V850E2/ML4

Timer Array Unit Control

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Abstract

This document describes how to set up the 16-bit timer array unit A (TAUA) and 32-bit timer array unit J (TAUJ) and also gives an outline of the operation and describes the procedure for using a sample program.

The features of the operation are described below:

- TAUA generates PWM, and outputs PWM signal to TA1_O1.
- TAUJ inputs TA1_O1, and measures the width of PWM.

Products

V850E2/ML4

Integrated development environments

CubeSuite+, GHS MULTI V5.1.7D, and IAR for V850 Kickstart V3.80.

When using this application note with other Renesas MCUs, careful evaluation is recommended after making modifications to comply with the alternate MCU.

Contents

1. Specifications

This application note illustrates the usage examples of the 16-bit TAUA (timer array unit A) and 32-bit TAUJ (timer array unit J).

In the TAUA, channel 0 is set as a master channel, channel 1 is set as a slave channel, and the PWM signal is output from the TA1_O1 pin in synchronous channel operation. In the TAUJ, the TAUJ0 is set to independent channel operation, the PWM signal output from the TAUA is input to the TJ_I0 pin, and the signal width is measured.

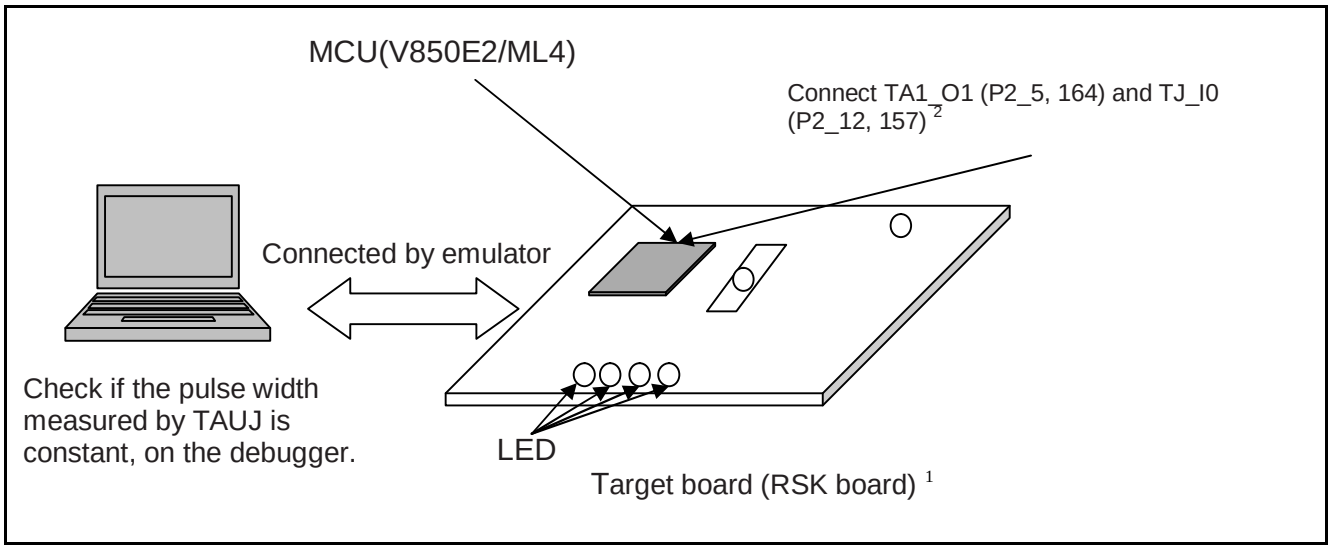
The basic timer specification is as follows.

Timer	機能
TAUA1 channel 0	Master channel, software triggered, interval timer mode.
TAUA1 channel 1	Slave channel, triggered by INTTAUAnIm of the master channel, one-count mode.
TAUJ0 channel 0	Slave channel, the start edge is rising edge of TAUAnTTINm , and the stop edge is falling edge of it, capture and one-count mode.

Table 1.1 lists the Peripheral Functions and their Applications and Fugure1.1 shows the Usage example.

Table 1.1 Peripheral Functions and their Applications

Peripheral Function	Application
Ports(P1_4, P1_5, P4_3, P4_4)	Connected to LEDs, and light on or off LEDs.
TAUA1	Timer generating PWM
TAUJ0	Time measuring pulse width.



Fugure1.1 Usage example

[1] Mass production of RSK board will start in August, 2012.
[2] TAUA1TTOUT1 and TJ_I0 are not implemented as pins on the board, connect the pins 157 and 164 on MCU directly.

2. Operation Confirmation Conditions

The sample code accompanying this application note has been run and confirmed under the conditions below.

Table 2.1 Operation Confirmation Conditions

Item	Contents
MCU used	V850E2/ML4
Operating frequency	200MHz (PLL multiplies the oscillator input frequency (fx: 10MHz) by 20.)
Operating voltage	3.3V
Integrated development environment	CubeSuite+ V1.00
	GHS MULTI V5.1.7D
	IAR for V850 Kickstart V3.80.1
C compiler	CX V1.20(CubeSuite+), optimization: default
	C-V850E 5.1.7 RELEASE(GHS MULTI) , optimization: default
	IAR C/C++ Compiler for V850 3.80.1 [Kickstart] (3.80.1.30078), optimization: default
Operating mode	Normal operation mode
Sample code version	V1.00
Board used	RSK board
Device used	E1 emulator or MINICUBE
Tool used	none

2.1 Pin(s) Used

Table 2.2 lists the **Pins Used and Its Function**.

Table 2.2 Pins Used and Its Functions

Pin Name	I/O	Function
PORT P1_4	output	Port mode, output, LED0
PORT P1_5	output	Port mode, output, LED1
PORT P4_3	output	Port mode, output, LED2
PORT P4_4	output	Port mode, output, LED3
TA1_O1	output	Output TAUA1 PWM
TJ_I0	input	Input for TAUJ0

3. Software

3.1 Operation Overview

Operation Overview is described in the following figure. The main() function initializes each functions, and initializes timers. When INTTAUJ0I0 occurred, the function int_tauj0i0() measures the pulse width.

Figure3.1 shows the Sequence diagram.

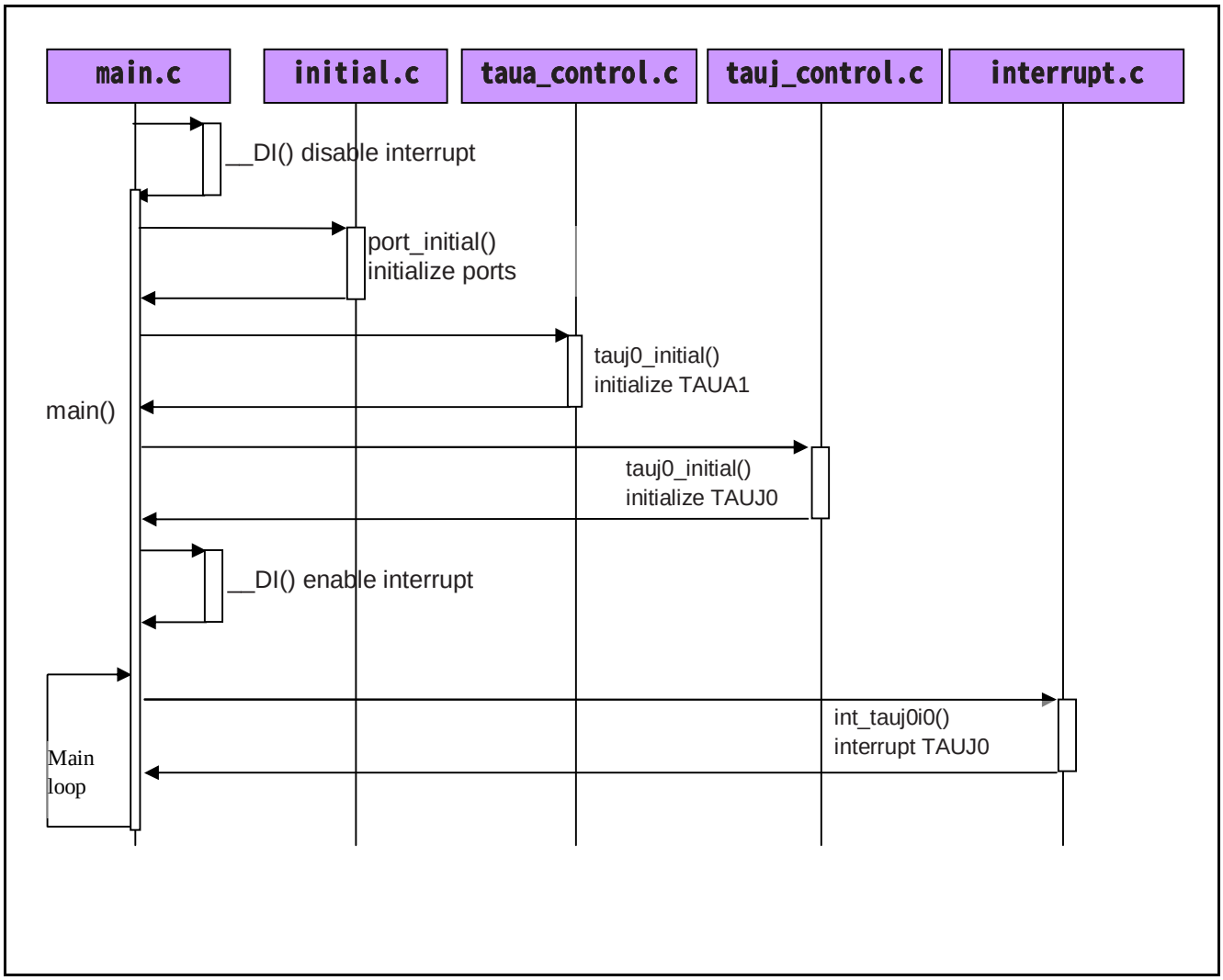


Figure3.1 Sequence diagram

3.2 Required Memory Size

Table 3.1 lists the Required Memory Size. (CubeSuite+, optimization=default)

Table 3.1 Required Memory Size

Memory Used	Size	Remarks
ROM	3228	Shown as ROM area size in map file
RAM	4120	Shown as RAM area size in map file
Maximum user stack usage	4	CubeSuite+ stack estimation tool calculated.
Maximum interrupt stack usage	32	The same as above.

Note: The required memory size varies depending on the C compiler version and its options.

3.3 File Composition

Table 3.2 lists the Files Used in the Sample Code. Files not generated by the integrated development environment should not be listed in this table.

Table 3.2 Files Used in the Sample Code

File Name	Outline	Remarks
crtE.s	Initialize hardware	Only in the project for CubeSuite+
startup.s		Only in the project for GHS MULTI
V850E2ML4.dir	Linker directive file	Only in the project for CubeSuite+
V850E2_ML4.ld		Only in the project for GHS MULTI
vector.s	Vector table	Only in the project for GHS MULTI
taua.h	Declare variables and functions.	
df4022_800.h	Declare register macros for V850E2/ML4	Only in the project for GHS MULTI
main.c	Main routine	
initial.c	Initialize software	
taua_control.c	Initialize TAUA1	
tauj_control.c	Initialize TAUJ0	
interrupt.c	Interrupt routines	

3.4 Option-Setting Memory

This sample does not specify any option-bytes. Specify them if necessary.

3.5 Variables

Table 3.3 lists the Global Variables.

Table 3.3 Global Variables

Type	Variable Name	Contents	Function Used
long long	pulse_width	Indicates pulse width	__interrupt void int_tauj0i0(void)
char	overflow_flag	Overflow flag of TAUJ0	__interrupt void int_tauj0i0(void)

3.6 Function(s)

Table 3.4 lists the Function(s).

Table 3.4 Function(s)

Function Name	Outline
void main(void)	Calls necessary initialization functions and waits interrupt in infinite loop.
void port_initial(void)	Sets up ports and their mode.
void tauj0_initial(void)	Initialize TAUA1
void taua1_initial(void)	Initialize TAUJ0
__interrupt void int_tauj0i0(void)	Interrupt TAUJ0 channel0, measuring the PWM's pulse width.

3.7 Function Specification(s)

The following tables list the sample code function specification(s).

main()	
Outline	Main routine
Header	–
Declaration	void main(void)
Description	Calls necessary initialization functions, starts transmission, and waits interrupt in infinite loop.
Arguments	– –
Return Value	–

port_initial()	
Outline	Sets up ports and their mode.
Header	taua.h
Declaration	void port_initial (void)
Description	Sets up ports, for controlling TAUA1, TAUJ0, and LEDs.
Arguments	none -
Return Value	none

taua1_initial()	
Outline	Initialize TAUA1
Header	taua.h
Declaration	void taua1_initial(void)
Description	Initialize TAUA1 to generate PWM.
Arguments	– –
Return Value	–

tauj0_initial()	
Outline	Initialize TAUJ0
Header	taua.h
Declaration	void tauj0_initial(void)
Description	InitializeTAUJ0 to measure the pulse width of the PWM.
Arguments	– –
Return Value	–

int_tauj0i0()	
Outline	Interrupt INTTAUJ0I0
Header	–
Declaration	__interrupt void int_tauj0i0(void)
Description	Interrupt INTTAUJ0I0 operation. Calculate the width of the PWM, from the value of TAUJ0CDR0 and overflow flag of TAUJ0.
Arguments	– –
Return Value	–

3.8 Flowchart(s)

3.8.1 Main Processing

Figure3.2 shows the Main Processing.

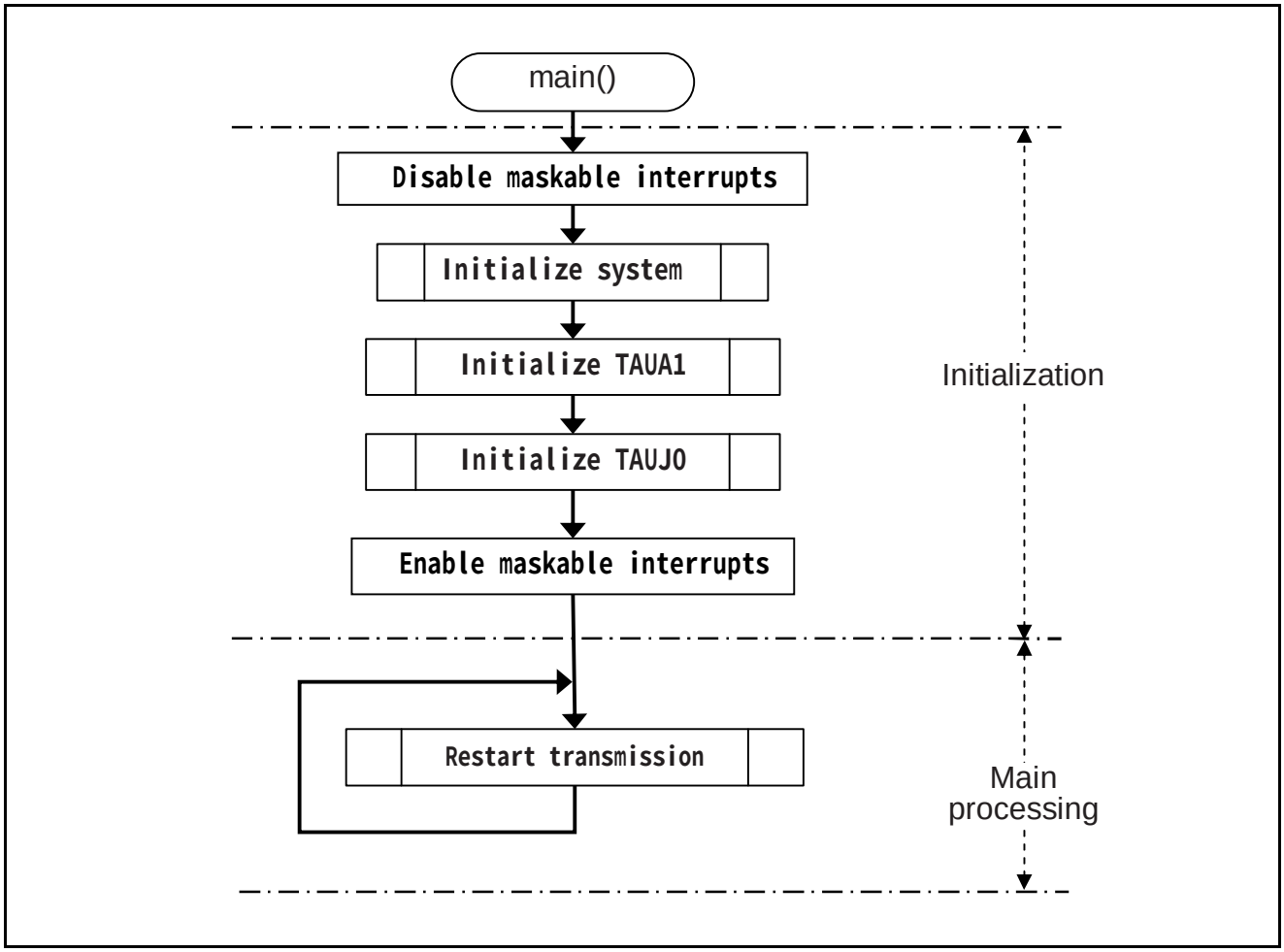


Figure3.2 Main Processing

3.8.2 Initialize TAUJ1

TAUJ0 measures the PWM pulse width, with rising edge of the signal TAUJnTTINm as a start trigger, and falling edge of the signal as a stop trigger.

Figure3.3 shows flowchart of Initialize TAUJ0.

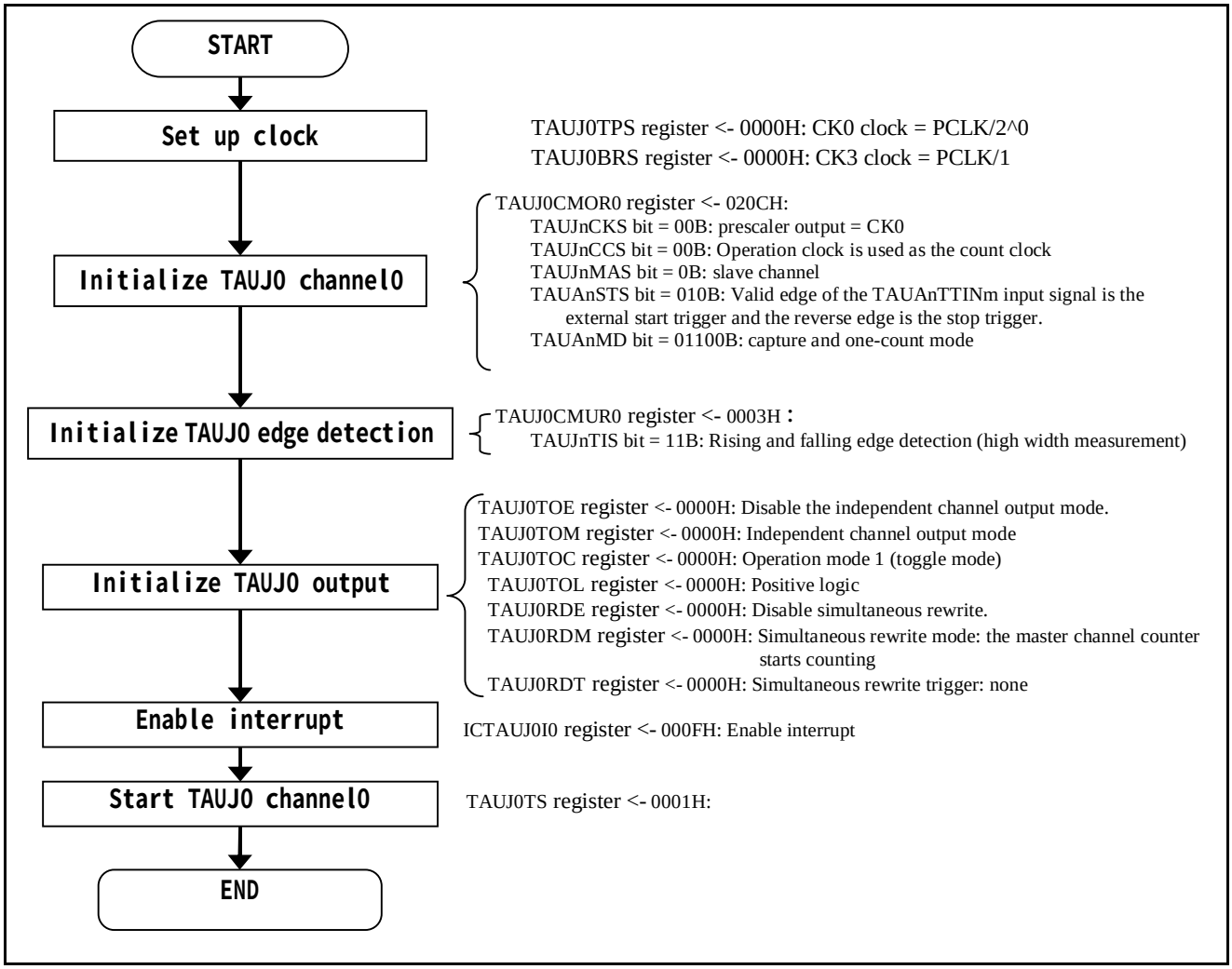


Figure3.3 Initialize TAUJ0

3.8.3 Initialize TAUA1

TAUA1generates PWM co-working with channel 0 and channel 1, and channel 1 outputs external PWM signal.

Figure3.3 shows flowchart of initializing TAUA1.

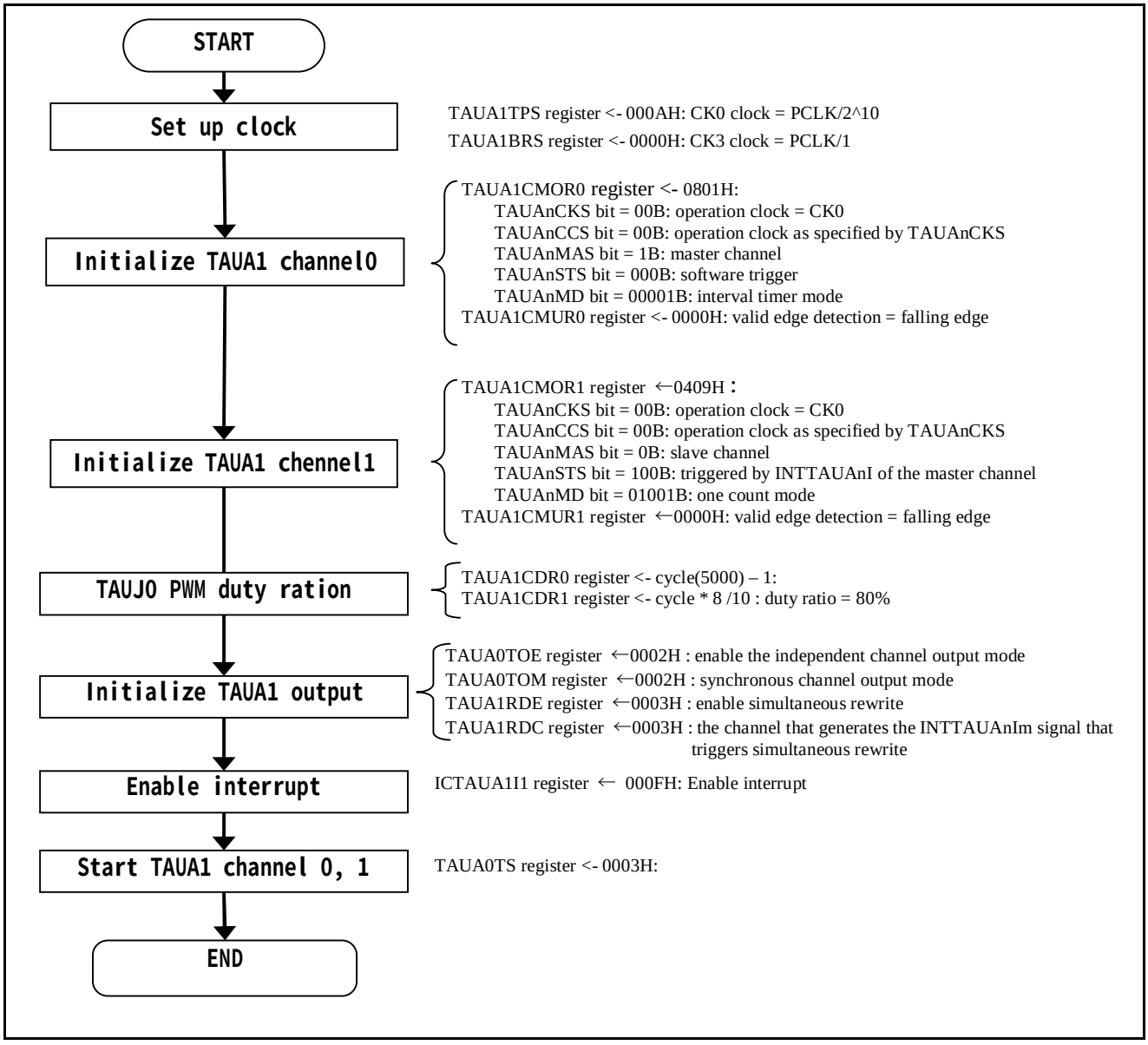


Figure3.4 Initialize UARTJ1 as transmitter

3.8.4 Interrupt: TAUJ0 (INTTAUJ0I0)

Operation of the interrupt TAUJ0 channel0, which occurs when the timer stop counting.

Figure3.5 shows flowchart of TAUJ0 (INTTAUJ0I0).

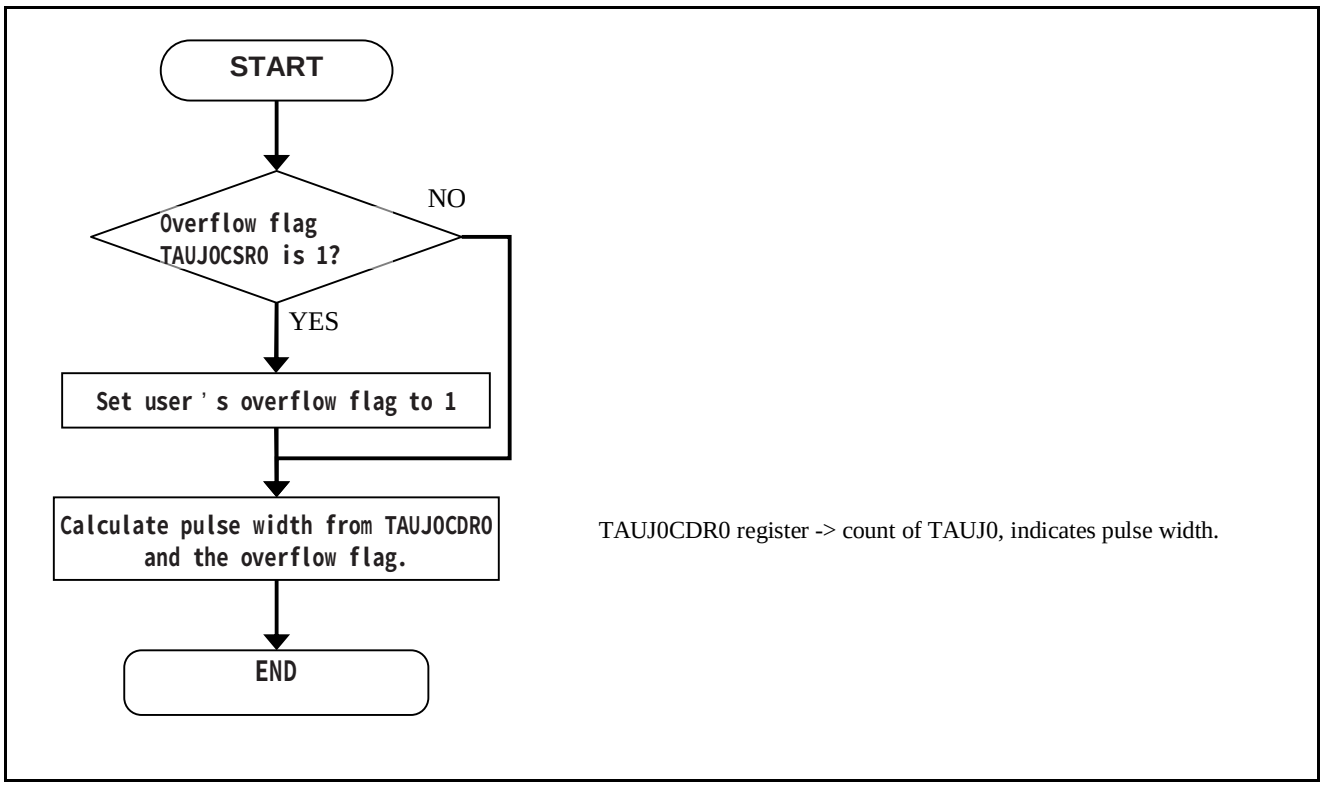


Figure3.5 TAUJ0 (INTTAUJ0I0)

4. Sample Code

Sample code can be downloaded from the Renesas Electronics website.

5. Reference Documents

User's Manual: Hardware

V850E2/ML4 User's Manual: Hardware (R01UH0262EJ)

The latest version can be downloaded from the Renesas Electronics website.

Technical Update/Technical News

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REVISION HISTORY	V850E2/ML4 Application Note Timer Array Unit Control

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		Page	Summary
1.00	Jun. 22, 2012	—	First edition issued

General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this manual, refer to the relevant sections of the manual. If the descriptions under General Precautions in the Handling of MPU/MCU Products and in the body of the manual differ from each other, the description in the body of the manual takes precedence.

1. Handling of Unused Pins
   Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.
   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.
2. Processing at Power-on
   The state of the product is undefined at the moment when power is supplied.
   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.
   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.
3. Prohibition of Access to Reserved Addresses
   Access to reserved addresses is prohibited.
   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.
4. Clock Signals
   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.
   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.
5. Differences between Products
   Before changing from one product to another, i.e. to one with a different type number, confirm that the change will not lead to problems.
   The characteristics of MPU/MCU in the same group but having different type numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different type numbers, implement a system-evaluation test for each of the products.

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