

To our customers,

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## Old Company Name in Catalogs and Other Documents

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Renesas Electronics website: <http://www.renesas.com>

April 1<sup>st</sup>, 2010  
Renesas Electronics Corporation

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

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

This manual explains the sample program functions of the interrupt functions 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.**

### 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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# 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

[Function]	Function description
[Function name]	Name of sample function
[Argument]	Type and overview of argument
[Processing content]	Processing content of sample 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

[Function name]	Name of interrupt function
[Processing content]	Processing content of interrupt function
[SFR(s) used]	Register name and setting content
[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 interrupt functions are shown below.

Item	V850E/IA4	V850E/IA3	V850ES/IK1	V850ES/IE2
INTP1	Provided	Not provided	Provided	
INTP7	Provided	Provided	Not provided	
INTLVI	Not providedt provided	Not provided	Provided	
INTCMP0	Provided	Provided	Not provided	
INTCMP1	Provided	Provided	Not provided	
INTCC00	Provided	Provided	Not provided	
INTCC01	Provided	Provided	Not provided	
INTCM00	Provided	Provided	Not provided	
INTCM01	Provided	Provided	Not provided	
INTCC10	Provided	Not provided	Not provided	
INTCC11	Provided	Not provided	Not provided	
INTCM10	Provided	Not provided	Not provided	
INTCM11	Provided	Not provided	Not provided	
INTDMA0	Provided	Provided	Not provided	
INTDMA1	Provided	Provided	Not provided	
INTDMA2	Provided	Provided	Not provided	
INTDMA3	Provided	Provided	Not provided	
INTCB1RE	Provided	Provided	Not provided	
INTCB1R	Provided	Provided	Not provided	
INTCB1T	Provided	Provided	Not provided	
INTAD2	Provided	Provided	Not provided	

**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	U18238E
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	This document
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

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## Interrupt functions

### Interrupts

[Function]	Implements multiple interrupt servicing by acknowledging processing of timer M that has a higher priority level during A/D interrupt servicing via using A/D converter 0.
[Function name]	int_main
[Argument]	None
[Processing content]	<ul style="list-style-type: none"><li>• Performs each interrupt setting by calling the initial setting function.</li><li>• Enables interrupts.</li></ul>
[SFR used]	None
[call function]	int_init
[Variable]	None
[Interrupts]	int_ad, int_time
[Interrupt sources]	INTAD0, INTTM0EQ0
[File name]	interrupt.c
[Caution]	None

[Function name]	int_init
[Processing content]	Performs initial setting of multiple interrupt servicing.
[SFR used]	None
[call functions]	int_ad0_init, int_tmp_init, int_tmq_init, int_tmq_op_init, int_tmm_init, int_interrupt_init, int_start_init
[Variable]	None
[File name]	interrupt.c
[Caution]	None

[Function name]	int_ad0_init
[Processing content]	Performs initial setting of A/D converter 0.
[SFRs used]	ADA0M0: 0x02 (Sets trigger mode.) ADA0M1: 0x01 (Sets conversion clock number to 124 (1.94 $\mu$ s).) ADA0S: 0x00 (Sets to ANI00.) ADA0M2: 0x01 (Sets to timer trigger mode 0, 1-buffer mode.)
[call function]	None
[Variable]	None
[File name]	interrupt.c
[Caution]	None

[Function name]	int_tmp_init
[Processing content]	Performs initial setting of timer P (TMP0).
[SFRs used]	TP0CTL0: 0x05 (Disables TMP0 operation, sets internal count clock to fxx/64.) TP0CTL1: 0x85 (Sets to tuning operation mode, free-running timer mode.) TP0IOC0: 0x00 (Disables timer output.) TP0IOC1: 0x00 (No edge detection) TP0IOC2: 0x00 (No edge detection) TP0OPT0: 0x00 (Sets to compare register.) TP0CCR0: 9800 (Sets compare value to 9,800 (every 9.8 ms).)
[call function]	None
[Variable]	None
[File name]	interrupt.c
[Caution]	None

[Function name]	int_tmq_init
[Processing content]	Performs initial setting of timer Q (TMQ0).
[SFRs used]	TQ0CTL1: 0x07 (Sets to 6-phase PWM output mode.) TQ0IOC0: 0x01 (Enables timer output.) TQ0IOC1: 0x00 (Not used) TQ0IOC2: 0x00 (Not used) TQ0OPT0: 0x00 (Sets to compare register.) TQ0CCR0: 10000 (Sets compare value to 10,000 (every 10 ms).) TQ0CTL0: 0x05 (Disables TMQ0 operation, sets internal count clock as fxx/64.)
[call function]	None
[Variable]	None
[File name]	interrupt.c
[Caution]	None

[Function name]	int_tmq_op_init
[Processing content]	Performs initial setting of TMQ0 option (TMQOP0).
[SFRs used]	TQ0OPT0: 0x00 (Performs up count.) TQ0OPT1: 0x80 (Enables crest interrupt (INTTQ0CC0 signal).) TQ0OPT2: 0x82 (Enables A/D trigger signal (TQTADT00) output of crest interrupt (INTTQ0CC0 signal).) TQ0OPT3: 0x02 (Enables A/D trigger signal (TQTADT01) output of crest interrupt (INTTQ0CC0 signal).) TQ0DTC: 0x000 (Sets dead time.)
[call function]	None
[Variable]	None
[File name]	interrupt.c
[Caution]	None

[Function name]	int_tmm_init
[Processing content]	Performs initial setting of timer M (TMM0).
[SFRs used]	TM0CTL0: 0x06 (Disables TMM0 operation, sets internal count clock as f <sub>xx</sub> /128.) TM0CMP0: 50000 (Sets compare value to 50,000 (every 100 ms).)
[call function]	None
[Variable]	None
[File name]	interrupt.c
[Caution]	None

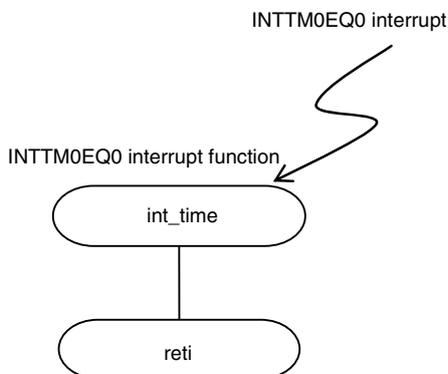
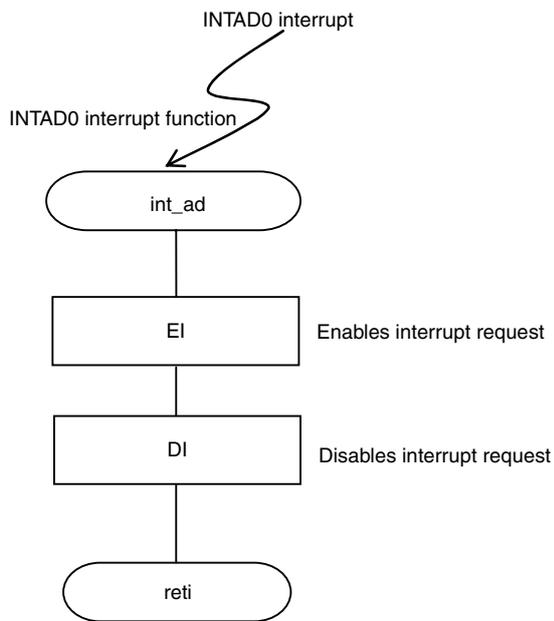
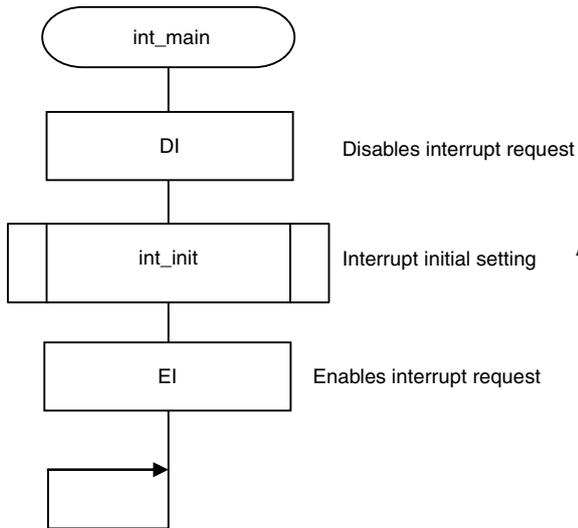
[Function name]	int_interrupt_init
[Processing content]	Performs initial setting of each interrupt.
[SFRs used]	AD0IC: 0x47 (Sets priority level of A/D0 conversion end interrupt request signal (INTAD0) to level 7.) TM0EQIC0: 0x46 (Sets priority level of compare match interrupt request signal (INTTM0EQ0) of timer M to level 6.) IMR3: 0xFFFF (Masks unused interrupt.) IMR2: 0xFFFF (Masks unused interrupt.) IMR1: 0xFFFF (Masks unused interrupt.) IMR0: 0xFFFF (Masks unused interrupt.) AD0IC.AD0MK: 0 (Enables INTAD0 interrupt servicing.) TM0EQIC0.TM0EQMK0: 0 (Enables INTTM0EQ0 interrupt servicing.)
[call function]	None
[Variable]	None
[File name]	interrupt.c
[Caution]	Set so that the priority level of the multiplying interrupt ( __interrupt) is higher than the multiplied interrupt ( __multi_interrupt) when generating a multiple interrupt.

[Function name]	int_start_init
[Processing content]	Starts operation of timer P (TMP0), timer Q (TMQ0), timer M (TMM0), and A/D converter 0.
[SFRs used]	TP0CTL0.TP0CE: 1 (Enables TMP0 operation.) TQ0CTL0.TQ0CE: 1 (Enables TMQ0 operation.) TM0CTL0.TM0CE: 1 (Enables TMM0 operation.) ADA0M0.ADA0CE: 1 (Enables A/D converter 0 operation.)
[call function]	None
[Variable]	None
[File name]	interrupt.c
[Caution]	None

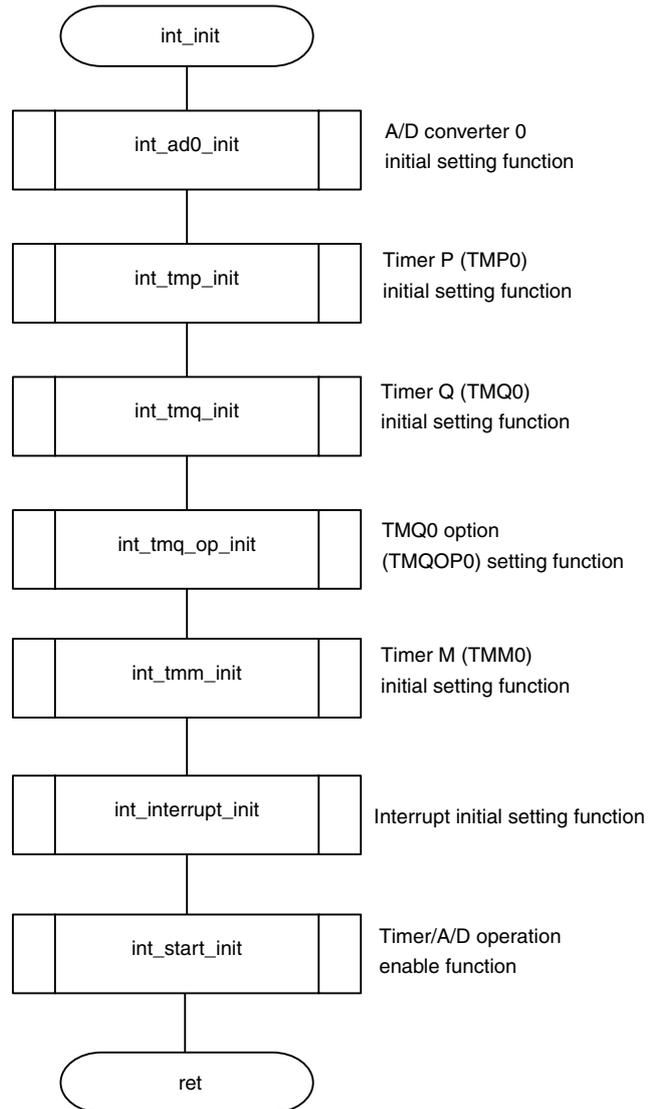
## Interrupt functions

[Function name]	int_ad
[Processing content]	There is no particular processing because this is used for confirmation of interrupt occurrence.
[SFR used]	None
[call function]	None
[Variable]	None
[File name]	interrupt.c
[Caution]	None

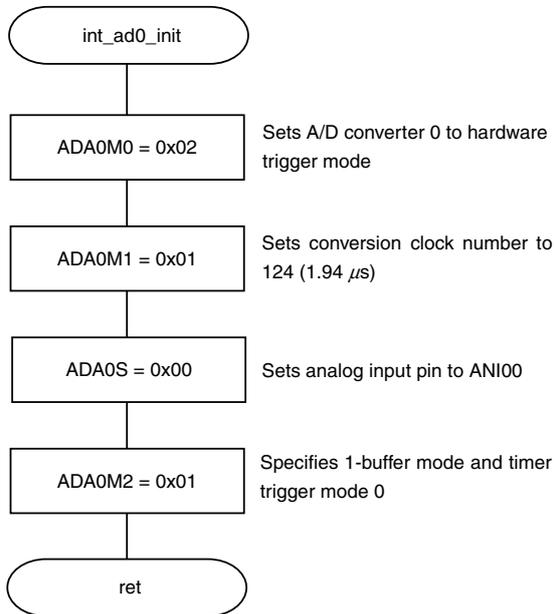
[Function name]	int_time
[Processing content]	There is no particular processing because this is used for confirmation of interrupt occurrence.
[SFR used]	None
[call function]	None
[Variable]	None
[File name]	interrupt.c
[Caution]	None



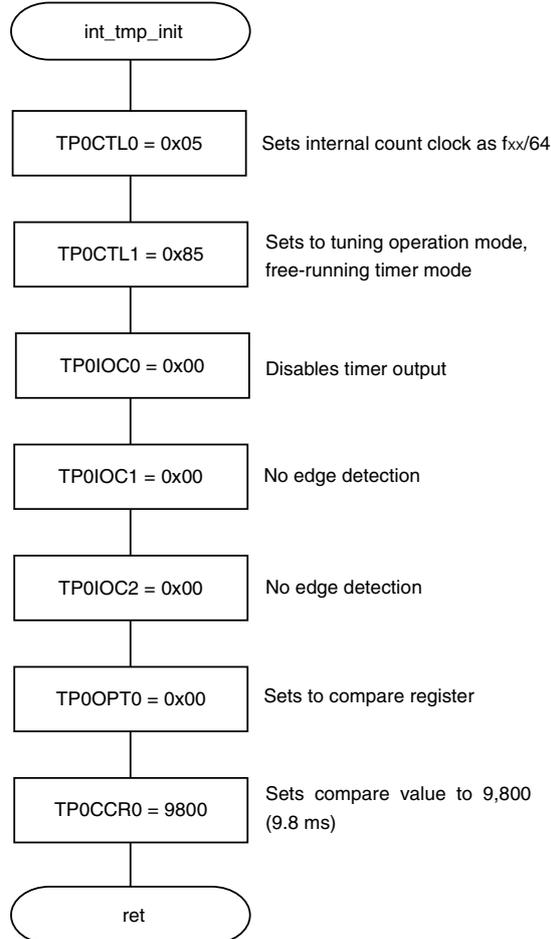
A/D converter 0/interrupt/timer setting function



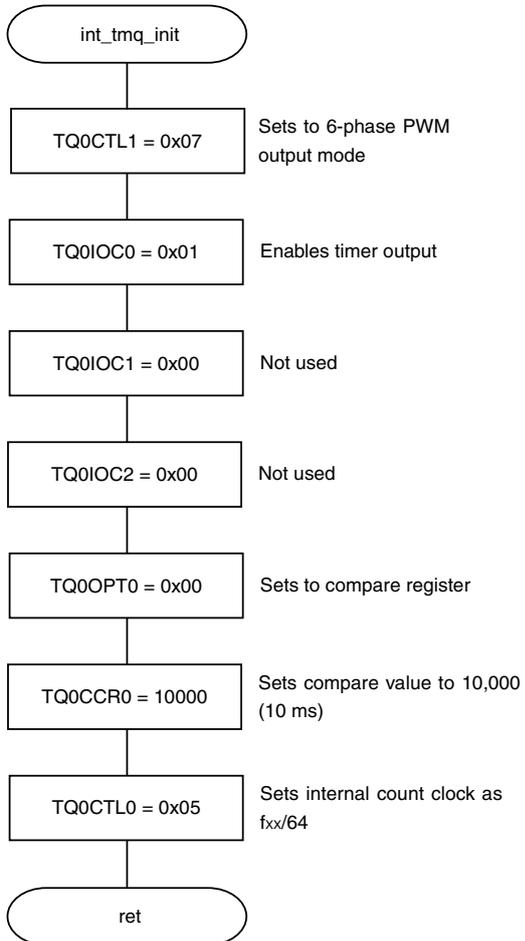
A/D converter 0 initial setting function



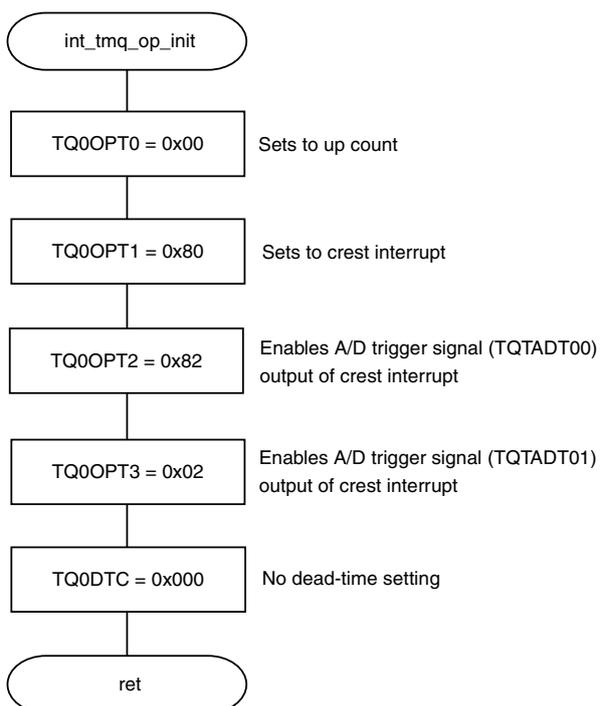
TMP initial setting function



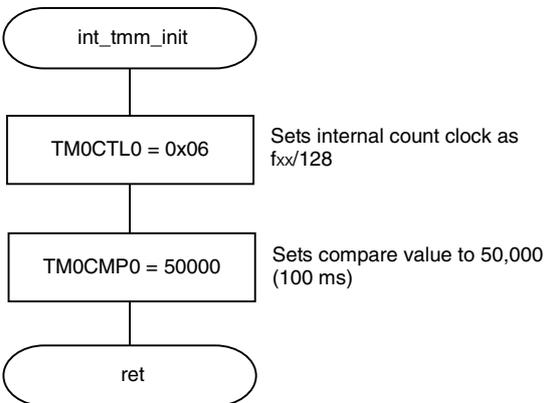
TMQ initial setting function



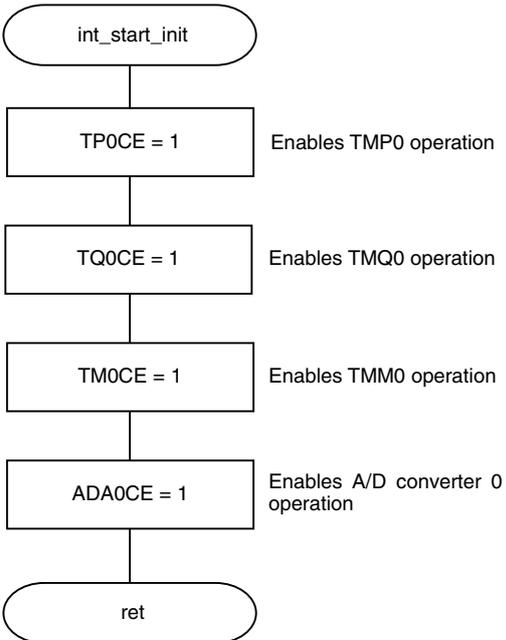
TMQ option setting function



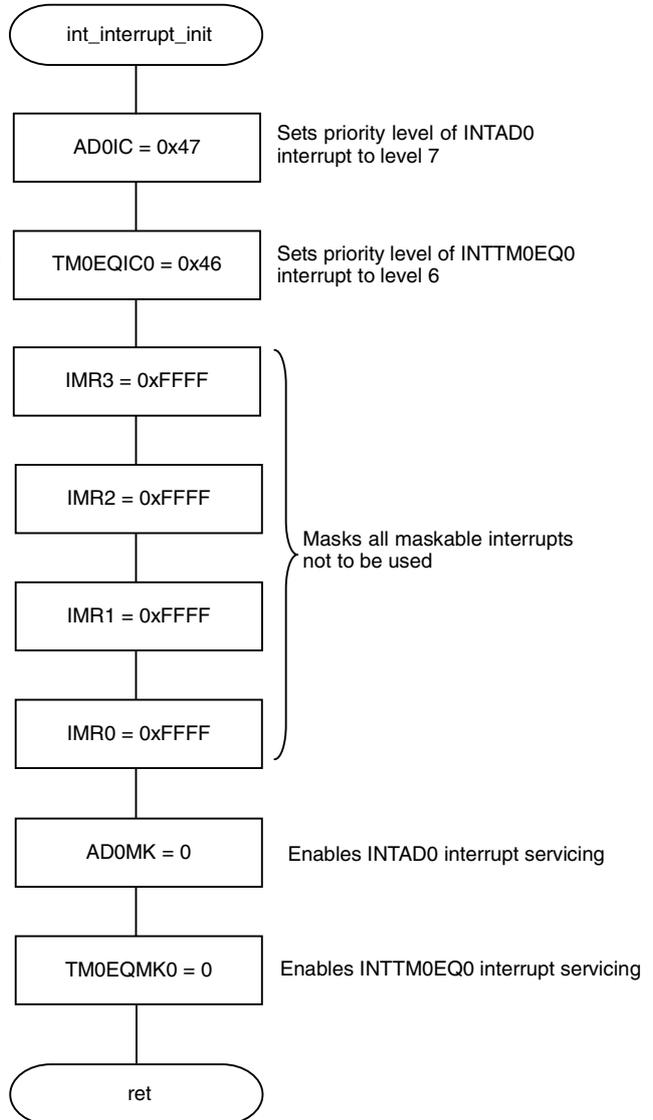
TMM initial setting function



Timer/A/D operation enable function



Interrupt initial setting function



## Interrupt functions

### External interrupts

[Function]	Implements an external interrupt by using INTP6.
[Function name]	ex_int_main
[Argument]	None
[Processing content]	<ul style="list-style-type: none"><li>• Performs each interrupt setting by calling the initial setting function.</li><li>• Enables interrupts.</li></ul>
[SFR used]	None
[call functions]	ex_int_init, ex_int_end
[Variable]	unsigned char flag
[Interrupt]	ex_int_p6_handler
[Interrupt source]	INTP6
[File name]	ex_interrupt.c
[Caution]	None

[Function name]	ex_int_init
[Processing content]	Performs initial setting of external interrupt.
[SFR used]	None
[call functions]	ex_int_p6_init, ex_int_interrupt_init
[Variable]	None
[File name]	ex_interrupt.c
[Caution]	None

[Function name]	ex_int_p6_init
[Processing content]	Performs settings of edge detection and noise elimination by setting the P06 pin to the external maskable interrupt request input.
[SFRs used]	PMC0: 0x40 (Sets P06 pin to external maskable interrupt request input (INTP6).) INTR0: 0x40 (Sets valid edge to rising edge.) INTF0: 0x00 (Sets valid edge to rising edge.) INTPNRC: 0x00 (Sets sampling clock as f <sub>xx</sub> /32.)
[call function]	None
[Variable]	None
[File name]	ex_interrupt.c
[Caution]	None

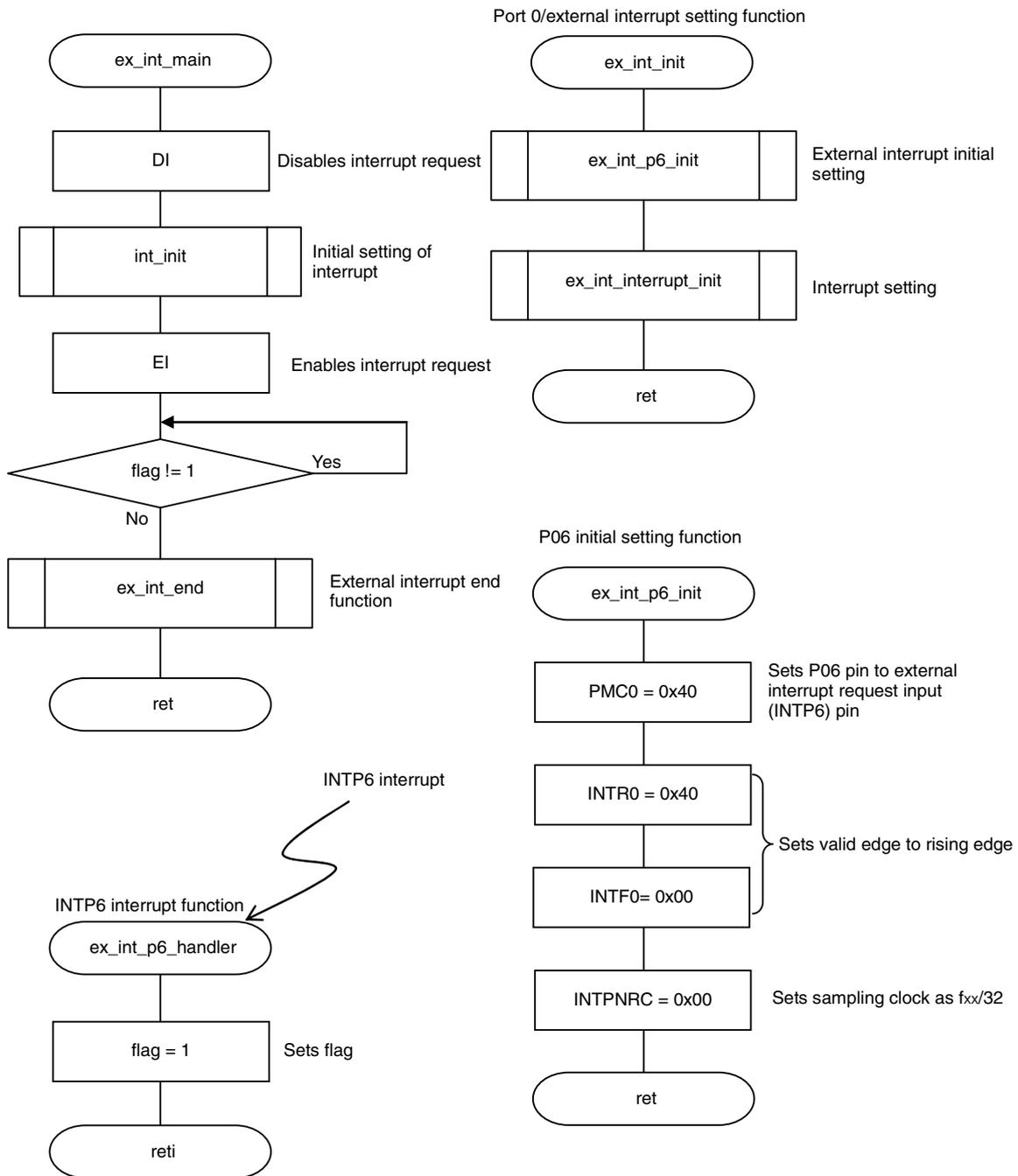
[Function name]	ex_int_interrupt_init
[Processing content]	Performs initial setting of interrupt.
[SFRs used]	PIC6: 0x45 (Sets priority level of INTP6 interrupt request signal to level 5.) IMR3: 0xFFFF (Masks unused interrupts.) IMR2: 0xFFFF (Masks unused interrupts.) IMR1: 0xFFFF (Masks unused interrupts.) IMR0: 0xFFFF (Masks unused interrupts.) PIC6.PMK6: 0 (Enables INTP6 interrupt servicing.)
[call function]	None
[Variable]	None
[File name]	ex_interrupt.c
[Caution]	None

[Function name]	ex_in_end
[Processing content]	Sets pin to port mode and edge specification to “No edge detection” after external interrupt occurrence.
[SFRs used]	INTR0: 0x00 (Sets to “No edge detection”). INTF0: 0x00 (Sets to “No edge detection”). PMC0: 0x00 (Sets P06 pin to port mode.)
[call function]	None
[Variable]	unsigned char flag
[File name]	ex_interrupt.c
[Caution]	None

## Interrupt function

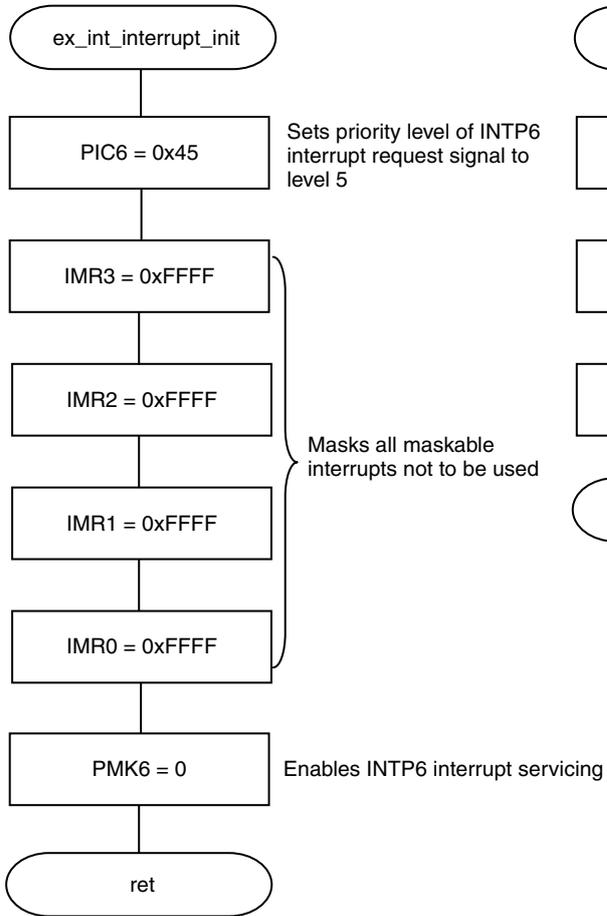
Interrupt function	ex_int_p6_handler
[Function name]	There is no particular processing because this is used for confirmation of interrupt occurrence.
[SFR used]	None
[call function]	None
[Variable]	unsigned char flag
[File name]	ex_interrupt.c
[Caution]	None

Interrupt functions  
External interruption (1/2)

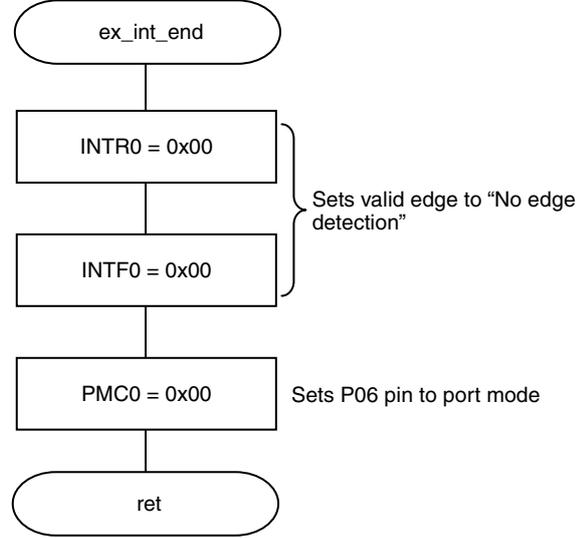


Interrupt functions  
External interruption (2/2)

Interrupt initial setting function



External interrupt end servicing function



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