

M4K Group (1)
Application Note
32-bit Timer Event Counter
(T32A-B)
Programmable Rectangular Wave
Output Function

Outlines

This application note is a reference material for developing products using the Programmable Rectangular Wave Output 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_PPG

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1. Preface

This sample program is used to check the function of the 32-bit timer event counter.

Using the PPG function of the T32A, this sample program outputs the pulses whose Duty ratios are preprogrammed.

When a push switch is pushed down, a Duty ratio is changed to another value. The Duty ratio of the PPG output pulse becomes, per pushed-down, 10 %, 25 %, 50 %, 75%, or 90%, one after the other.

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	ch3	PC0 (T32A03OUTA)	PPG output
	ch0	-	Timer interrupt
Input/Output Ports	-	PE2 (Input Port)	Input
		PE3 (Input Port)	
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
Push switch (SW1)	PPG output
Push switch (SW2)	Duty change

A PC should be connected to the USB_UART connector to communicate with the terminal software.

The push switch (SW1) is pushed down, the PPG pulse is output and the Duty ratio value is displayed to the terminal software.

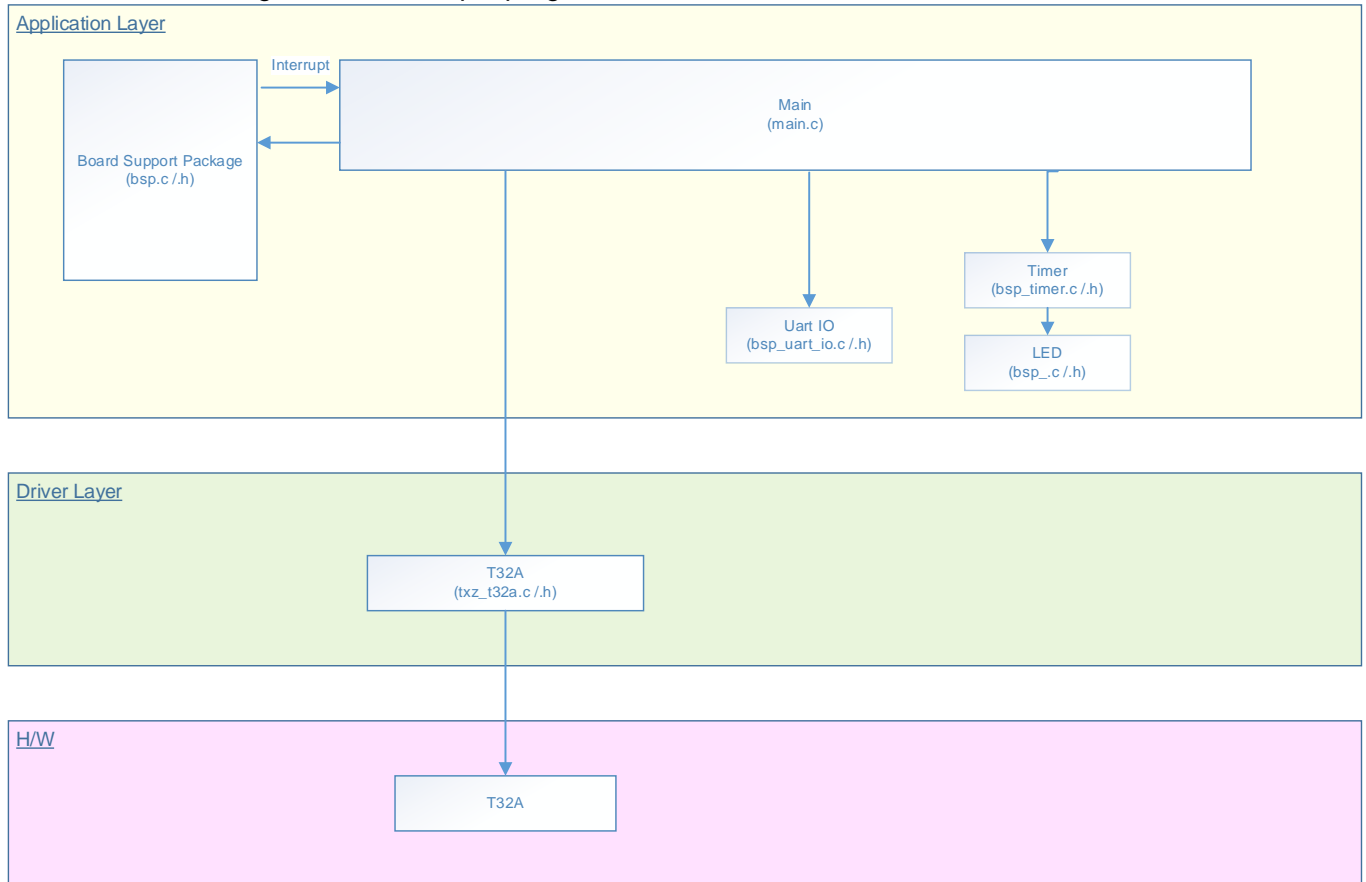
When the push switch (SW2) is pushed down, the PPG output stops and the Duty ratio is changed to another value. The Duty ration becomes, per push-down, 10 %, 25 %, 50 %, 75 %, 90 %, and 10% again, one after the other.

The rectangular wave output with the set Duty ratio can be checked on the PC0.

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 initialization of the PPG and the initialization of the interrupt should be done as the initialization of the Timer driver.

The initialization of USB_UART and the initialization of the push switches should be done as the initialization of the application software.

The Timer is started.

The initial Duty ratio value is output to the terminal software.

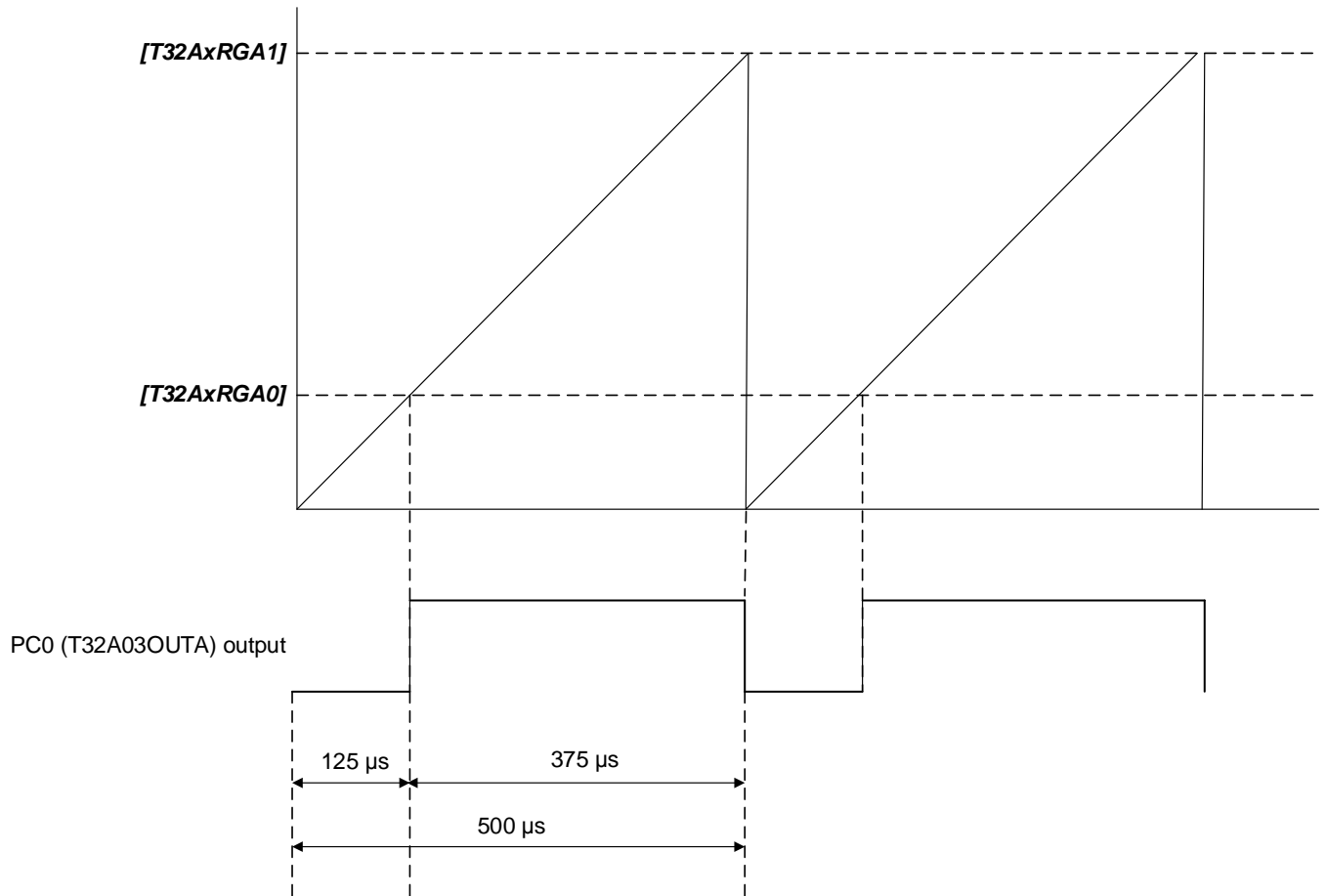
After that, the sample program waits for an input of the push switch.

The push switch (SW1) is pushed down, the pulse whose Duty ratio is set by the other push switch (SW2) is output to the port.

When the push switch (SW2) is pushed down, the PPG output stops and the Duty ratio is changed to another value. The Duty ratio becomes, per push-down, 10 %, 25 %, 50 %, 75 %, 90 %, and 10% again, one after the other.

Then, the sample program waits for an input. The process above repeats.

The following example is an output wave with the Duty ratio of 25 %.



7.4. Change of Duty Setting

When the Duty ratio is changed, the following setting should be modified in the 87th line in the “main.c”
`static uint32_t tgtRisingTiming[5U] = { 10U, 25U, 50U, 75U, 90U };`
 5 values among 10 % to 90 % are set above.

The pulse cycle is set in the 366th line.
`p_pulse->init.pulse_trailing = 500U;`
 The initial value is 500 μ s.

The rise timing is set in the 560th line.
`RisingTimingus[i] = tgtRisingTiming[i] * 5U;`

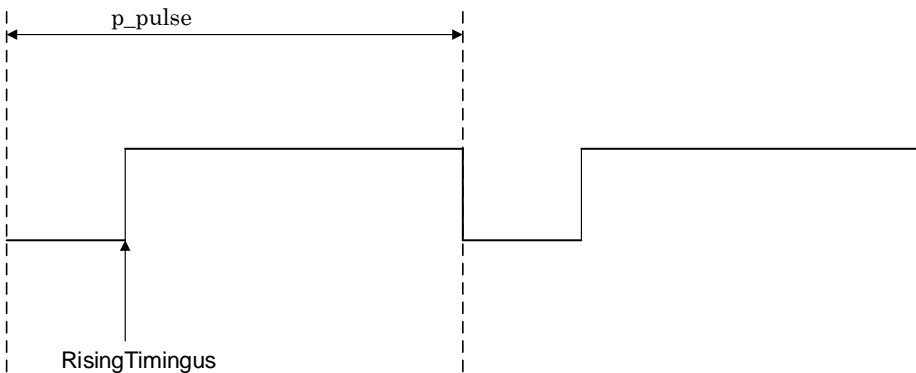
The pulse setting is as follows;
 The setting of the pulse cycle: p_pulse
 The setting of the pulse rise timing: RisingTimingus

When the pulse width is changed, the change of pulse cycle should be set and the rising timing should be set properly according to the changed cycle.

Example: The pulse cycle is set to 600 μ s.
`p_pulse->init.pulse_trailing = 600U;`

In this case, the multiple value for the rising timing should be set to 1/100 of the pulse cycle, that is, 6U to output the pulse which has a proper Duty ratio.

`RisingTimingus[i] = tgtRisingTiming[i] * 6U;`



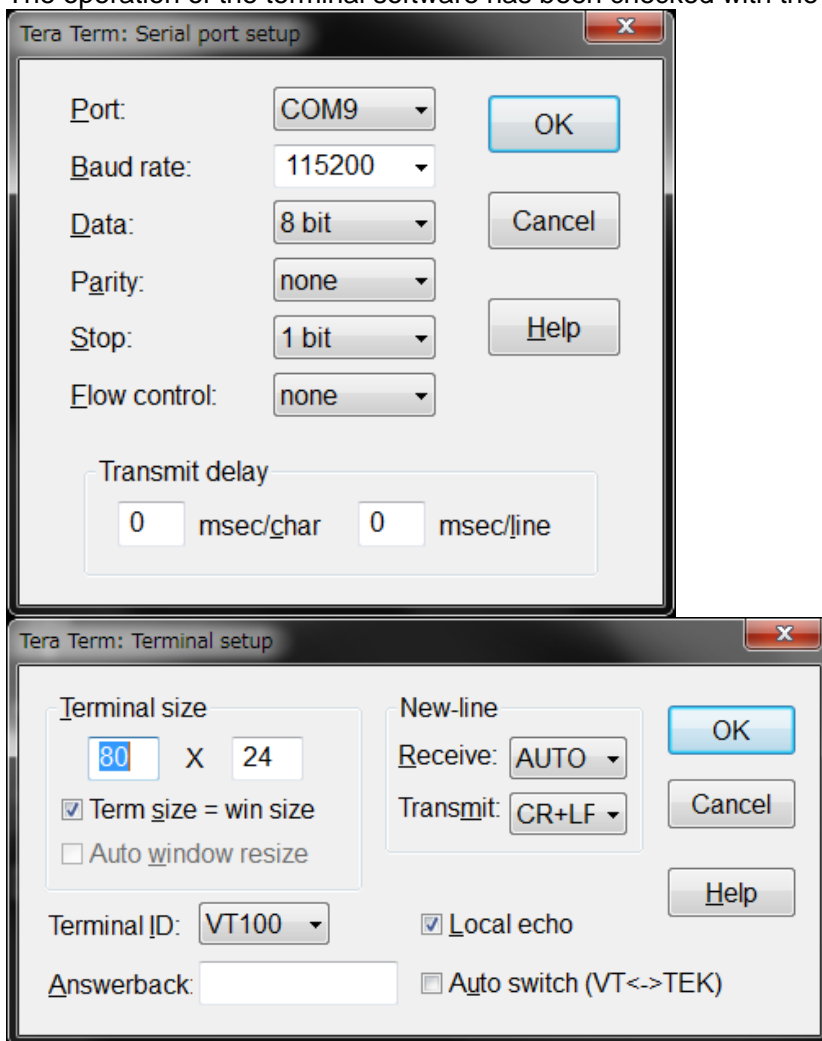
7.5. Output Example of Terminal Software

When the sample program is executed, the Duty ratio is displayed as follows;

```
PPG Output
Duty: 10%
Change to Duty: 25%
PPG Output
Duty: 25%
Change to Duty: 50%
PPG Output
Duty: 50%
Change to Duty: 75%
```

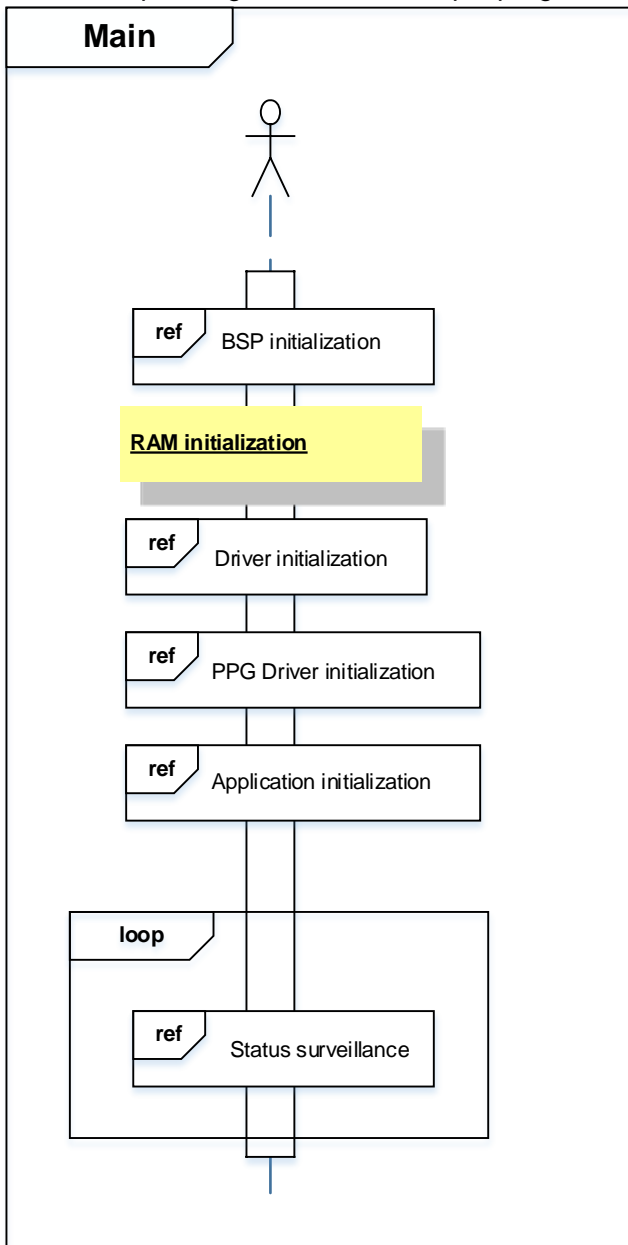
7.5.1. Setting Example of Terminal Software

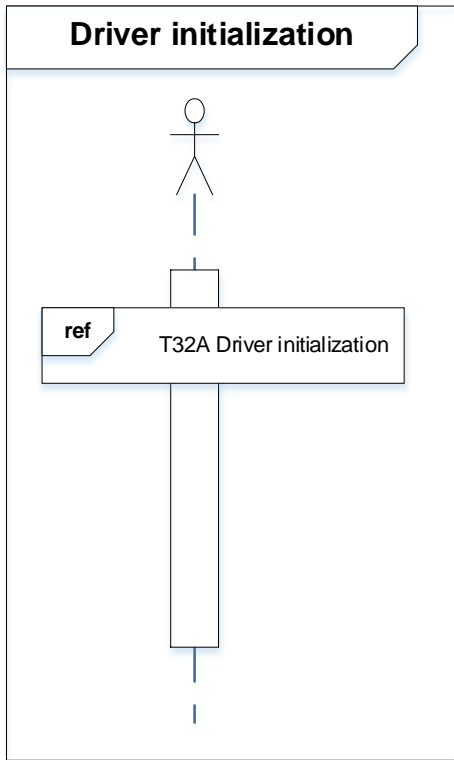
The operation of the terminal software has been checked with the following settings.

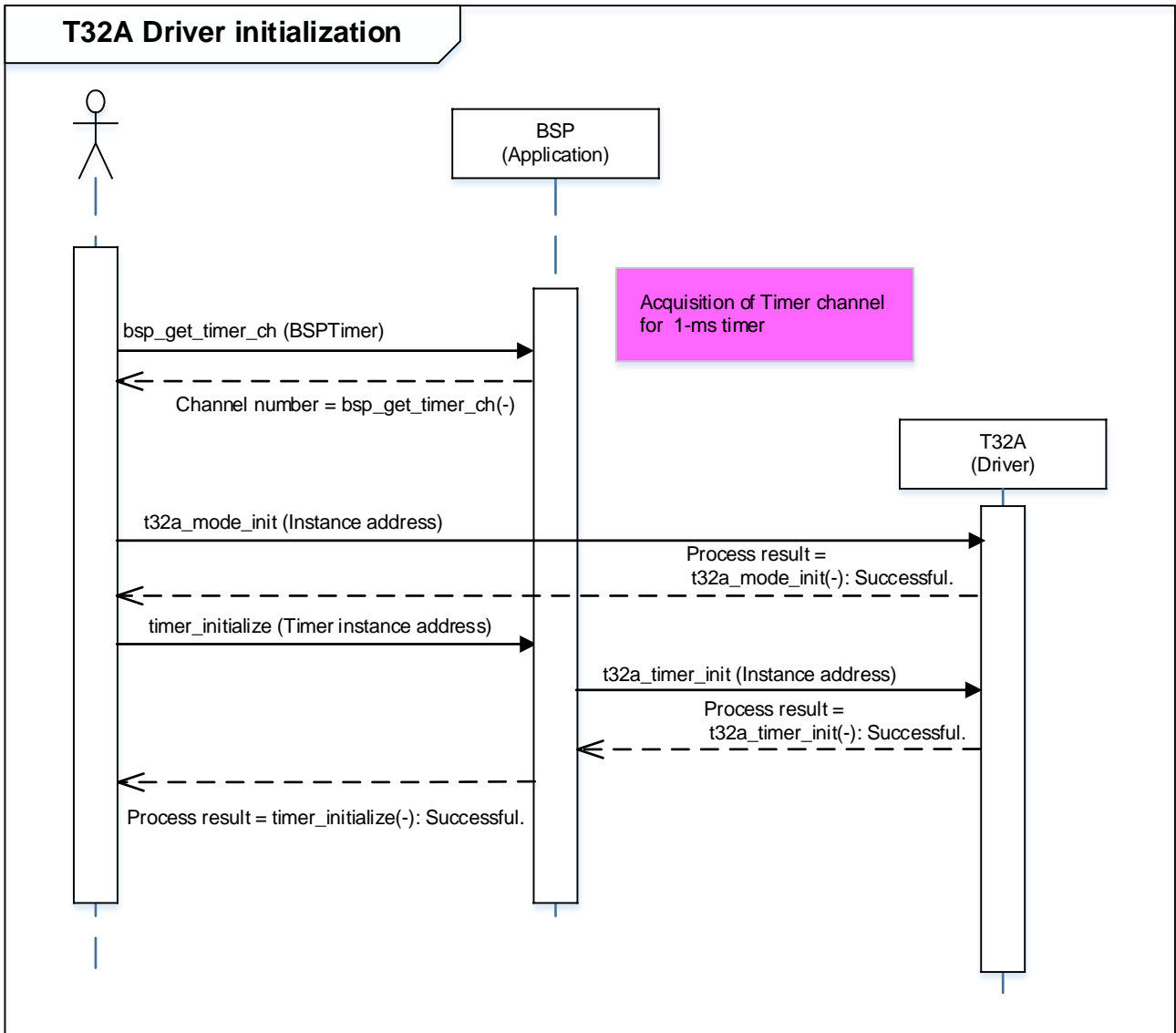


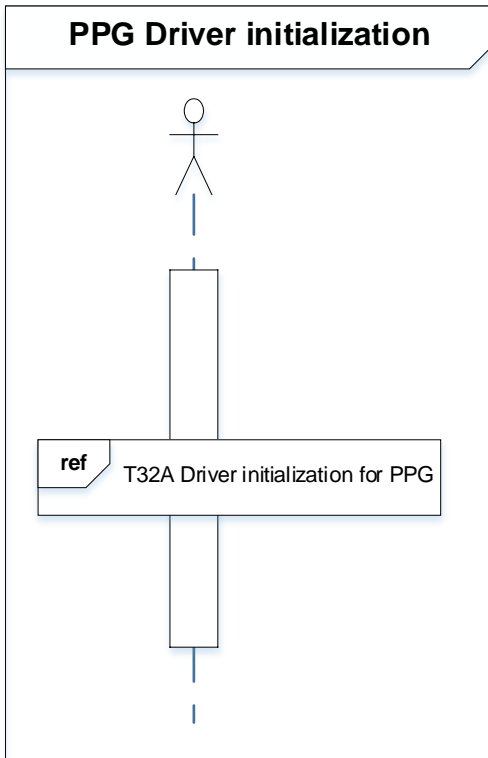
7.6. Operating Flow of Sample Program

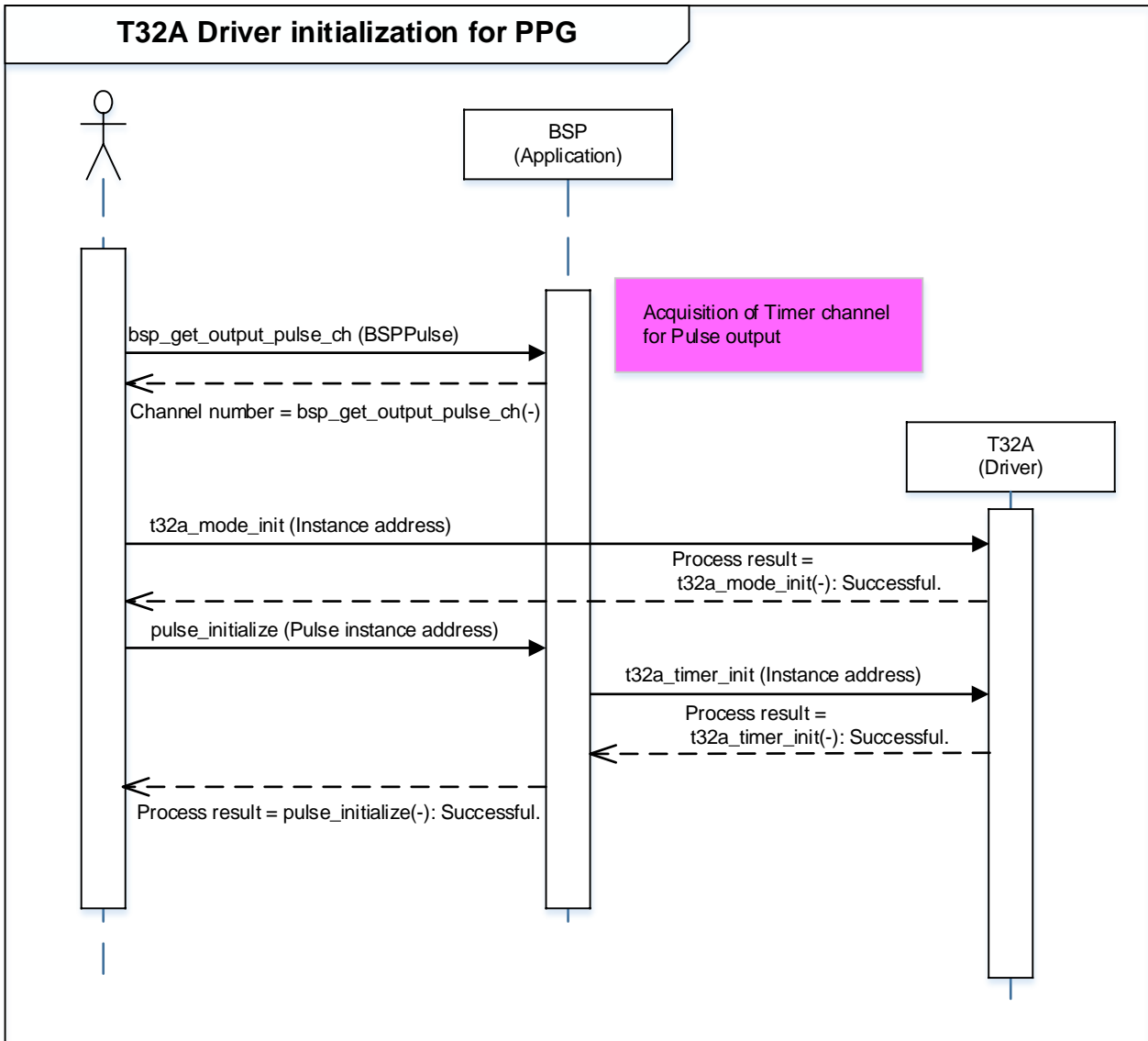
The basic operating flows of the sample program are shown in the following;

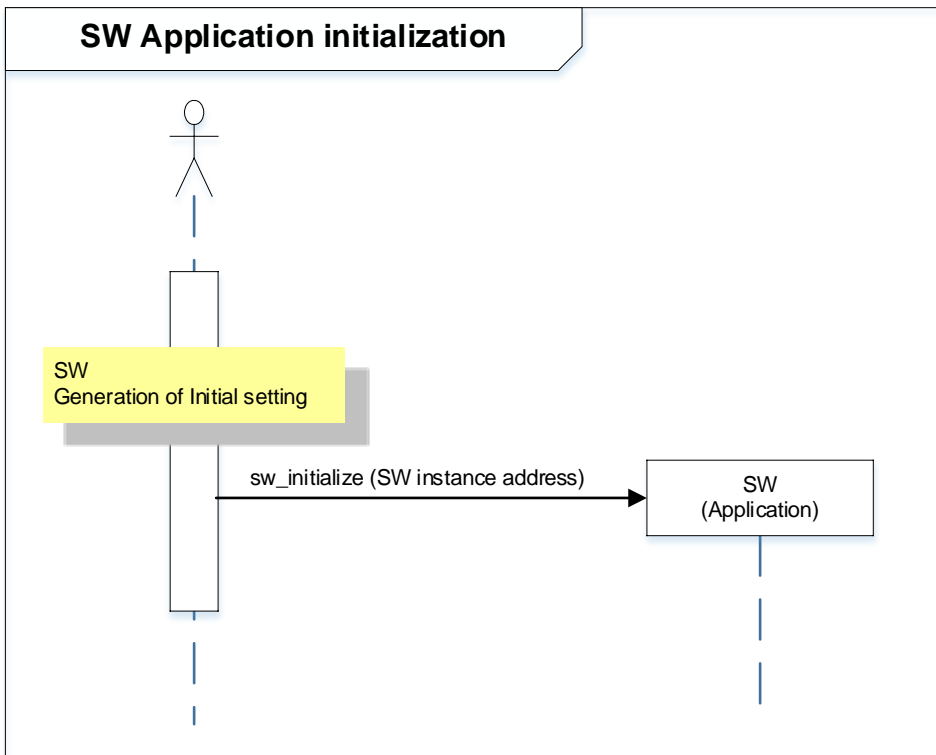
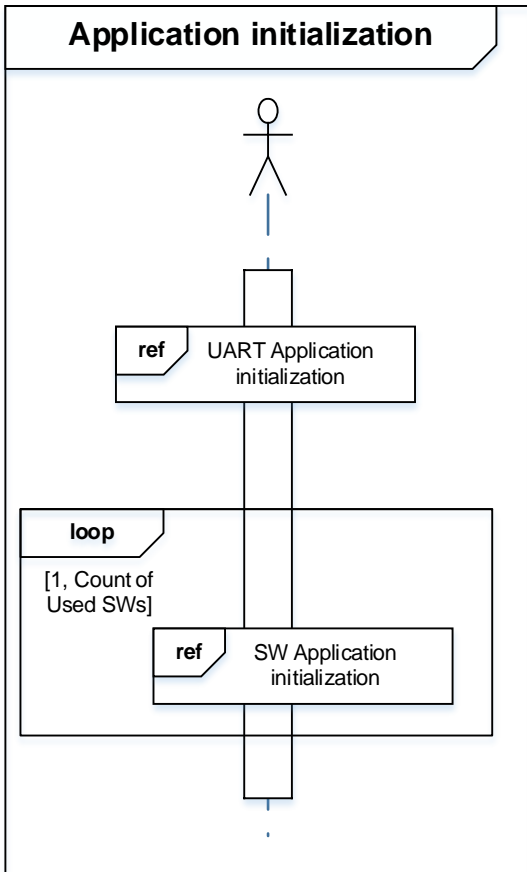


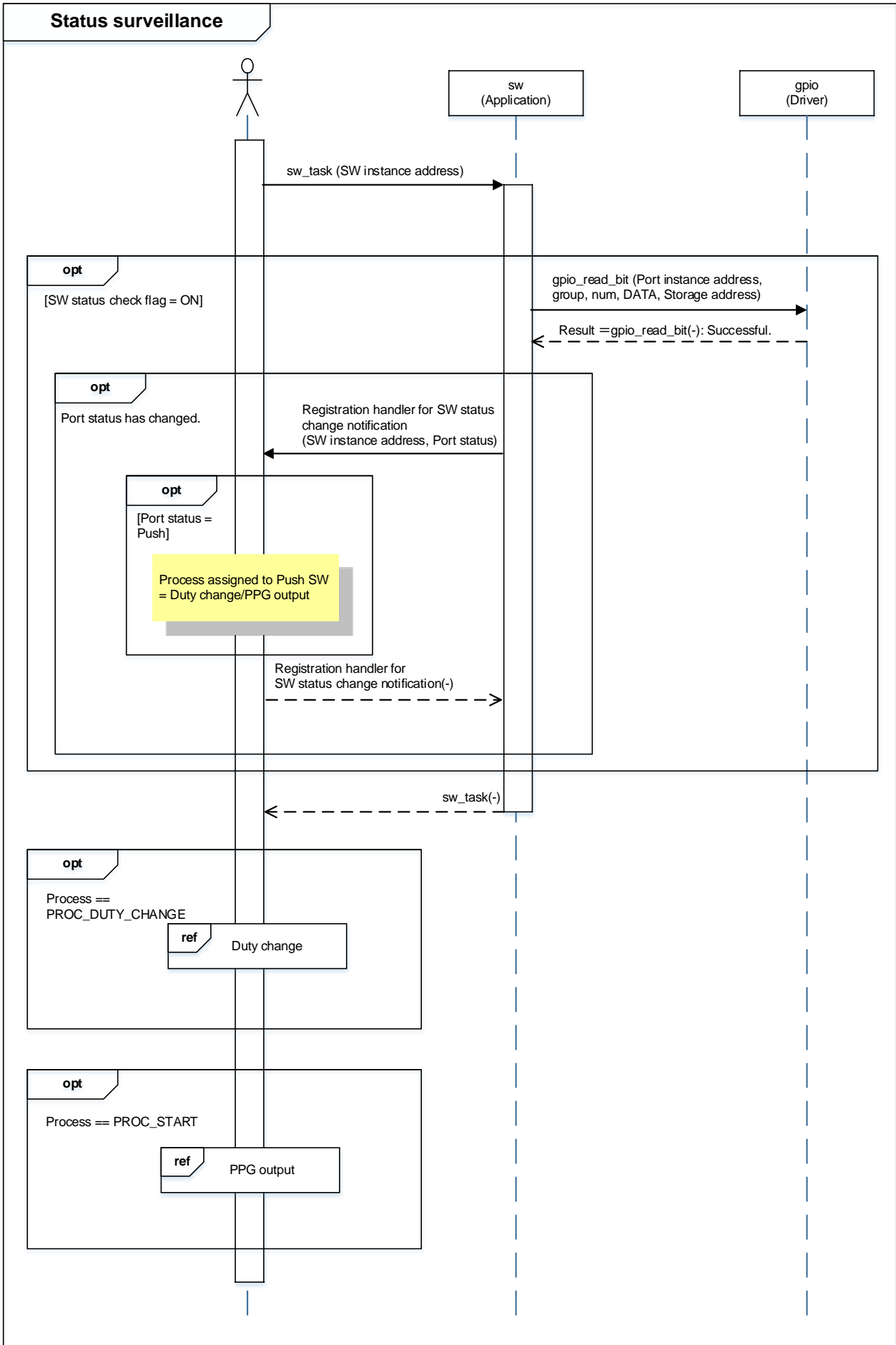


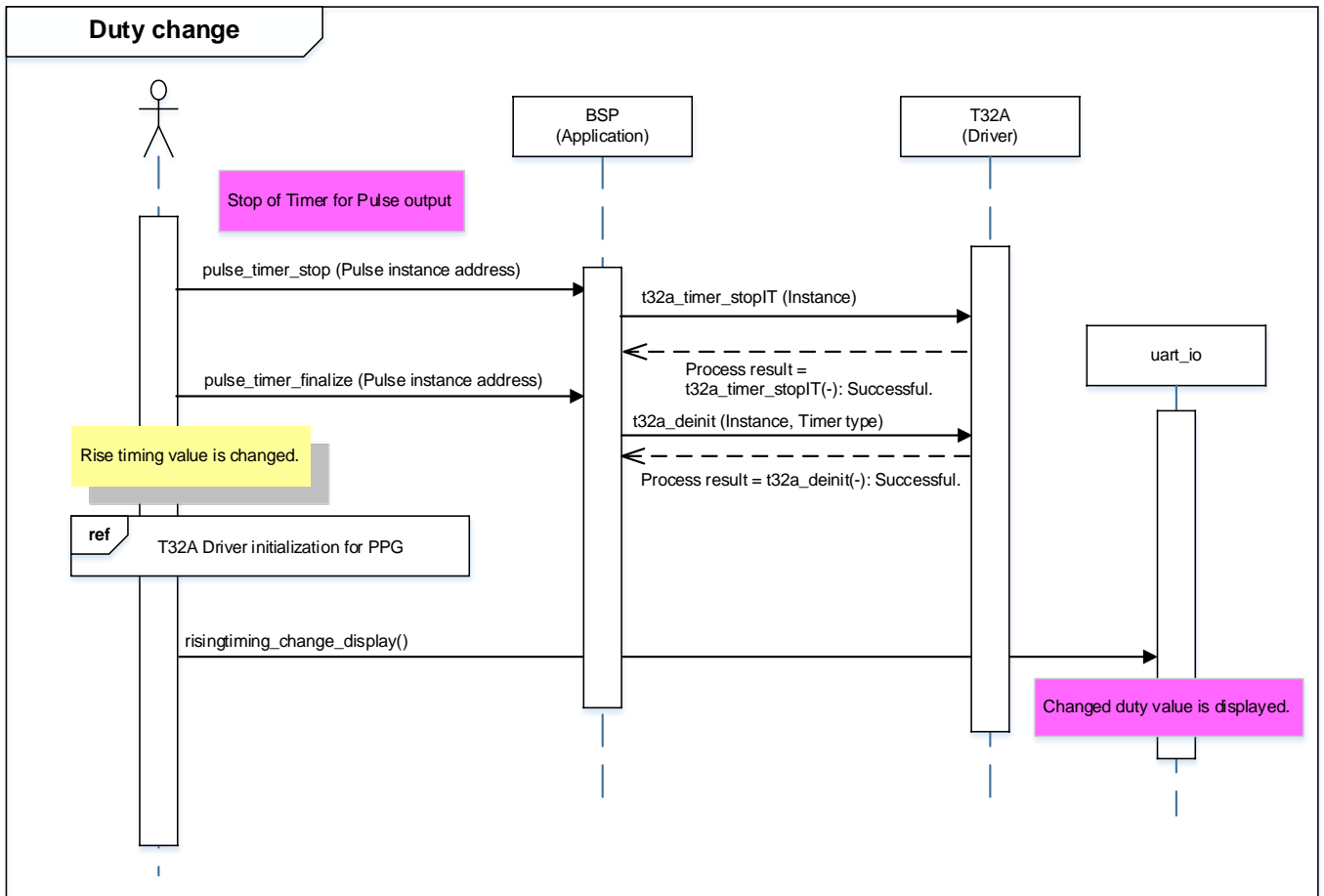


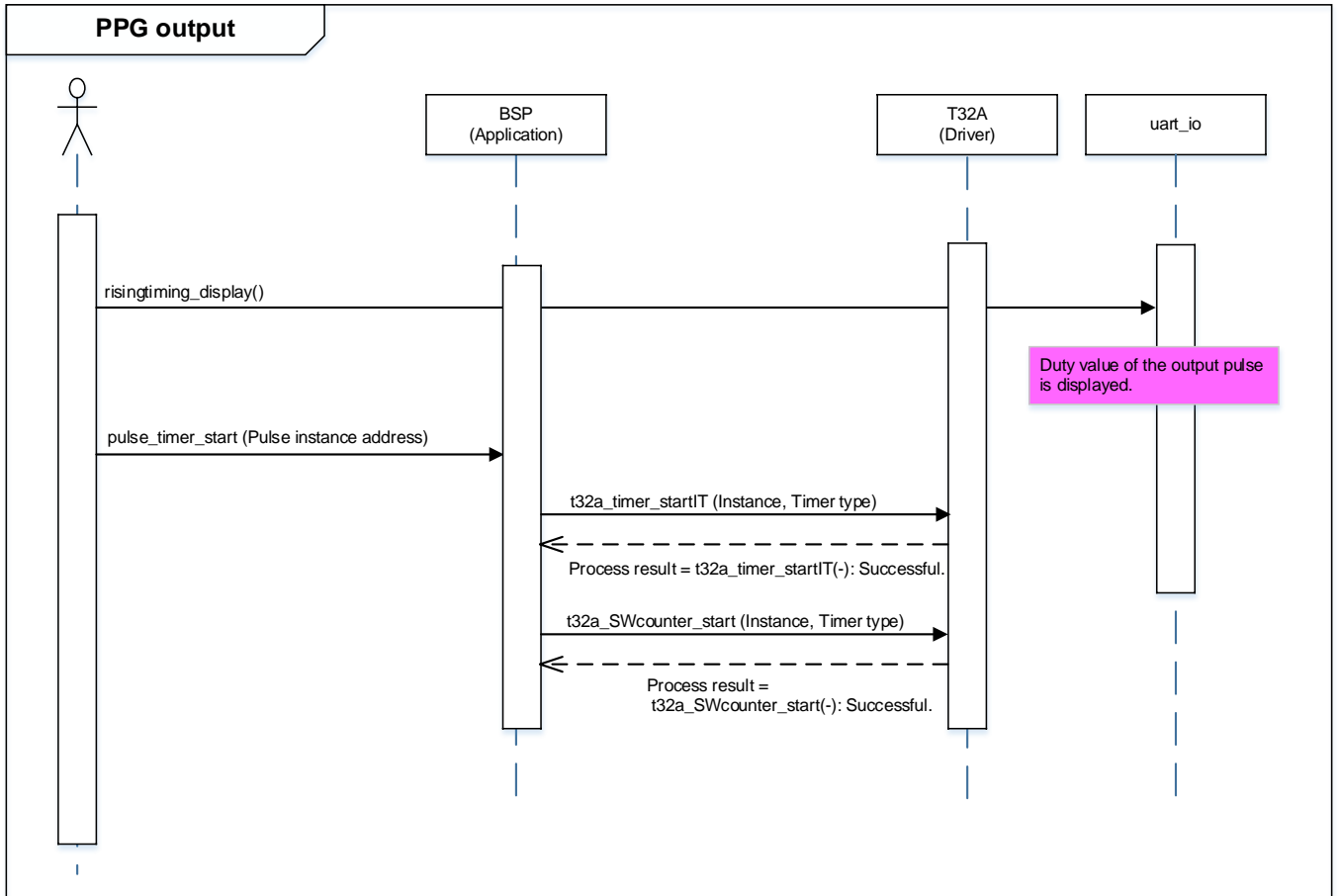












8. Points to Remember on Handling of Sample Programs

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

9. Revision History

Revision	Date	Description
1.0	2019-10-21	First release

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