

**M4K Group (1)**  
**Application Note**  
**Digital Noise Filter Circuit**  
**(DNF-A)**

**Outlines**

This application note is a reference material for developing products using the Digital noise filter circuit (DNF) function of M4K Group (1).

This document helps the user check operation of the product and develop its program.

Target sample program: DNF\_LED

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## 1. Preface

This sample program is used to check the operation of the Digital noise filter circuit function. An external interrupt signal is detected using the Digital noise filter circuit, and an output port is controlled. The external interrupt signal generated by push-down of a Push switch is detected via the Digital noise filter circuit. It controls the output port.

## 2. Reference Document

1. Datasheet  
TMPM4K Group (1) datasheet Rev2.0 (Japanese edition)
2. Reference manual  
Digital Noise Filter Circuit (DNF-A) Rev3.0 (Japanese edition)  
Input/Output Ports (PORT- M4K (1)) Rev2.0 (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
Digital Noise Filter Circuit	-	-	Digital noise filter
Input/Output Ports	-	PA1 (INT9)	External interrupt
	-	PL4 (Output Port)	Output

## 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
Sample program	v1.0.0

## 6. Evaluation Board Operation

Pin name of Microcontroller	Function
PA1	External interrupt input (Push switch)
PL4	High or Low output

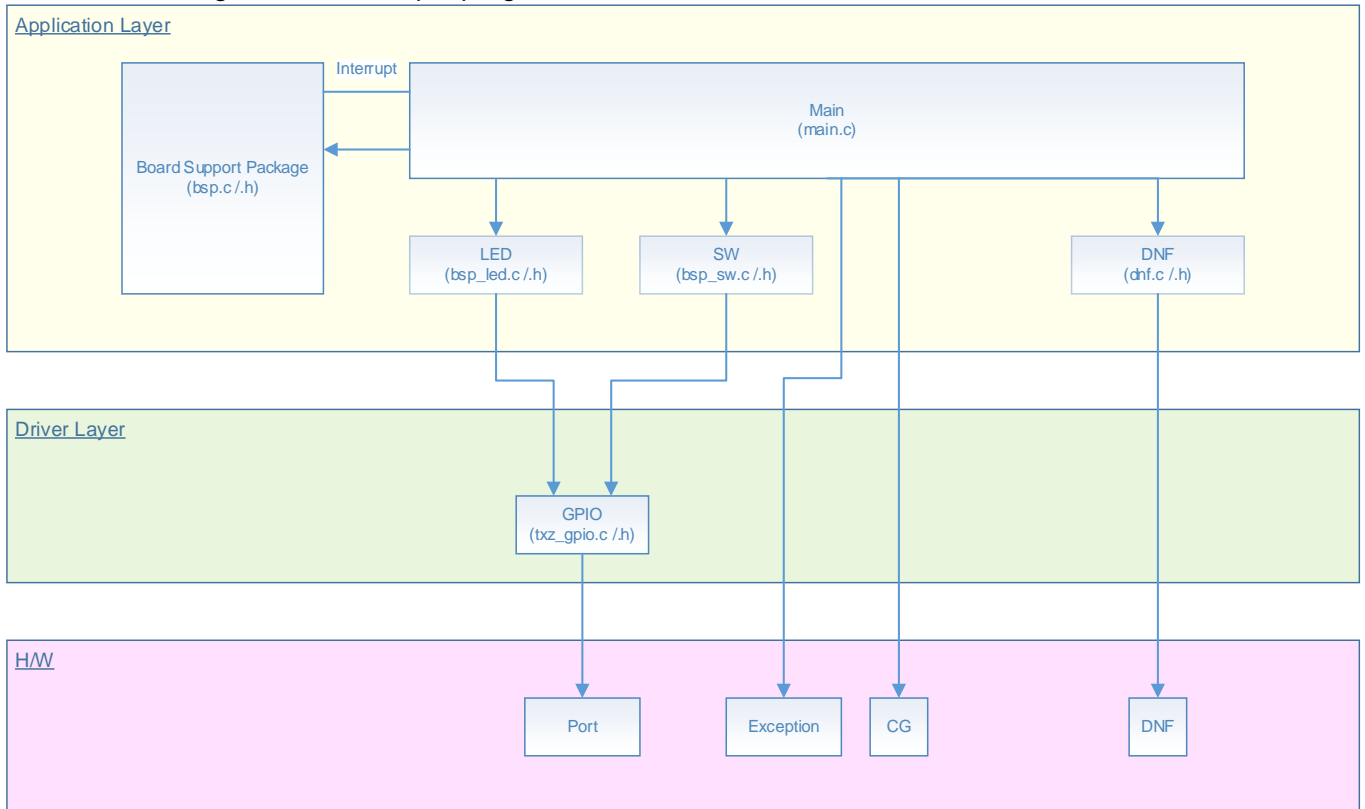
The evaluation board should be connected to a PC.

Whenever the push switch is pushed down, the output of the PL4 is toggled between High and Low levels.

## 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 is done.
- The initialization of the timer driver is done.
- The initialization of the application software is done.

The Timer starts.

The Timer operates in each sample program. This sample program does not use the Timer.

The following settings are done; the clock of the Digital noise filter, the enable of an external interrupt, the registration of registers, and the enable of the NVIC interrupt.

The PA1 is used as an input pin of an external interrupt, and the noise filter is enabled.

Whenever the push switch is pushed down, the PA1 interrupt is generated and the output of the PL4 is toggled between High and Low levels.

#### 7.4. Change of Noise Reduction Time of DNF

The noise reduction time of the Digital noise filter can be changed by modifying the clock frequency of the noise filter.

The clock frequency is set in the "main.c".

```
REG_DNFCKCR_set ((TSB_DNF_TypeDef *) bsp_get_dnf_reg (BSP_DNF_0),  
REG_DNF_NFCKCR_NFCKS_CLOCK_2);  
"REG_DNF_NFCKCR_NFCKS_CLOCK_2" sets the clock frequency.
```

The clock selection is defined in the "dnf.h".

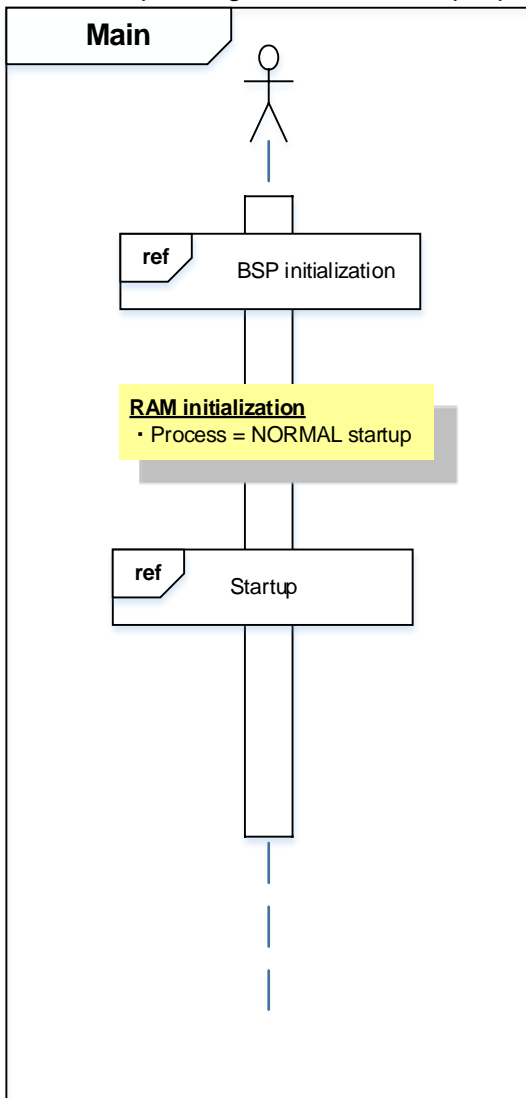
```
REG_DNF_NFCKCR_NFCKS_STOP: Stop of the clock control circuit  
REG_DNF_NFCKCR_NFCKS_CLOCK_2: fc/2 clock output  
REG_DNF_NFCKCR_NFCKS_CLOCK_4: fc/4 clock output  
REG_DNF_NFCKCR_NFCKS_CLOCK_8: fc/8 clock output  
REG_DNF_NFCKCR_NFCKS_CLOCK_16: fc/16 clock output  
REG_DNF_NFCKCR_NFCKS_CLOCK_32: fc/32 clock output  
REG_DNF_NFCKCR_NFCKS_CLOCK_64: fc/64 clock output  
REG_DNF_NFCKCR_NFCKS_CLOCK_128: fc/128 clock output
```

The noise reduction time is calculated with the following formula.

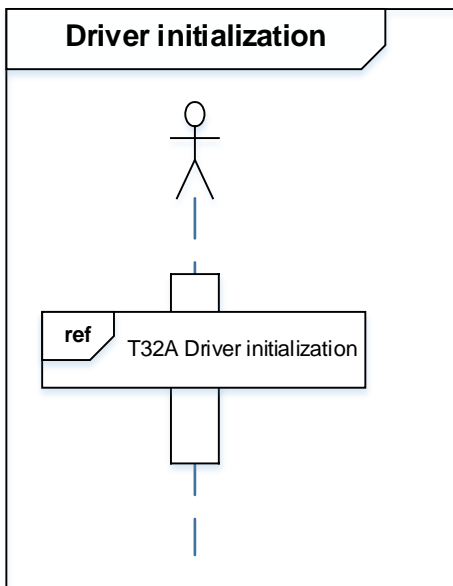
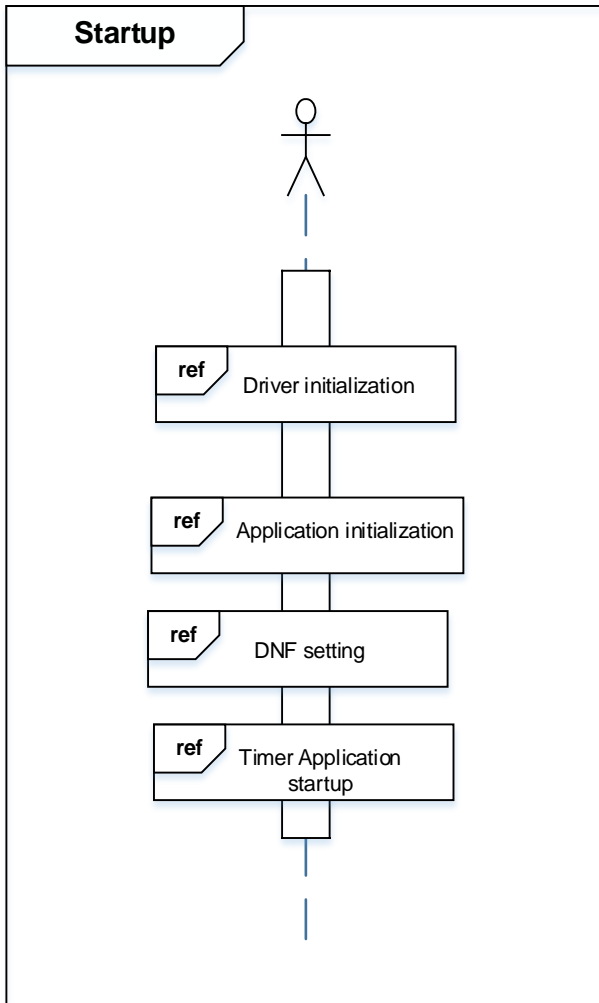
Noise reduction time ( $\mu$ s) = (1/Noise filter clock frequency) \* 7 (clocks)

### 7.5. Operating Flow of Sample Program

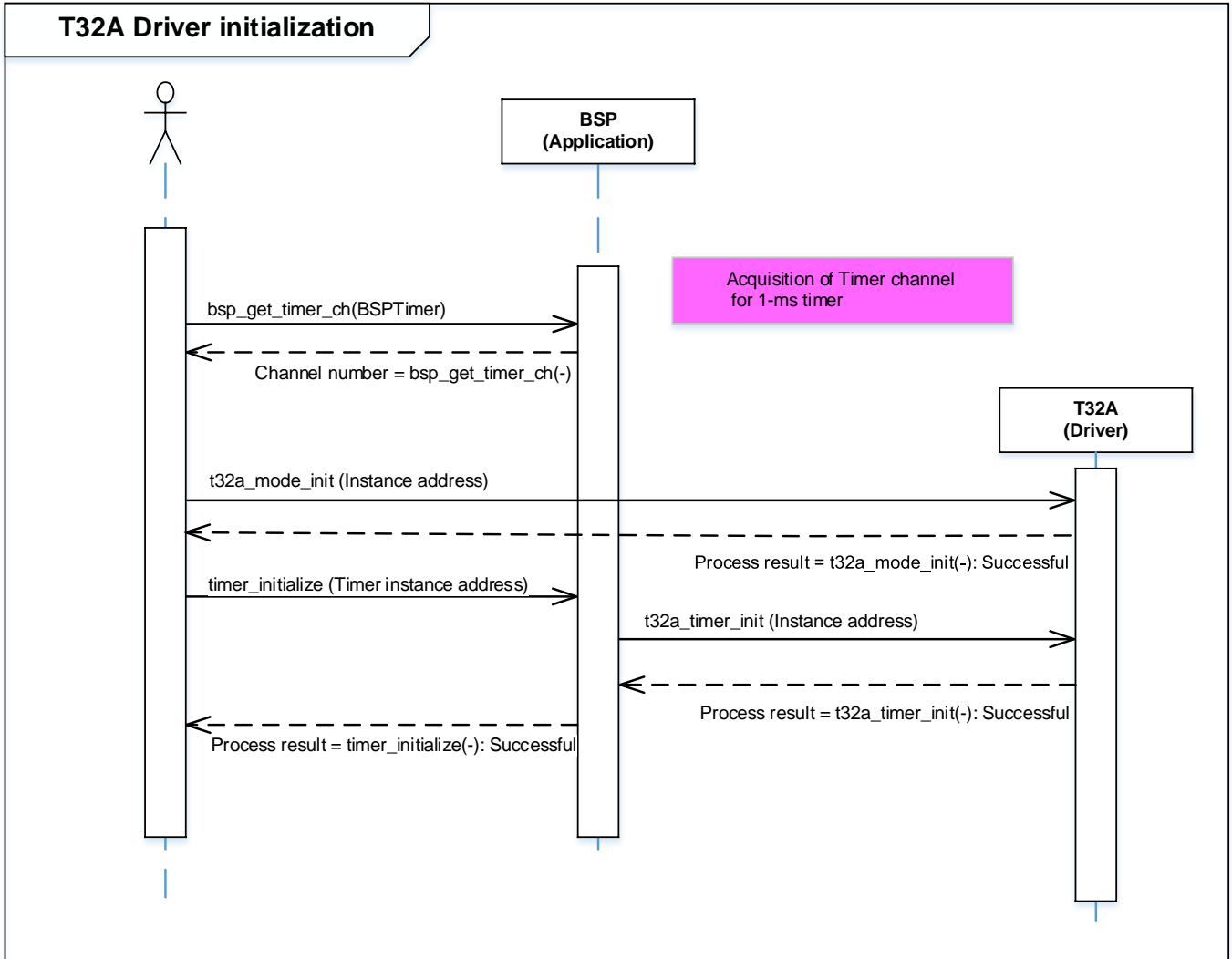
The basic operating flows of the sample program are shown in the following;

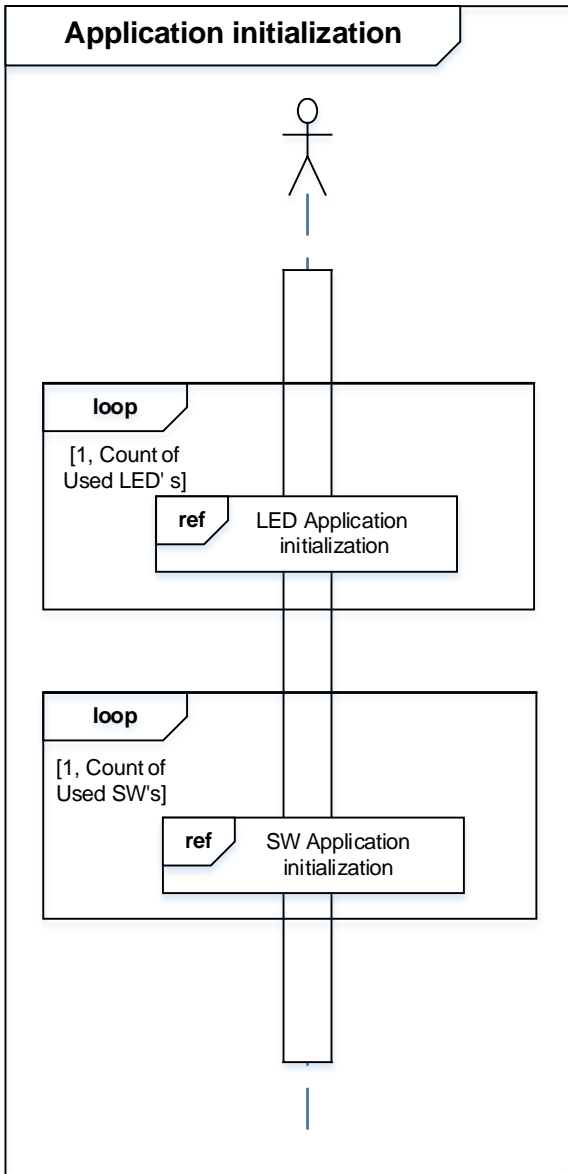


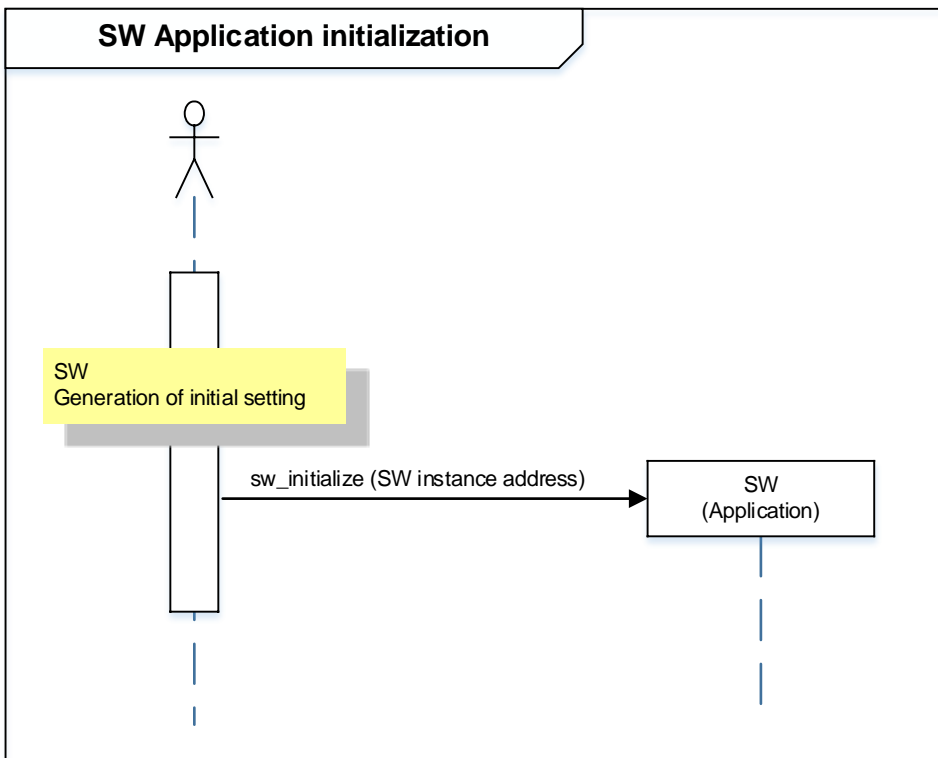
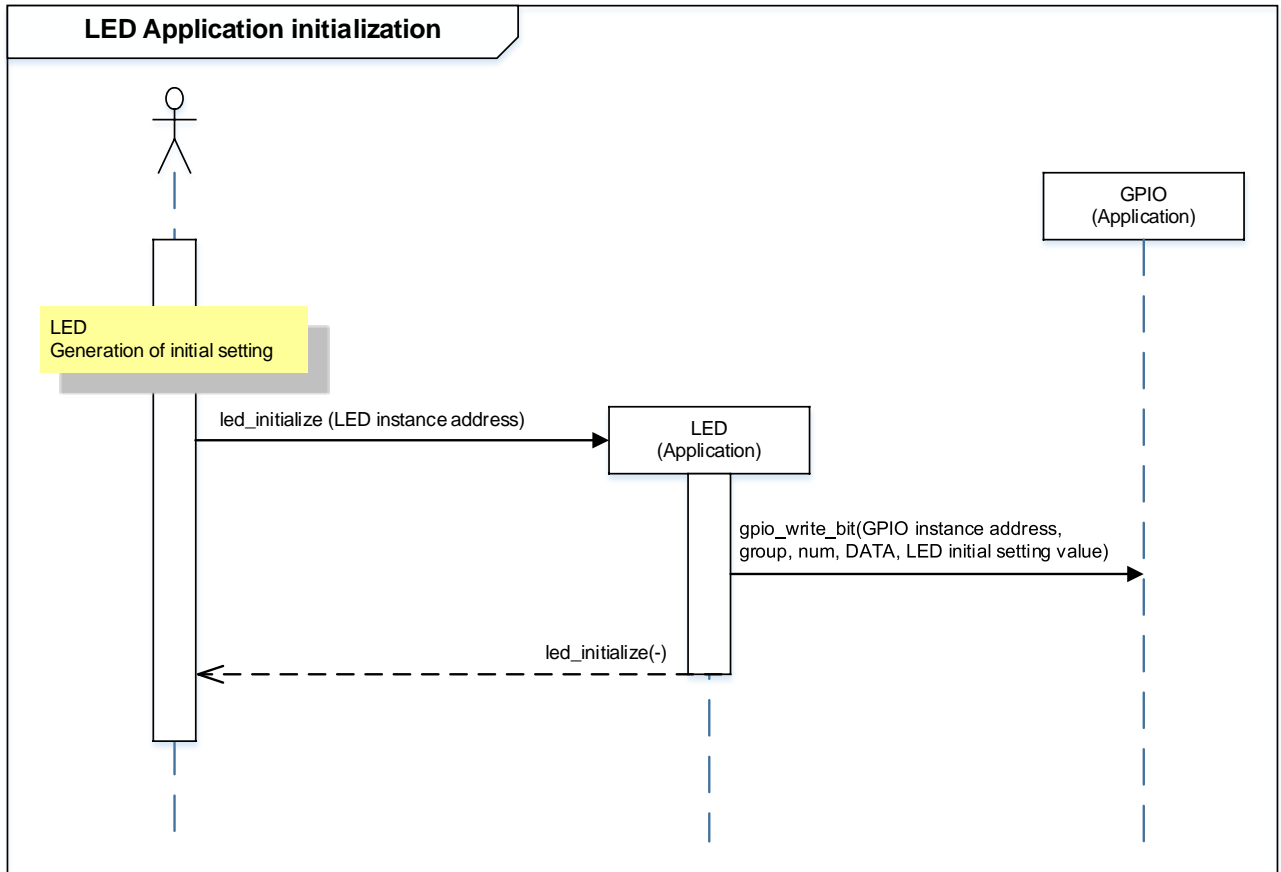


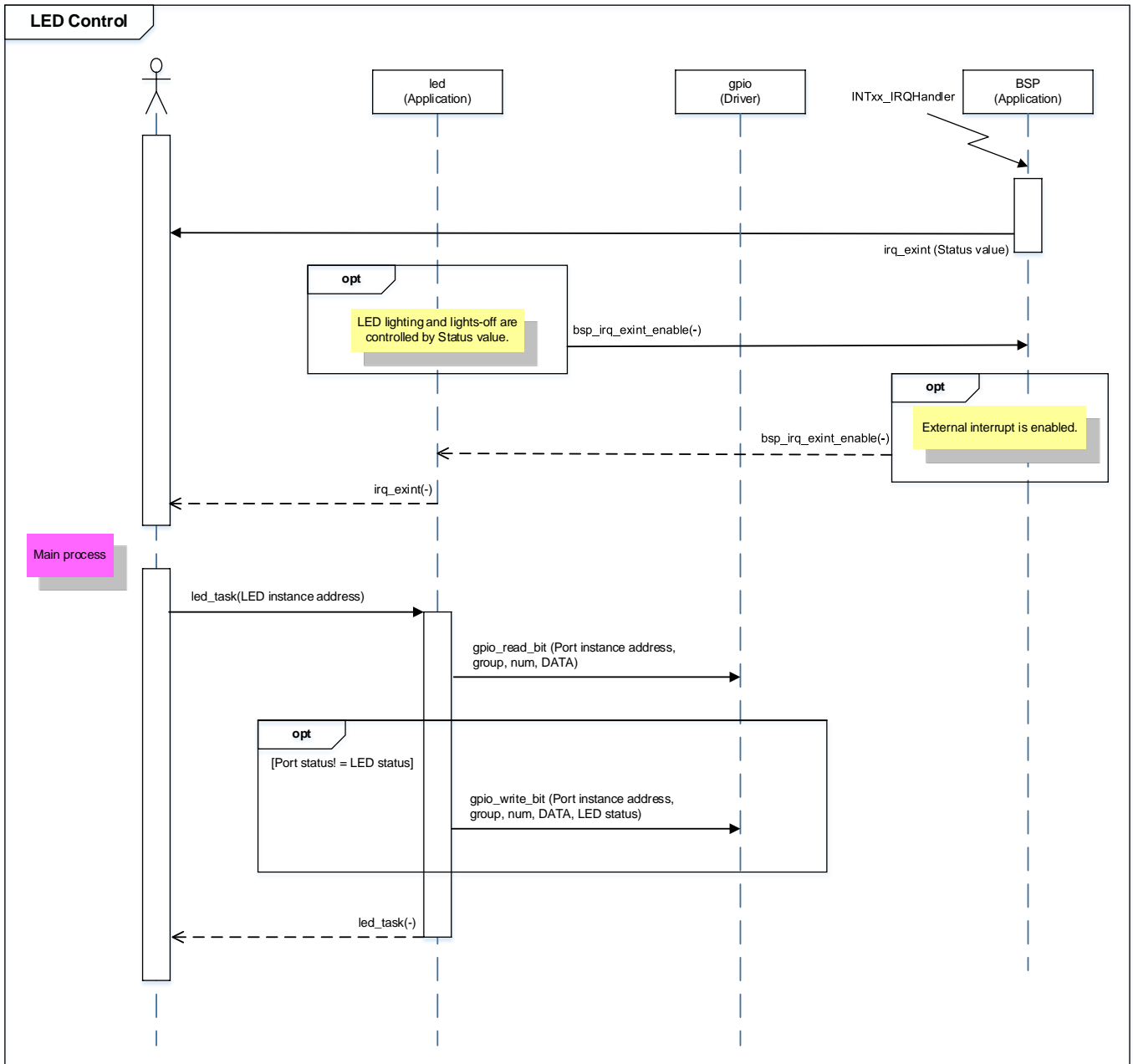


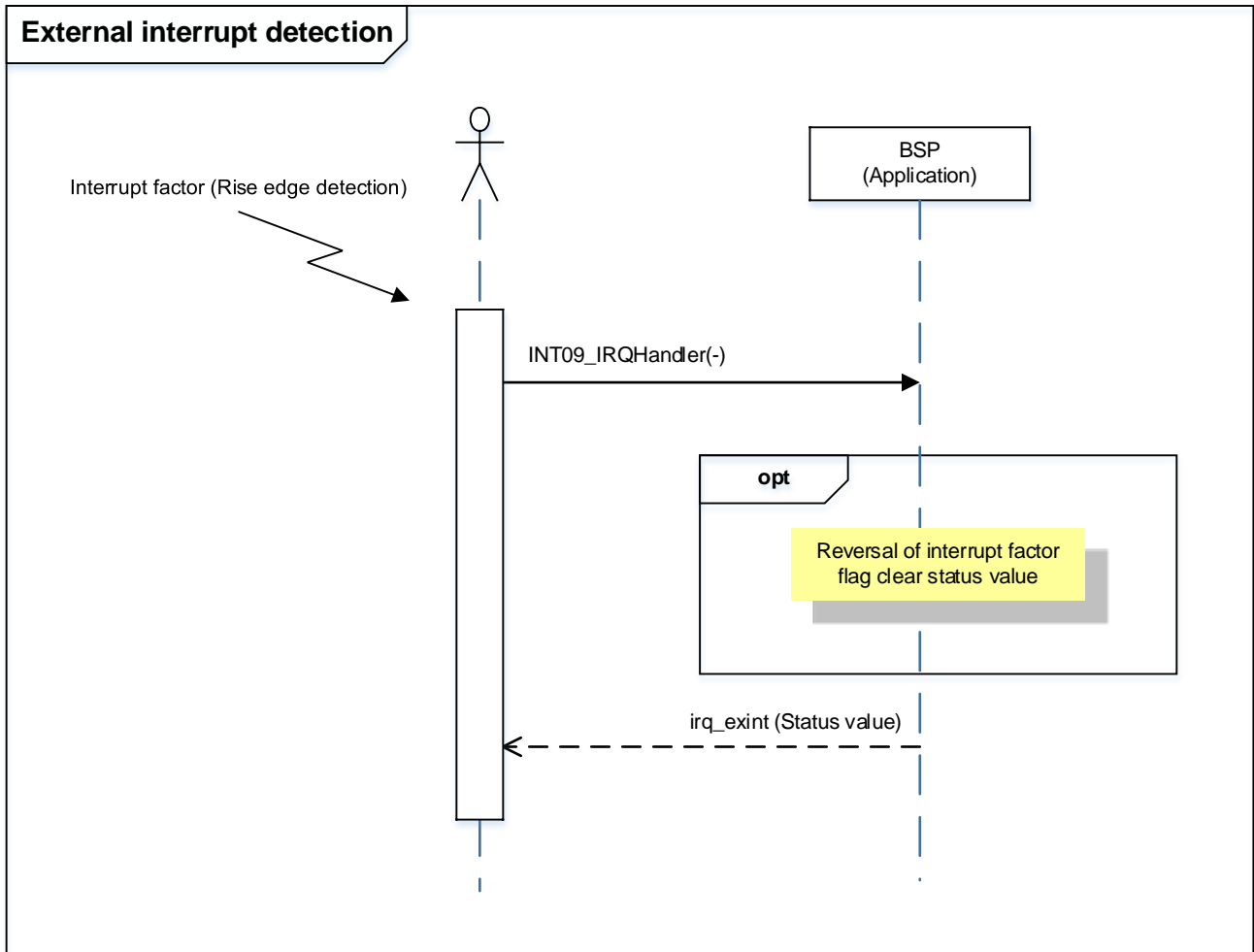
The 32-bit timer event counter in TPM4K4 is running, but, processing using timer count is not performed.

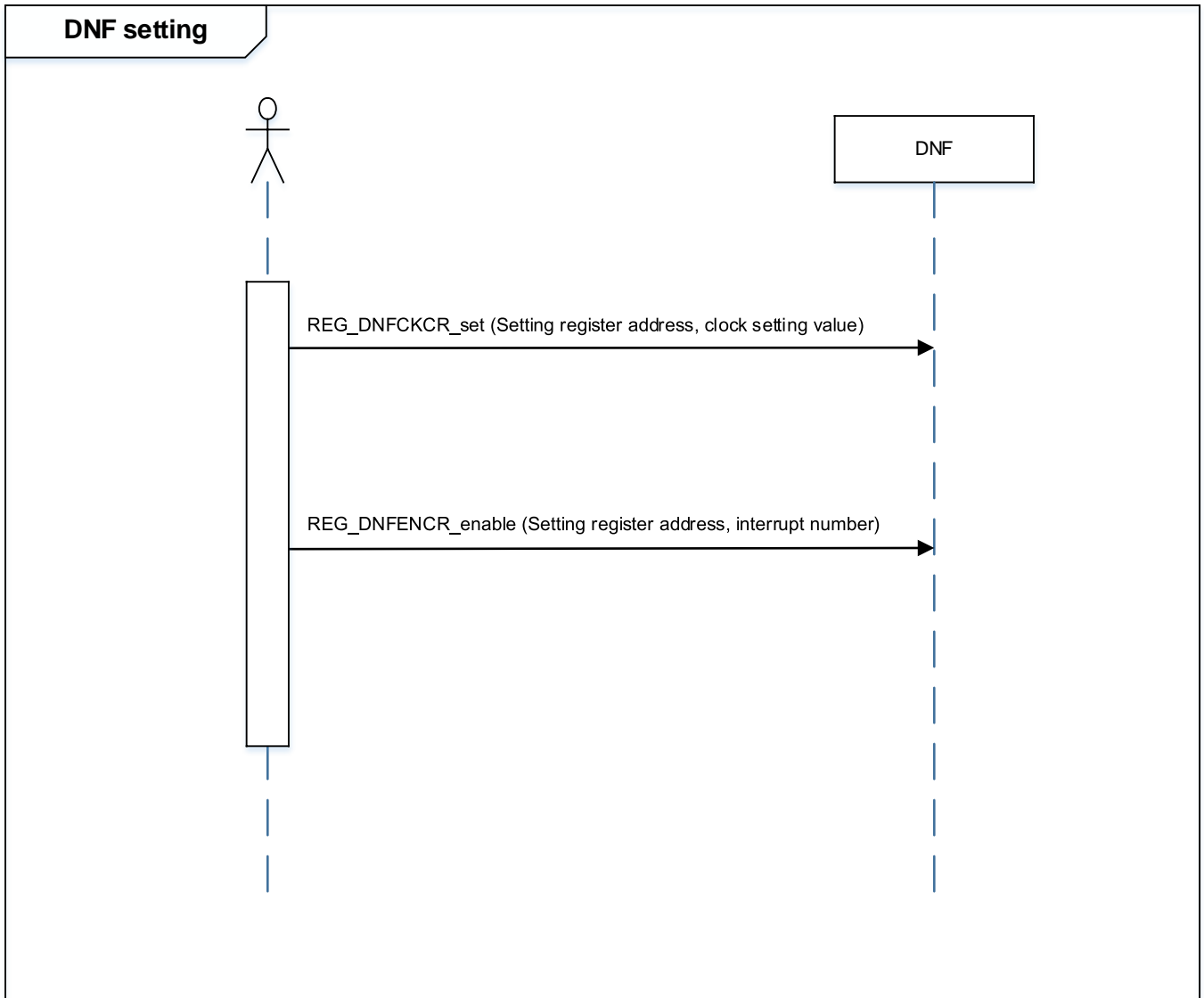












## 8. Points to Remember on Handling of Sample Programs

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

## 9. Revision History

Revision	Date	Description
1.0	2019-10-08	First release



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