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April 1st, 2010
Renesas Electronics Corporation

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

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Manual for Using Sample Program Functions Timer ENC (V850E/IA3, V850E/IA4)

This manual explains the sample program functions of the 16-bit 2-phase encoder input up/down counter/general-purpose timer (TMENC) 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 microcontroller.

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.

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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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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**

Note The function lists are structured as follows.

Hardware name (symbol)

[Function]	Function description
[Function name]	Name of sample function
[Argument(s)]	Type and overview of argument
[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 related to the 16-bit 2-phase encoder input up/down counter/general-purpose timer (TMENC)

Item	V850E/IA4	V850E/IA3
No. of channels	2	1

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 and V850E/IA4

Document Name	Document No.
V850E1 Architecture User's Manual	U14559E
V850E/IA3, V850E/IA4 Hardware User's Manual	U16543E
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	This manual
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

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16-bit 2-phase encoder input up/down counter/general-purpose timer (TMENC1n) (n = 0, 1)

General-purpose timer mode: Interval operation

[Functions]	Performs count operation based on the clock selected by software, and generates an interrupt request signal (INTCM00) upon match detection between the values of the counter (TMENC10) and the compare register (CM100). Clears TMENC10 upon the count clock subsequent to the matched count clock.	
[Function name]	timerenc_gen_interval	
[Argument]	None	
[Processing content]	Performs count operation of an fxx/32 count clock, and generates an interrupt when the value of TMENC10 reaches 249 (1 ms).	
[Starting method]	Starts by calling the timerenc_gen_interval_st function.	
[SFRs used]	TUM10	Specifies the operation mode of TMENC10.
	TMC10	Controls the clear operation of TMENC10.
	PRM10	Selects the count clock.
	CM100	Compare register
[call function]	main main function	
[Variable]	None	
[Interrupt]	timerenc_CM00_int	
[Interrupt source]	INTCM00	
[File name]	timerenc_gen_interval\timerenc_gen_0.c, timerenc_gen_interval\MAIN.C	
[Caution]	None	

The interval cycle can be calculated by the following formula.

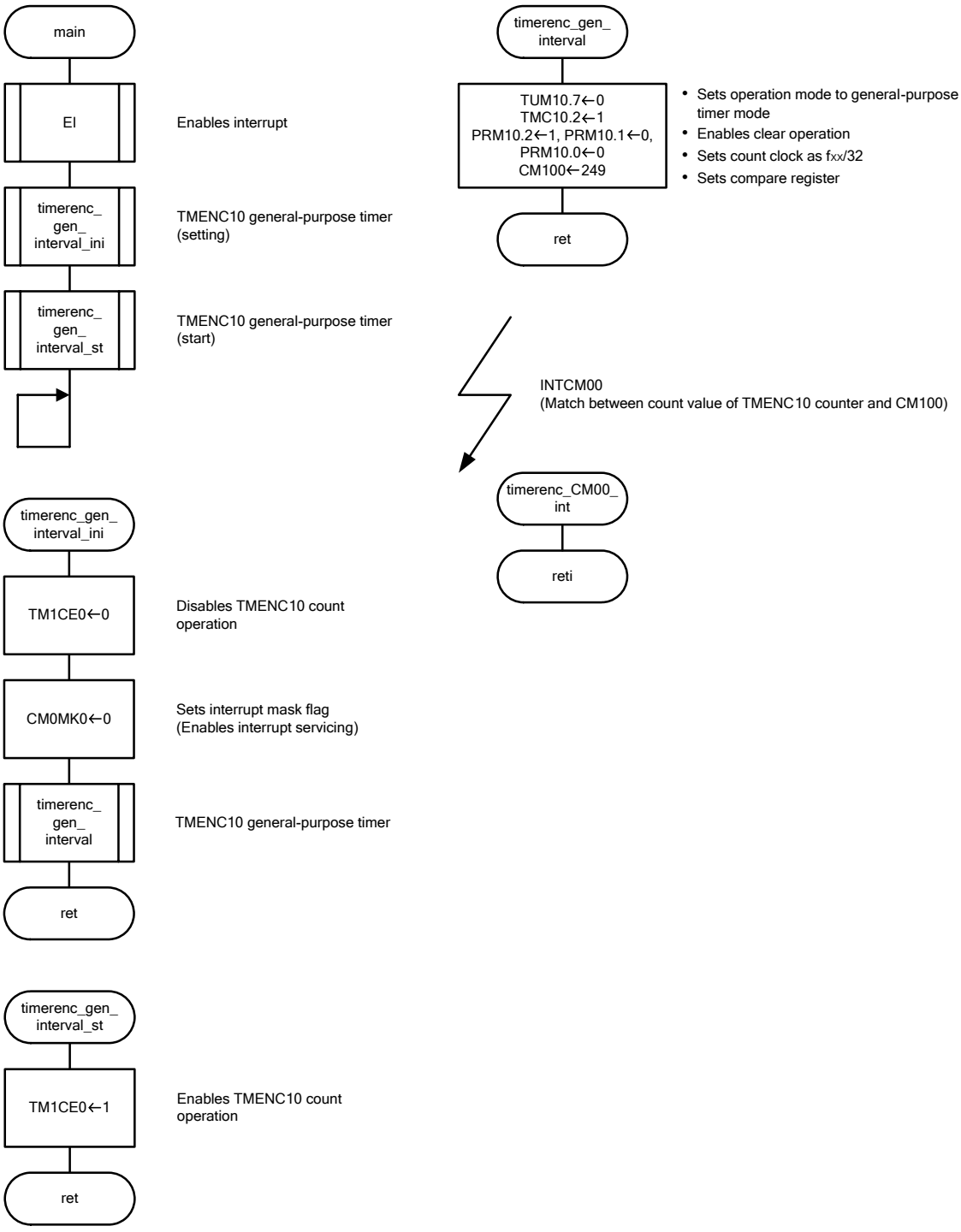
Interval cycle = (value of CM100 register + 1) × Count clock rate of TMENC10

[Function name]	timerenc_gen_interval_st
[Argument]	None
[Processing content]	Starting function of timerenc_gen_interval
[Starting method]	Call this function after calling the timerenc_gen_interval function.
[SFR used]	TMC10.TM1CE0 Controls TMENC10 operation.
[call function]	None
[Variable]	None
[File name]	timerenc_gen_interval\timerenc_gen_0.c
[Caution]	None

Interrupt function

[Function name]	timerenc_CM00_int
[Overview]	Defined by the user.
[Factor]	INTCM00 Match between the values of the TMENC10 counter and CM100
[call function]	None
[Variable]	None
[File name]	timerenc_gen_interval\timerenc_gen_0.c
[Caution]	None

General-purpose timer mode: Interval operation



16-bit 2-phase encoder input up/down counter/general-purpose timer (TMENC1n) (n = 0, 1)

General-purpose timer mode: Free-running operation

[Function]	Perorms count operation based on the clock selected by software, and generates an interrupt request signal (INTCM00) upon match detection between the values of the counter (TMENC10) and the compare register (CM100).	
[Function name]	timerenc_gen_freerun	
[Argument]	None	
[Processing content]	Performs count operation of an fxx/32 count clock, and generates an interrupt when the value of TMENC10 reaches 0x8000.	
[Starting method]	Starts by calling the timerenc_gen_freerun_st function.	
[SFRs used]	TUM10	Specifies the operation mode of TMENC10.
	TMC10	Controls the clear operation of TMENC10.
	PRM10	Selects the count clock.
	CM100	Compare register
[call function]	main main function	
[Variable]	None	
[Interrupt]	timerenc_CM00_int	
[Interrupt source]	INTCM00	
[File name]	timerenc_gen_freerun\timerenc_gen_1.c, timerenc_gen_freerun\MAIN.C	
[Caution]	None	

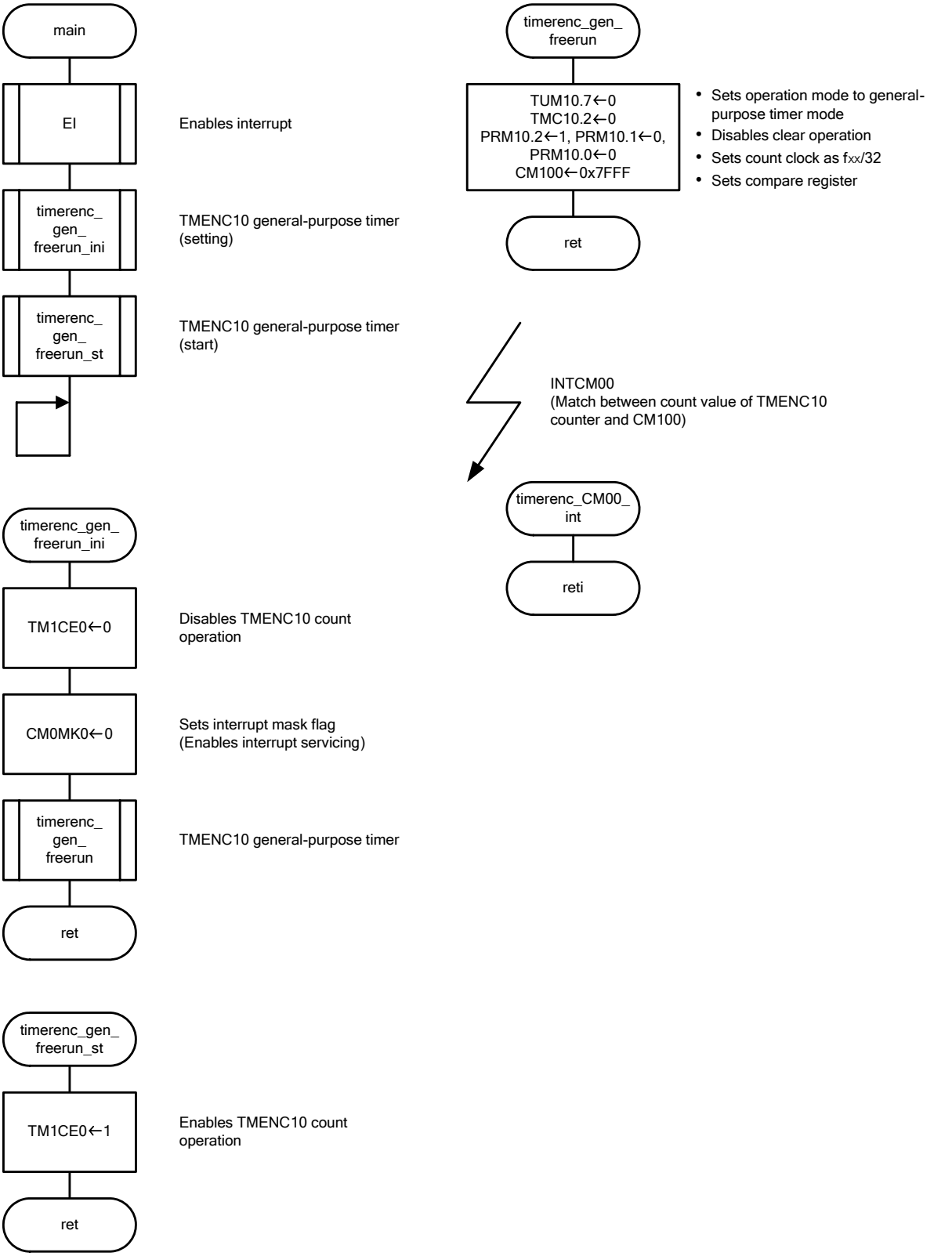
The free-running cycle can be calculated by the following formula.

Free-running cycle = 65,536 × Count clock rate of TMENC10

[Function name]	timerenc_gen_freerun_st
[Argument]	None
[Processing content]	Starting function of timerenc_gen_freerun
[Starting method]	Call this function after calling the timerenc_gen_freerun function.
[SFR used]	TMC10.TM1CE0 Controls TMENC10 operation.
[call function]	None
[Variable]	None
[File name]	timerenc_gen_freerun\timerenc_gen_1.c
[Caution]	None

Interrupt function

[Function name]	timerenc_CM00_int
[Overview]	Defined by the user.
[Factor]	INTCM00 Match between the values of the TMENC10 counter and CM100
[call function]	None
[Variable]	None
[File name]	timerenc_gen_freerun\timerenc_gen_1.c
[Caution]	None


main
EI
Enables interrupt
timerenc_
gen_
freerun_ini
TMENC10 general-purpose timer
(setting)
timerenc_
gen_
freerun_st
TMENC10 general-purpose timer
(start)
timerenc_gen_
freerun
TUM10.7←0
TMC10.2←0
PRM10.2←1, PRM10.1←0,
PRM10.0←0
CM100←0x7FFF
• Sets operation mode to general-purpose timer mode
• Disables clear operation
• Sets count clock as fXX/32
• Sets compare register
ret
INTCM00
(Match between count value of TMENC10
counter and CM100)
timerenc_CM00_
int
reti
timerenc_gen_
freerun_ini
TM1CE0←0
Disables TMENC10 count
operation
CM0MK0←0
Sets interrupt mask flag
(Enables interrupt servicing)
timerenc_
gen_
freerun
TMENC10 general-purpose timer
ret
timerenc_gen_
freerun_st
TM1CE0←1
Enables TMENC10 count
operation
ret

16-bit 2-phase encoder input up/down counter/general-purpose timer (TMENC1n) (n = 0, 1)

General-purpose timer mode: Compare function

[Functions]	Performs count operation based on the clock selected by software, and generates an interrupt request signal upon match detection between the values of the counter (TMENC10) and the compare register. Interrupt request signals INTCM00, INTCM01, INTCC00, and INTCC01 are generated for compare registers CM100, CM101, CC100, and CC101 respectively.	
[Function name]	timerenc_gen_compare	
[Argument]	None	
[Processing content]	Performs count operation of an fxx/32 count clock, and generates an interrupt upon the count subsequent to which the values of TMENC10 match their respective compare register values.	
[Starting method]	Starts by calling the timerenc_gen_compare_st function.	
[SFRs used]	TUM10	Specifies the operation mode of TMENC10.
	CCR10	Specifies the operation mode of the CC100 register.
		Specifies the operation mode of the CC101 register.
	TMC10	Controls the clear operation of TMENC10.
	PRM10	Selects the count clock.
	CM100	Compare register
	CM101	Compare register
	CC100	Compare register
	CC101	Compare register
[call function]	main main function	
[Variable]	None	
[Interrupts]	timerenc_CM00_int timerenc_CM01_int timerenc_CC00_int timerenc_CC01_int	
[Interrupt sources]	INTCM00 INTCM01 INTCC00 INTCC01	
[File name]	timerenc_gen_compare\timerenc_gen_2.c, timerenc_gen_compare\MAIN.C	
[Caution]	None	

[Function name]	timerenc_gen_compare_st
[Argument]	None
[Processing content]	Starting function of timerenc_gen_comapre
[Starting method]	Call this function after calling the timerenc_gen_compare function.
[SFR used]	TMC10.TM1CE0 Controls TMENC10 operation.
[call function]	None
[Variable]	None
[File name]	timerenc_gen_compare\timerenc_gen_2.c
[Caution]	None

Interrupt functions

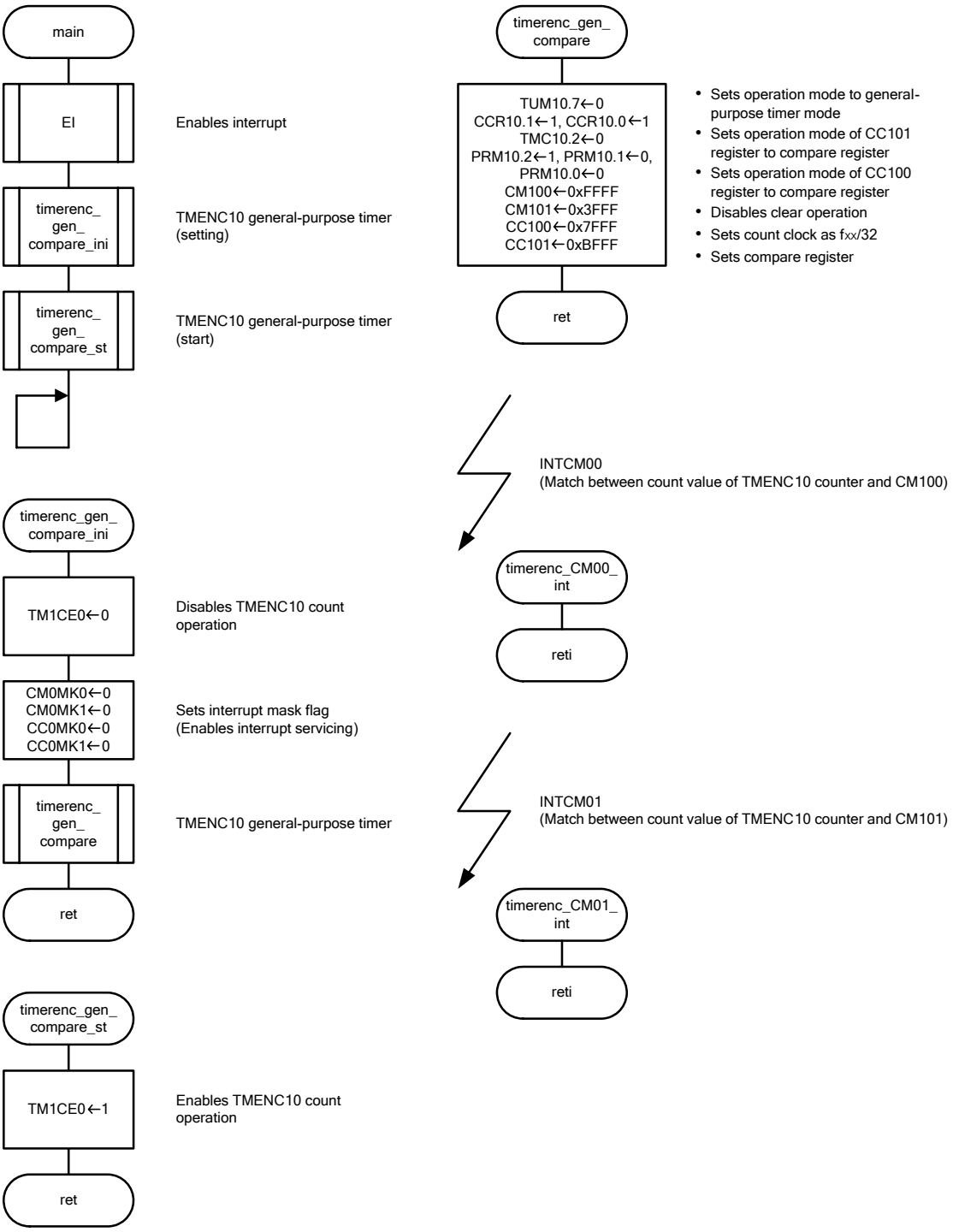
[Function name]	timerenc_CM00_int
[Overview]	Defined by the user.
[Factor]	INTCM00 Match between the values of the TMENC10 counter and CM100
[call function]	None
[Variable]	None
[File name]	timerenc_gen_compare\timerenc_gen_2.c
[Caution]	None

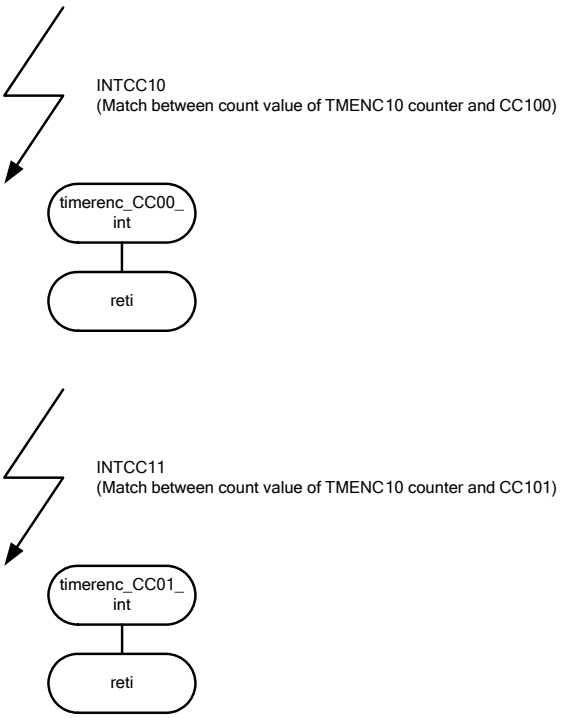
[Function name]	timerenc_CM01_int
[Overview]	Defined by the user.
[Factor]	INTCM01 Match between the values of the TMENC10 counter and CM101.
[call function]	None
[Variable]	None
[File name]	timerenc_gen_compare\timerenc_gen_2.c
[Caution]	None

[Function name]	timerenc_CC00_int
[Overview]	Defined by the user.
[Factor]	INTCC00 Match between the values of the TMENC10 counter and CC100.
[call function]	None
[Variable]	None
[File name]	timerenc_gen_compare\timerenc_gen_2.c
[Caution]	None

[Function name]	timerenc_CC01_int
[Overview]	Defined by the user.
[Factor]	INTCC01 Match between the values of the TMENC10 counter and CC101.
[call function]	None
[Variable]	None
[File name]	timerenc_gen_compare\timerenc_gen_2.c
[Caution]	None

General-purpose timer mode: Compare function (1/2)




INTCC10
(Match between count value of TMENC10 counter and CC100)
timerenc_CC00_
int
reti
INTCC11
(Match between count value of TMENC10 counter and CC101)
timerenc_CC01_
int
reti

16-bit 2-phase encoder input up/down counter/general-purpose timer (TMENC1n) (n = 0, 1)

General-purpose timer mode: Capture function

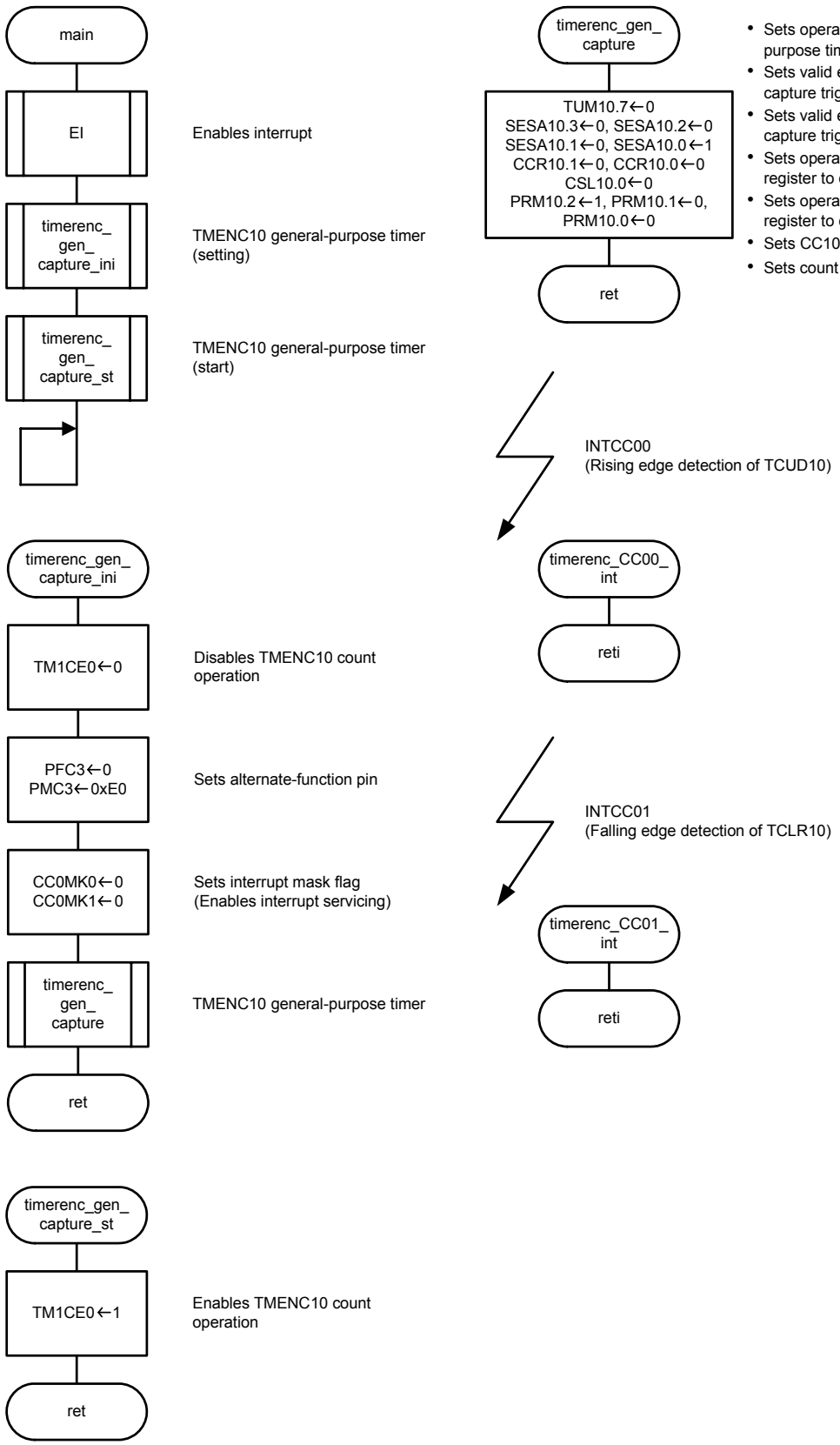
[Functions]	Performs count operation based on the clock selected by software, and captures the counter (TMENC10) value to the capture registers CC100 and CC101 upon valid edge of the TCUD10 and TCLR10 input signals that are specified as the capture trigger signals. Generates interrupt request signals (INTCC00 and INTCC01) during capture operation.	
[Function name]	timerenc_gen_capture	
[Argument]	None	
[Processing content]	Generates an interrupt upon valid edge detection of the capture trigger signal, via count operation of an fxx/32 count clock.	
[Starting method]	Starts by calling the timerenc_gen_capture_st function.	
[SFRs used]	TUM10	Specifies the operation mode of TMENC10.
	SESA10	• Specifies the valid edge of the capture trigger of the CC100 register. • Specifies the valid edge of the capture trigger of the CC101 register.
	CCR10	• Specifies the operation mode of the CC100 register. • Specifies the operation mode of the CC101 register.
	CSL10	Selects the capture input signal of the CC101 register.
	TMC10	Controls the clear operation of TMENC10.
	PRM10	Selects the count clock.
	CC100	Capture register
	CC101	Capture register
[call function]	main main function	
[Variable]	None	
[Interrupts]	timerenc_CC00_int timerenc_CC01_int	
[Interrupt sources]	INTCC00 INTCC01	
[File name]	timerenc_gen_capture\timerenc_gen_3.c, timerenc_gen_capture\MAIN.C	
[Caution]	• CC100 and CC101 registers must not be read successively.	

[Function name]	timerenc_gen_capture_st	
[Argument]	None	
[Processing content]	Starting function of timerenc_gen_capture	
[Starting method]	Call this function after calling the timerenc_gen_capture function.	
[SFR used]	TMC10.TM1CE0	Controls TMENC10 operation.
[call function]	None	
[Variable]	None	
[File name]	timerenc_gen_capture\timerenc_gen_3.c	
[Caution]	None	

Interrupt functions

[Function name]	timerenc_CC00_int	
[Overview]	Defined by the user.	
[Factor]	INTCC00	Valid edge detection of the TCUD10 input signal specified as the capture trigger signal
[call function]	None	
[Variable]	None	
[File name]	timerenc_gen_capture\timerenc_gen_3.c	
[Caution]	None	

[Function name]	timerenc_CC01_int	
[Overview]	Defined by the user.	
[Factor]	INTCC01	Valid edge detection of the TCLR10 input signal specified as the capture trigger signal
[call function]	None	
[Variable]	None	
[File name]	timerenc_gen_capture\timerenc_gen_3.c	
[Caution]	None	


main
EI
Enables interrupt
timerenc_
gen_
capture_ini
TMENC10 general-purpose timer
(setting)
timerenc_
gen_
capture_st
TMENC10 general-purpose timer
(start)
timerenc_gen_
capture
TUM10.7←0
SESA10.3←0, SESA10.2←0
SESA10.1←0, SESA10.0←1
CCR10.1←0, CCR10.0←0
CSL10.0←0
PRM10.2←1, PRM10.1←0,
PRM10.0←0
ret
• Sets operation mode to general-purpose timer mode
• Sets valid edge of CC101 capture trigger to falling edge
• Sets valid edge of CC100 capture trigger to rising edge
• Sets operation mode of CC101 register to capture register
• Sets operation mode of CC100 register to capture register
• Sets CC101 input to TCLR10
• Sets count clock as fXX/32
INTCC00
(Rising edge detection of TCUD10)
timerenc_gen_
capture_ini
TM1CE0←0
Disables TMENC10 count
operation
PFC3←0
PMC3←0xE0
Sets alternate-function pin
CC0MK0←0
CC0MK1←0
Sets interrupt mask flag
(Enables interrupt servicing)
timerenc_
gen_
capture
TMENC10 general-purpose timer
ret
timerenc_CC00_
int
reti
INTCC01
(Falling edge detection of TCLR10)
timerenc_CC01_
int
reti
timerenc_gen_
capture_st
TM1CE0←1
Enables TMENC10 count
operation
ret

16-bit 2-phase encoder input up/down counter/general-purpose timer (TMENC1n) (n = 0, 1)

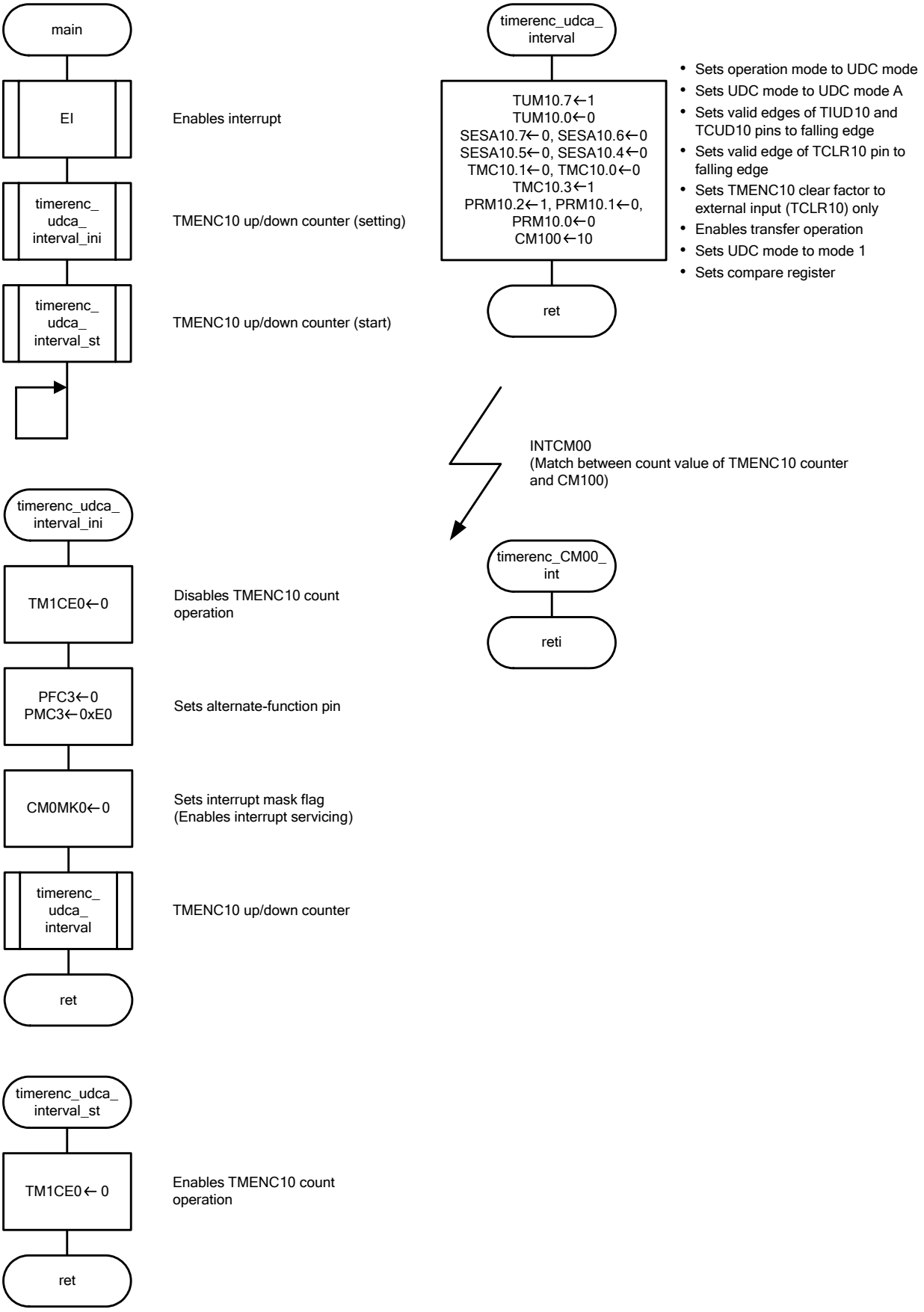
UDC mode A: interval/transfer operation

[Functions]	Performs a count up/down of the counter (TMENC10) for the number of clock pulses input from the external input pin. Performs a count up/down according to the mode specified by the PRM10 register, clears TMENC10 upon the count clock subsequent to which the value of the compare register (CM100) matches, and generates an interrupt request signal (INTCM00). Transfers the value of CM100 to TMENC10 upon the subsequent count clock to which if the count value of TMENC10 becomes 0 during count down.	
[Function name]	timerenc_udca_interval	
[Argument]	None	
[Processing content]	Performs a count up/down by loading the clock pulse input from the external input pin, and generates an interrupt upon the count clock subsequent to which the values of TMENC10 and CM100 match. Transfers the value of CM100 upon the count subsequent to which if the value of TMENC10 becomes 0 during count down.	
[Starting method]	Starts by calling the timerenc_udca_interval_st function.	
[SFRs used]	TUM10	• Specifies the operation mode of TMENC10. • Specifies the operation during UDC mode.
	SESA10	• Specifies the valid edges of the TIUD10 and TCUD10 pins. • Specifies the valid edge of the TCLR10 pin.
	TMC10	• Specifies the clear factor of TMENC10. • Specifies the transfer operation from the CM100 register to TMENC10.
	PRM10	Selects the count operation mode.
	CM100	Sets compare register.
[call function]	main main function	
[Variable]	None	
[Interrupt]	timerenc_CM00_int	
[Interrupt source]	INTCM00	
[File name]	timerenc_udca_interval\timerenc_udca_0.c, timerenc_udca_interval\MAIN.C	
[Caution]	None	

[Function name]	timerenc_udca_interval_st
[Argument]	None
[Processing content]	Starting function of timerenc_udca_interval
[Starting method]	Call this function after calling the timerenc_udca_interval function.
[SFR used]	TMC10.TM1CE0 Controls TMENC10 operation.
[call function]	None
[Variable]	None
[File name]	timerenc_udca_interval\timerenc_udca_0.c
[Caution]	None

Interrupt function

[Function name]	timerenc_CM00_int
[Overview]	Defined by the user.
[Factor]	INTCM00 Match between the values of the TMENC10 counter and CM100
[call function]	None
[Variable]	None
[File name]	timerenc_udca_interval\timerenc_udca_0.c
[Caution]	None


main
EI
Enables interrupt
timerenc_ udca_ interval_ini
TMENC10 up/down counter (setting)
timerenc_ udca_ interval_st
TMENC10 up/down counter (start)
timerenc_udca_ interval
TUM10.7←1
TUM10.0←0
SESA10.7←0, SESA10.6←0
SESA10.5←0, SESA10.4←0
TMC10.1←0, TMC10.0←0
TMC10.3←1
PRM10.2←1, PRM10.1←0,
PRM10.0←0
CM100←10
• Sets operation mode to UDC mode
• Sets UDC mode to UDC mode A
• Sets valid edges of TIUD10 and TCUD10 pins to falling edge
• Sets valid edge of TCLR10 pin to falling edge
• Sets TMENC10 clear factor to external input (TCLR10) only
• Enables transfer operation
• Sets UDC mode to mode 1
• Sets compare register
ret
INTCM00
(Match between count value of TMENC10 counter and CM100)
timerenc_udca_ interval_ini
TM1CE0←0
Disables TMENC10 count operation
PFC3←0
PMC3←0xE0
Sets alternate-function pin
CM0MK0←0
Sets interrupt mask flag
(Enables interrupt servicing)
timerenc_ udca_ interval
TMENC10 up/down counter
ret
timerenc_CM00_ int
reti
timerenc_udca_ interval_st
TM1CE0←0
Enables TMENC10 count operation
ret

16-bit 2-phase encoder input up/down counter/general-purpose timer (TMENC1n) (n = 0, 1)

UDC mode A: Compare function

(1/2)

[Functions]	Performs a count up/down of the counter (TMENC10) for the number of clock pulses input from the external input pin. Performs a count up/down according to the mode specified by the PRM10 register, and generates an interrupt request signal upon match detection between the values of TMENC10 and the compare register. Interrupt request signals INTCM00, INTCM01, INTCC00, and INTCC01 are generated for compare registers CM100, CM101, CC100, and CC101 respectively. Clears TMENC10 when INTCM00 is generated.	
[Function name]	timerenc_udca_compare	
[Argument]	None	
[Processing content]	Performs a count up/down by loading the clock pulse input from the external input pin, and generates an interrupt upon the count clock subsequent to which the values of TMENC10 match their respective compare register values	
[Starting method]	Starts by calling the timerenc_udca_compare_st function.	
[SFRs used]	TUM10	• Specifies the operation mode of TMENC10. • Specifies the operation during UDC mode.
	SESA10	• Specifies the valid edges of the TIUD10 and TCUD10 pins. • Specifies the valid edge of the TCLR10 register.
	CCR10	• Specifies the operation mode of the CC100 register. • Specifies the operation mode of the CC101 register.
	TMC10	• Specifies the clear factor of TMENC10. • Specifies the transfer operation from the CM100 register to TMENC10.
	PRM10	Selects the count operation mode.
	CM100	Compare register
	CM101	Compare register
	CC100	Compare register
	CC101	Compare register
[call function]	main main function	
[Variable]	None	
[Interrupts]	timerenc_CM00_int timerenc_CM01_int timerenc_CC00_int timerenc_CC01_int	

[Interrupt sources]	INTCM00 INTCM01 INTCC00 INTCC01
[File name]	timerenc_udca_compare\timerenc_udca_1.c, timerenc_udca_compare\MAIN.C
[Caution]	None

[Function name]	timerenc_udca_compare_st
[Argument]	None
[Processing content]	Starting function of timerenc_udca_comapre
[Starting method]	Call this function after calling the timerenc_udca_compare function.
[SFR used]	TMC10.TM1CE0 Controls TMENC10 operation.
[call function]	None
[Variable]	None
[File name]	timerenc_udca_compare\timerenc_udc_1.c
[Caution]	None

Interrupt functions

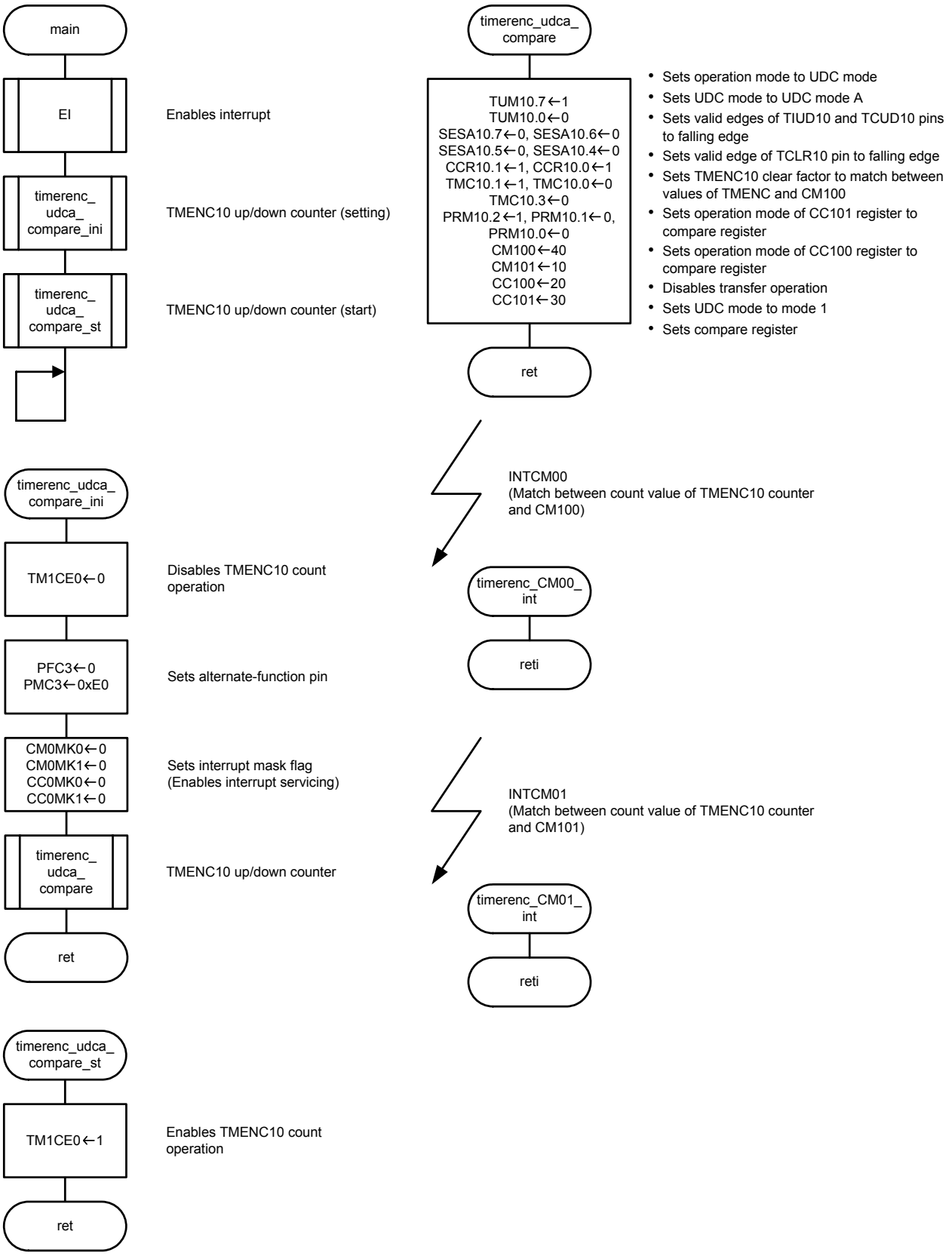
[Function name]	timerenc_CM00_int
[Overview]	Defined by the user.
[Factor]	INTCM00 Match between the values of the TMENC10 counter and CM100
[call function]	None
[Variable]	None
[File name]	timerenc_udca_compare\timerenc_udc_1.c
[Caution]	None

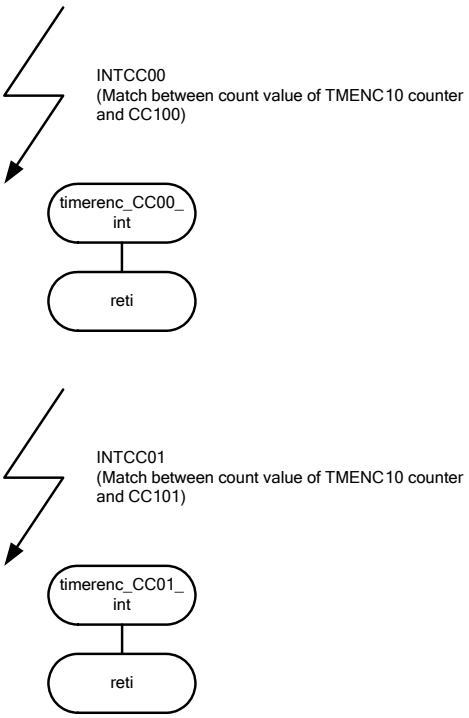
[Function name]	timerenc_CM01_int
[Overview]	Defined by the user.
[Factor]	INTCM01 Match between the values of the TMENC10 counter and CM101.
[call function]	None
[Variable]	None
[File name]	timerenc_udca_compare\timerenc_udc_1.c
[Caution]	None

[Function name]	timerenc_CC00_int
[Overview]	Defined by the user.
[Factor]	INTCC00 Match between the values of the TMENC10 counter and CC100.
[call function]	None
[Variable]	None
[File name]	timerenc_udca_compare\timerenc_udc_1.c
[Caution]	None

[Function name]	timerenc_CC01_int
[Overview]	Defined by the user.
[Factor]	INTCC01 Match between the values of the TMENC10 counter and CC101.
[call function]	None
[Variable]	None
[File name]	timerenc_udca_compare\timerenc_udc_1.c
[Caution]	None

UDC mode A: Compare function (1/2)




INTCC00
(Match between count value of TMENC10 counter
and CC100)
timerenc_CC00_
int
reti
INTCC01
(Match between count value of TMENC10 counter
and CC101)
timerenc_CC01_
int
reti

16-bit 2-phase encoder input up/down counter/general-purpose timer (TMENC1n) (n = 0, 1)

UDC mode A: Capture function

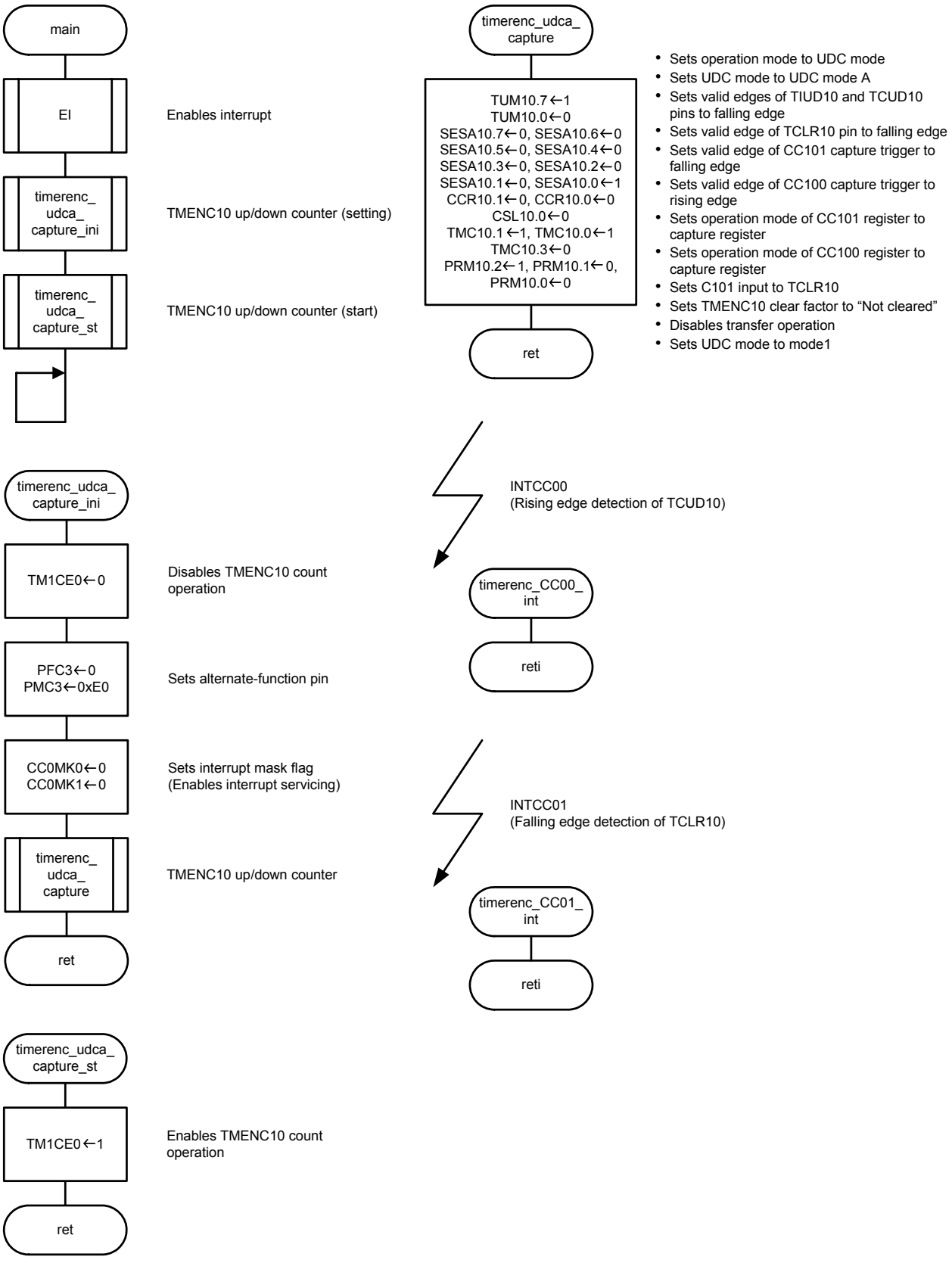
[Functions]	Performs a count up/down of the counter for the number of clock pulses input from the external input pin. Performs a count up/down according to the mode specified by the PRM10 register, and captures the value of TMENC10 to the capture registers CC100 and CC101 upon valid edge detection of the TCUD10 and TCLR10 input signals that are specified as the capture trigger signals.	
[Function name]	timerenc_udca_capture	
[Argument]	None	
[Processing content]	Performs a count up/down by loading the clock pulse input from the external input pin, and generates an interrupt upon valid edge of the capture trigger signal.	
[Starting method]	Starts by calling the timerenc_udca_capture_st function.	
[SFRs used]	TUM10	• Specifies the operation mode of TMENC10. • Specifies the operation during UDC mode.
	SESA10	• Specifies the valid edges of the TIUD10 and TCUD10 pins. • Specifies the valid edge of the TCLR10 register. • Specifies the valid edge of the capture trigger of the CC100 register. • Specifies the valid edge of the capture trigger of the CC101 register.
	CCR10	• Specifies the operation mode of the CC100 register. • Specifies the operation mode of the CC101 register.
	CSL10	Selects the capture input signal of the CC101 register.
	TMC10	• Specifies the clear factor of TMENC10. • Specifies the transfer operation from the CM100 register to TMENC10.
	PRM10	Selects the count operation mode.
	CC100	Capture register
	CC101	Capture register
[call function]	main main function	
[Variable]	None	
[Interrupt]	timerenc_CC00_int timerenc_CC01_int	
[Interrupt source]	INTCC00 INTCC01	
[File name]	timerenc_udca_capture\timerenc_udca_2.c, timerenc_udca_capture\MAIN.C	
[Caution]	• CC100 and CC101 registers must not be read successively.	

[Function name]	timerenc_udca_capture_st	
[Argument]	None	
[Processing content]	Starting function of timerenc_udca_capture	
[Starting method]	Call this function after calling the timerenc_udca_capture function.	
[SFR used]	TMC10.TM1CE0	Controls TMENC10 operation.
[call function]	None	
[Variable]	None	
[File name]	timerenc_udca_capture\timerenc_udc_2.c	
[Caution]	None	

Interrupt functions

[Function name]	timerenc_CC00_int	
[Overview]	Defined by the user.	
[Factor]	INTCC00	Valid edge detection of the TCUD10 input signal specified as the capture trigger signal
[call function]	None	
[Variable]	None	
[File name]	timerenc_udca_capture\timerenc_udc_2.c	
[Caution]	None	

[Function name]	timerenc_CC01_int	
[Overview]	Defined by the user.	
[Factor]	INTCC01	Valid edge detection of the TCLR10 input signal specified as the capture trigger signal
[call function]	None	
[Variable]	None	
[File name]	timerenc_udca_capture\timerenc_udc_2.c	
[Caution]	None	


main
EI
Enables interrupt
timerenc_ udca_ capture_ini
TMENC10 up/down counter (setting)
timerenc_ udca_ capture_st
TMENC10 up/down counter (start)
timerenc_udca_ capture_ini
TM1CE0←0
Disables TMENC10 count operation
PFC3←0
PMC3←0xE0
Sets alternate-function pin
CC0MK0←0
CC0MK1←0
Sets interrupt mask flag (Enables interrupt servicing)
timerenc_ udca_ capture
TMENC10 up/down counter
ret
timerenc_udca_ capture_st
TM1CE0←1
Enables TMENC10 count operation
ret
timerenc_udca_ capture
TUM10.7←1
TUM10.0←0
SESA10.7←0, SESA10.6←0
SESA10.5←0, SESA10.4←0
SESA10.3←0, SESA10.2←0
SESA10.1←0, SESA10.0←1
CCR10.1←0, CCR10.0←0
CSL10.0←0
TMC10.1←1, TMC10.0←1
TMC10.3←0
PRM10.2←1, PRM10.1←0,
PRM10.0←0
ret
• Sets operation mode to UDC mode
• Sets UDC mode to UDC mode A
• Sets valid edges of TIUD10 and TCUD10 pins to falling edge
• Sets valid edge of TCLR10 pin to falling edge
• Sets valid edge of CC101 capture trigger to falling edge
• Sets valid edge of CC100 capture trigger to rising edge
• Sets operation mode of CC101 register to capture register
• Sets operation mode of CC100 register to capture register
• Sets C101 input to TCLR10
• Sets TMENC10 clear factor to “Not cleared”
• Disables transfer operation
• Sets UDC mode to mode1
INTCC00
(Rising edge detection of TCUD10)
timerenc_CC00_ int
reti
INTCC01
(Falling edge detection of TCLR10)
timerenc_CC01_ int
reti

16-bit 2-phase encoder input up/down counter/general-purpose timer (TMENC1n) (n = 0, 1)

UDC mode B: Basic operation

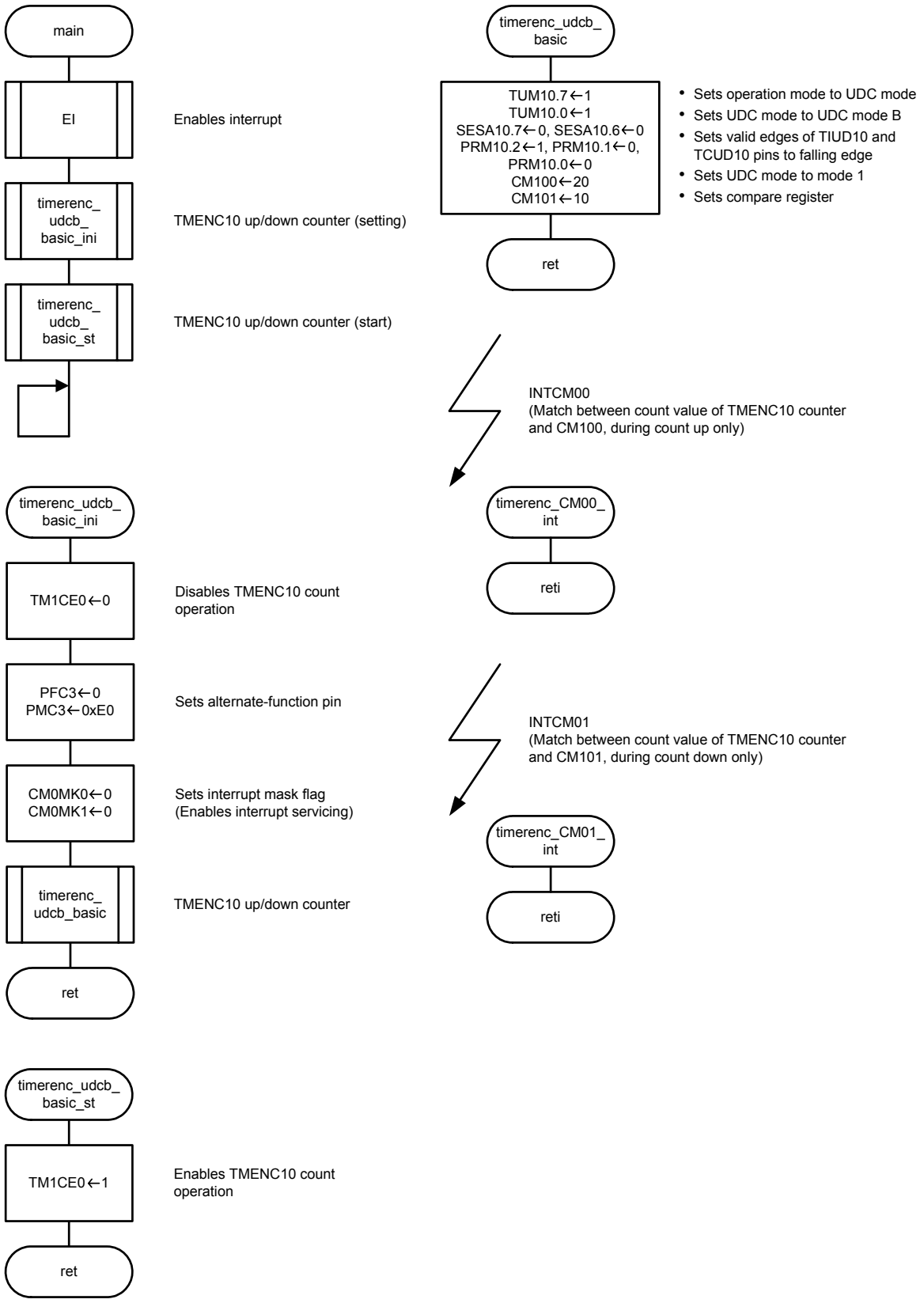
[Functions]	Performs a count up/down of the counter for the number of clock pulses input from the external input pin. Performs a count up/down according to the mode specified by the PRM10 register, and generates interrupt request signals INTCM00 and INTCM01 respectively upon a match between the values of TMENC10 and CM100 if during count up, and a match between the values of TMENC10 and CM101 if during count down.	
[Function name]	timerenc_udcb_basic	
[Argument]	None	
[Processing content]	Performs a count up/down by loading the clock pulses input from the external input pin, and generates interrupts upon the count clocks subsequent to which the values of TMENC10 and CM100 match if during count up, and the values of TMENC10 and CM101 match if during count down.	
[Starting method]	Starts by calling the timerenc_udcb_basic_st function.	
[SFRs used]	TUM10	• Specifies the operation mode of TMENC10. • Specifies the operation during UDC mode.
	SESA10	Specifies the valid edges of the TIUD10 and TCUD10 pins.
	PRM10	Selects the count operation mode.
	CM100	Compare register
	CM101	Compare register
[call function]	main main function	
[Variable]	None	
[Interrupts]	timerenc_CM00_int timerenc_CM01_int	
[Interrupt sources]	INTCM00 INTCM01	
[File name]	timerenc_udcb_basic\timerenc_udcb_0.c, timerenc_udcb_basic\MAIN.C	
[Caution]	• Interrupt generation and counter clearance are not performed if the value of TMENC10 matches the value of CM101 during count up, or the value of CM100 during count down.	

[Function name]	timerenc_udcb_basic_st	
[Argument]	None	
[Processing content]	Starting function of timerenc_udcb_basic	
[Starting method]	Call this function after calling the timerenc_udcb_basic function.	
[SFR used]	TMC10.TM1CE0	Controls TMENC10 operation.
[call function]	None	
[Variable]	None	
[File name]	timerenc_udcb_basic\timerenc_udcb_0.c	
[Caution]	None	

Interrupt functions

[Function name]	timerenc_CM00_int	
[Overview]	Defined by the user.	
[Factor]	INTCM00	Match between the values of the TMENC10 counter and CM100 during count up
[call function]	None	
[Variable]	None	
[File name]	timerenc_udcb_basic\timerenc_udcb_0.c	
[Caution]	None	

[Function name]	timerenc_CM01_int	
[Overview]	Defined by the user.	
[Factor]	INTCM01	Match between the values of the TMENC10 counter and CM101 during count down
[call function]	None	
[Variable]	None	
[File name]	timerenc_udcb_interval\timerenc_udc_0.c	
[Caution]	None	


main
EI
Enables interrupt
timerenc_
udcb_
basic_ini
TMENC10 up/down counter (setting)
timerenc_
udcb_
basic_st
TMENC10 up/down counter (start)
timerenc_udcb_
basic_ini
TM1CE0←0
Disables TMENC10 count
operation
PFC3←0
PMC3←0xE0
Sets alternate-function pin
CM0MK0←0
CM0MK1←0
Sets interrupt mask flag
(Enables interrupt servicing)
timerenc_
udcb_basic
TMENC10 up/down counter
ret
timerenc_udcb_
basic_st
TM1CE0←1
Enables TMENC10 count
operation
ret
timerenc_udcb_
basic
TUM10.7←1
TUM10.0←1
SESA10.7←0, SESA10.6←0
PRM10.2←1, PRM10.1←0,
PRM10.0←0
CM100←20
CM101←10
• Sets operation mode to UDC mode
• Sets UDC mode to UDC mode B
• Sets valid edges of TIUD10 and
TCUD10 pins to falling edge
• Sets UDC mode to mode 1
• Sets compare register
ret
INTCM00
(Match between count value of TMENC10 counter
and CM100, during count up only)
timerenc_CM00_
int
reti
INTCM01
(Match between count value of TMENC10 counter
and CM101, during count down only)
timerenc_CM01_
int
reti

16-bit 2-phase encoder input up/down counter/general-purpose timer (TMENC1n) (n = 0, 1)

UDC mode B: Compare function

(1/2)

[Functions]	Performs a count up/down of the counter (TMENC10) for the number of clock pulses input from the external input pin. Performs a count up/down according to the mode specified by the PRM10 register, and generates an interrupt request signal upon match detection between the values of TMENC10 and the compare register. Interrupt request signals INTCM00, INTCM01, INTCC00, and INTCC01 are generated for compare register CM100, CM101, CC100, and CC101 respectively. Clears TMENC10 when INTCM00 is generated.	
[Function name]	timerenc_udcb_compare	
[Argument]	None	
[Processing content]	Performs a count up/down by loading the clock pulses input from the external input pin, and generates an interrupt upon a match between the values of TMENC10 and the corresponding compare registers.	
[Starting method]	Starts by calling the timerenc_udcb_compare_st function.	
[SFRs used]	TUM10	• Specifies the operation mode of TMENC10. • Specifies the operation during UDC mode.
	SESUD10	Specifies the valid edges of the TIUD10 and TCUD10 pins.
	CCR10	• Specifies the operation mode of the CC100 register. • Specifies the operation mode of the CC101 register.
	PRM10	Selects the count operation mode.
	CM100	Compare register
	CM101	Compare register
	CC100	Compare register
	CC101	Compare register
[call function]	main main function	
[Variable]	None	
[Interrupts]	timerenc_CM00_int timerenc_CM01_int timerenc_CC00_int timerenc_CC01_int	
[Interrupt sources]	INTCM00 INTCM01 INTCC00 INTCC01	

[File name]	timerenc_udcb_compare\timerenc_udcb_1.c, timerenc_udcb_compare\MAIN.C
[Caution]	• Interrupt generation and counter clearance are not performed if the value of TMENC10 matches the value of CM101 during count up, or the value of CM100 during count down. • CC100 and CC101 function as normal compare registers. Interrupts are generated upon matches between the values of the compare registers and the corresponding count clocks, regardless of whether being during count up/down.

[Function name]	timerenc_udcb_compare_st	
[Argument]	None	
[Processing content]	Starting function of timerenc_udcb_comapre	
[Starting method]	Call this function after calling the timerenc_udcb_compare function.	
[SFR used]	TMC10.TM1CE0	Controls TMENC10 operation.
[call function]	None	
[Variable]	None	
[File name]	timerenc_udcb_compare\timerenc_udcb_1.c	
[Caution]	None	

Interrupt functions

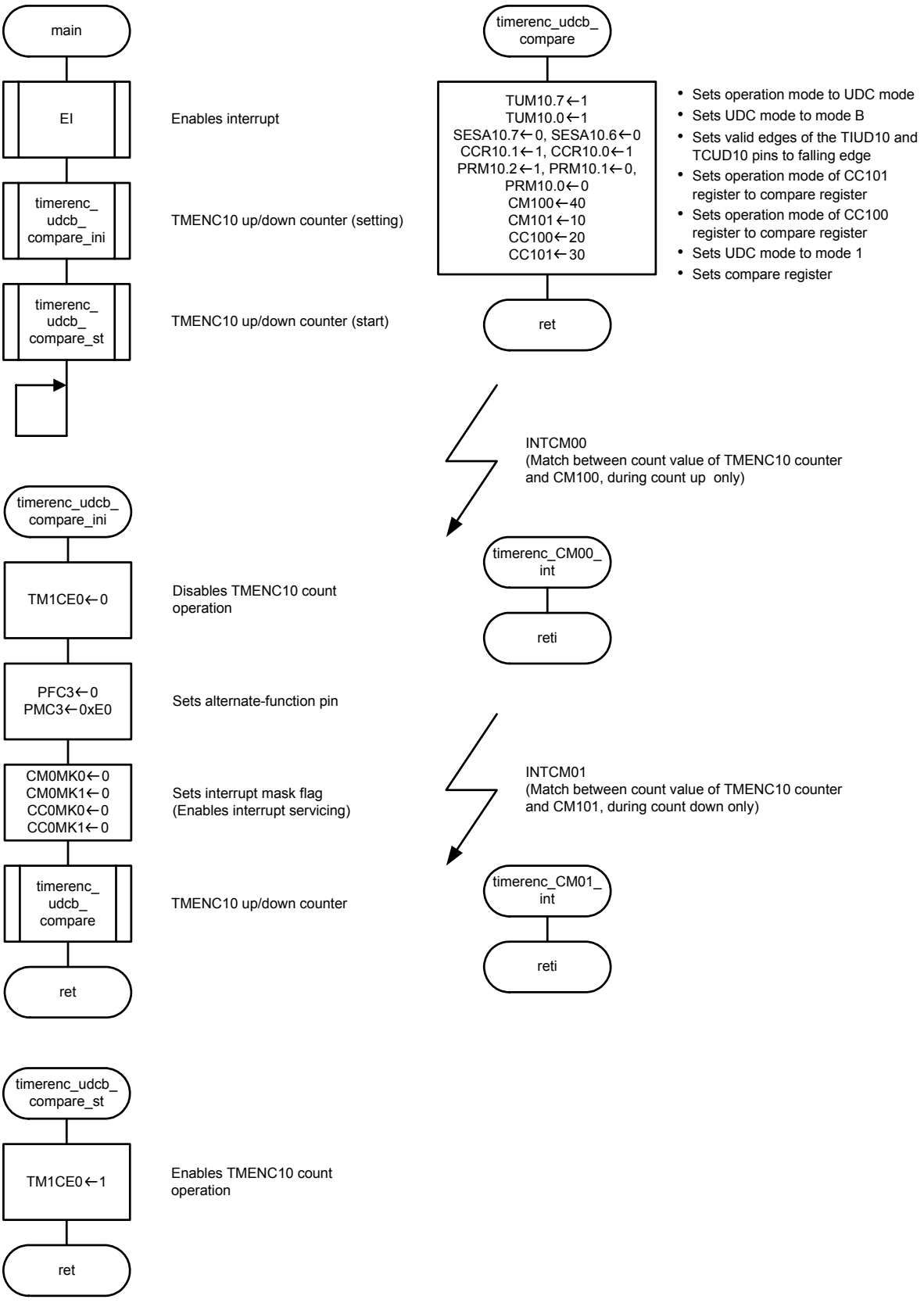
[Function name]	timerenc_CM00_int	
[Overview]	Defined by the user.	
[Factor]	INTCM00	Match between the values of the TMENC10 counter and CM100 during count up
[call function]	None	
[Variable]	None	
[File name]	timerenc_udcb_compare\timerenc_udcb_1.c	
[Caution]	None	

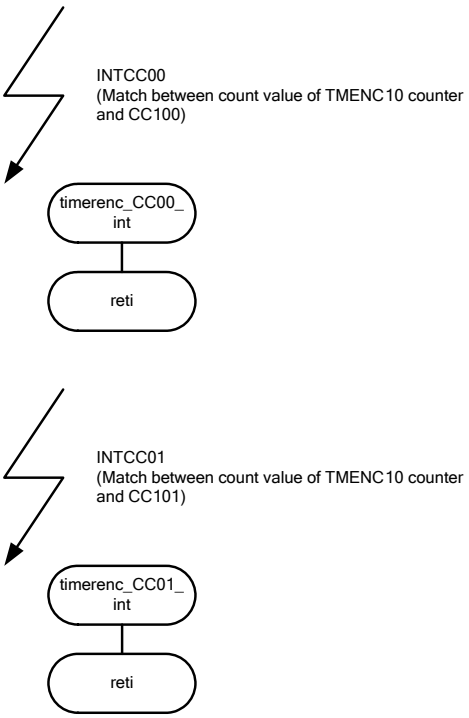
[Function name]	timerenc_CM01_int	
[Overview]	Defined by the user.	
[Factor]	INTCM01	Match between the values of the TMENC10 counter and CM101 during count down
[call function]	None	
[Variable]	None	
[File name]	timerenc_udcb_compare\timerenc_udcb_1.c	
[Caution]	None	

[Function name]	timerenc_CC00_int	
[Overview]	Defined by the user.	
[Factor]	INTCC00	Match between the values of the TMENC10 counter and CC100.
[call function]	None	
[Variable]	None	
[File name]	timerenc_udcb_compare\timerenc_udc_1.c	
[Caution]	None	

[Function name]	timerenc_CC01_int	
[Overview]	Defined by the user.	
[Factor]	INTCC01	Match between the values of the TMENC10 counter and CC101.
[call function]	None	
[Variable]	None	
[File name]	timerenc_udcb_compare\timerenc_udc_1.c	
[Caution]	None	

UDC mode B: Compare function (1/2)




INTCC00
(Match between count value of TMENC10 counter
and CC100)
timerenc_CC00_
int
reti
INTCC01
(Match between count value of TMENC10 counter
and CC101)
timerenc_CC01_
int
reti

16-bit 2-phase encoder input up/down counter/general-purpose timer (TMENC1n) (n = 0, 1)

UDC mode B: Capture function

(1/2)

[Functions]	Performs a count up/down of the counter (TMENC10) for the number of clock pulses input from the external input pin. Perfroms count up/down according to the mode specified by the PRM10 register, and captures the value of TMENC10 to the capture registers CC100 and CC101 upon valid edge of the TCUD10 and TCLR10 input signals that are specified as the capture trigger signals. Generates an interrupt request signal during capture operation.	
[Function name]	timerenc_udcb_capture	
[Argument]	None	
[Processing content]	Performs a count up/down by loading the clock pulse input from the external input pin, and generates an interrupt upon valid edge of the capture trigger signal.	
[Starting method]	Starts by calling the timerenc_udcb_capture_st function.	
[SFRs used]	TUM10	• Specifies the operation mode of TMENC10. • Specifies the operation during UDC mode.
	SESA10	• Specifies the valid edges of the TIUD10 and TCUD10 pins. • Specifies the valid edge of the TCLR10 register. • Specifies the valid edge of the capture trigger of the CC100 register. • Specifies the valid edge of the capture trigger of the CC101 register.
	CCR10	• Specifies the operation mode of the CC100 register. • Specifies the operation mode of the CC101 register.
	CSL10	Selects the capture input signal of the CC101 register.
	PRM10	Selects the count operation mode.
	CM100	Compare register
	CM101	Compare register
	CC100	Capture register
	CC101	Capture register
[call function]	main main function	
[Variable]	None	
[Interrupts]	timerenc_CC00_int timerenc_CC01_int	
[Interrupt sources]	INTCC00 INTCC01	
[File name]	timerenc_udcb_capture\timerenc_udc_2.c, timerenc_udcb_capture\MAIN.C	

[Caution]	• CC100 and CC101 registers must not be read successively. • CM100 and CM101 registers function as compare registers. Thus, the counter is cleared if the counter (TMENC10) value matches the value of the CM101 register during count up, or matches the value of the CM100 register during count down. The counter starts from 0000H. Thus, the counter practically stands still because it is cleared by each count when the CM100 and CM101 register values are set to 0000H. Therefore, set appropriate values to the CM100 and CM101 registers.

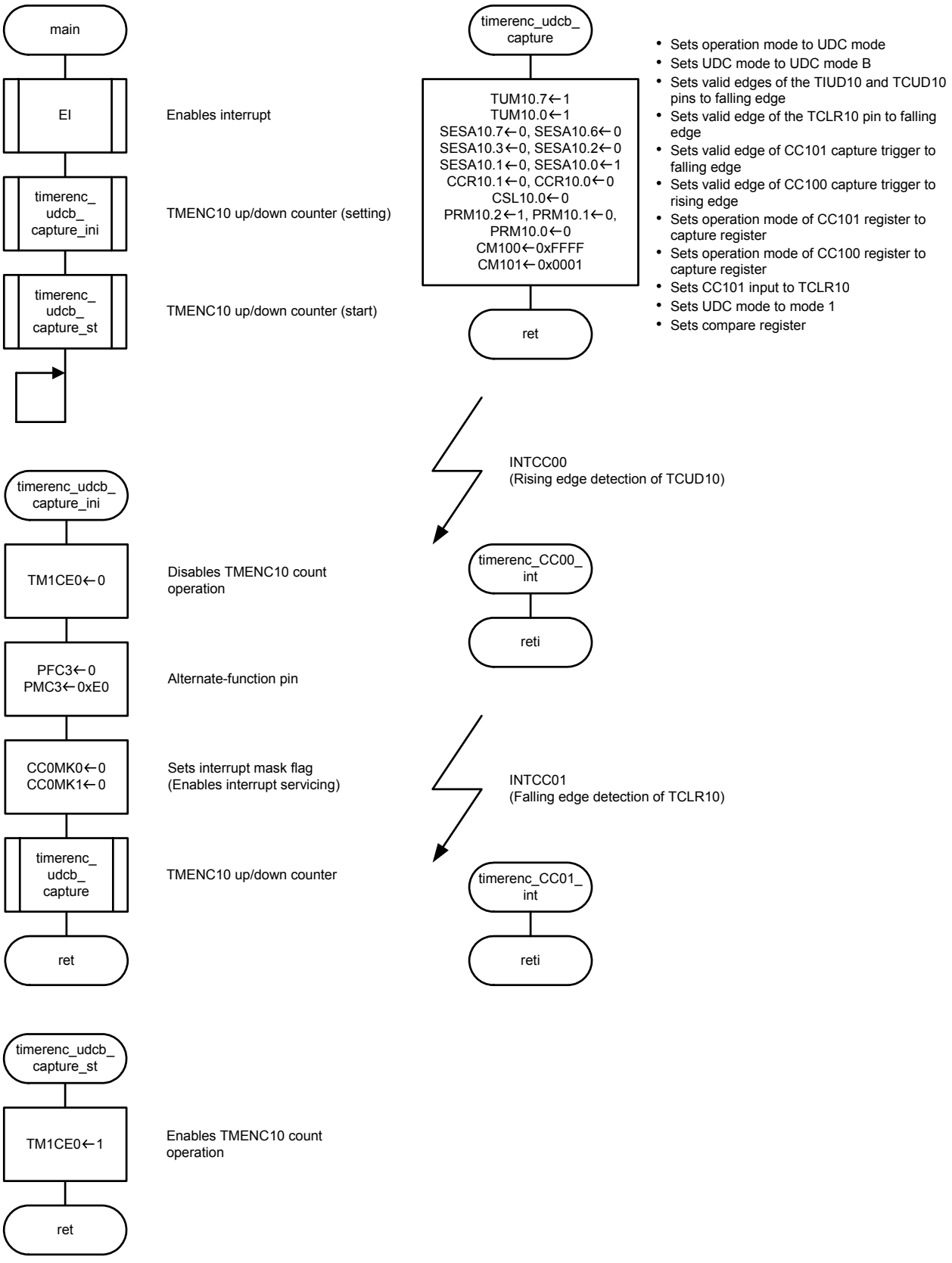
[Function name]	timerenc_udcb_capture_st	
[Argument]	None	
[Processing content]	Starting function of timerenc_udcb_capture	
[Starting method]	Call this function after calling the timerenc_udcb_capture function.	
[SFR used]	TMC10.TM1CE0	Controls TMENC10 operation.
[call function]	None	
[Variable]	None	
[File name]	timerenc_udcb_capture\timerenc_udc_2.c	
[Caution]	None	

Interrupt functions

[Function name]	timerenc_CC00_int	
[Overview]	Defined by the user.	
[Factor]	INTCC00	Valid edge detection of the TCUD10 input signal specified as the capture trigger signal
[call function]	None	
[Variable]	None	
[File name]	timerenc_udcb_capture\timerenc_udc_2.c	
[Caution]	None	

[Function name]	timerenc_CC01_int	
[Overview]	Defined by the user.	
[Factor]	INTCC01	Valid edge detection of the TCLR10 input signal specified as the capture trigger signal
[call function]	None	
[Variable]	None	
[File name]	timerenc_udcb_capture\timerenc_udc_2.c	
[Caution]	None	

UDC mode B: Capture function



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