M3H Group(1)
Application Note
32-bit Timer Event Counter
(T32A-B)
Programmable Pulse Output Function

Outlines

This application note is a reference material for developing products using the programmable pulse output (PPG) function in the 32-bit timer event counter (T32A) of M3H Group(1).
This document helps the user check operation of the product and develop its program.

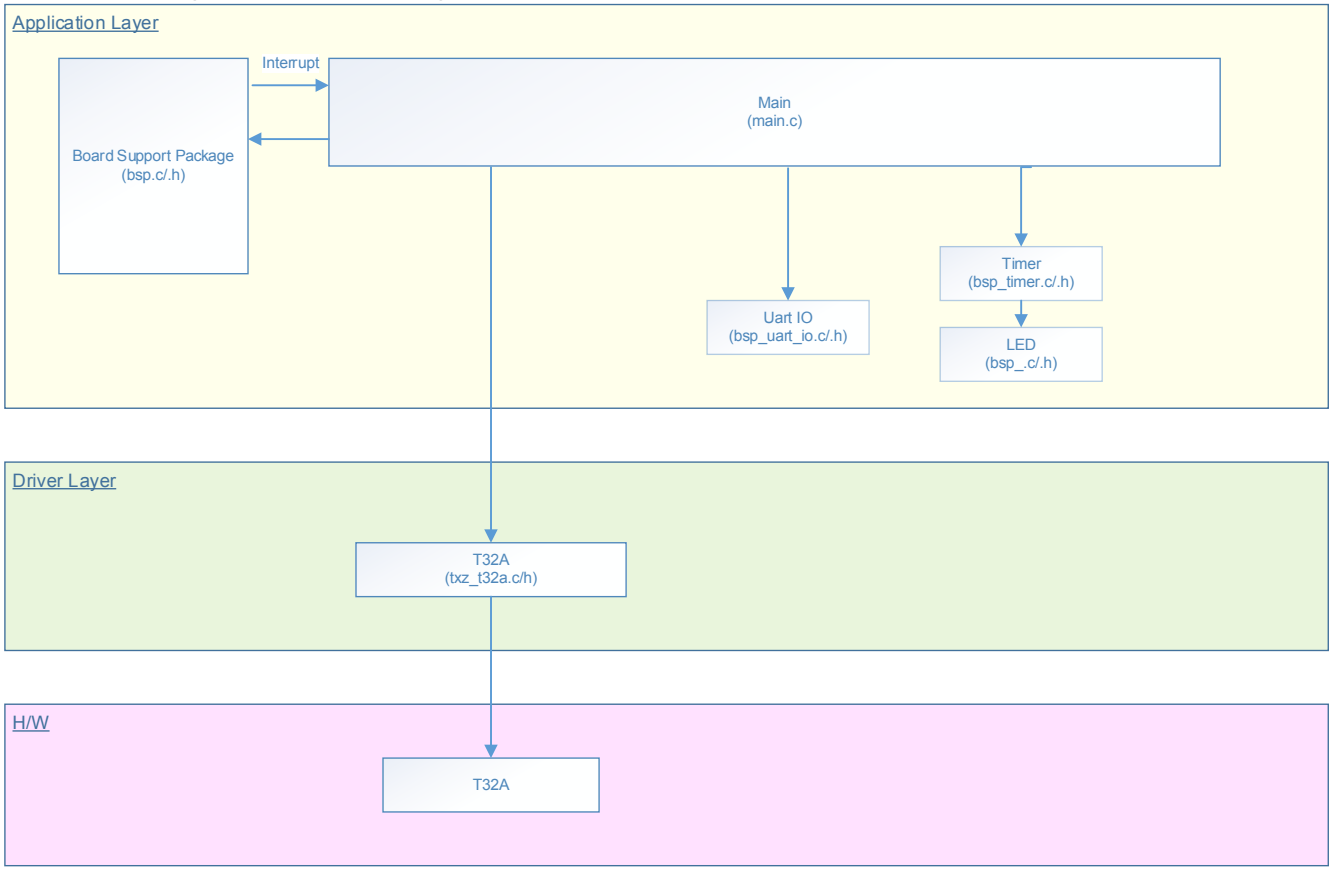
Target sample program: Timer_PPG

Table of Contents

1. Preface

This sample program executes to start the PPG output of the timer function when the PN1 Push Switch is pushed down.
When the PN2 Push Switch is pushed down, the PPG output stops. And the duty rate is changed to 10 %, 25 %, 50 %, 75%, or 90%, one after the other, by the push-down.

Structure diagram of Sample program



2. Reference Document

- Datasheet
  TMPM3H group (1) datasheet Rev2.0 (Japanese edition)
- Reference manual
  32-bit timer/event counter (T32A-B) Rev2.1 (Japanese edition)
- Other reference document
  TMPM3H(1) Group Peripheral Driver User Manual (Doxygen)

3. Function to Use

IP	Channel	Port	Function/Operation mode
32-bit timer event counter	Timer A ch3	PJ0 (T32A03OUTA)	PPG operation
	Timer A ch0	-	Timer interrupt
Input or output port	-	PN1 (Input Port) PN2 (Input Port)	Input
Asynchronous serial communication circuit	ch0	PA1 (UT0TXDA) PA2(UT0RXD)	Asynchronous communication with PC

4. Target Device

The target devices of application note are as follows.

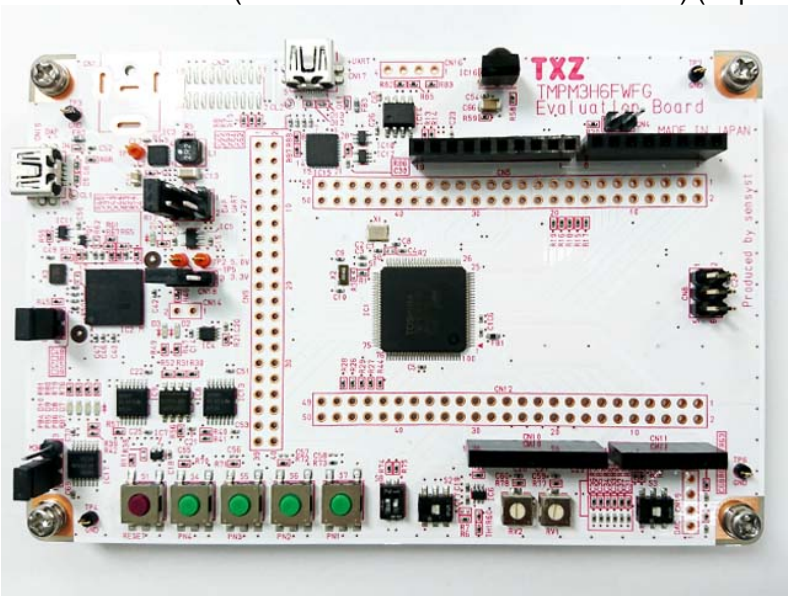
TMPM3H6FWFG	TMPM3H6FUFG	TMPM3H6FSFG
TMPM3H6FWDFG	TMPM3H6FUDFG	TMPM3H6FSDFG
TMPM3H5FWFG	TMPM3H5FUFG	TMPM3H5FSFG
TMPM3H5FWDFG	TMPM3H5FUDFG	TMPM3H5FSDFG
TMPM3H4FWUG	TMPM3H4FUUG	TMPM3H4FSUG
TMPM3H4FWFG	TMPM3H4FUFG	TMPM3H4FSFG
TMPM3H3FWUG	TMPM3H3FUUG	TMPM3H3FSUG
TMPM3H2FWDUG	TMPM3H2FUDUG	TMPM3H2FSDUG
TMPM3H2FWQG	TMPM3H2FUQG	TMPM3H2FSQG
TMPM3H1FWUG	TMPM3H1FUUG	TMPM3H1FSUG
TMPM3H1FPUG	TMPM3H0FSDUG	TMPM3H0FMDUG

* This sample program operates on the evaluation board of TMPM3H6FWFG.
If other function than the TMPM3H6 one is checked, it is necessary that CMSIS Core related files (C startup file and I/O header file) should be changed properly.
The BSP related file is dedicated to the evaluation board (TMPM3H6). If other function than the TMPM3H6 one is checked, the BSP related file should be changed properly.

5. Operation Confirmation Condition

Used microcontroller TMPM3H6FWFG
Used board TMPM3H6FWFG Evaluation Board (Product of Sensyst)
Unified development environment IAR Embedded Workbench for ARM 8.11.2.13606
Unified development environment µVision MDK Version 5.24.2.0
Terminal software Tera Term V4.96
Sample program V1100

Evaluation board (TMPM3H6FWFG Evaluation Board) (Top view)



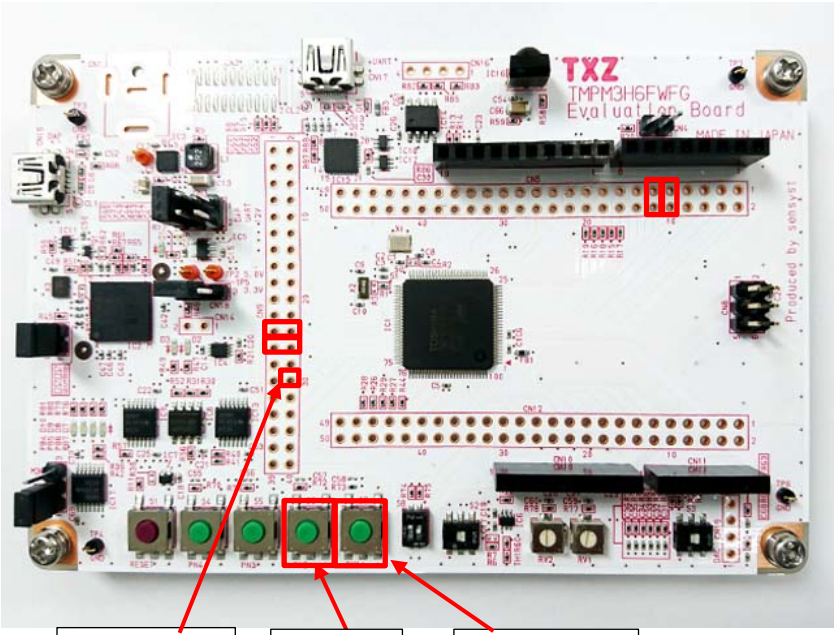
For purchasing the board, refer to the following homepage. (http://www.chip1stop.com/)

6. Evaluation Board Setting

The following pin connections should be done on the evaluation board.

CN5		
Use	Through-hole No.	Setting
UART (RXD)	9-10	Connection
UART (TXD)	11-12	Connection

CN9		
Use	Through-hole No.	Setting
Push SW (S6)	23-24	Connection
Push SW (S7)	25-26	Connection



7. Operation of Evaluation Board

PPG output and duty ratio can be switch with Push Switch.

Key	Function
S7 (PN1)	PPG output
S6 (PN2)	Duty change

The duty ratios preset in this sample program are 10 %, 25 %, 50 %, 75 %, and 90 %.
The PPG output can be monitored at PJ0 (T32A03OUTA). (It can be monitored at CN9: 30 pin.)

8. Outline of Timer Event Counter (T32A) Function

T32A is composed two 16-bit timer that can be used Timer A and Timer B. Also it can use Timer C that is connected Timer A and Timer B as 32-bit timer. When use Timer C, Timer A and Timer B cannot be used.

The T32A have an interval timer, event counter, input capture, 2-phase counter input, PPG output, Synchronous Start, and Trigger start/stop function.

The timer has the following functions;
16-bit timer: Timer A and Timer B
32-bit timer: Timer C

9. Sample Program

When Low input is detected at PortN1, the PPG output starts.
When Low input is detected at PortN2, the PPG output stops. And the duty ratio is changed.
The terminal software can display the duty ratio value.

The pulse width has been set to 500μs in this sample program.
5 values are defined for the duty ratio of the PPG output (50μs, 125μs, 250μs, 375μs, and 450μs)
Those values generate 5 duty ratios, 10 %, 25 %, 50 %, 75 %, and 90 %, respectively.

9.1. Initialization

The following initialization is done after power is supplied.
The initialization of each clock setting is done.
The duty ratio of the PPG output is set after System clock setting.
Then, the GPIO setting is done.
Perform initialization setting of PORT for pulse output.
Timer A ch0 is initialized for the timer driver setting.
Timer A ch3 is initialized for the pulse driver setting.

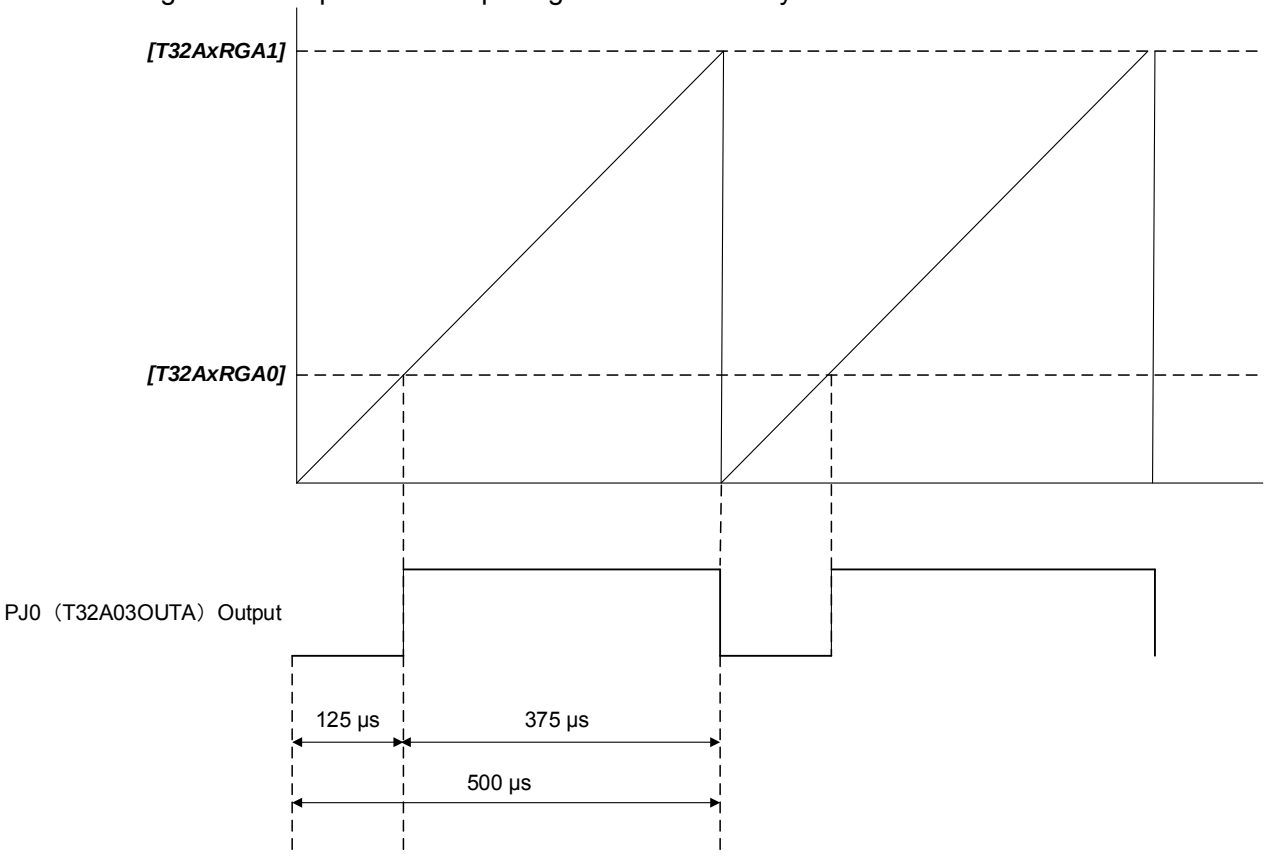
9.2. Sample Program Main Operation

The timer setting is done to use the timer for PPG operation.
Timer A ch0 has been selected for Switch polling in this sample program.
1-ms timer interrupt checks Switch status.
Timer A ch3 has been selected as the timer for the output pulse.

When the value in Timer A counter matches the values in Timer registers (***[T32AxRGA0]*** and ***[T32AxRGA1]***), the timer output is set or cleared, respectively, which a pulse with an arbitrary width can be generated.
And it is output from T32A03OUTA pin.

The setting condition can be displayed by the terminal software.
UART setting should be done, and the setting condition is displayed.

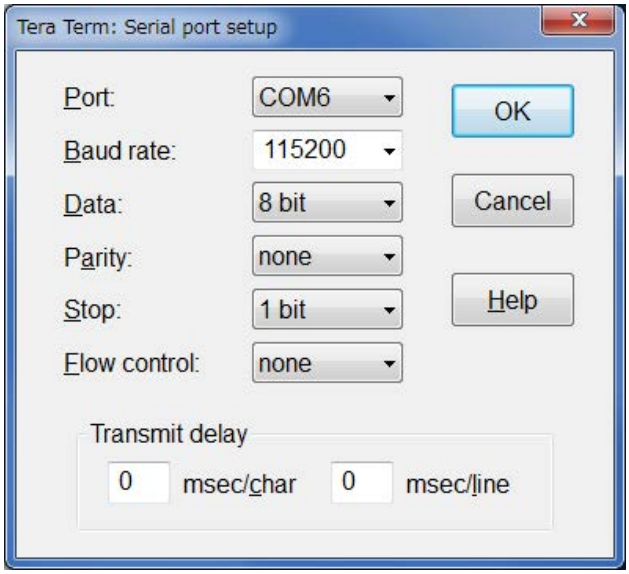
The following is an example of the output signal with 25-% duty.

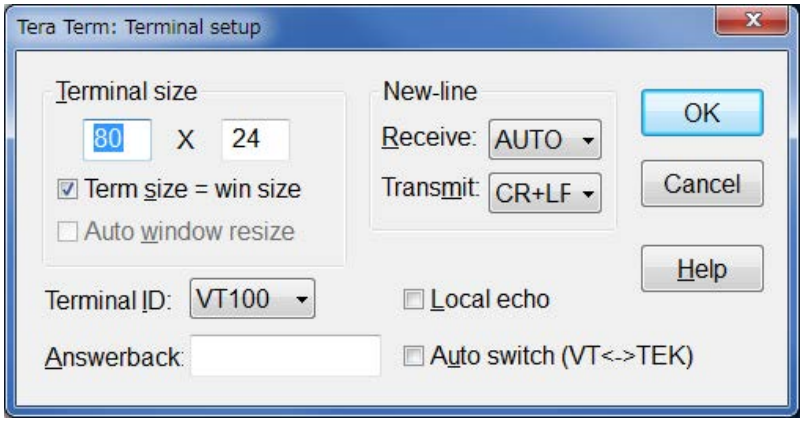


9.3. Output Example of Sample Program

9.3.1. Setting Example of Terminal Software

The operation of the terminal software (Tera Term) has been checked with the following settings.





9.4. Duty Setting Change

When the duty is changed, the following setting should be modified.
```
static uint32_t tgtRisingTiming[5U] = { 10U, 25U, 50U, 75U, 90U };
```
5 values are available from 10 % to 90 % in the above setting.

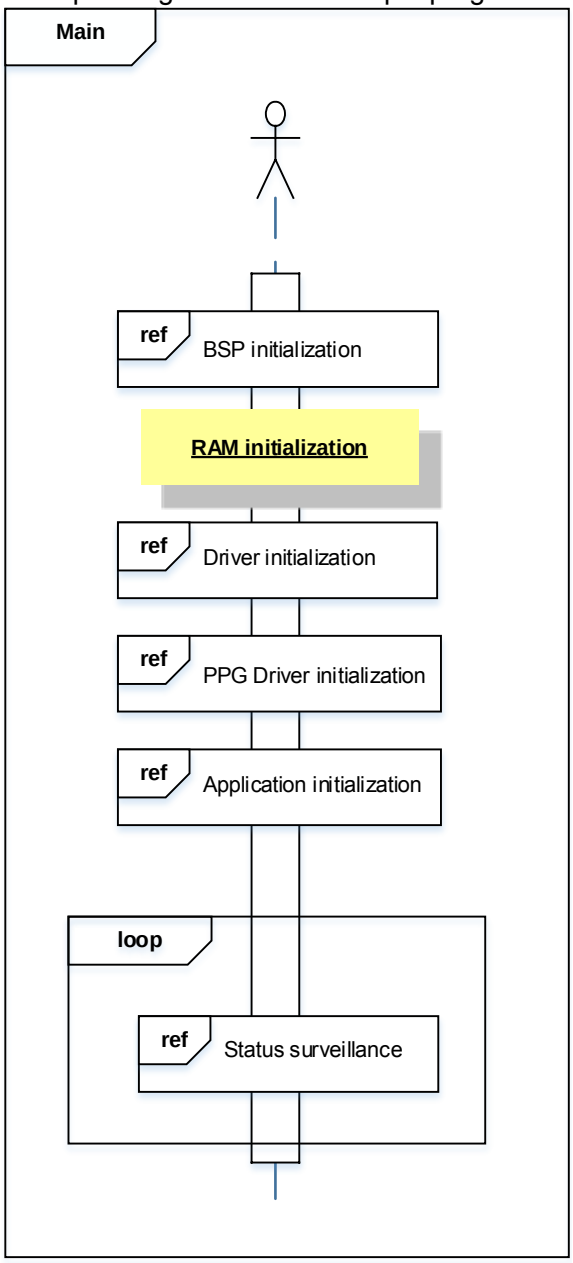
For example, 10 % duty is calculated by the following formula;
Pulse width setting;
```
p_pulse->init.pulse_trailing = 500U;
```
500-µs pulse width is defined above.

Duty setting;
```
RisingTimingus[i] = tgtRisingTiming[i] * 5U;
```
The rising time is set above.
The duty ratios of 10 %, 25 %, 50 %, 75 %, and 90 % are defined in tgtRisingTiming[i].
The rising times are calculated to 50, 125, 250, 375, and 450µs, respectively.
The pulse width is supposed to be 500µs to calculate the duty ratios.

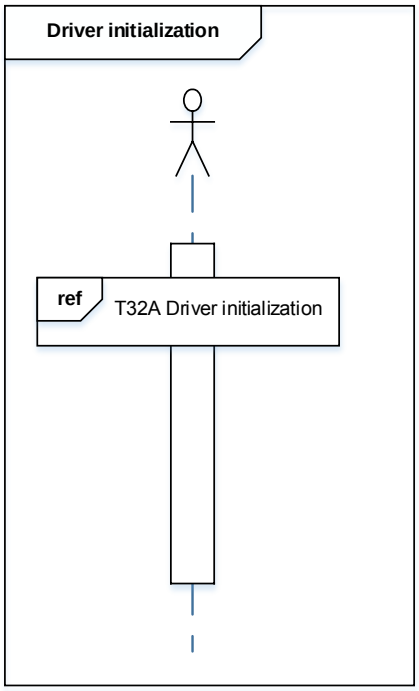
If the duty ratio is changed, the corresponding set value should be changed in the following.
```
static uint32_t tgtRisingTiming[5U] = { 10U, 25U, 50U, 75U, 90U };
```

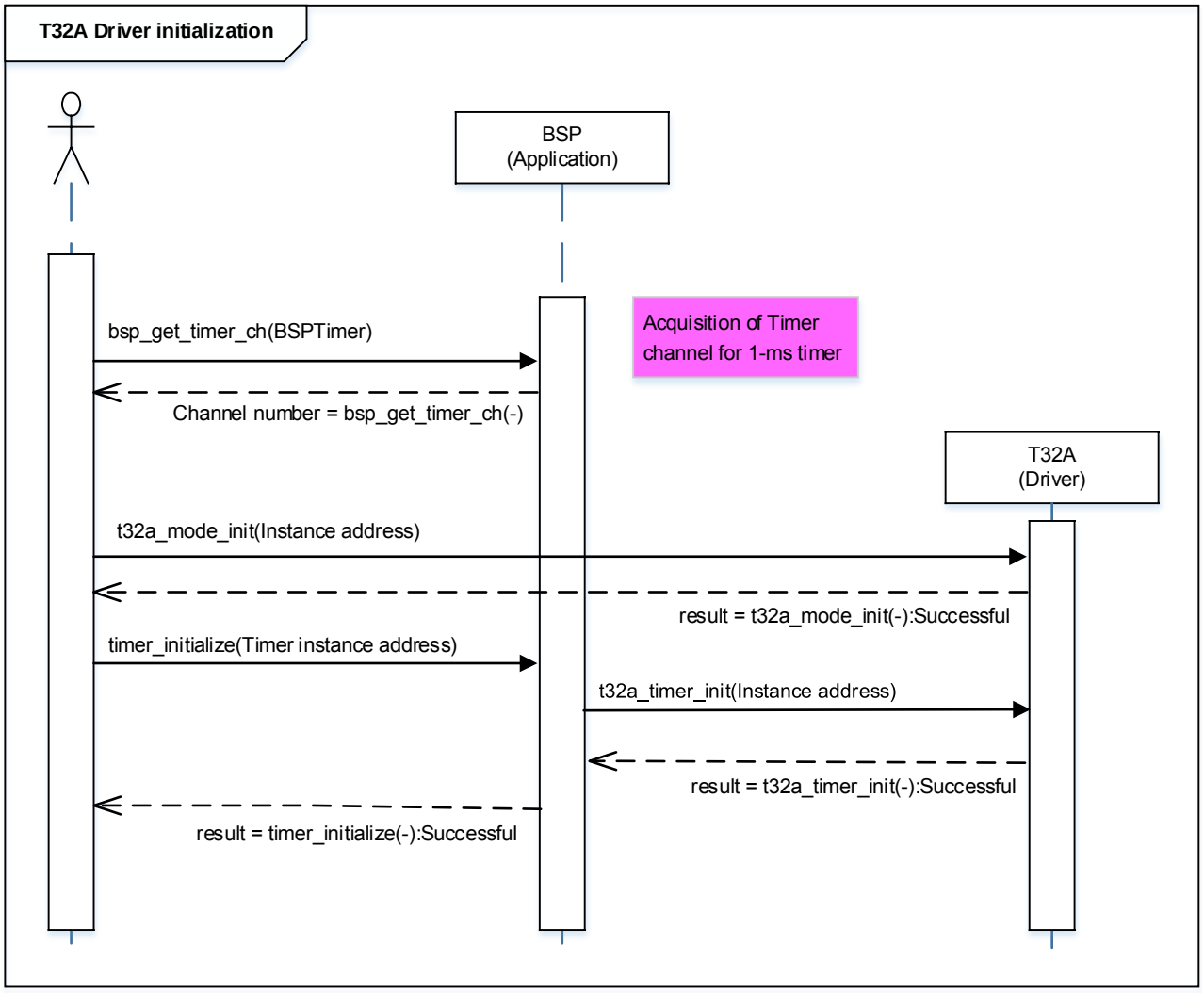
9.5. Operating Flow of Sample Program

The operating flows of the sample program are shown as follows.

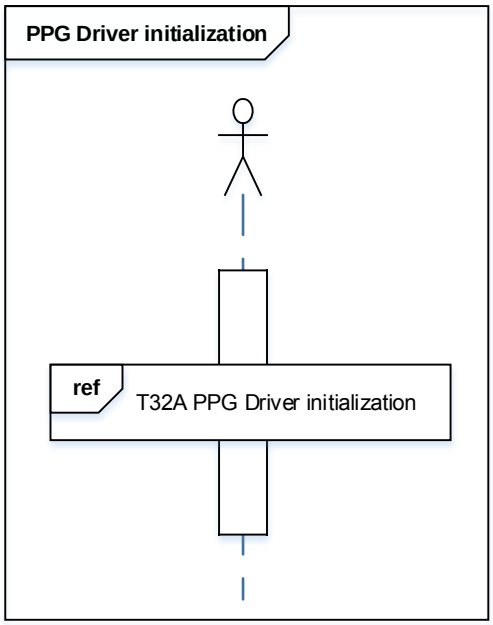


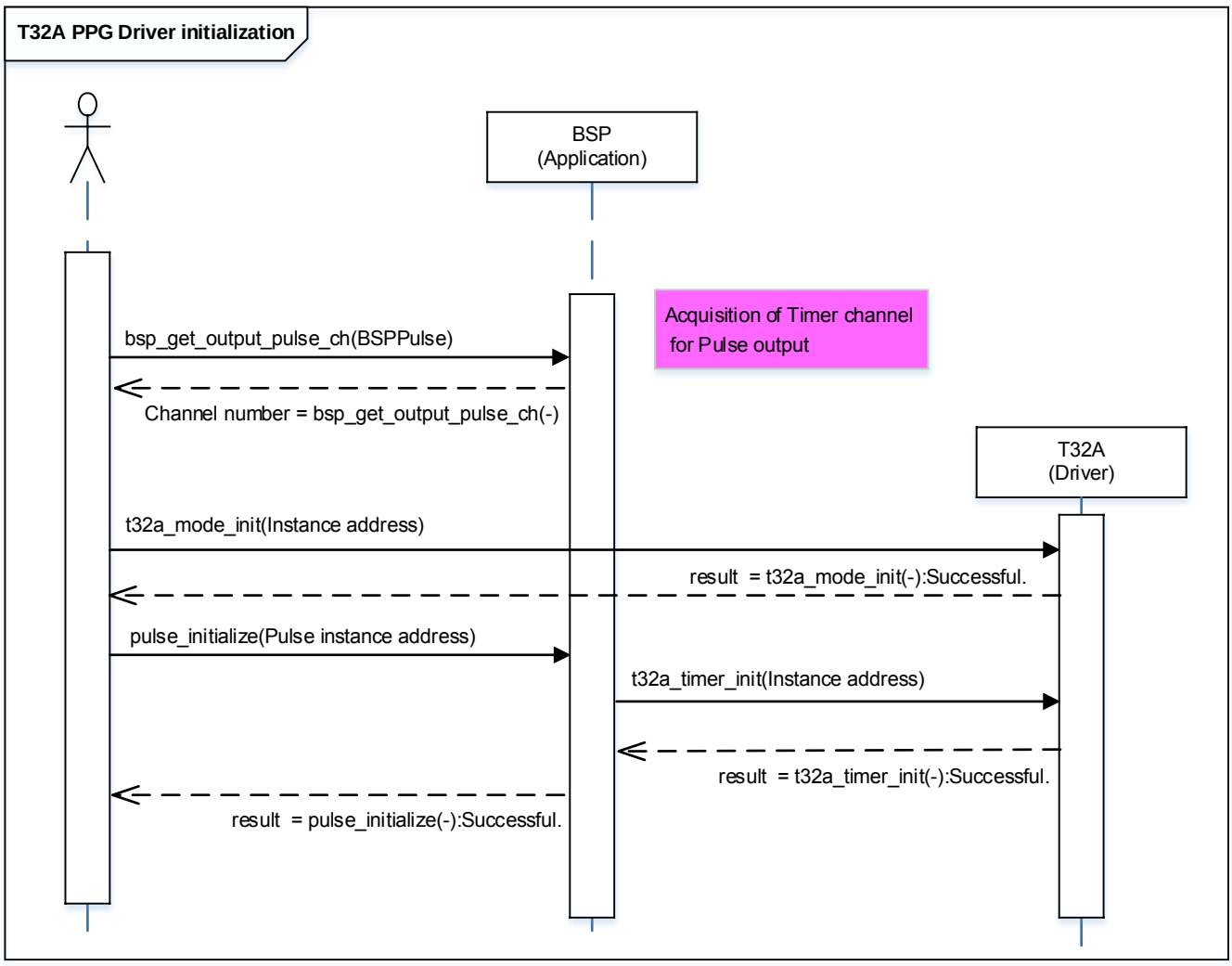
Driver initialization



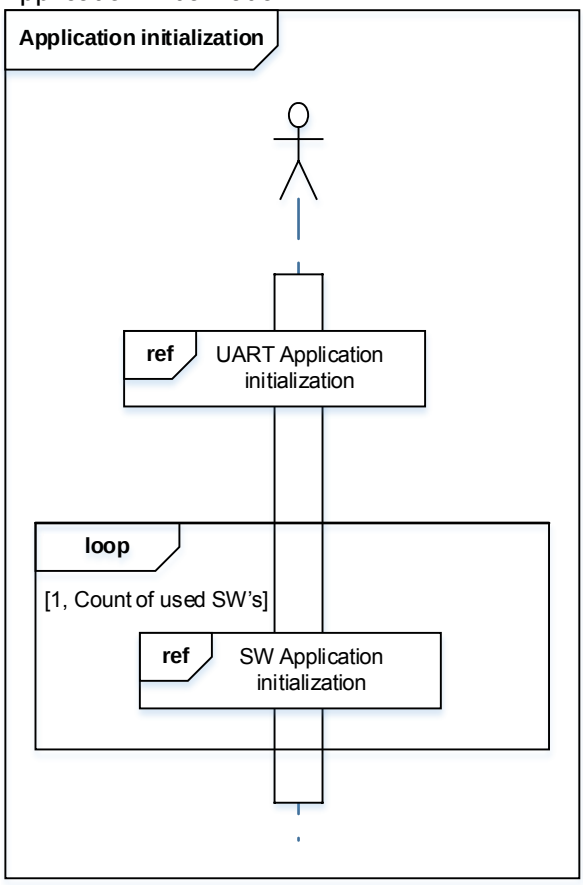


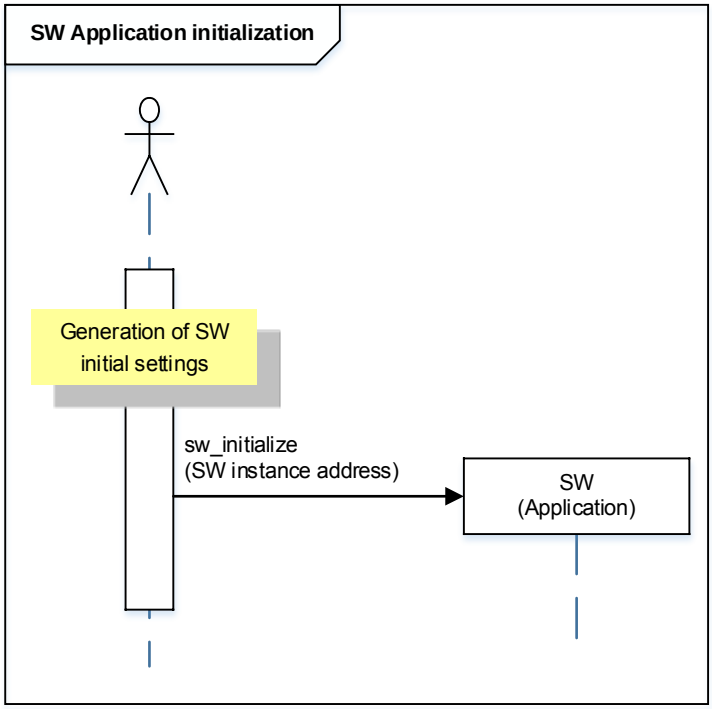
PPG Driver initialization



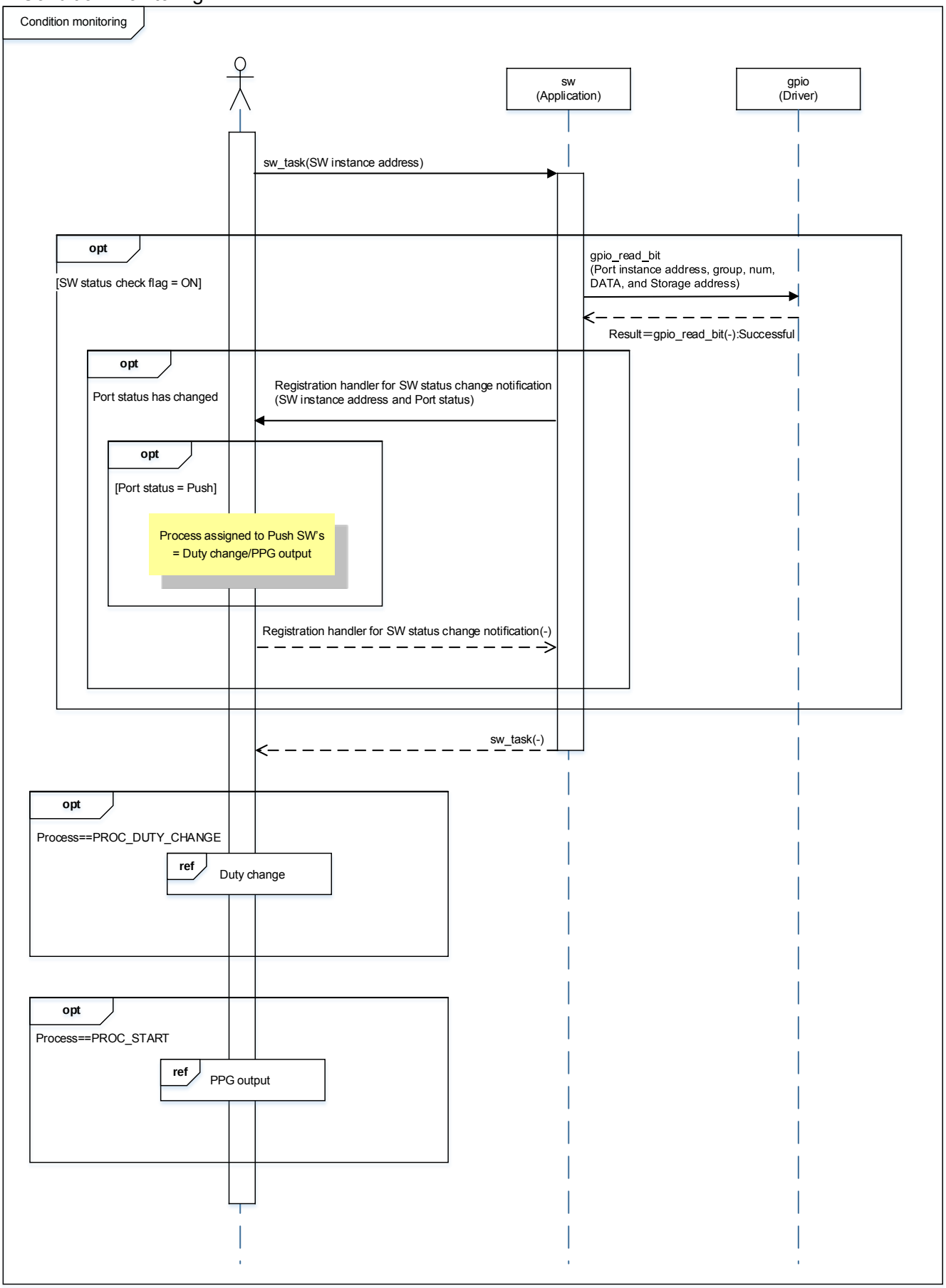


Application initialization

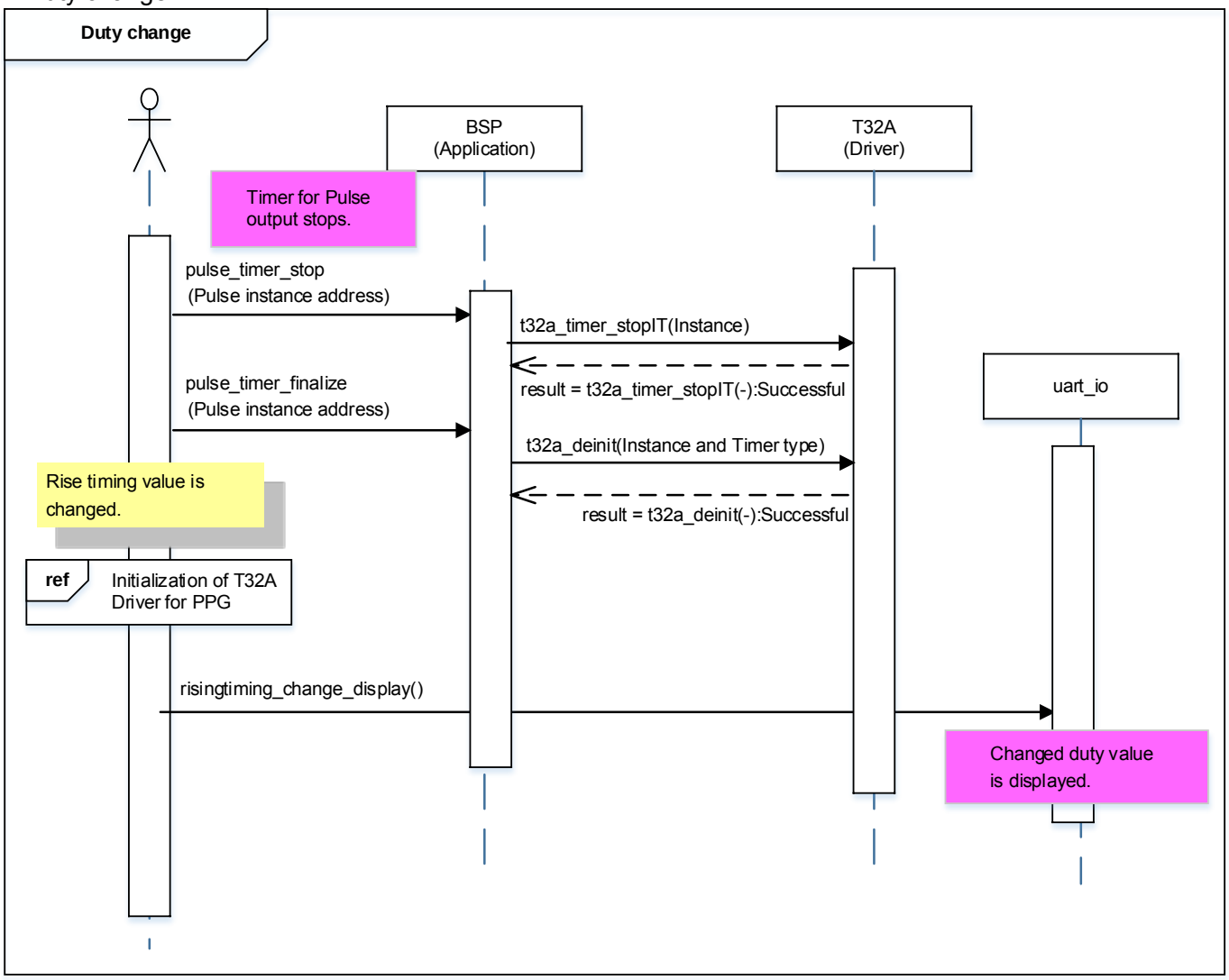




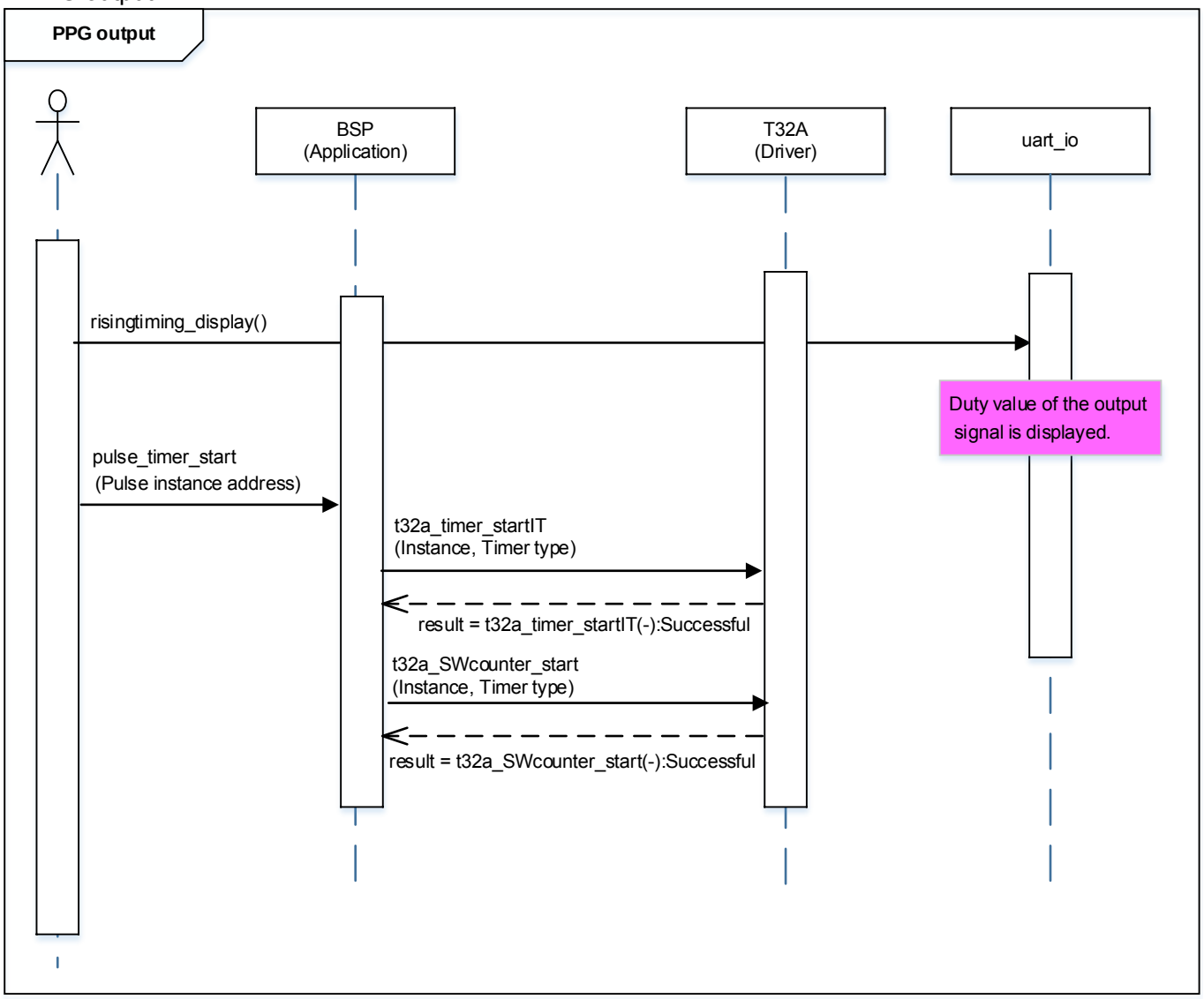
Condition monitoring



Duty change


Duty change
BSP
(Application)
T32A
(Driver)
uart_io
Timer for Pulse
output stops.
pulse_timer_stop
(Pulse instance address)
t32a_timer_stopIT(Instance)
result = t32a_timer_stopIT(-):Successful
pulse_timer_finalize
(Pulse instance address)
t32a_deinit(Instance and Timer type)
result = t32a_deinit(-):Successful
Rise timing value is
changed.
ref
Initialization of T32A
Driver for PPG
risingtiming_change_display()
Changed duty value
is displayed.

PPG output


PPG output
BSP
(Application)
T32A
(Driver)
uart_io
risingtiming_display()
Duty value of the output signal is displayed.
pulse_timer_start
(Pulse instance address)
t32a_timer_startIT
(Instance, Timer type)
result = t32a_timer_startIT(-):Successful
t32a_SWcounter_start
(Instance, Timer type)
result = t32a_SWcounter_start(-):Successful

10. Precaution

When using the sample program with CPU other than TMPM3H6, please check operation sufficiently.

11. Revision History

Rev	Date	Page	Description
1.0	2018-03-09	-	First release

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