M4K Group (1)
Application Note
32-bit Timer Event Counter
(T32A-B)
Interval Timer Function

Outlines

This application note is a reference material for developing products using the interval timer function of the 32-bit timer event counter (T32A) of M4K Group (1).
This document helps the user check operation of the product and develop its program.

Target sample program: Timer_LED

Table of Contents

1. Preface

This sample program blinks an LED with a constant interval using the Timer A.
Push switches are used to change the stop and the re-start of the blink of the LED.

2. Reference Document

1. Datasheet
   TMPM4K Group (1) datasheet Rev2.0 (Japanese edition)
2. Reference manual
   32-bit Timer Event Counter (T32A-B) Rev3.0 (Japanese edition)
   Input/Output Ports (PORT-M4K(1)) Rev2.0 (Japanese edition)
   Asynchronous Serial Communication Circuit (UART-C) Rev3.0 (Japanese edition)
3. Application note
   M4K Group (1) Application Note Startup (CMSIS System & Clock Configuration) Rev1.0
4. Other reference document
   TMPM4KxA Group Peripheral Driver User Manual (Doxygen) V1.0.4.0

3. Function to Use

IP	Channel	Port	Function/Operation mode
32-bit Timer Event Counter	ch0	-	Interval timer
Input/Output Ports	-	PE2 (Input Port) PE3 (Input Port)	Input
	-	PJ0 (Output Port) PJ2 (Output Port) PJ4 (Output Port) PL4 (Output Port)	Output
Asynchronous Serial Communication Circuit	ch0	PK0 (UT0RXD) PK1 (UT0TXDA)	UART mode

4. Target Device

The target devices of this application note are as follows;

TMPM4K4FYAUG	TMPM4K4FWAUG	TMPM4K4FUAUG	TMPM4K4FSAUG
TMPM4K4FYAFG	TMPM4K4FWAFG	TMPM4K4FUAFG	TMPM4K4FSAFG
TMPM4K2FYADUG	TMPM4K2FWADUG	TMPM4K2FUADUG	TMPM4K2FSADUG
TMPM4K1FYAUG	TMPM4K1FWAUG	TMPM4K1FUAUG	TMPM4K1FSAUG
			TMPM4K0FSADUG

* This sample program operates on the evaluation board of TMPM4K4FYAUG.
If other function than the TMPM4K4 one is checked, it is necessary that CMSIS Core related files (the startup file and I/O header file) should be changed properly.
Additionally, the name of microcontroller which is set to the project should be changed.
The BSP related file is dedicated to the evaluation board (TMPM4K4FYAUG). If other function than the TMPM4K4 one is checked, the BSP related file should be changed properly.

5. Operation Confirmation Condition

Used microcontroller	TMPM4K4FYAUG
Used board	TMPM4K4 evaluation board (Product of ESP-kikaku Co. Ltd.)
Integrated development environment	IAR Embedded Workbench for ARM 8.22.2
Integrated development environment	Arm® Keil® MDK Version 5.24.2.0
Terminal software	Tera Term V4.96
Sample program	v1.0.0

6. Evaluation Board Operation

Board function	Microcontroller pin name	Function
Push switch (SW1)	PE2	Port function stop
Push switch (SW2)	PE3	Port function re-start (Blink operation)

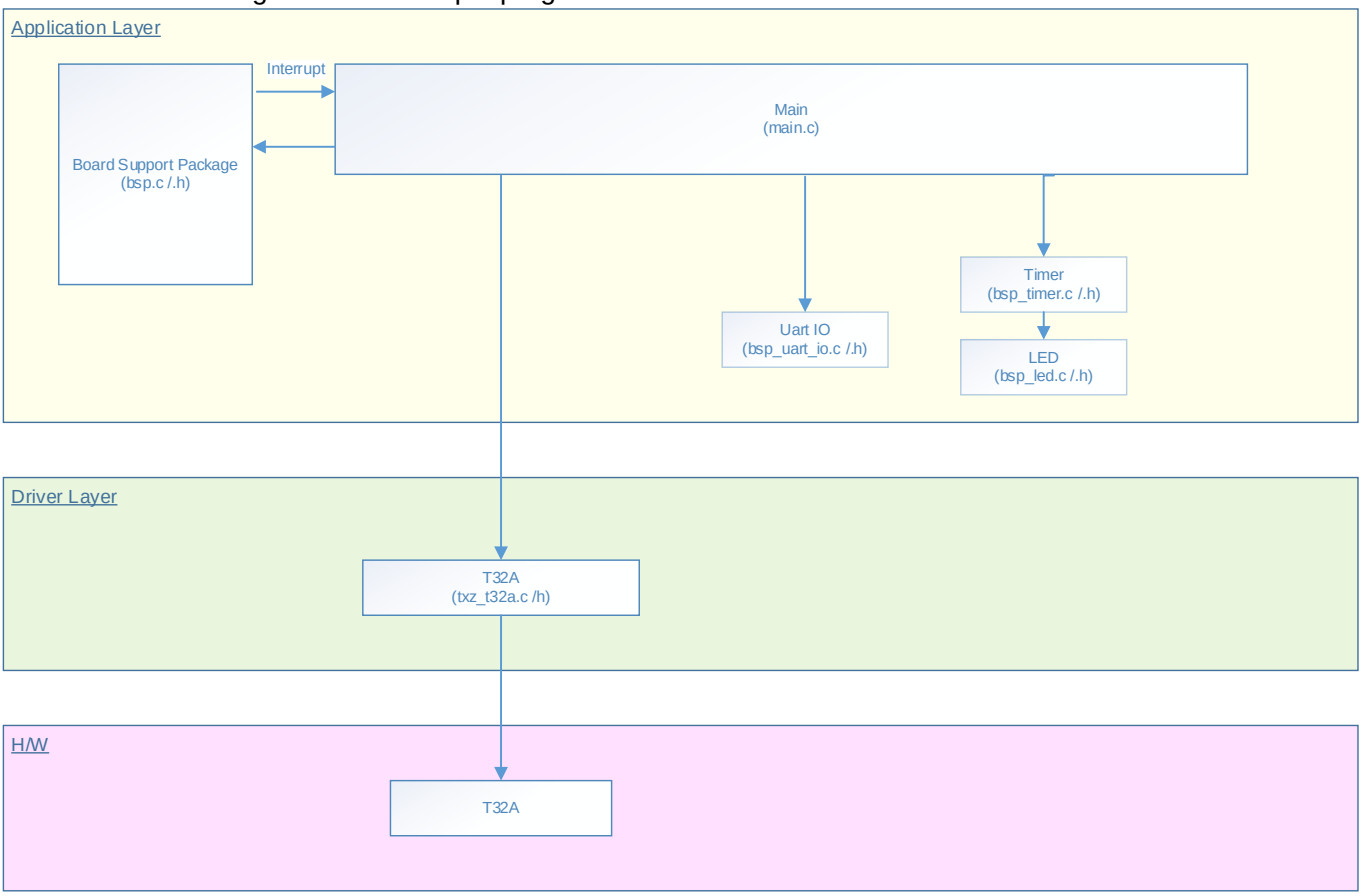
Corresponding port	LED on the board
PJ0	LED1
PJ2	LED2
PJ4	LED3
PL4	Unconnected.

The change of the operation is done by the push switch.
A PC should be connected with a USB_UART connector to communicate with the terminal software.
When the sample program is started up, the timer start-up interval is displayed on the terminal software (Tera Term).
When the push switch (SW1) is pushed down, the LED stops blinking. When the push switch (SW2) is pushed down, the LED re-starts to blink.

7. Sample Program

7.1. Structure Diagram of Sample Program

The structure diagram of the sample program is shown below.



7.2. Startup Routine

The following initialization is done after power is supplied.
The initialization of each clock setting and the initialization of the watchdog timer setting are done.

7.3. Main Operation

The initialization of the BSP should be done.
The initialization of the variables should be done.
The timer interval should be set as the initialization of the Timer driver.
The initialization of the USB_UART, the initialization of the LED's, and the initialization of the push switches should be done as the initialization of the application software.

The value of the timer interval is output to the terminal software.
The Timer is started.
Whenever the timer interval elapses, the LED lights and lights out alternatively.

When the push switch (SW1) is pushed down, the Timer stops and the status of the LED remains.
When the push switch (SW2) is pushed down, the Timer re-starts and the LED blinks.

7.4. Change of Timer Setting

The timer setting time can be changed by either of the followings;

- Change of the time of the Timer
- Change of the count-up value

Change of the time of the Timer
”static TXZ_Result driver_initialize (void)” in the “main” function should be used.

```
p_timer->init.interval = 1000
```

The setting value above is 1 ms.
When “1000 (1 μs*1000)” is modified, the blink time is changed.

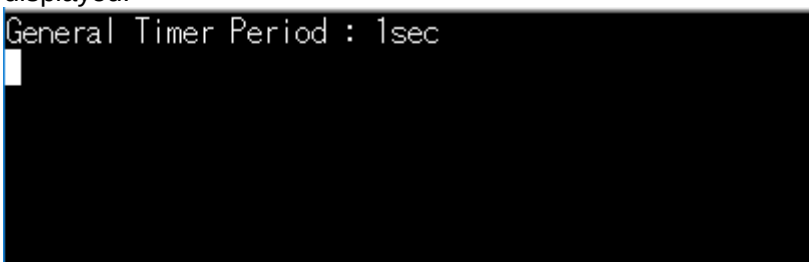
Change of the count-up value
”static void timer_interval_handler (uint32_t id)” in the “main” function should be used.

```
if (count < 1000) {     /* 1ms * 1000 = 1sec LED on */
    count++;
    on = 1;
}else if ( (count >= 1000) && (count < 2000) ) {    /* 1ms * 1000 = 1sec LED off */
    count++;
    on = 0;
```

The blink time can be changed by modifying the count value above.

7.5. Output Example of Terminal Software

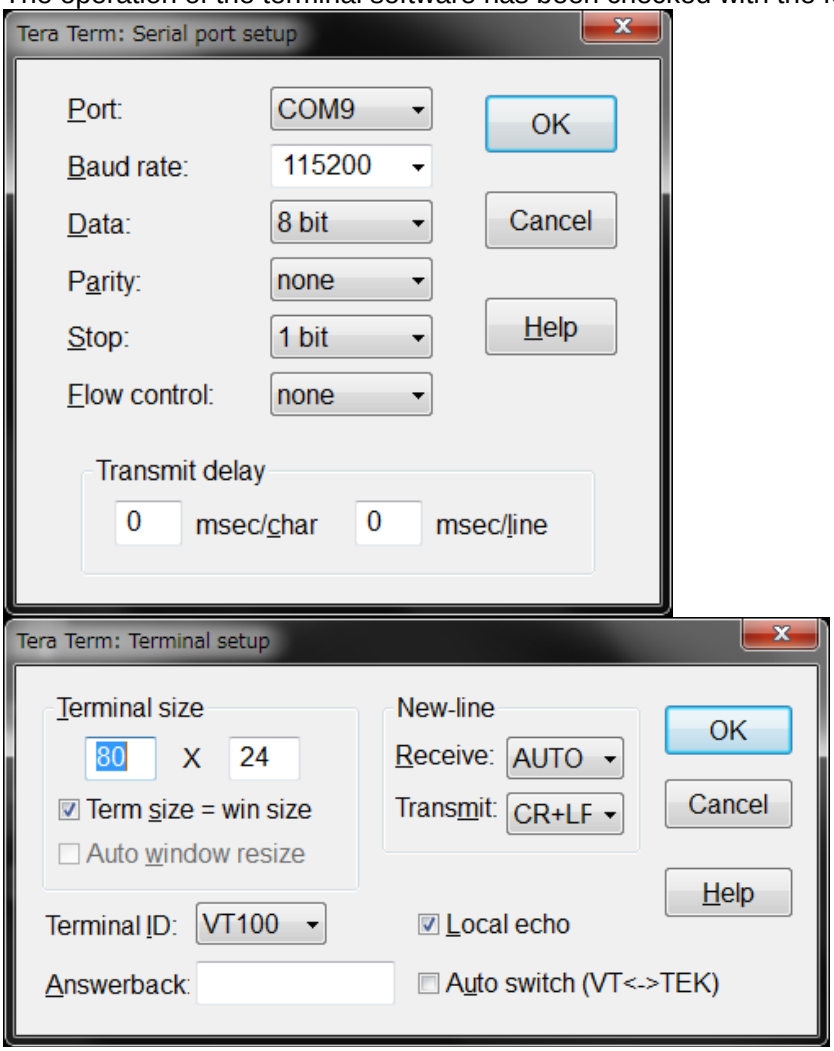
After the sample program is executed, the lighting interval and the definition of the push switch are displayed.



The display above is defined by “printf”.
If “General Timer Period” is changed, the setting time is different from the displayed result.

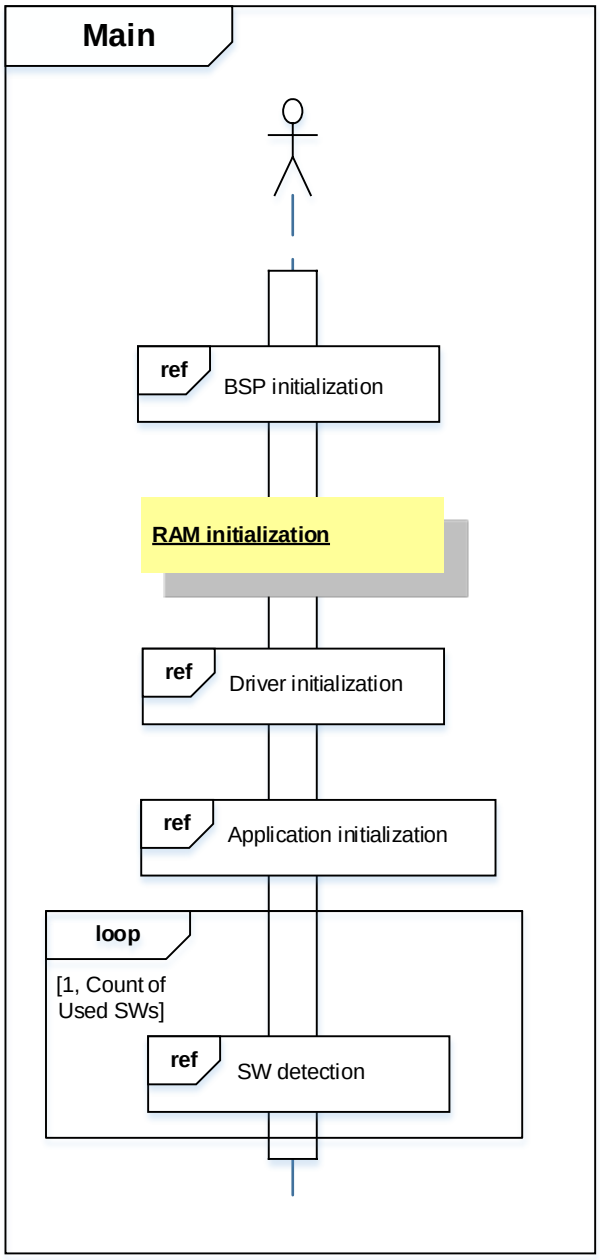
7.5.1. Setting Example of Terminal Software

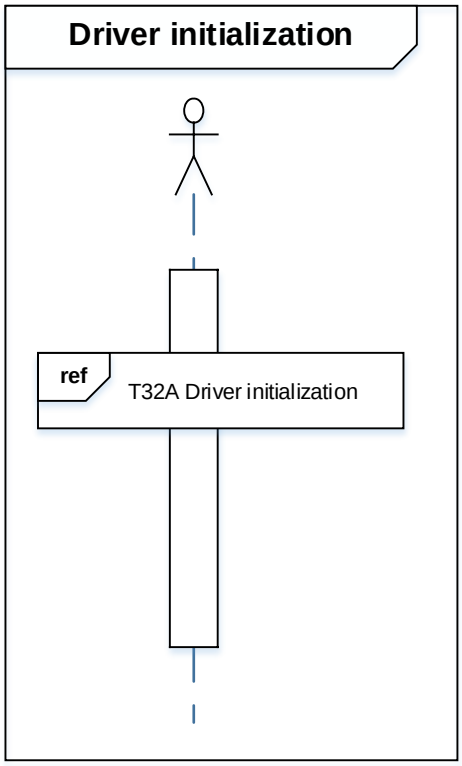
The operation of the terminal software has been checked with the following settings.

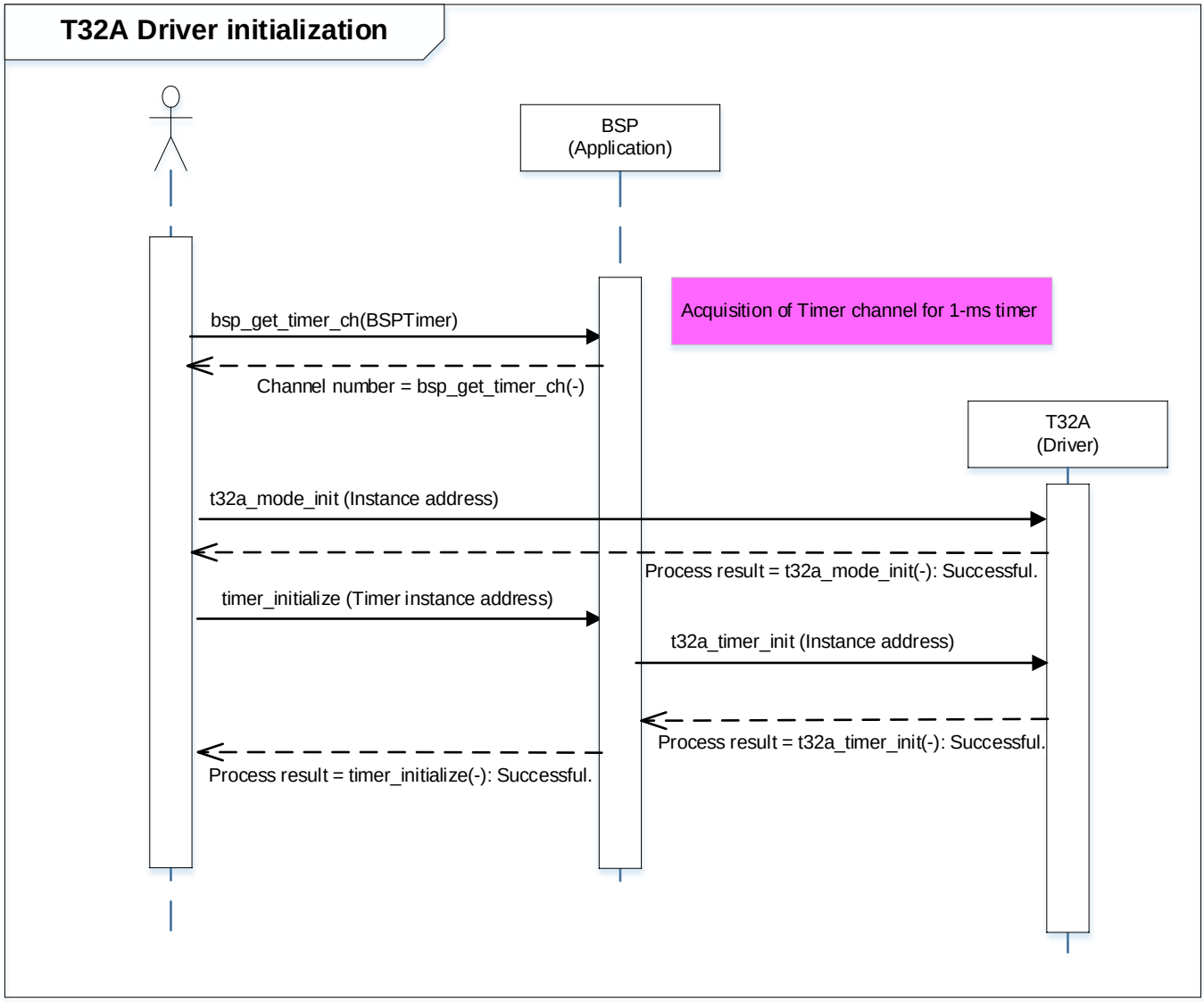


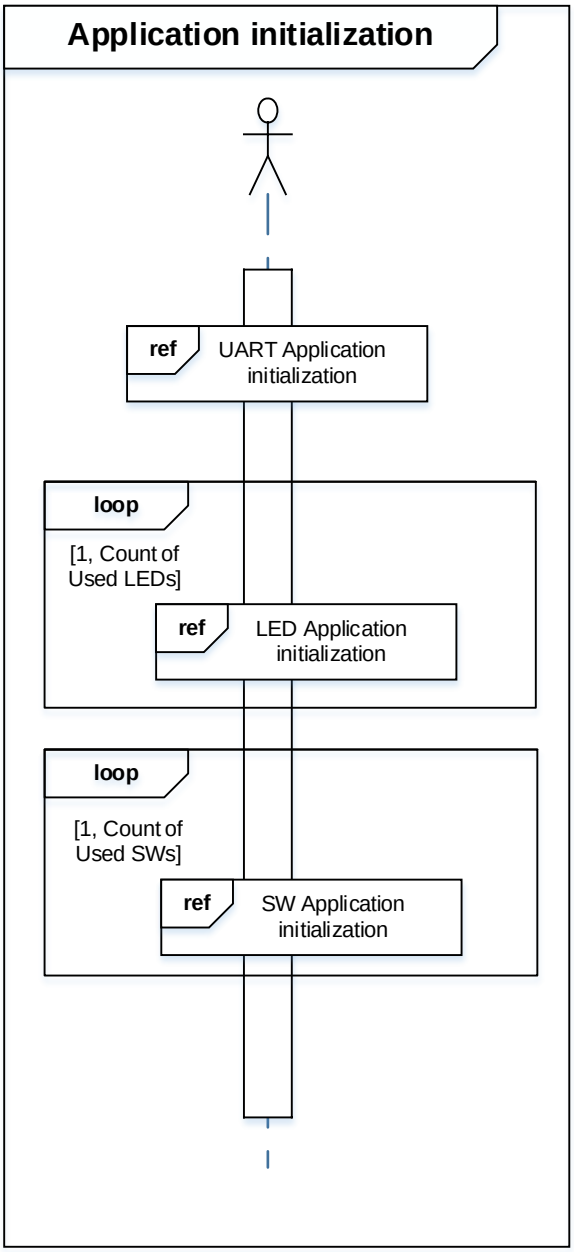
7.6. Operating Flow of Sample Program

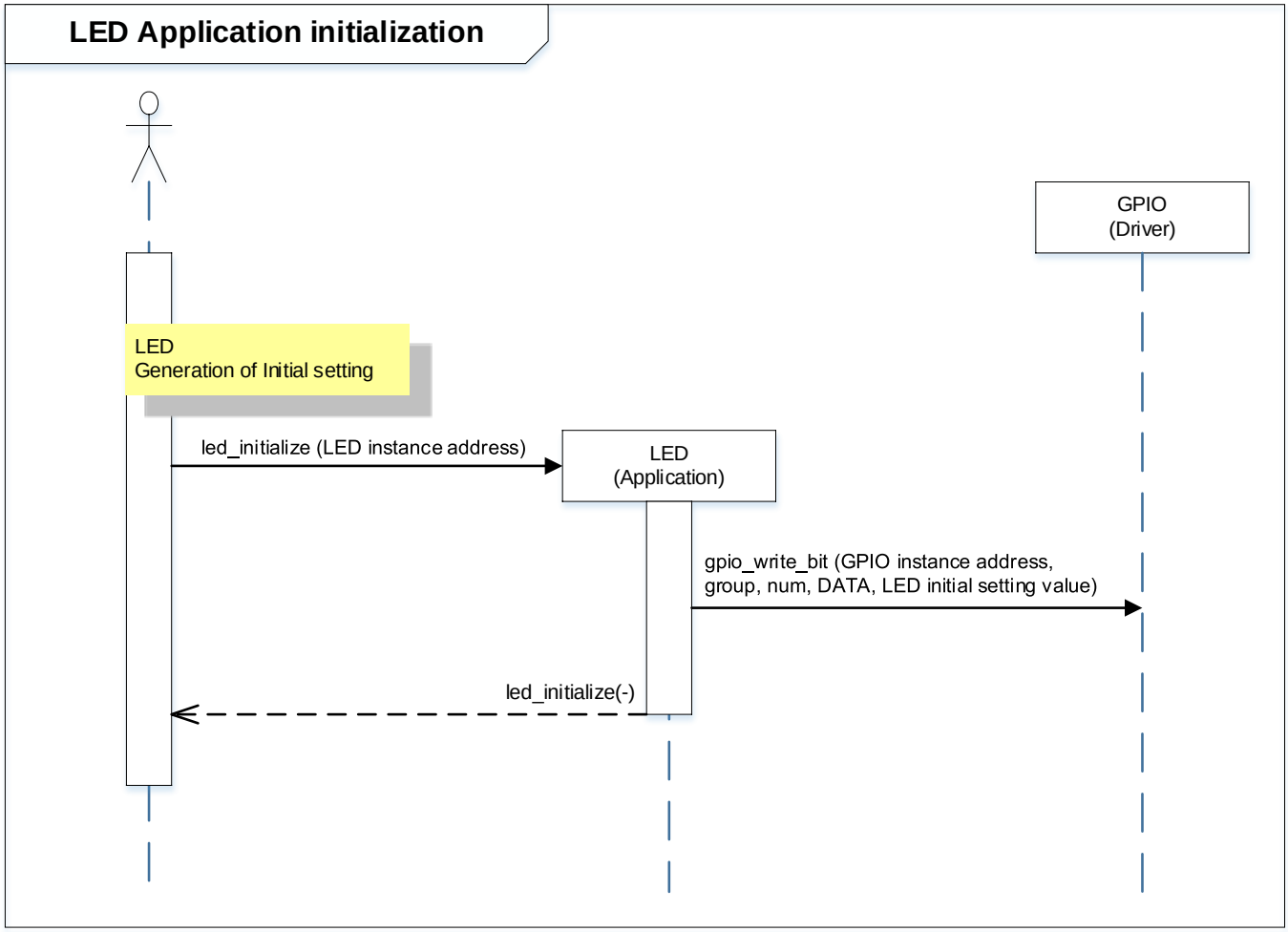
The basic operating flows of the sample program are shown in the following;

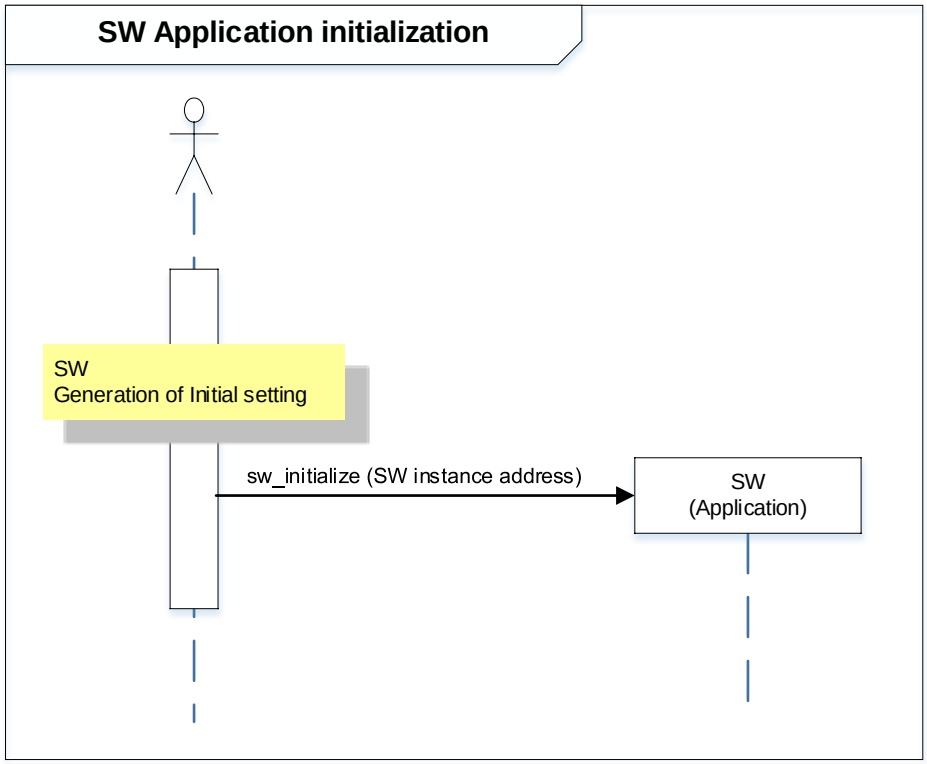


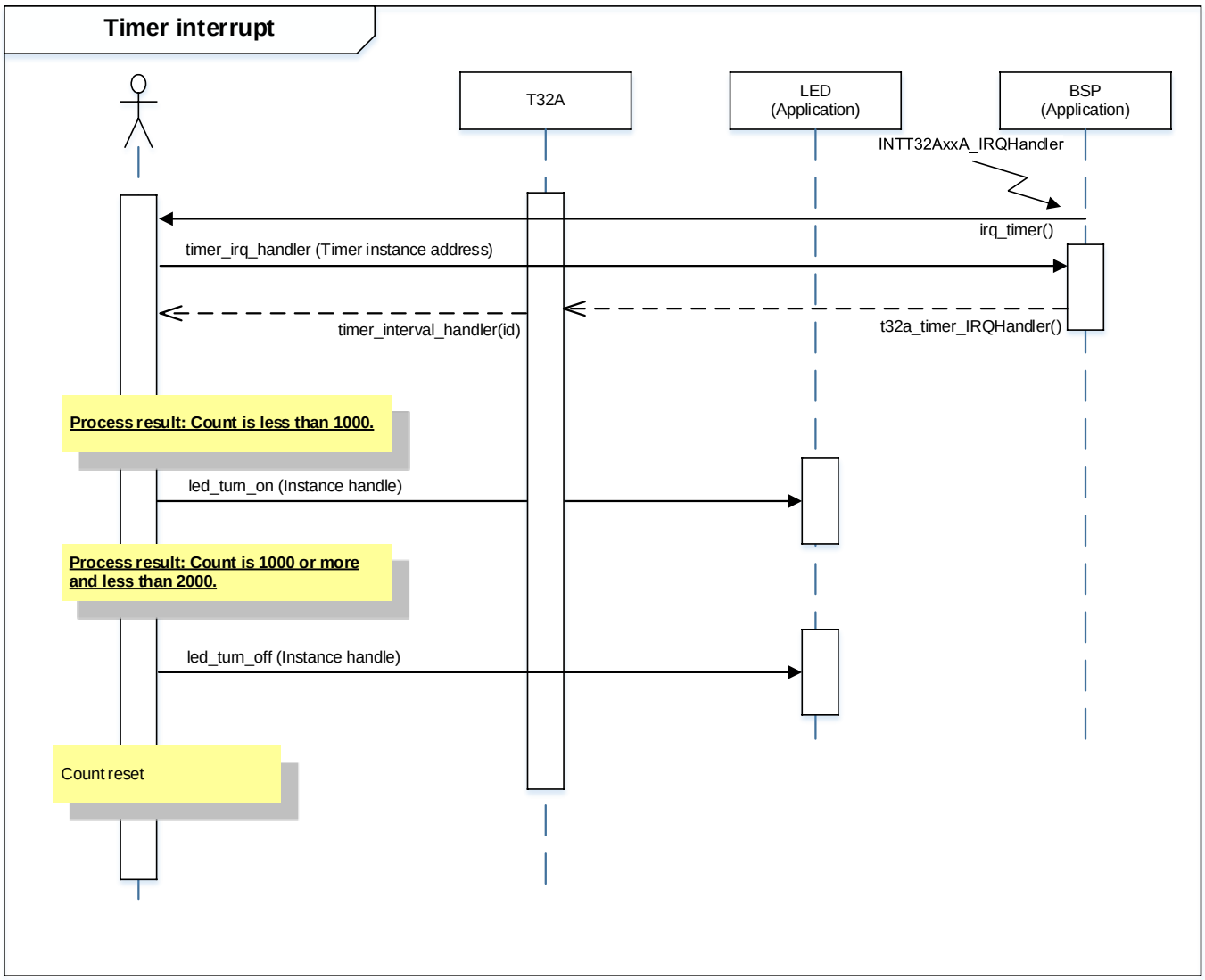

Driver initialization
ref
T32A Driver initialization

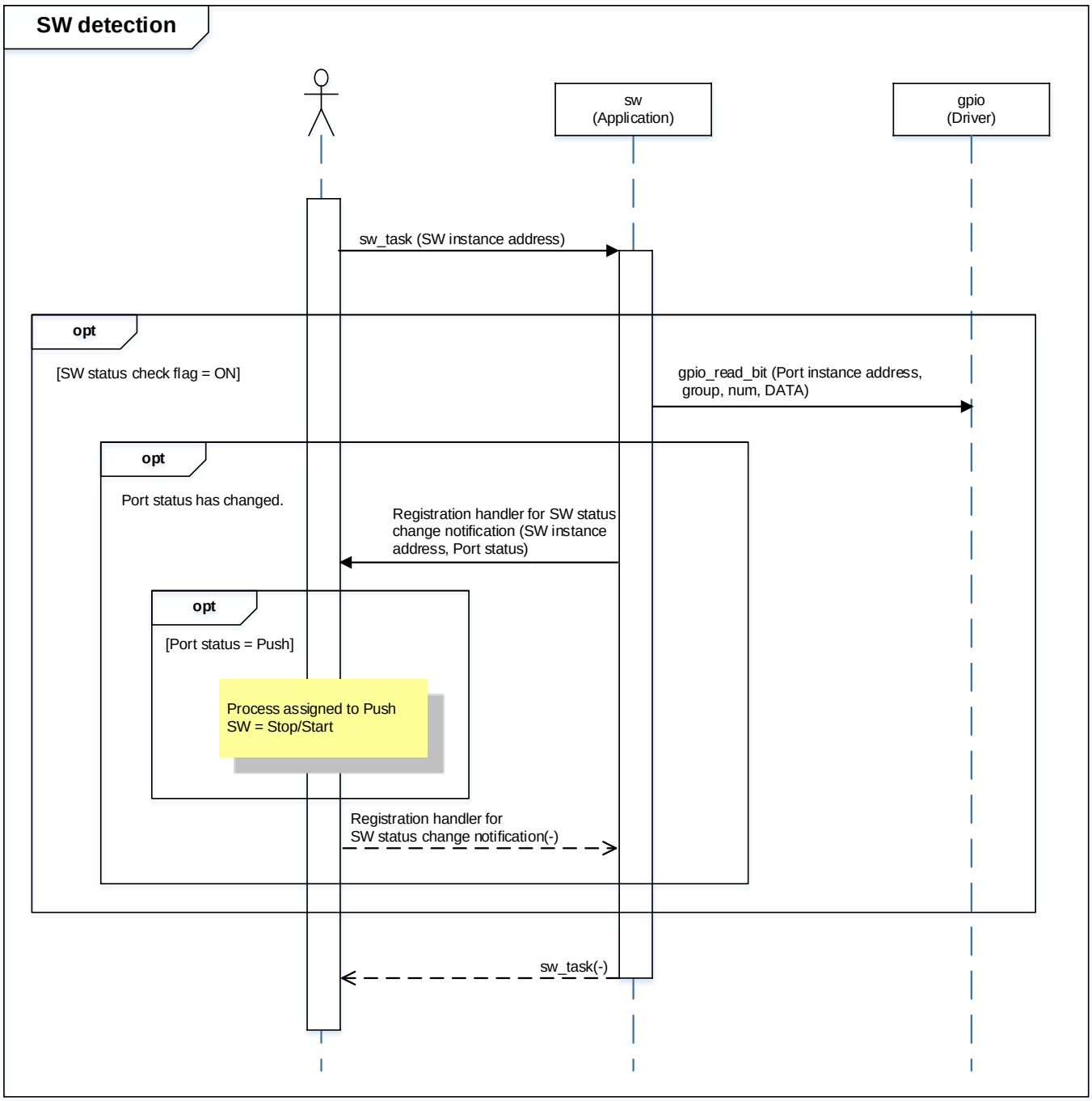

T32A Driver initialization
BSP
(Application)
Acquisition of Timer channel for 1-ms timer
bsp_get_timer_ch(BSPTimer)
Channel number = bsp_get_timer_ch(-)
T32A
(Driver)
t32a_mode_init (Instance address)
Process result = t32a_mode_init(-): Successful.
timer_initialize (Timer instance address)
t32a_timer_init (Instance address)
Process result = t32a_timer_init(-): Successful.
Process result = timer_initialize(-): Successful.


Application initialization
ref
UART Application initialization
loop
[1, Count of Used LEDs]
ref
LED Application initialization
loop
[1, Count of Used SWs]
ref
SW Application initialization


LED Application initialization
GPIO
(Driver)
LED
Generation of Initial setting
led_initialize (LED instance address)
LED
(Application)
gpio_write_bit (GPIO instance address,
group, num, DATA, LED initial setting value)
led_initialize(-)


SW Application initialization
SW
Generation of Initial setting
sw_initialize (SW instance address)
SW
(Application)


Timer interrupt
T32A
LED
(Application)
BSP
(Application)
INTT32AxxA_IRQHandler
irq_timer()
timer_irq_handler (Timer instance address)
timer_interval_handler(id)
t32a_timer_IRQHandler()
Process result: Count is less than 1000.
led_turn_on (Instance handle)
Process result: Count is 1000 or more and less than 2000.
led_turn_off (Instance handle)
Count reset


SW detection
sw
(Application)
gpio
(Driver)
sw_task (SW instance address)
opt
[SW status check flag = ON]
gpio_read_bit (Port instance address,
group, num, DATA)
opt
Port status has changed.
Registration handler for SW status
change notification (SW instance
address, Port status)
opt
[Port status = Push]
Process assigned to Push
SW = Stop/Start
Registration handler for
SW status change notification(-)
sw_task(-)

8. Points to Remember on Handling of Sample Programs

When using the sample program with other than “Operation Confirmation Condition“, please check the operation sufficiently.

9. Revision History

Revision	Date	Description
1.0	2019-10-18	First release

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