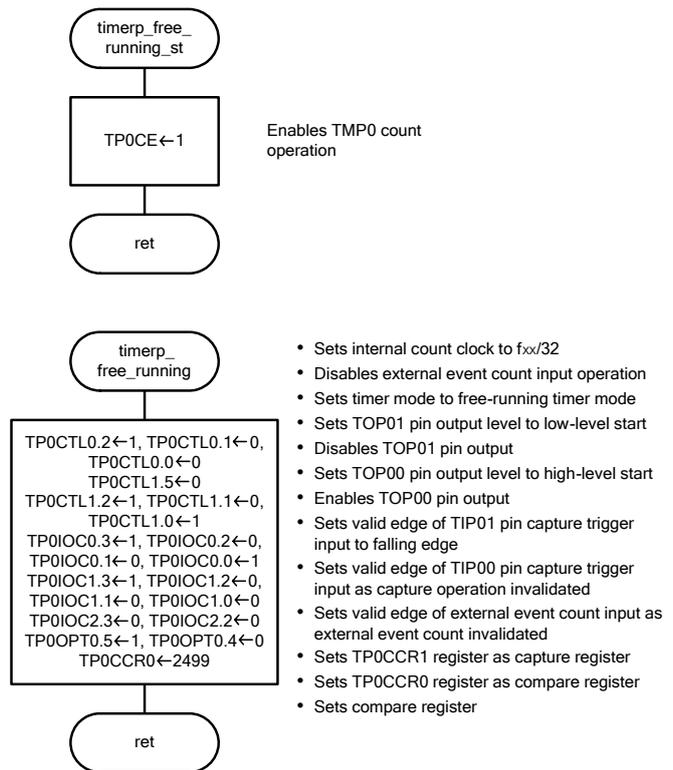
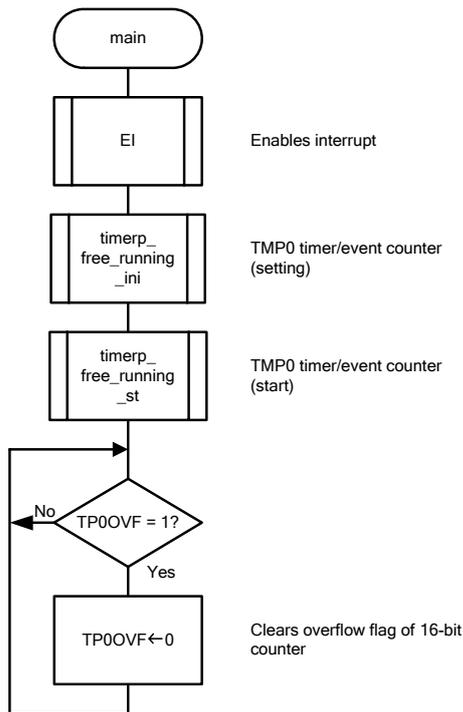
[Function name]	timerp_TP0CC0_int
[Overview]	Defined by the user.
[Factor]	INTTP0CC0 Match between the count value of the 16-bit counter and TP0CCR0
[call function]	None
[Variable]	None
[File name]	timerp_free_running\timerp_6.c
[Caution]	None

[Function name]	timerp_TP0CC1_int
[Overview]	Defined by the user.
[Factor]	INTTP0CC1 Detects the valid edge of the TIP01 pin input.
[call function]	None
[Variable]	None
[File name]	timerp_free_running\timerp_6.c
[Caution]	None

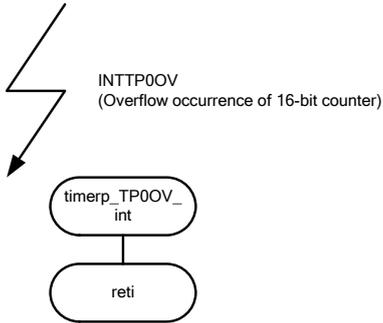
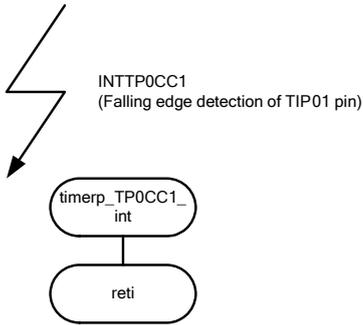
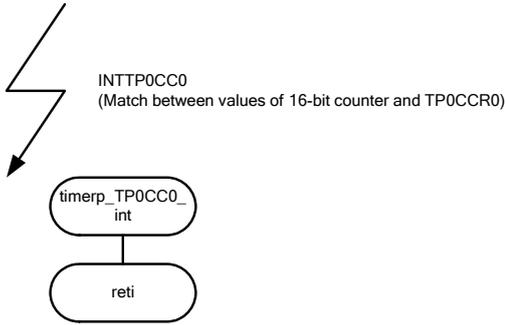
[Function name]	timerp_TP0OV_int
[Overview]	Defined by the user.
[Factor]	INTTP0OV Overflow occurrence of 16-bit counter
[call function]	None
[Variable]	None
[File name]	timerp_free_running\timerp_6.c
[Caution]	None

16-bit timer/event counter P (TMPn)

Free-running timer mode (1/2)



16-bit timer/event counter P (TMPn)
Free-running timer mode (2/2)



16-bit timer/event counter P (TMPk) (k = 0, 2) Pulse width measurement mode

[Functions]	<p>Clears the 16-bit counter by storing the count value to the TP0CCR0 register when the valid edge of the capture trigger input (TIP00 pin) is detected.</p> <p>Measures the valid edge interval of the TIP00 pin by generating an interrupt when the valid edge of the TIP00 pin input is detected and reading the TP0CCR0 register value.</p> <p>Can be implemented with TMP0 and TMP2.</p>
[Function name]	timerp_pulse_measure
[Argument]	None
[Processing content]	<p>Performs count operation of an f_{xx}/32 count clock, generates an interrupt by storing the count value of the 16-bit counter to the TP0CCR0 register when the valid edge of the TIP00 pin input is detected, and clears the counter.</p> <p>Generates an INTTP0OV interrupt when a counter overflow is detected.</p>
[Starting method]	Starts by calling the timerp_pulse_measure_st function.
[SFRs used]	<p>TP0CTL0 Selects the count clock.</p> <p>TP0CTL1 Selects the timer mode.</p> <p>TP0IOC1 Sets the valid edge of the capture trigger input signal (TIP00 and TIP01 pins).</p> <p>TP0IOC2</p> <ul style="list-style-type: none"> • Sets the valid edge of the external event counter input signal (TIP00 pin). • Sets the valid edge of the external trigger input signal (TIP00 pin). <p>TP0OPT0 Selects between the capture/compare functions of the TP0CCR0 and TP0CCR1 registers.</p> <p>TP0CCR0 Capture register of the 16-bit counter</p>
[call function]	main main function
[Variable]	None
[Interrupts]	<p>timerp_TP0CC0_int</p> <p>timerp_TP0OV_int</p>
[Interrupt sources]	<p>INTTP0CC0</p> <p>INTTP0OV</p>
[File name]	<p>timerp_pulse_measure\timerp_7.c,</p> <p>timerp_pulse_measure\MAIN.C</p>
[Cautions]	<ul style="list-style-type: none"> • If a slow clock is selected as the count clock and a capture trigger is input immediately after the TP0CTL0.TP0CE bit has been set, 0xFFFF may be captured instead of 0x0000 to the TP0CCR0 register. • The following care must be exercised for setting the registers. <ul style="list-style-type: none"> TPkCTL1 <ul style="list-style-type: none"> Bit 7: Only TMP0 is settable. TMP2 must be set to 0. TPkIOC0 <ul style="list-style-type: none"> Set to 0x00.

The pulse width can be calculated by the following formula.

$$\text{Pulse width} = (\text{Value of TP0CCR0 register} + 1) \times \text{Count clock cycle}$$

The pulse width if an overflow of the 16-bit counter is detected can be calculated by the following formula.

$$\text{Pulse width} = (\text{Value of TP0CCR0 register} + 0x10001) \times \text{Count clock cycle}$$

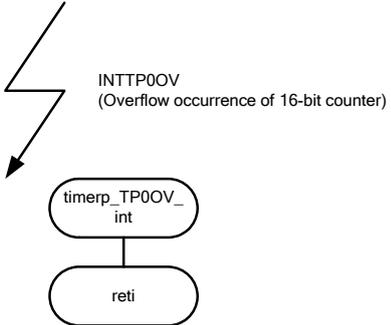
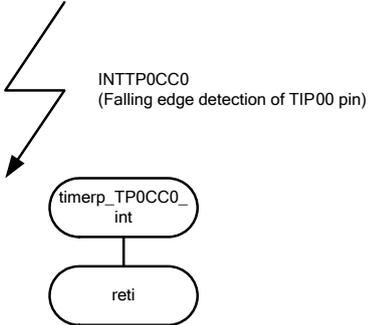
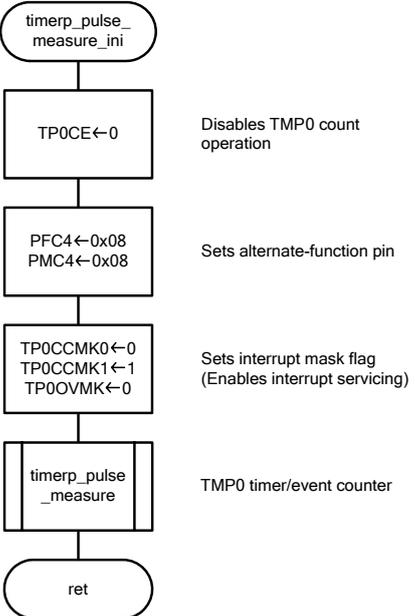
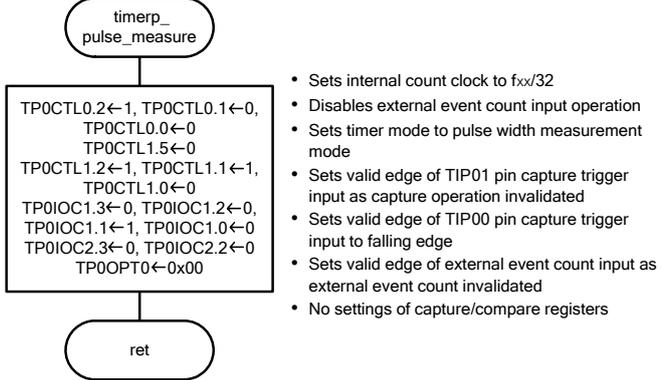
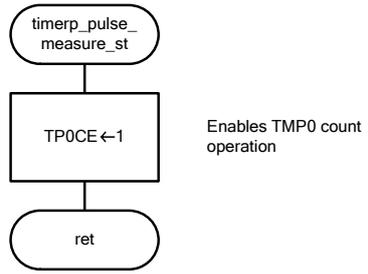
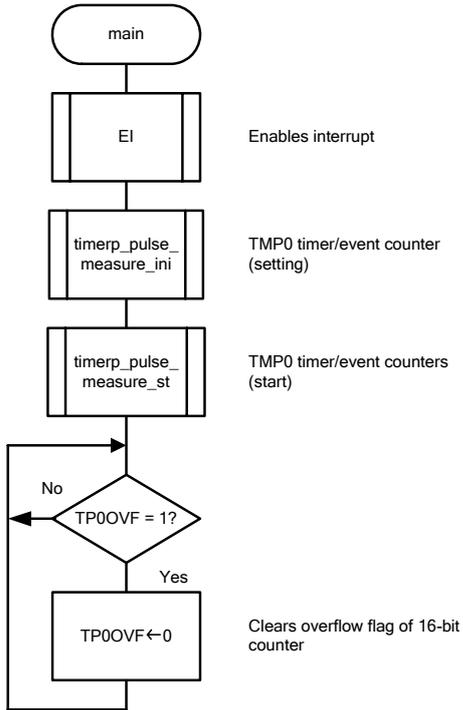
[Function name]	timerp_pulse_measure_st
[Argument]	None
[Processing content]	Starting function of timerp_pulse_measure
[Starting method]	Call this function after calling the timerp_pulse_measure function.
[SFR used]	TP0CTL0.TP0CE Controls TMP0 operation.
[call function]	None
[Variable]	None
[File name]	timerp_pulse_measure\timerp_7.c
[Caution]	None

Interrupt functions

[Function name]	timerp_TP0CC0_int
[Overview]	Defined by the user.
[Factor]	INTTP0CC0 Valid edge detection of TIP00 pin input
[call function]	None
[Variable]	None
[File name]	timerp_pulse_measure\timerp_7.c
[Caution]	None

[Function name]	timerp_TP0OV_int
[Overview]	Defined by the user.
[Factor]	INTTP0OV Overflow occurrence of 16-bit counter
[call function]	None
[Variable]	None
[File name]	timerp_pulse_measure\timerp_7.c
[Caution]	None

16-bit timer/event counter P (TMPk)
Pulse width measurement mode



*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
800-366-9782
<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

Podbielskistrasse 166 B
30177 Hannover
Tel: 0 511 33 40 2-0

Munich Office

Werner-Eckert-Strasse 9
81829 München
Tel: 0 89 92 10 03-0

Stuttgart Office

Industriestrasse 3
70565 Stuttgart
Tel: 0 711 99 01 0-0

United Kingdom Branch

Cygnus House, Sunrise Parkway
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

Sucursal en España

Juan Esplandiú, 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

Steijgerweg 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 Shanghai Ltd.

Room 2511-2512, Bank of China Tower,
200 Yincheng Road Central,
Pudong New Area, Shanghai P.R. China P.C:200120
Tel: 021-5888-5400
<http://www.cn.necel.com/>

NEC Electronics Hong Kong Ltd.

12/F., Cityplaza 4,
12 Taikoo Wan Road, Hong Kong
Tel: 2886-9318
<http://www.hk.necel.com/>

NEC Electronics Taiwan Ltd.

7F, No. 363 Fu Shing North Road
Taipei, Taiwan, R. O. C.
Tel: 02-8175-9600
<http://www.tw.necel.com/>

NEC Electronics Singapore Pte. Ltd.

238A Thomson Road,
#12-08 Novena Square,
Singapore 307684
Tel: 6253-8311
<http://www.sg.necel.com/>

NEC Electronics Korea Ltd.

11F., Samik Lavied'or Bldg., 720-2,
Yeoksam-Dong, Kangnam-Ku,
Seoul, 135-080, Korea
Tel: 02-558-3737
<http://www.kr.necel.com/>

G06.11A