M4G 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 (DNF) function of M4G group (1). This document helps the user check operation of the product and develop its program.

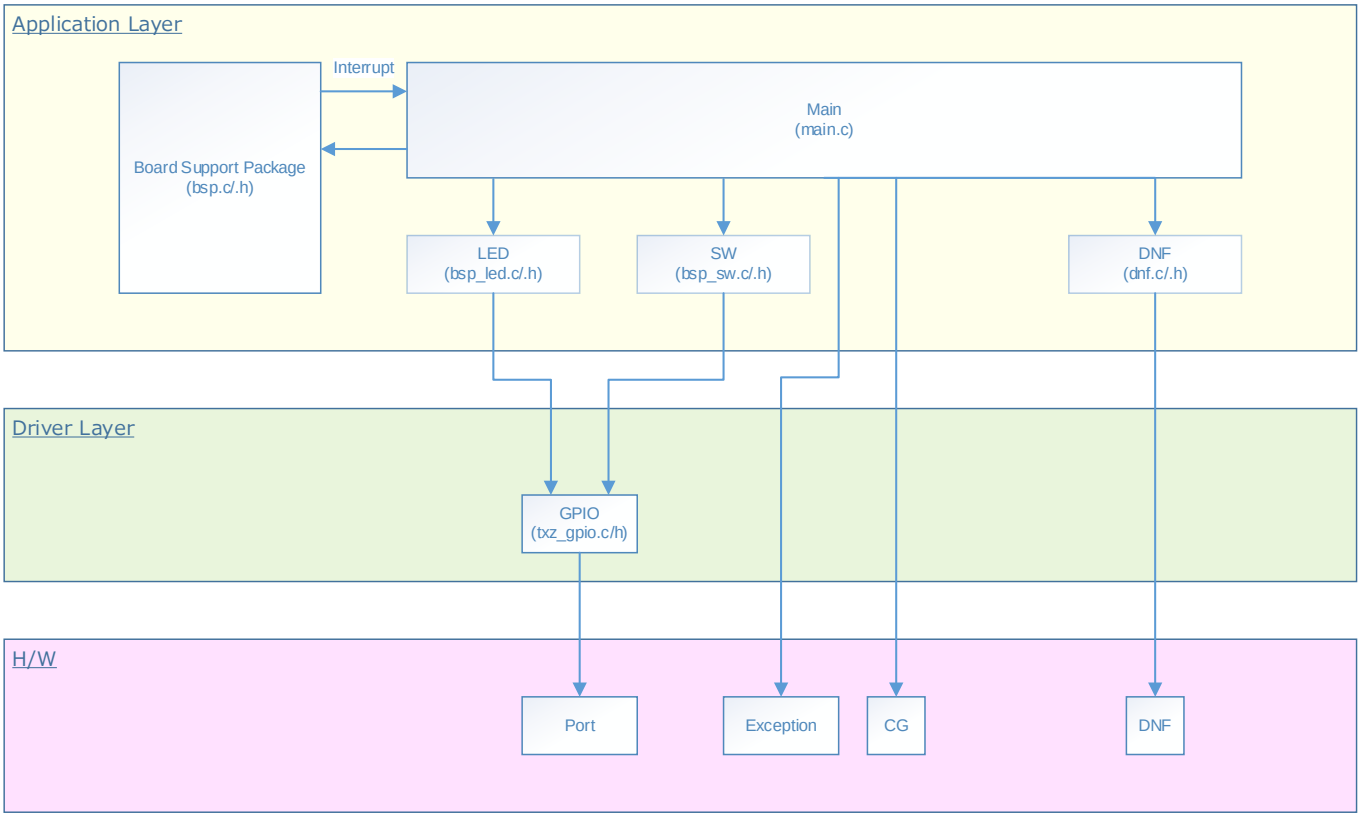
Target sample program: DNF_LED

Table of Contents

1. Preface

This sample program is used to check the operation of the digital noise filter circuit function.
The LED light ON/OFF is switched by an interrupt process via the digital noise filter by pushing down the switch.

Structure diagram of Sample program



2. Reference Document

- Datasheet
  TMPM4G Group (1) datasheet Rev1.0 (Japanese edition)
- Reference manual
  Digital Noise Filter Circuit (DNF-A) Rev2.0 (Japanese edition)
  Input / Output Ports (PORT-M4G(1)) Rev1.0 (Japanese edition)
  Exception (EXCEPTIN-M4G(1)) Rev1.0 (Japanese edition)
- Application Note
  M4G Group (1) Application Note Startup (CMSIS System & Clock Configuration) Rev1.0
- Other reference document
  TMPM4G (1) Group Peripheral Driver User Manual (Doxygen)

3. Function to Use

IP	channel/unit	Port	Function/Operation mode
Digital Noise Filter Circuit	unit A	-	Digital noise filter
Input / Output Ports	-	PL0(INT01a)	External interrupt
	-	PE7(Output Port)	Output

4. Target Device

The target devices of this application note are as follows;

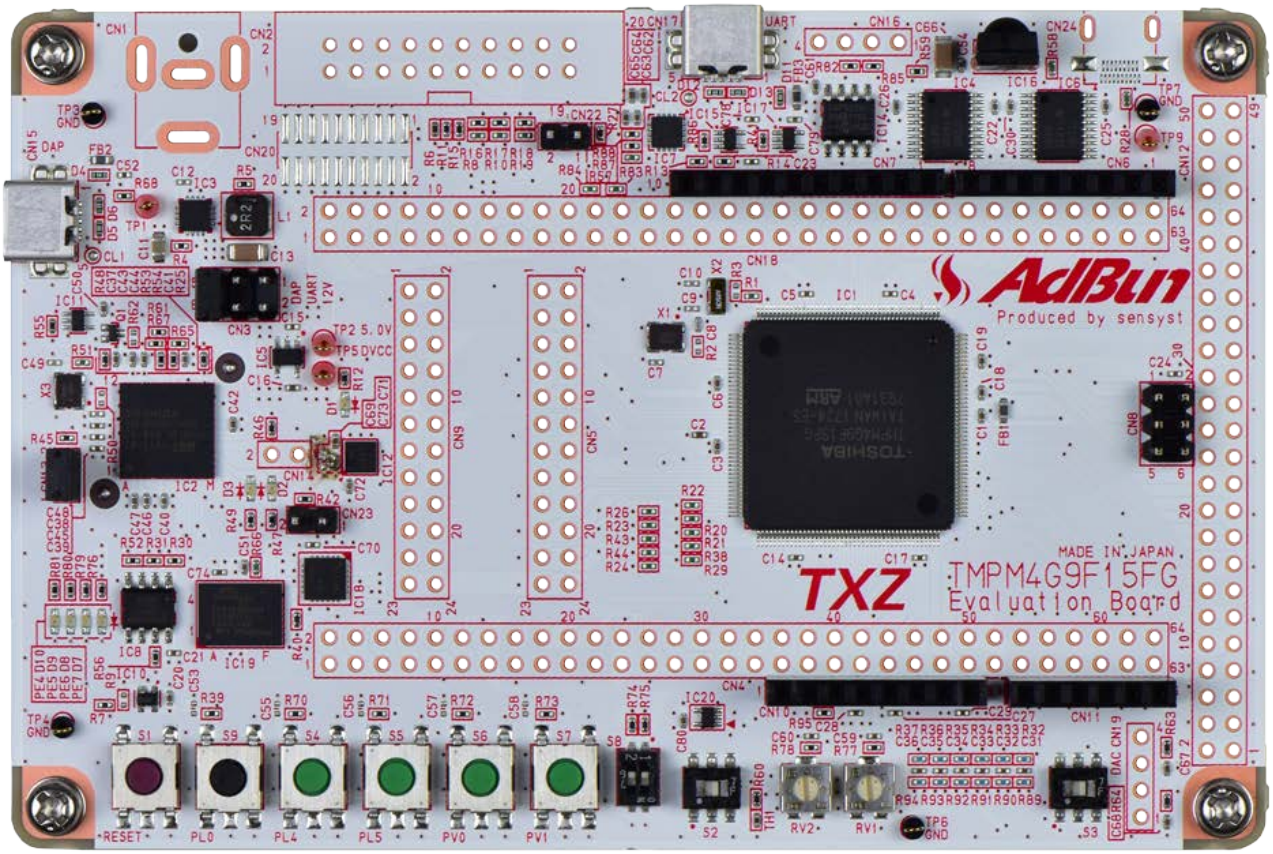
TMPM4G9F15FG	TMPM4G9F10FG	TMPM4G9FEFG	TMPM4G9FDFG
TMPM4G9F15XBG	TMPM4G9F10XBG	TMPM4G9FEXBG	TMPM4G9FDXBG
TMPM4G8F15FG	TMPM4G8F10FG	TMPM4G8FEFG	TMPM4G8FDFG
TMPM4G8F15XBG	TMPM4G8F10XBG	TMPM4G8FEXBG	TMPM4G8FDXBG
	TMPM4G7F10FG	TMPM4G7FEFG	TMPM4G7FDFG
	TMPM4G6F10FG	TMPM4G6FEFG	TMPM4G6FDFG

*This sample program operates on the evaluation board of TMPM4G9F15FG.
If other function than the TMPM4G9F15 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 (TMPM4G9F15). If other function than the TMPM4G9F15 one is checked, the BSP related file should be changed properly.

5. Operation Confirmation Condition

Used microcontroller	TMPM4G9F15FG
Used board	TMPM4G9F15FG Evaluation Board by Sensyst
Unified development environment	IAR Embedded Workbench for ARM 8.11.2.13606
Unified development environment	µVision MDK Version 5.24.2.0
Sample program	V1000

Evaluation board (TMPM4G9F15FG Evaluation Board) Top view

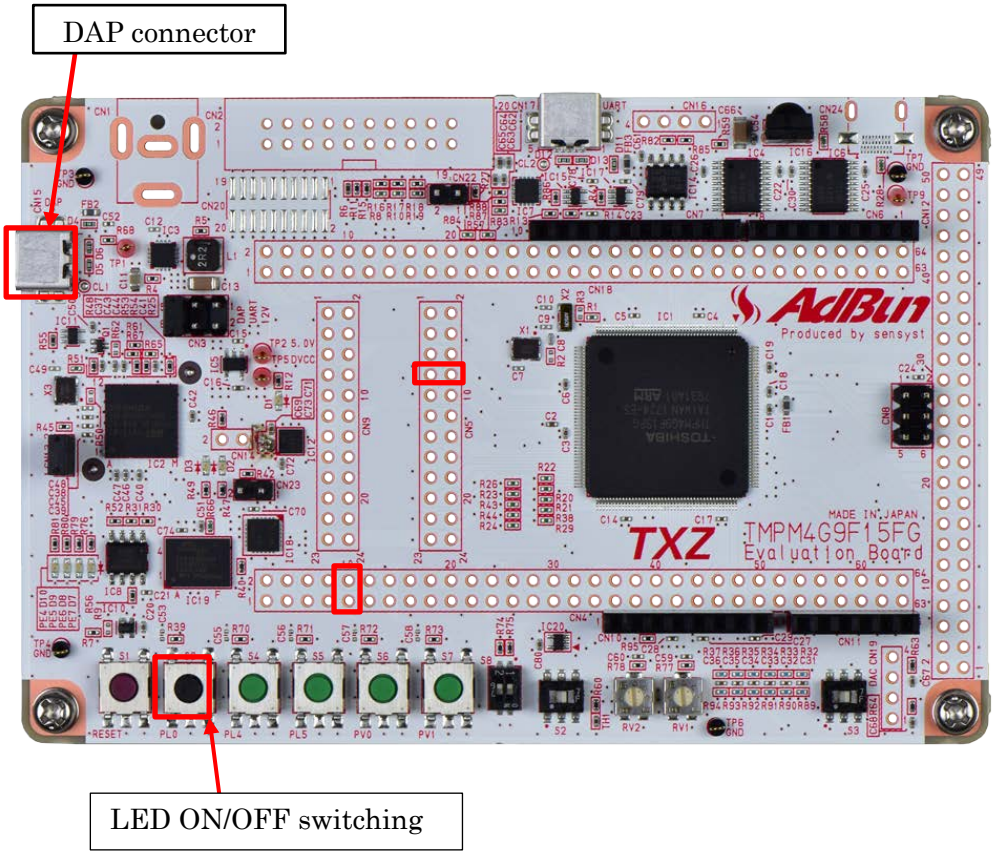


6. Evaluation Board Setting

The following pin connections should be done on the evaluation board

CN4		
Board function	Through-hole No.	Through-hole No.
Push switch (S9)	9: StopSW_INT	10: PL0

CN9		
Board function	Through-hole No.	Through-hole No.
LED(D7)	7: LED3	8: PE7



7. Operation of Evaluation Board

When Push switch (S9) is pushed down, LED (D7) lights on.
When Push switch (S9) is pushed down again, LED (D7) lights off.

8. Outline of DNF Function

The digital noise filter circuit can remove the noise of a predetermined width from the external interrupt pin input

9. Sample Program

Detects the external interrupt signal generated by pushing down the push switch via DNF and turns the LED on / off.

9.1. Initialization

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

9.2. Sample Program Main Operation

The initialization of BSP is executed.
The initialization of timer driver is executed.
As the initialization of applications, the LEDs and push switches are initialized.
The timer starts.
The DNF is set.
Enables an interrupt of DNF.
Standby until switch S9 is pushed down.

The light of LED is ON when the pushing down of switch S9 is detected.
The light of LED is OFF when switch S9 is pushed down again.
After that, the light of LED repeats ON/OFF every time when the switch S9 is pushed down.

9.3. DNF Noise Removal Time Change

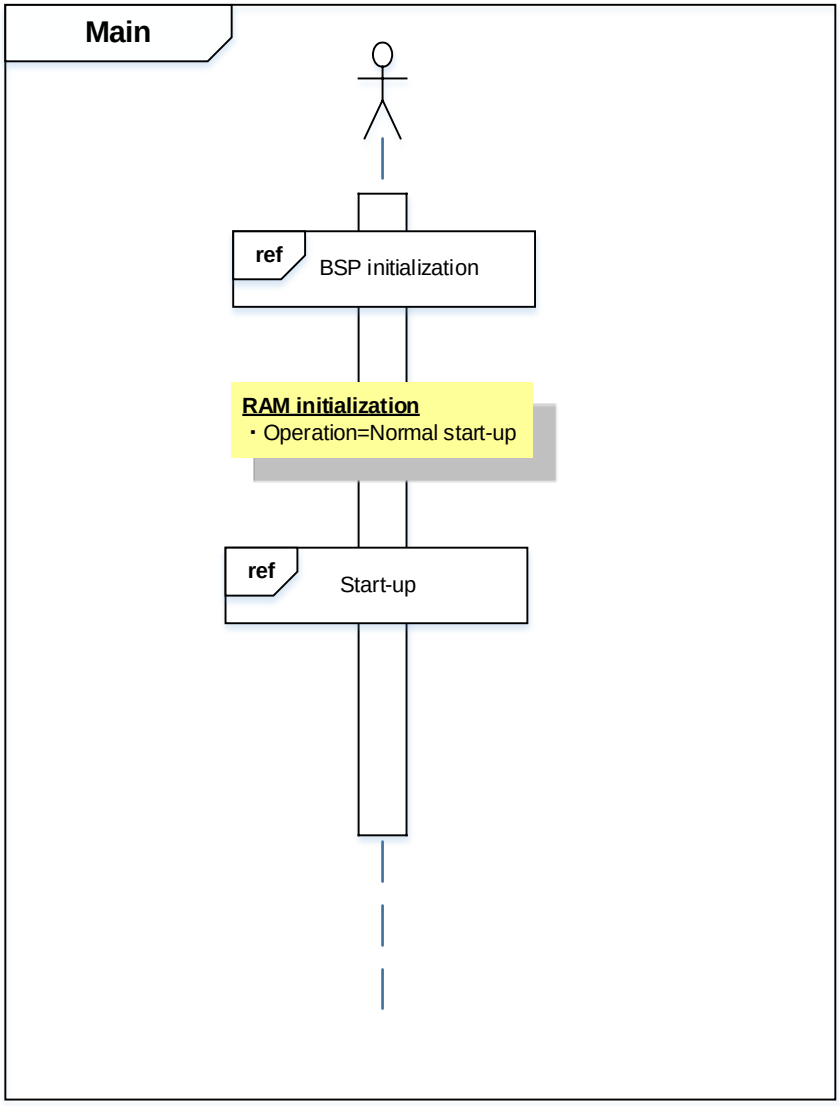
By changing the noise filter clock frequency, it is possible to change the noise removal time of the digital noise filter.
"REG_DNF_NFCKCR_NFCKS_CLOCK_2" defined in main.c is the setting part.
Clock selection is defined in dnf.h
REG_NFCKCR_set((TSB_DNF_TypeDef *)bsp_get_dnf_reg(BSP_DNF_0),
REG_DNF_NFCKCR_NFCKS_CLOCK_2);

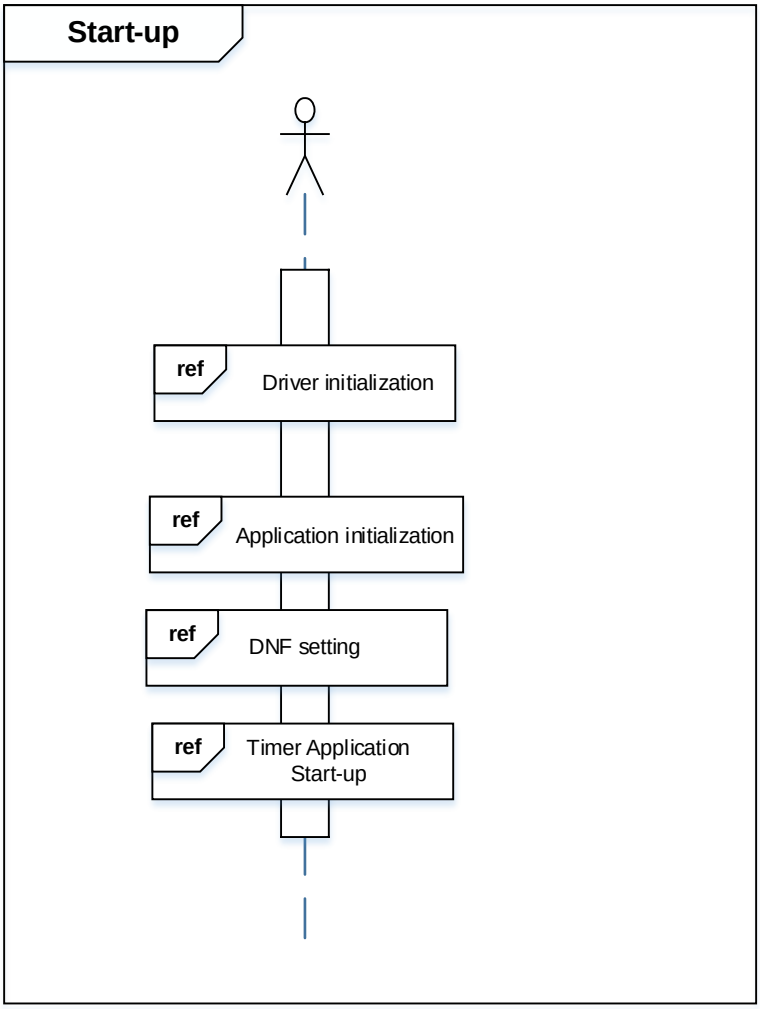
REG_DNF_NFCKCR_NFCKS_STOP : Clock control circuit stops
REG_DNF_NFCKCR_NFCKS_CLOCK_ 2: fc / 2 clock output
REG_DNF_NFCKCR_NFCKS_CLOCK_ 4: fc / 4 clock output
REG_DNF_NFCKCR_NFCKS_CLOCK_ 8: fc / 8 clock output
REG_DNF_NFCKCR_NFCKS_CLOCK_ 16: fc / 16 clock output
REG_DNF_NFCKCR_NFCKS_CLOCK_ 32: fc / 32 clock output
REG_DNF_NFCKCR_NFCKS_CLOCK_ 64: fc / 64 clock output
REG_DNF_NFCKCR_NFCKS_CLOCK_ 128: fc / 128 clock output

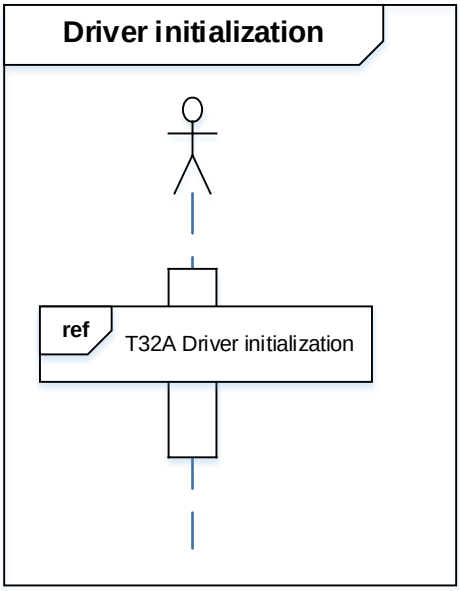
Noise removal time (μs) = 1 / noise filter clock frequency * 7 clocks

9.4. Operating Flow of Sample Program

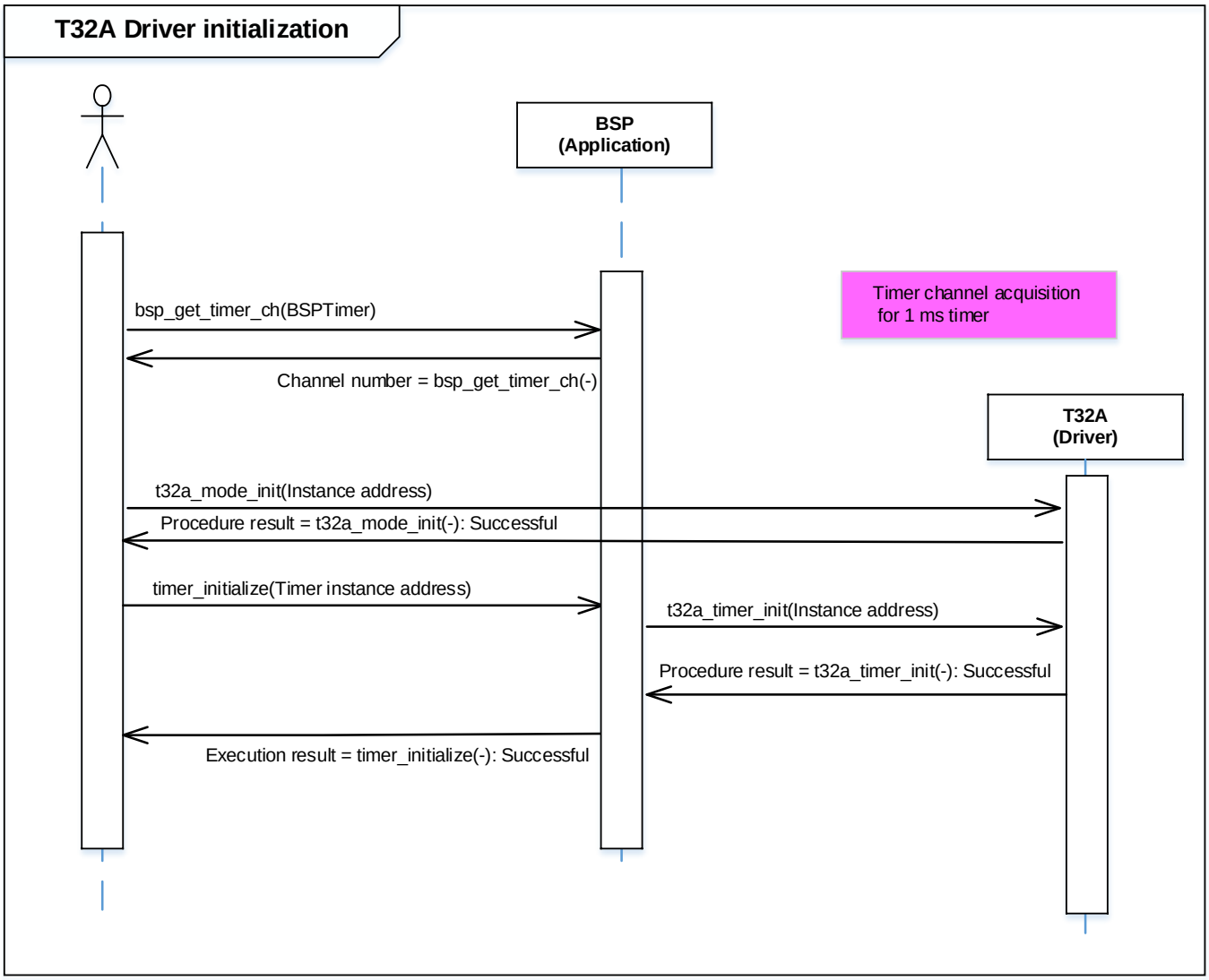
The basic operating flows of the sample program are shown in the following.

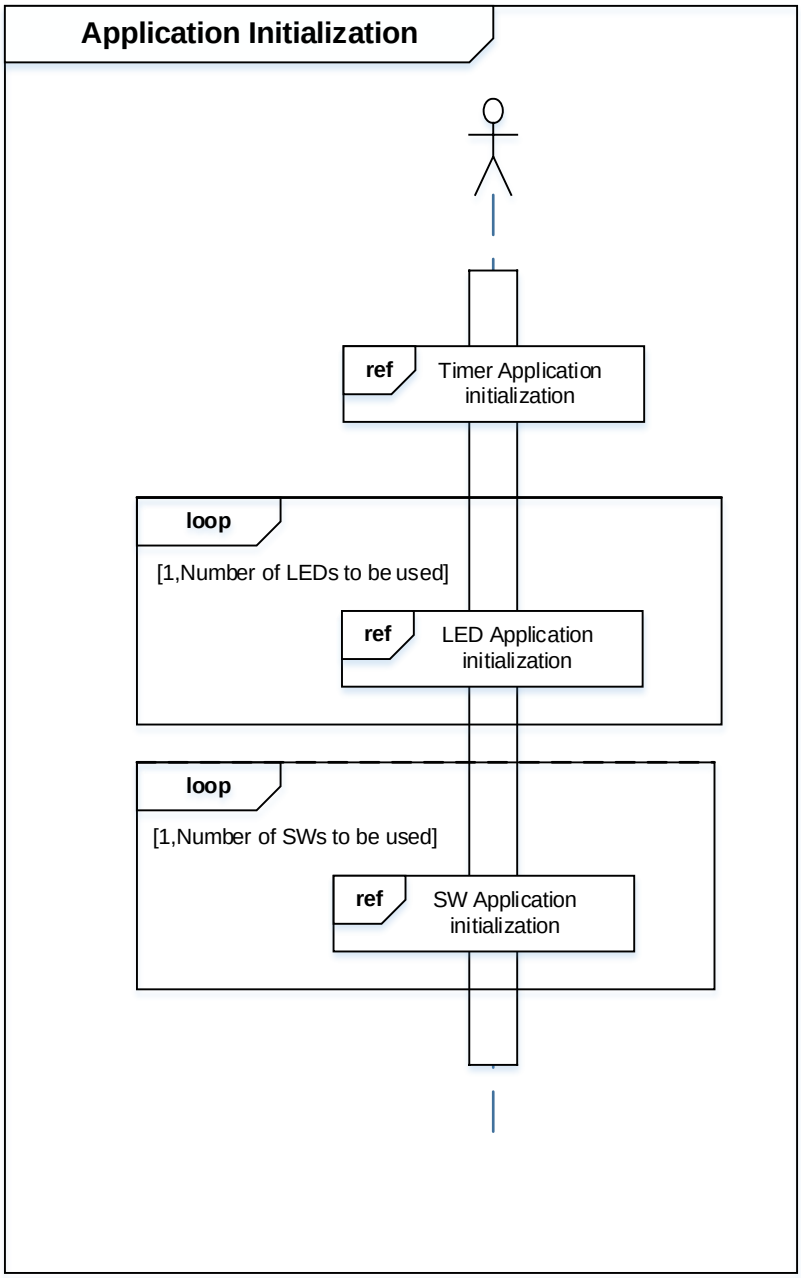


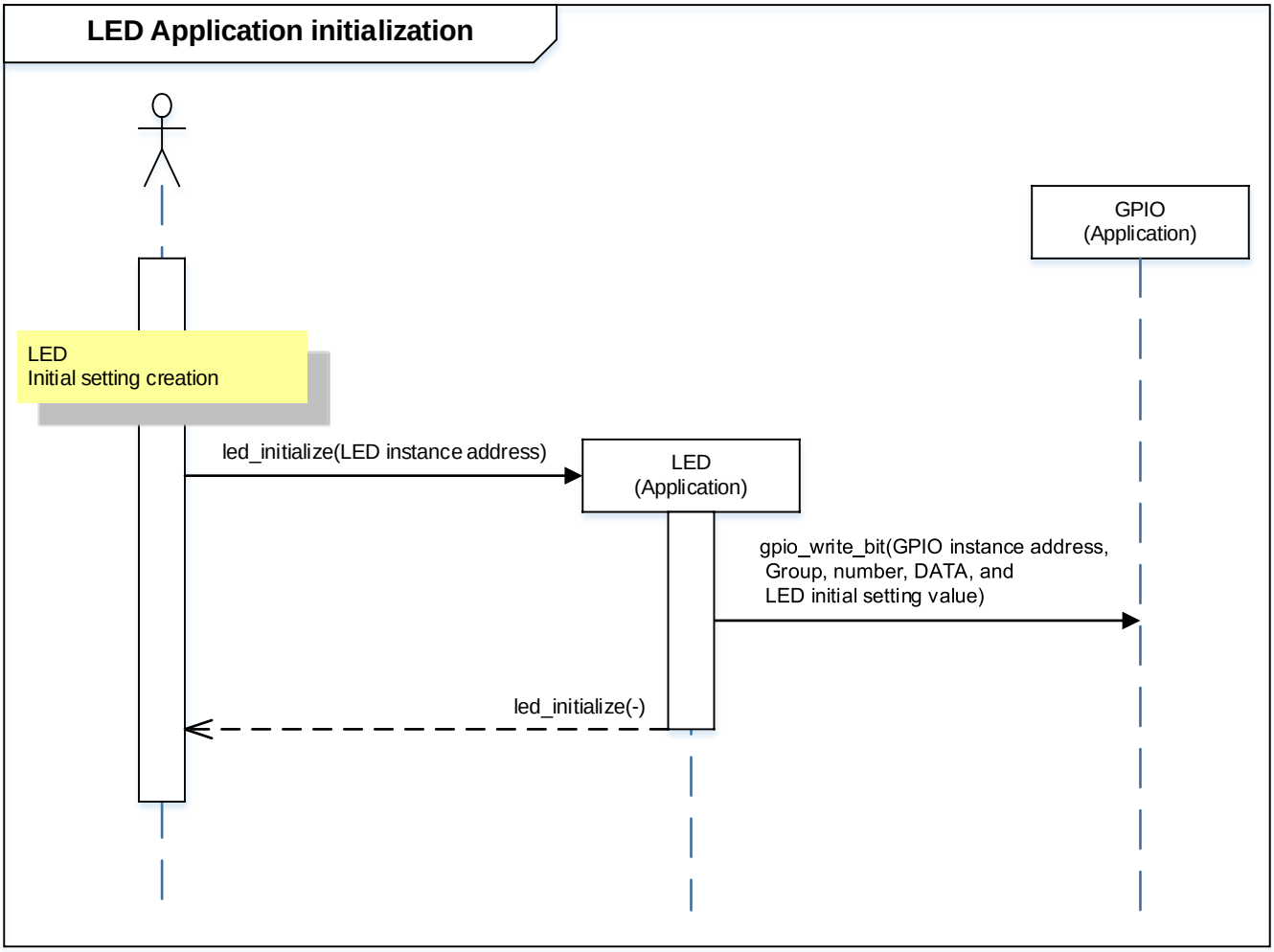

Start-up
ref
Driver initialization
ref
Application initialization
ref
DNF setting
ref
Timer Application
Start-up

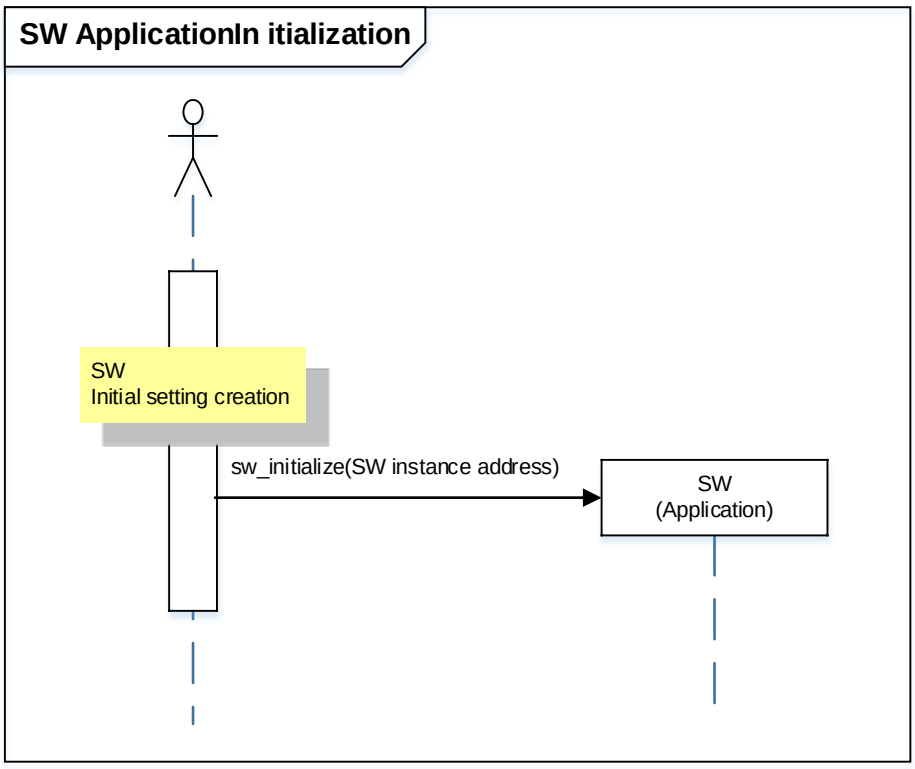

Driver initialization
ref
T32A Driver initialization

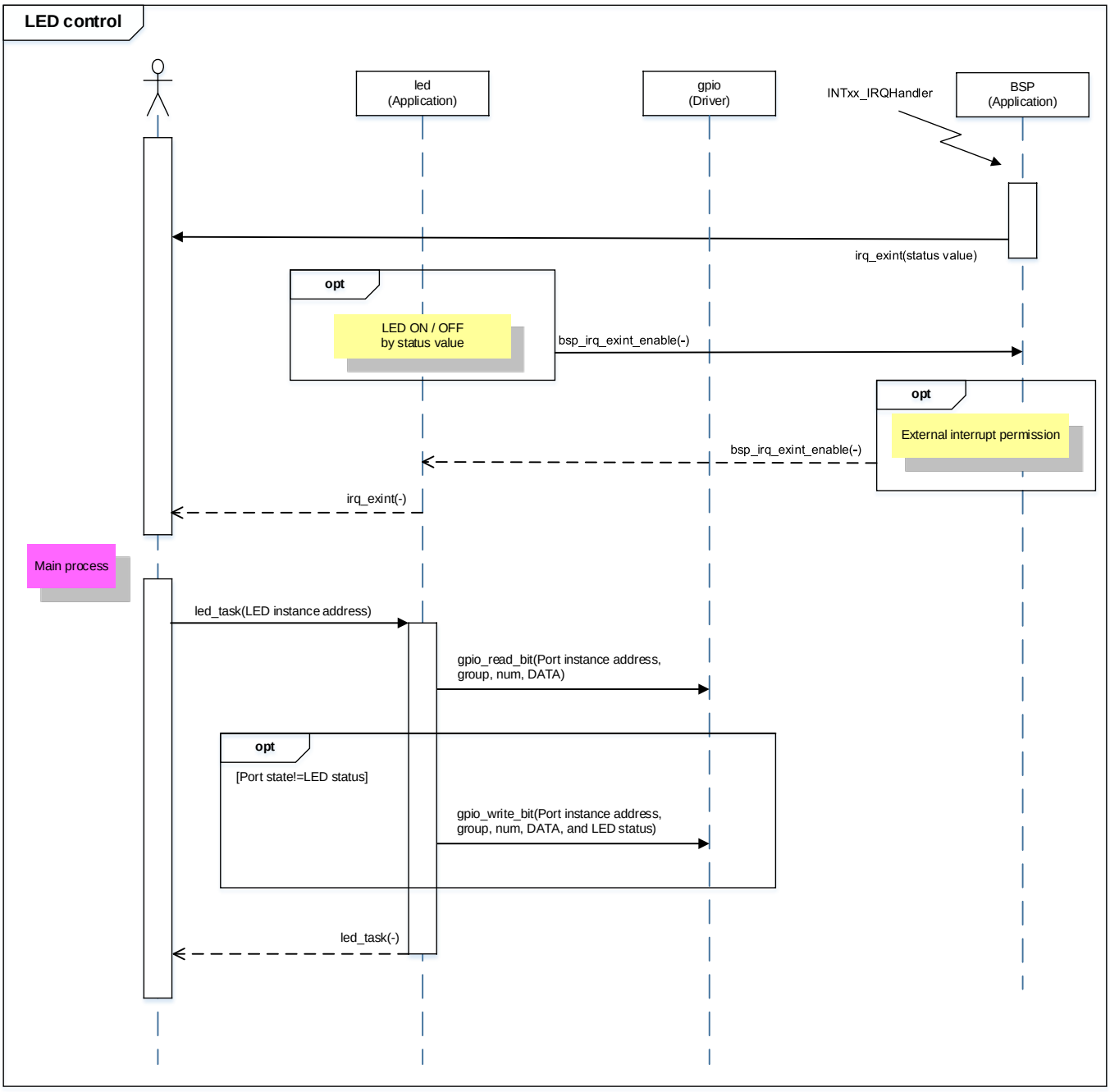
The 32-bit timer event counter of TMPM4G9 is running, but processing using timer count is not used.

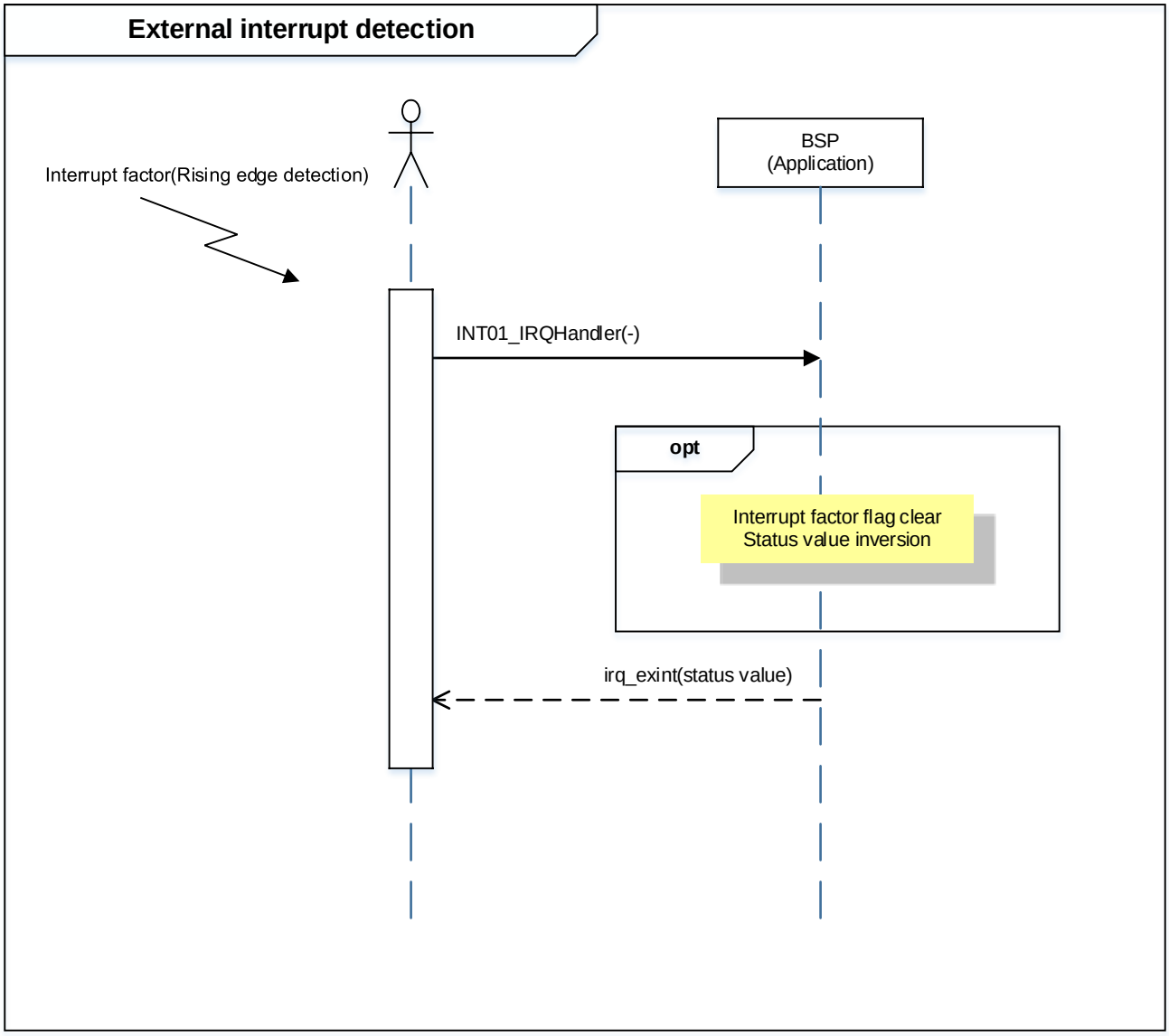


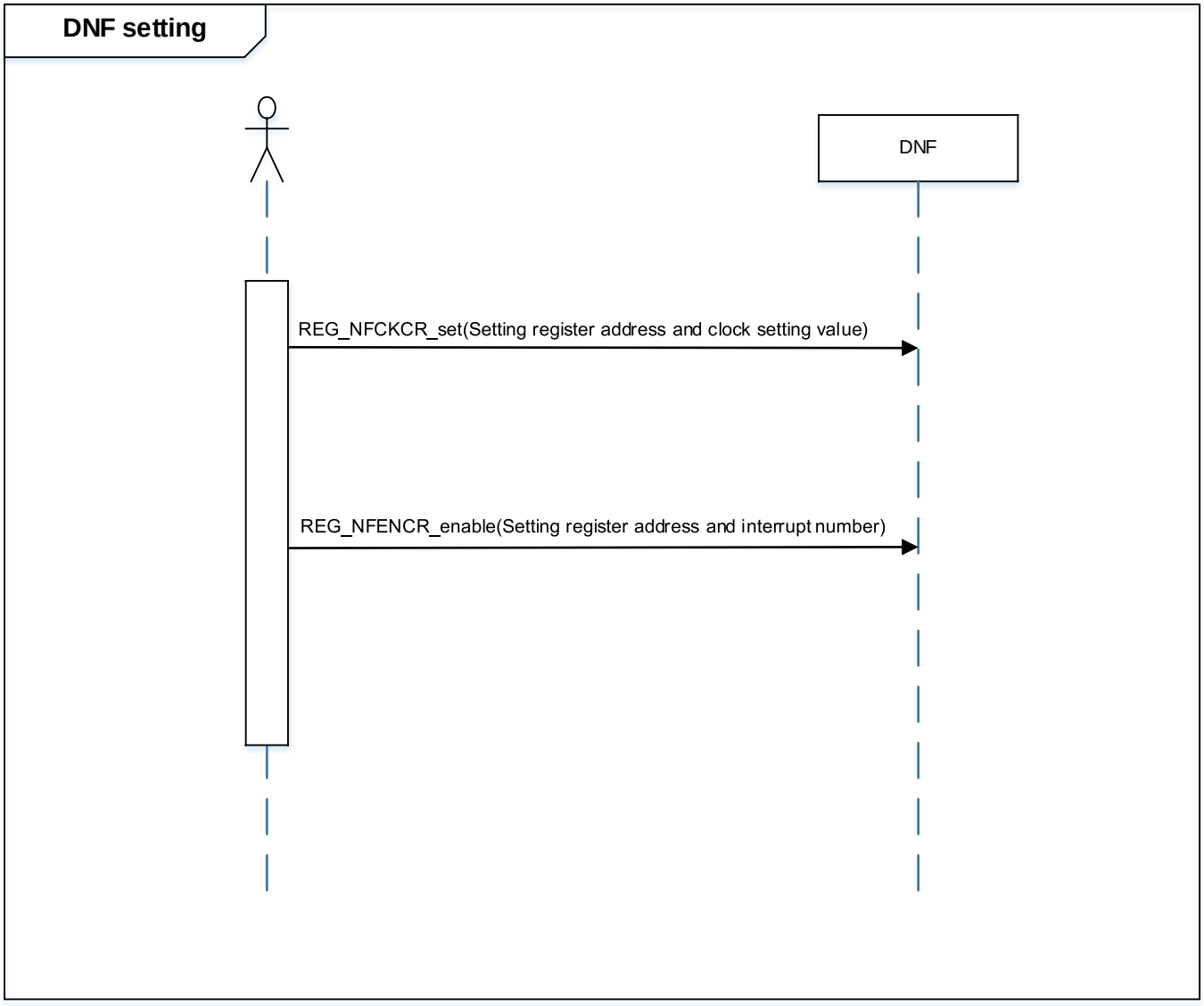

Application Initialization
ref
Timer Application initialization
loop
[1,Number of LEDs to be used]
ref
LED Application initialization
loop
[1,Number of SWs to be used]
ref
SW Application initialization


LED Application initialization
GPIO
(Application)
LED
Initial setting creation
led_initialize(LED instance address)
LED
(Application)
gpio_write_bit(GPIO instance address,
Group, number, DATA, and
LED initial setting value)
led_initialize(-)


SW ApplicationIn itialization
SW
Initial setting creation
sw_initialize(SW instance address)
SW
(Application)


LED control
led
(Application)
gpio
(Driver)
INTxx_IRQHandler
BSP
(Application)
irq_exint(status value)
opt
LED ON / OFF
by status value
bsp_irq_exint_enable(-)
opt
External interrupt permission
bsp_irq_exint_enable(-)
irq_exint(-)
Main process
led_task(LED instance address)
gpio_read_bit(Port instance address,
group, num, DATA)
opt
[Port state!=LED status]
gpio_write_bit(Port instance address,
group, num, DATA, and LED status)
led_task(-)


External interrupt detection
Interrupt factor(Rising edge detection)
BSP
(Application)
INT01_IRQHandler(-)
opt
Interrupt factor flag clear
Status value inversion
irq_exint(status value)


DNF setting
DNF
REG_NFCKCR_set(Setting register address and clock setting value)
REG_NFENCR_enable(Setting register address and interrupt number)

10. Precaution

When using the sample program with CPU other than TMPM4G9F15, please check operation sufficiently.

11. Revision History

Rev	Date	Description
1.0	2018-11-27	First release

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