M4G Group (1)
Application Note
Clock Control and Operation Mode
(CG-M4G(1)-C)

Outlines

This application note is a reference material for developing products using clock control and operation mode (CG) function of M4G group (1).

The release of low power mode is performed by external interrupt.
This document helps the user check operation of the product and develop its program.

Target sample program: CGRST_EXINT

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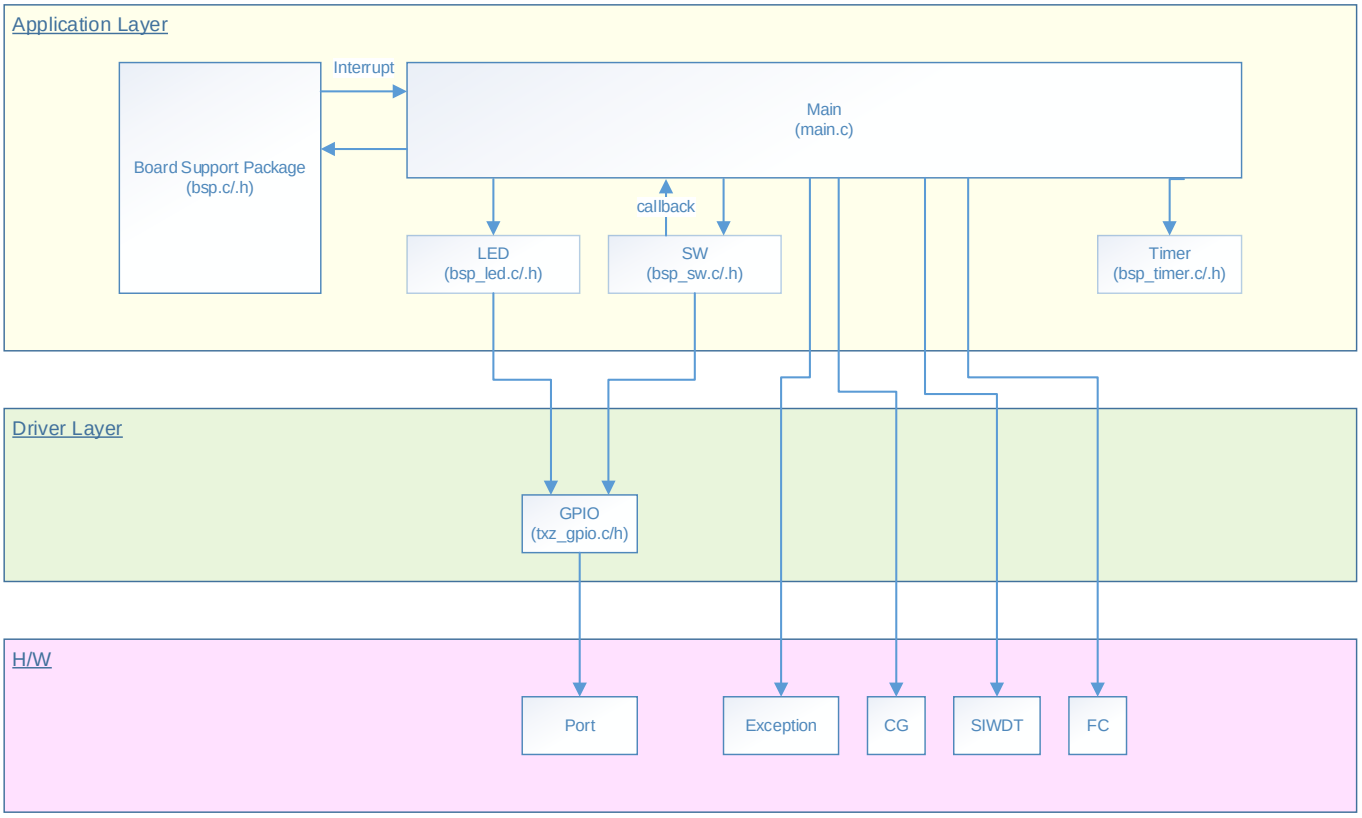
1. Preface

The operation mode of this sample program can be changed from NORMAL mode to low power mode by using the evaluation board and operating the push switch on the evaluation board. Then the operation state can be checked by LED. In low power mode, the mode is returned to NORMAL mode by an external interrupt.

Structure diagram of Sample program



2. Reference Document

- Datasheet
  TMPM4G group (1) datasheet Rev1.0 (Japanese edition)
- Reference manual
  Clock Control and Operation Mode (CG-M4G(1)-D) Rev1.0 (Japanese edition)
  Input/Output Port (PORT-M4G(1)) Rev1.0 (Japanese edition)
  Exception (EXCEPT-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. Referred function

IP	Channel	Port	Function / Operation mode
Clock control	-	-	System clock control / mode change
Input/Output Port	-	PV0 (Input Port) PL4 (Input Port) PL5 (Input Port)	Input
		PL0 (INT01a)	External interrupt
	-	PE4 (Output Port) PE5 (Output Port) PE6 (Output Port) PE7 (Output Port)	Output

4. Target Device

The target devices of this application note are as follows;

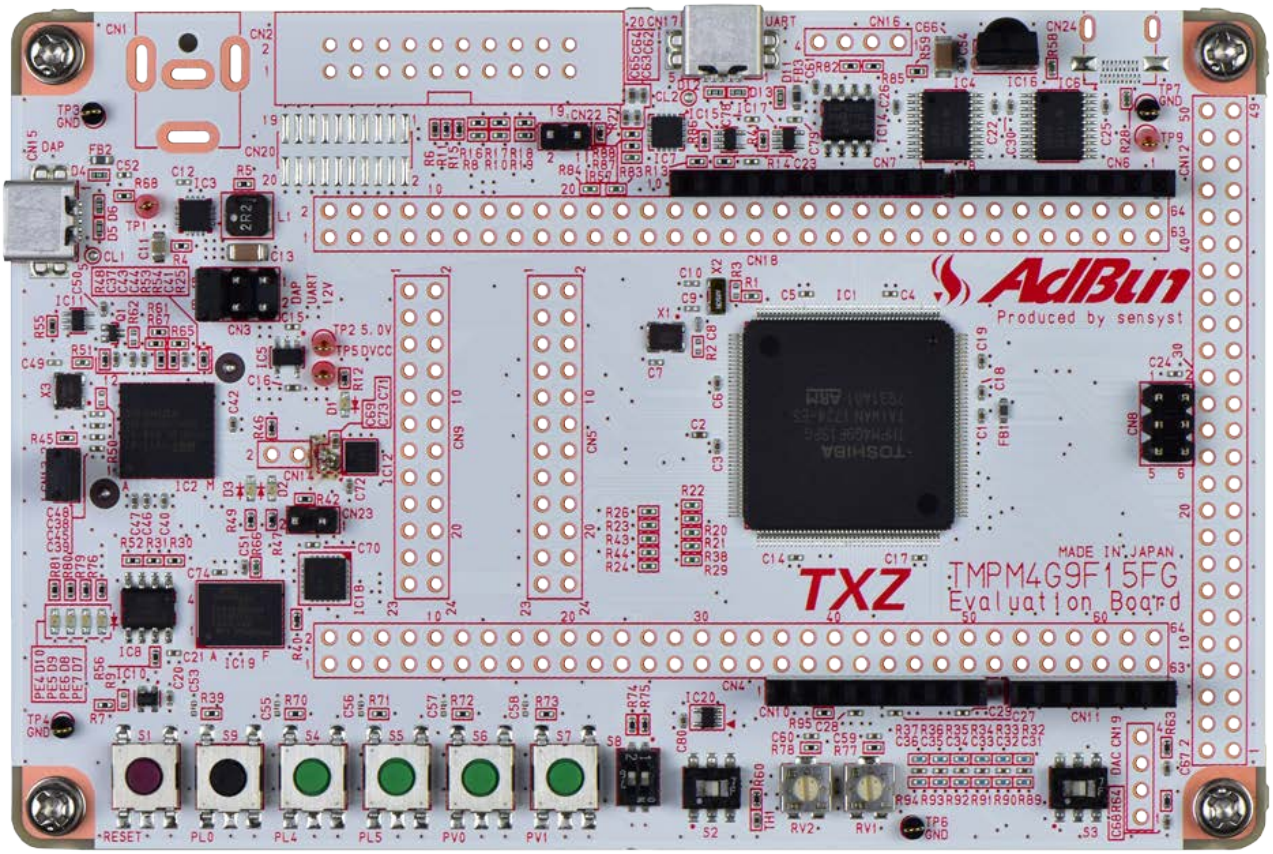
TMPM4G9F15FG	TMPM4G9F10FG	TMPM4G9FEFG	TMPM4G9FDFG
TMPM4G9F15XBG	TMPM4G9F10XBG	TMPM4G9FEXBG	TMPM4G9FDXBG
TMPM4G8F15FG	TMPM4G8F10FG	TMPM4G8FEFG	TMPM4G8FDFG
TMPM4G8F15XBG	TMPM4G8F10XBG	TMPM4G8FEXBG	TMPM4G8FDXBG
	TMPM4G7F10FG	TMPM4G7FEFG	TMPM4G7FDFG
	TMPM4G6F10FG	TMPM4G6FEFG	TMPM4G6FDFG

*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. Conditions for Correct Operation

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

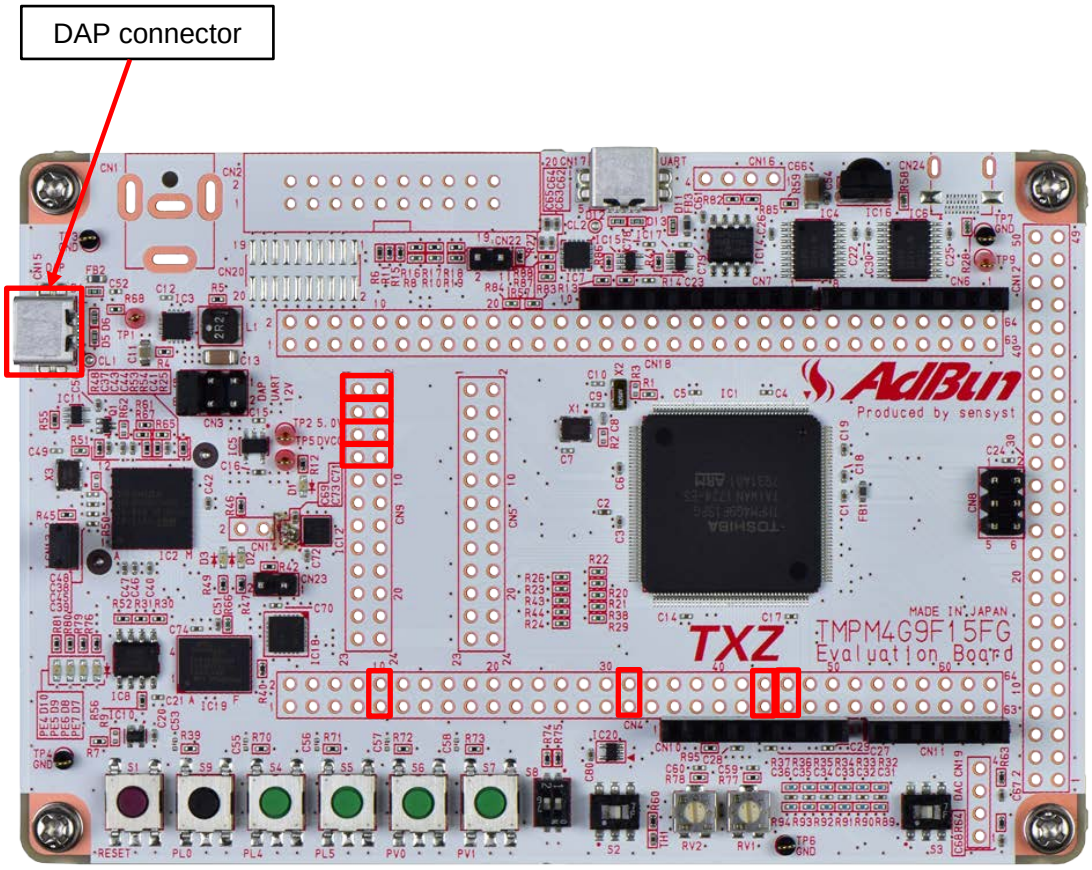


6. Evaluation Board Setting

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

CN4		
Board function	Through-hole No.	Through-hole No.
Push SW (S9)	9: StopSW_INT	10: PL0
Push SW (S6)	31: ISD_SW0	32: PV0
Push SW (S5)	43: SW_INT1	44: PL5
Push SW (S4)	45: SW_INT0	46: PL4

CN9		
Board function	Through-hole No.	Through-hole No.
LED (D10)	1: LED0	2: PE4
LED (D9)	3: LED1	4: PE5
LED (D8)	5: LED2	6: PE6
LED (D7)	7: LED3	9: PE7



7. Operation of Evaluation Board

After reset, the sample program operates in NORMAL mode, and LED10 of PE4 is blinking.
The push switch is used for changing to low power mode.

IDLE S4: PL4
STOP1 S5: PL5
STOP2 S6: PV0

The operation mode is checked by LED.
The operation mode of LED lighting is as follows.

NORMAL mode D10: PE4 (Blinking)
Low power consumption mode IDLE D9: PE5 (Lighting)
STOP1 D8: PE6 (Lighting)
STOP2 D7: PE7 (Lighting)

LED blinking cycle

NORMAL mode: Repeating ON and OFF every one second
Low power consumption mode IDLE: Lighting
STOP1: Lighting
STOP2: Lighting

Returning to NORMAL mode by interrupt control

The operation mode returns from low power mode to NORMAL mode by pushing down the push switch, S9: PL0.
The transition between low power modes is not supported.
Only pushing down the S9 switch is valid.

8. Outline of clock control Function

The clock/mode control block can select a clock gear or prescaler clock and set the warm-up of oscillator. Furthermore, it has Normal mode and a low power consumption mode in order to reduce power consumption using mode transition.

There is the following as a function relevant to a clock.
- System clock control
- Prescaler clock control

9. Sample Program

The mode is switched to low power mode (IDLE / STOP1 / STOP2) as a trigger by the port input by the push switch.
When the mode is entered to the low power mode, the LED lights and the operation mode change can be checked.
After changing to the low power mode, the mode is returned to the NORMAL mode by a detection of an external interrupt.

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 STOP2 reset flag should be checked.
The initialization of BSP (Board Support Package) is executed.
External interrupt should be enabled.
The initialization of variables is executed.

After each initialization is completed, the operation should enter to the main operation.

In the sample program, the timer is set as the initialization of the driver.
1-ms timer, LED, and the push switch are set as the initialization of the application.

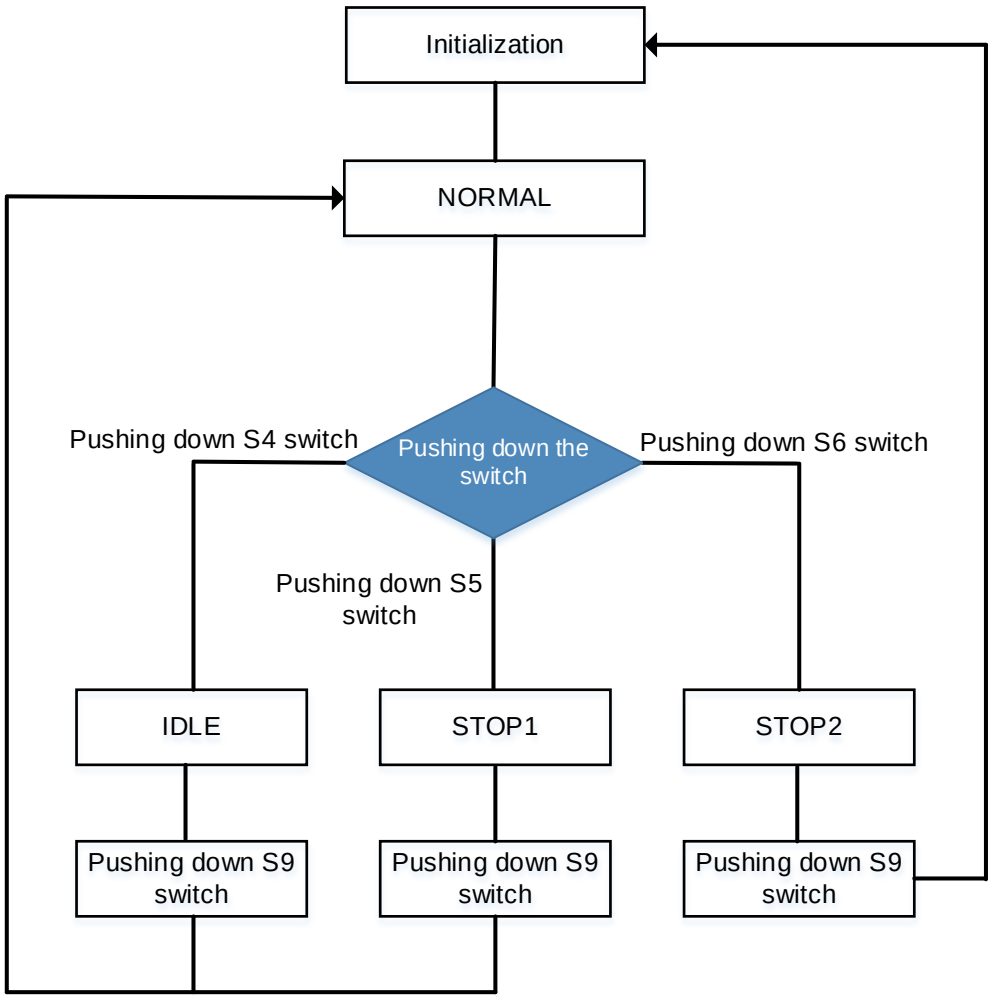
The mode transition is executed by the push switch.
S4 switch pushing down: From NORMAL to IDLE mode
S5 switch pushing down: From NORMAL to STOP1 mode
S6 switch pushing down: From NORMAL to STOP2 mode

Using LEDs, the operation mode of the sample program can be checked.
In the NORMAL mode operation, LED D10 blinks.
The LEDs repeat to turn ON and OFF every one second.
In the IDLE mode, LED D9 lights.
In the STOP1 mode, LED D8 lights.
In the STOP2 mode, LED D7 lights.

When the mode is entered to the low power mode by the push switch, the operation is as follows.
When the INT01a interrupt is detected, the mode returns to NORMAL mode.
For a return from STOP2 mode, port keeping is released after the reset flag register is checked.
The operation after that is same as other mode return.
In this sample program, the transition between low power modes is invalid. Therefore, the operation mode should be entered to NORMAL mode once and entered to other low power mode.

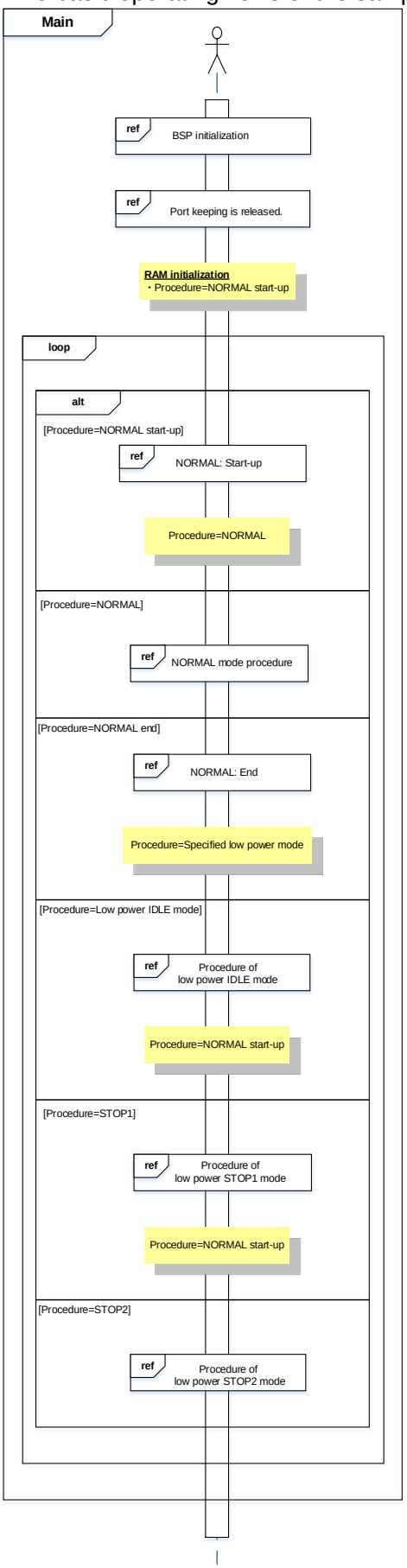
9.3. Operation Mode Transition

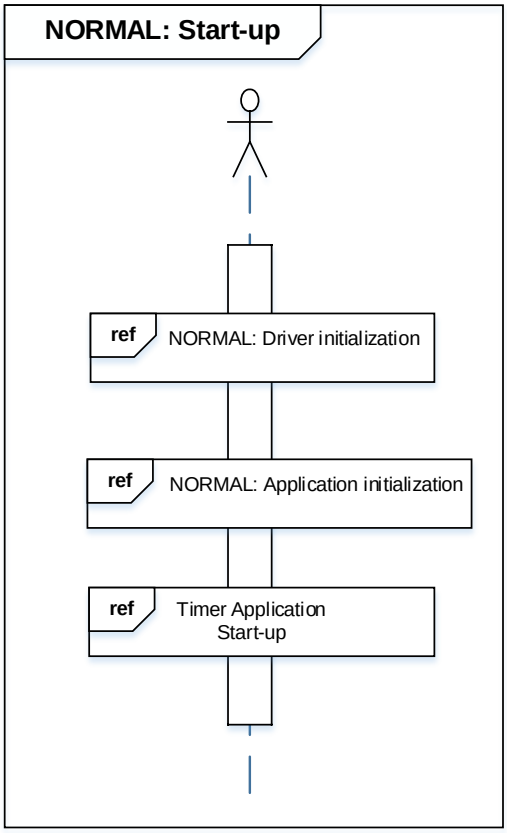
In this sample program, the operation mode is changed to low power mode by setting PORT pin (push switch S4, S5, S6) to GND.
After the power supply is turned on and reset, the state enters to NORMAL mode.
The mode is returned to NORMAL mode by interrupt of the push switch S9 (INT01a).

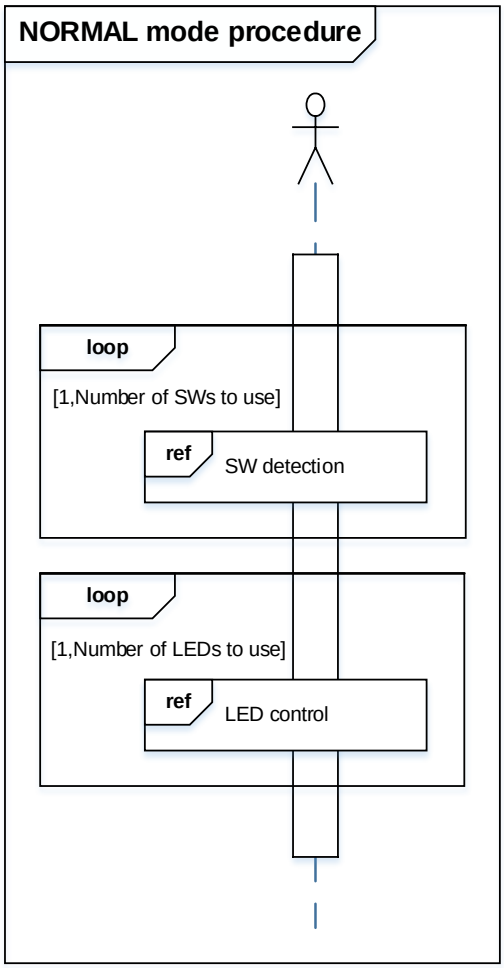


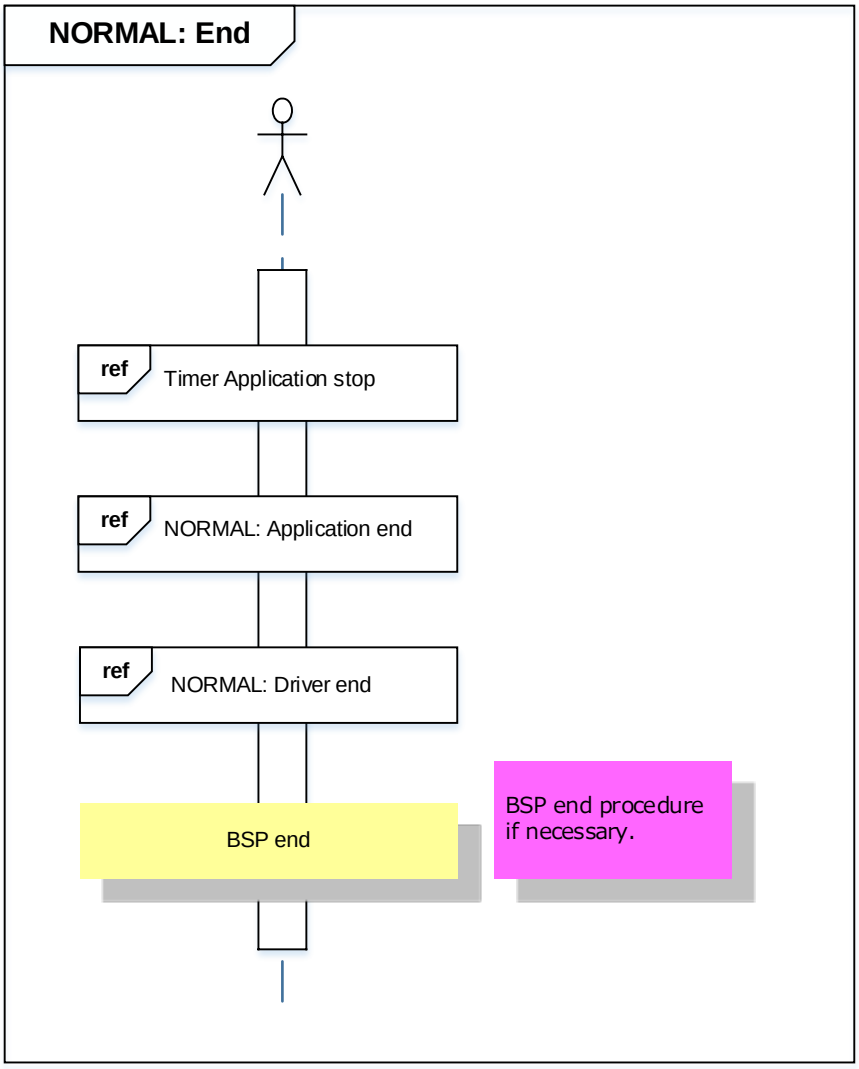
9.4. Operating Flow of Sample Program

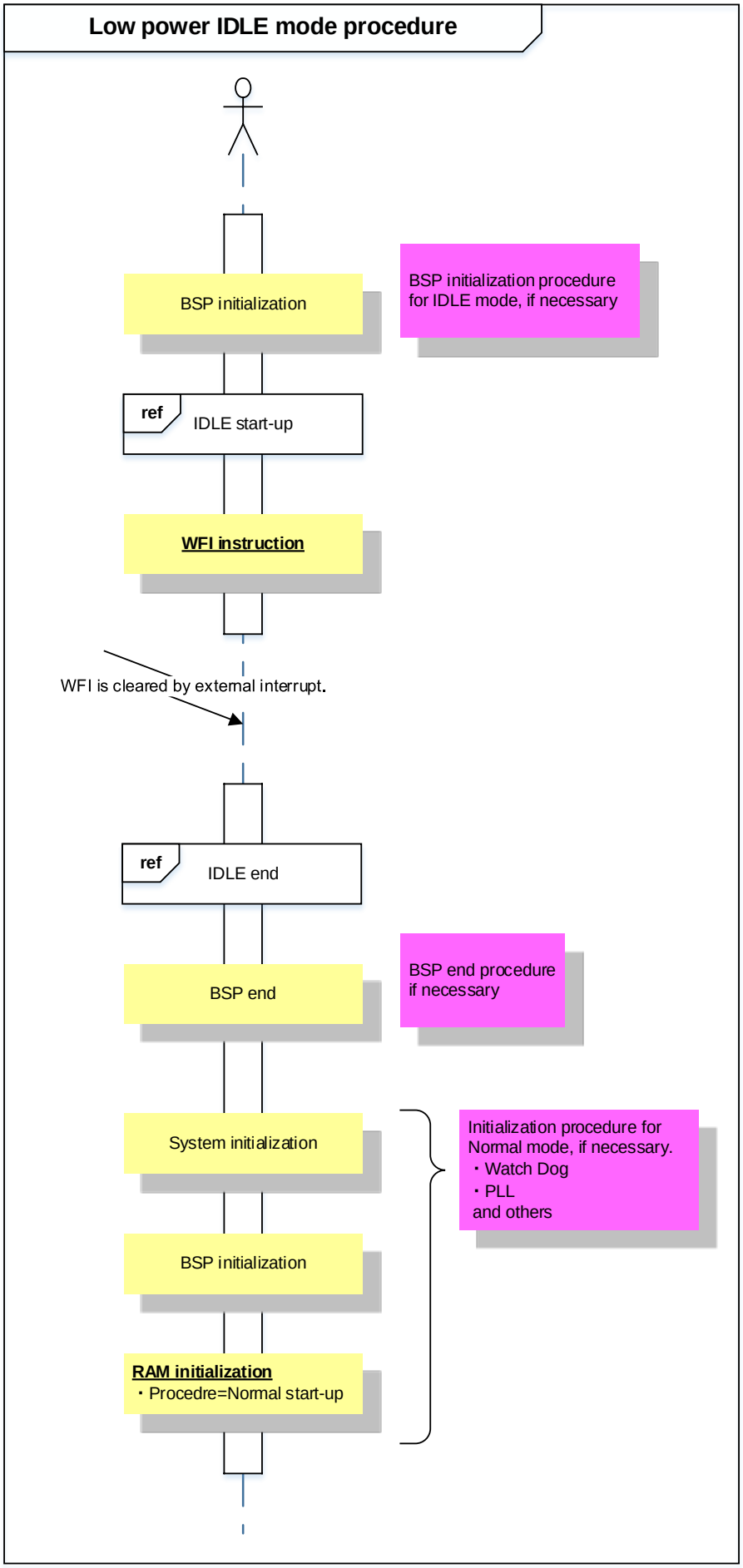
The basic operating flows of the sample program are shown in the following;

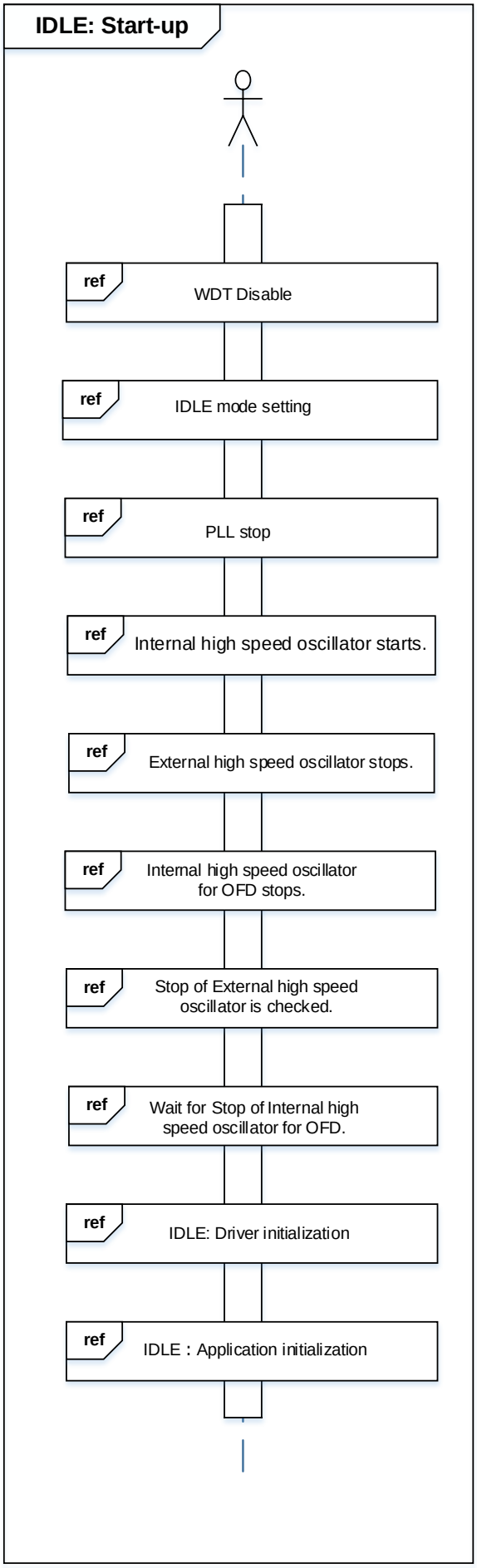


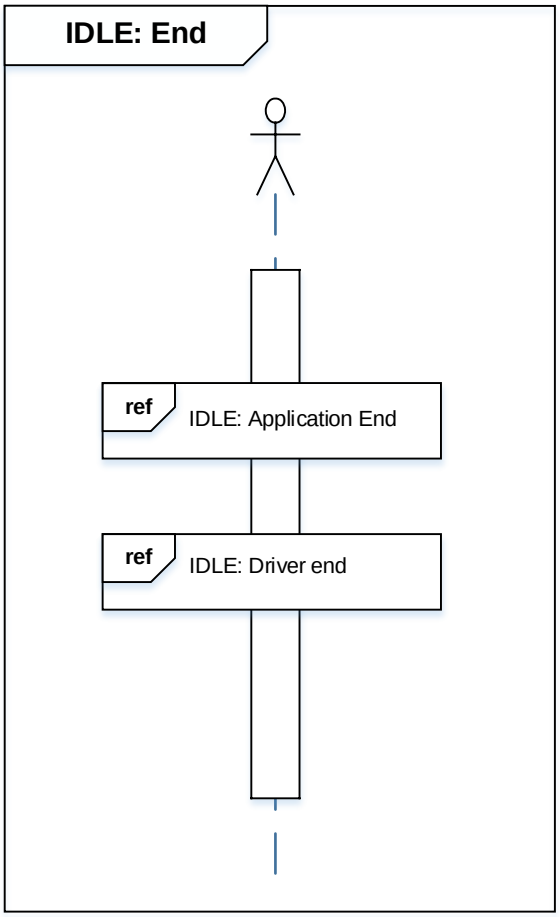

NORMAL: Start-up
ref
NORMAL: Driver initialization
ref
NORMAL: Application initialization
ref
Timer Application
Start-up

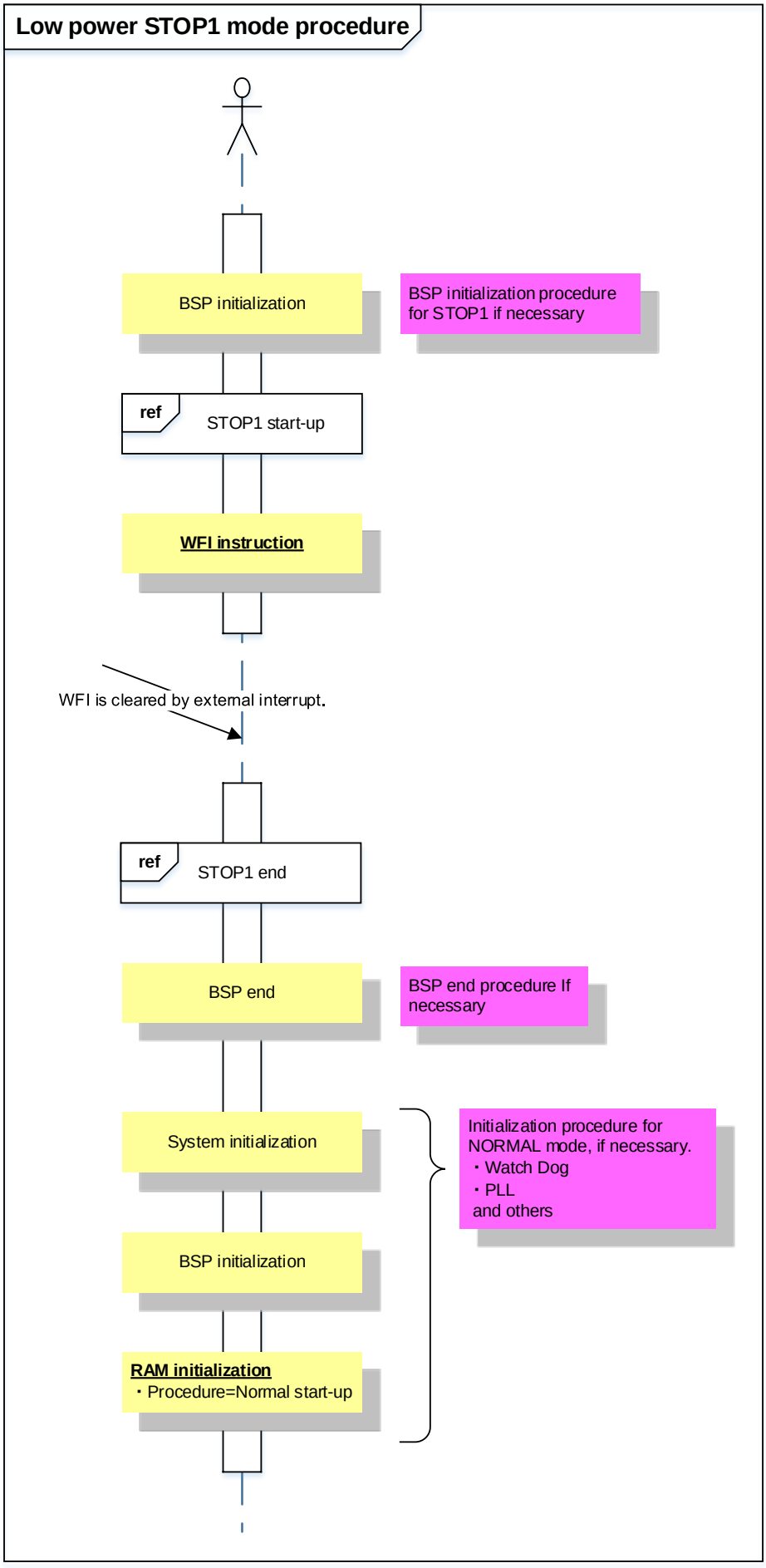

NORMAL mode procedure
loop
[1,Number of SWs to use]
ref
SW detection
loop
[1,Number of LEDs to use]
ref
LED control

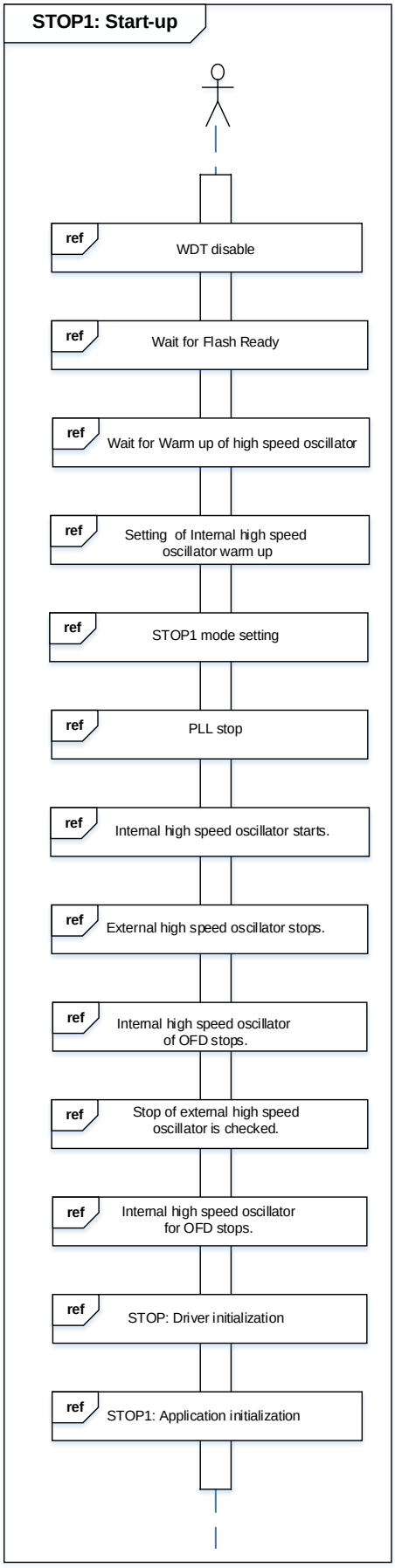

NORMAL: End
ref
Timer Application stop
ref
NORMAL: Application end
ref
NORMAL: Driver end
BSP end
BSP end procedure
if necessary.

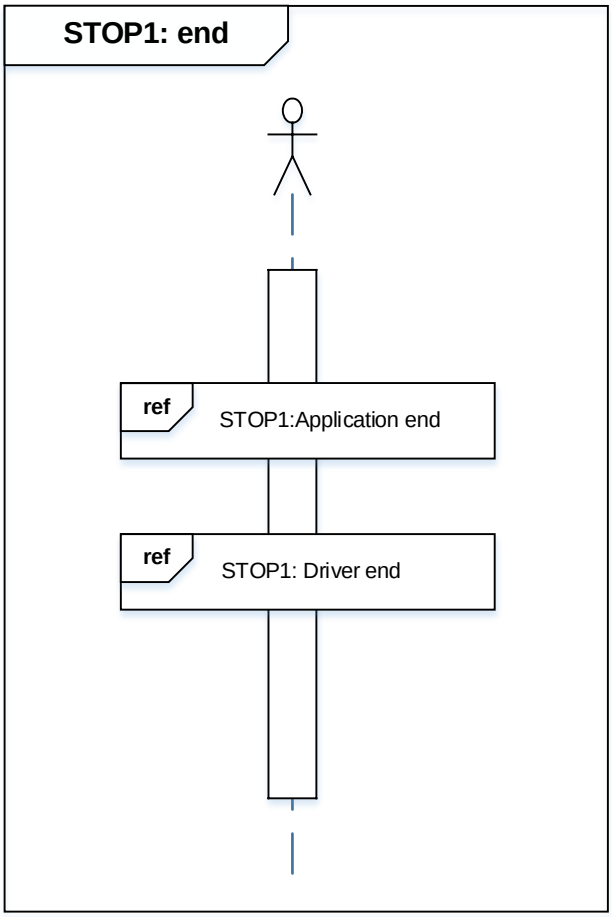

Low power IDLE mode procedure
BSP initialization
BSP initialization procedure for IDLE mode, if necessary
ref
IDLE start-up
WFI instruction
WFI is cleared by external interrupt.
ref
IDLE end
BSP end
BSP end procedure if necessary
System initialization
Initialization procedure for Normal mode, if necessary.
・Watch Dog
・PLL
and others
BSP initialization
RAM initialization
・Procedre=Normal start-up

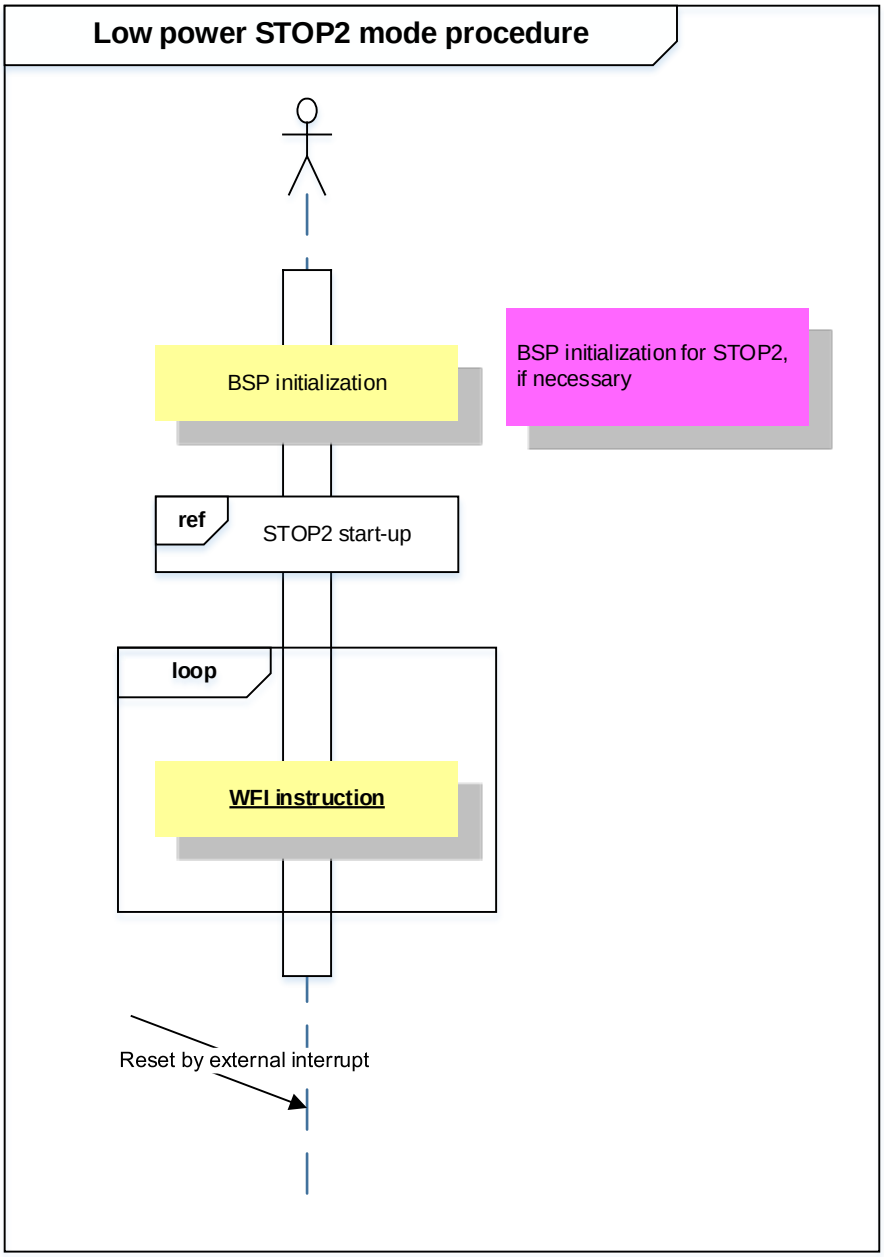

IDLE: Start-up
ref
WDT Disable
ref
IDLE mode setting
ref
PLL stop
ref
Internal high speed oscillator starts.
ref
External high speed oscillator stops.
ref
Internal high speed oscillator for OFD stops.
ref
Stop of External high speed oscillator is checked.
ref
Wait for Stop of Internal high speed oscillator for OFD.
ref
IDLE: Driver initialization
ref
IDLE：Application initialization

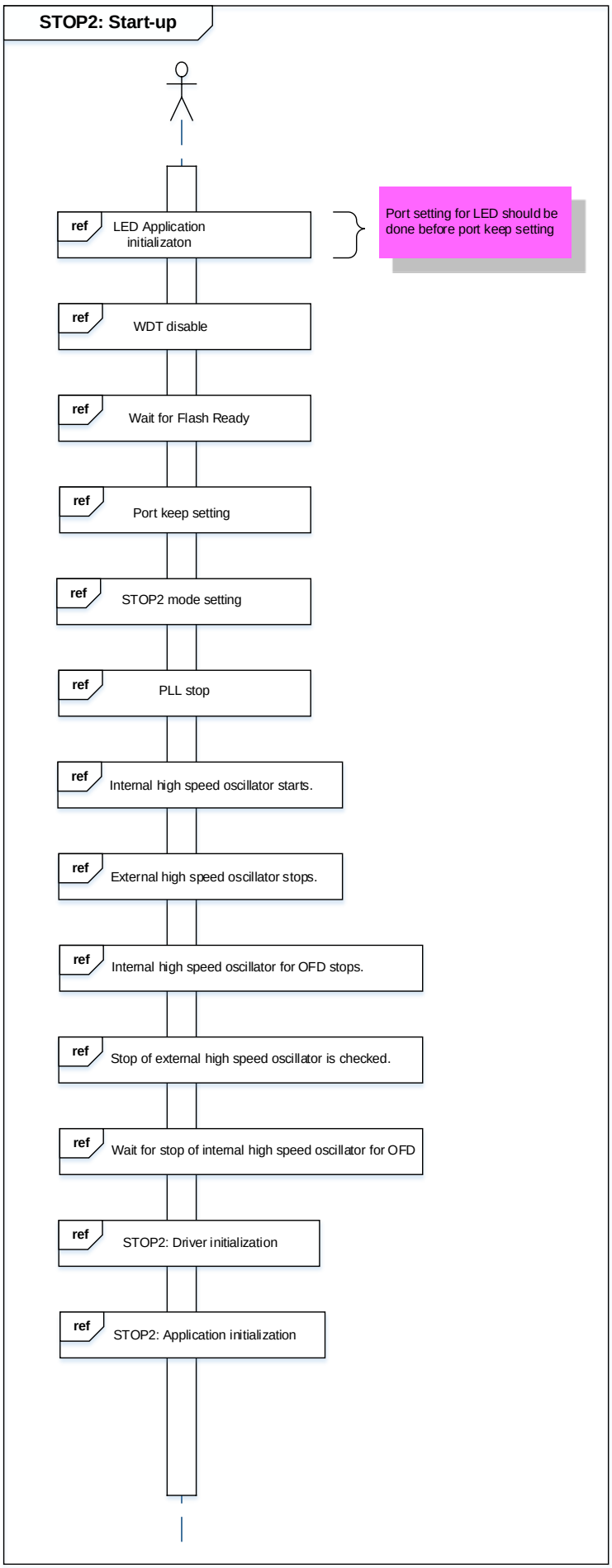

IDLE: End
ref
IDLE: Application End
ref
IDLE: Driver end

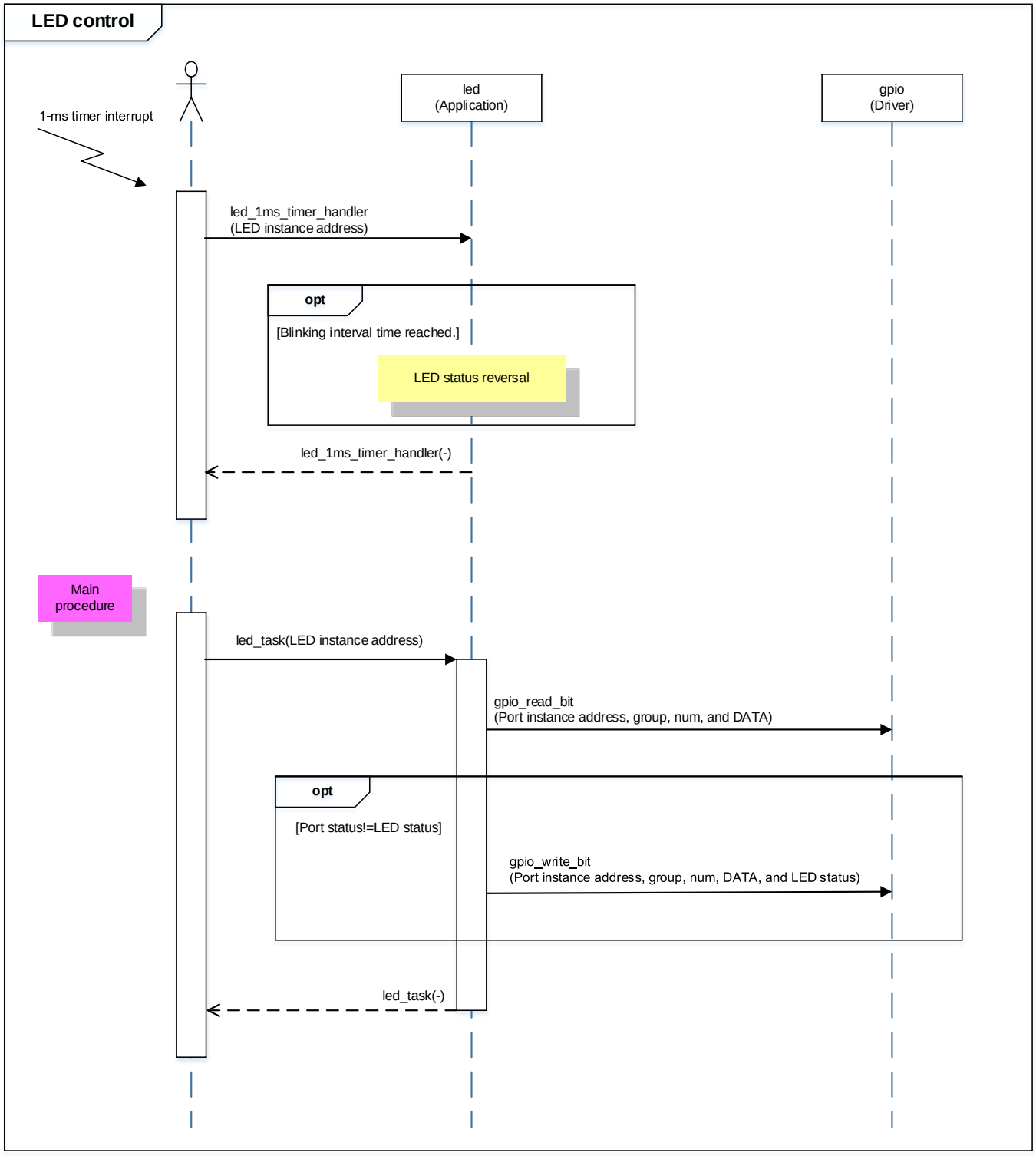

Low power STOP1 mode procedure
BSP initialization
BSP initialization procedure for STOP1 if necessary
ref
STOP1 start-up
WFI instruction
WFI is cleared by external interrupt.
ref
STOP1 end
BSP end
BSP end procedure If necessary
System initialization
Initialization procedure for NORMAL mode, if necessary.
・Watch Dog
・PLL
and others
BSP initialization
RAM initialization
・Procedure=Normal start-up

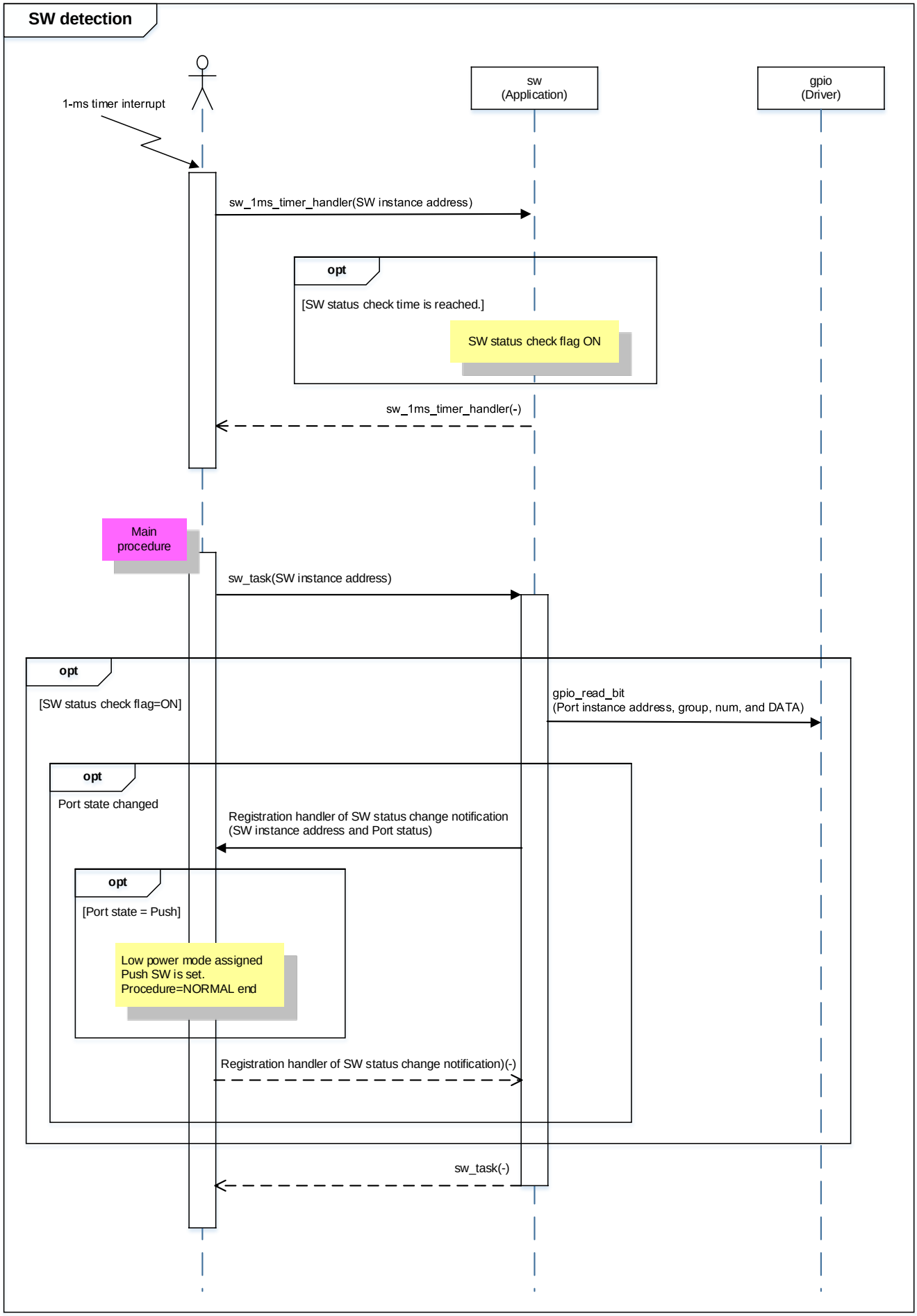

STOP1: Start-up
ref
WDT disable
ref
Wait for Flash Ready
ref
Wait for Warm up of high speed oscillator
ref
Setting of Internal high speed oscillator warm up
ref
STOP1 mode setting
ref
PLL stop
ref
Internal high speed oscillator starts.
ref
External high speed oscillator stops.
ref
Internal high speed oscillator of OFD stops.
ref
Stop of external high speed oscillator is checked.
ref
Internal high speed oscillator for OFD stops.
ref
STOP: Driver initialization
ref
STOP1: Application initialization

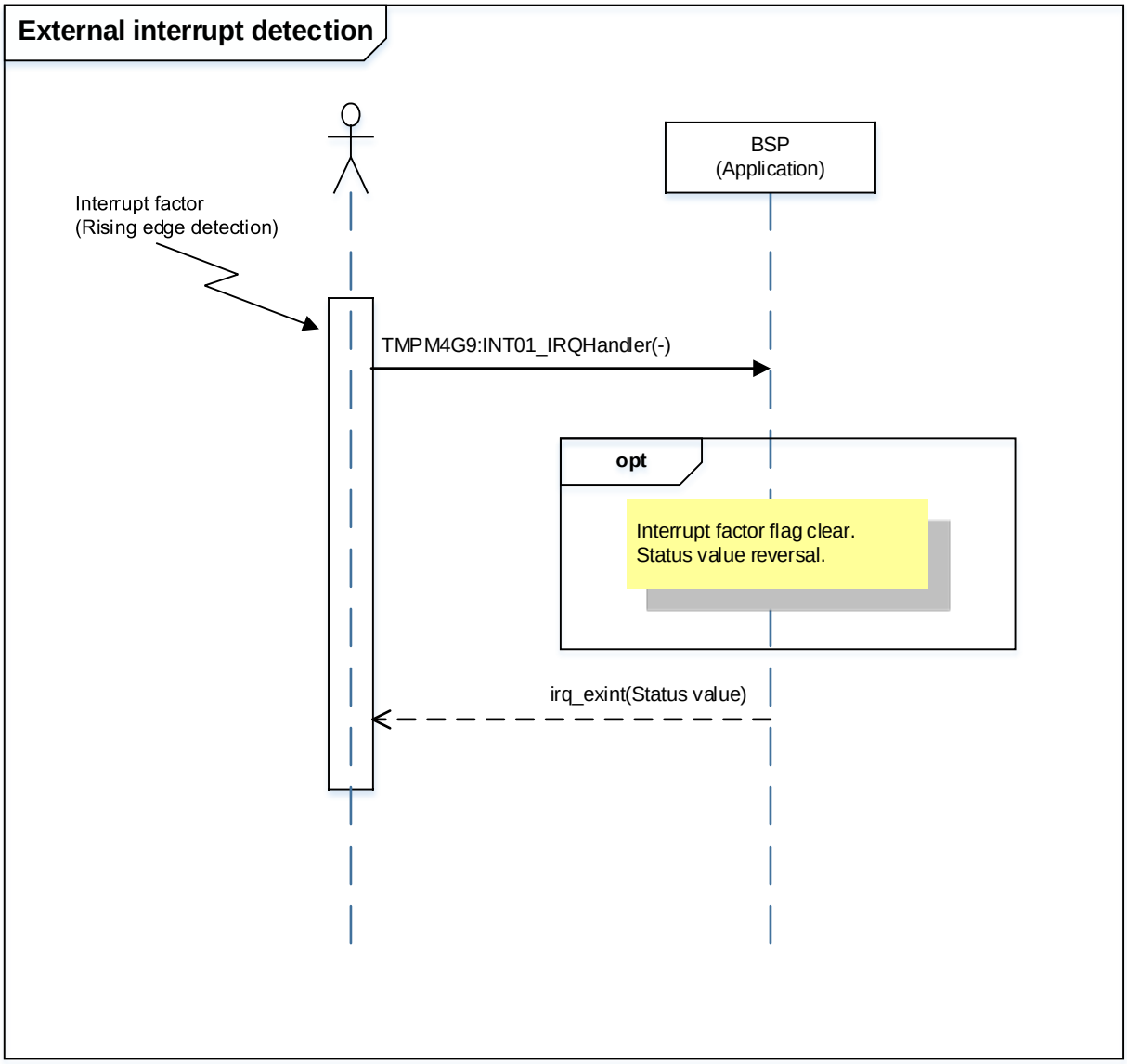

STOP1: end
ref
STOP1:Application end
ref
STOP1: Driver end

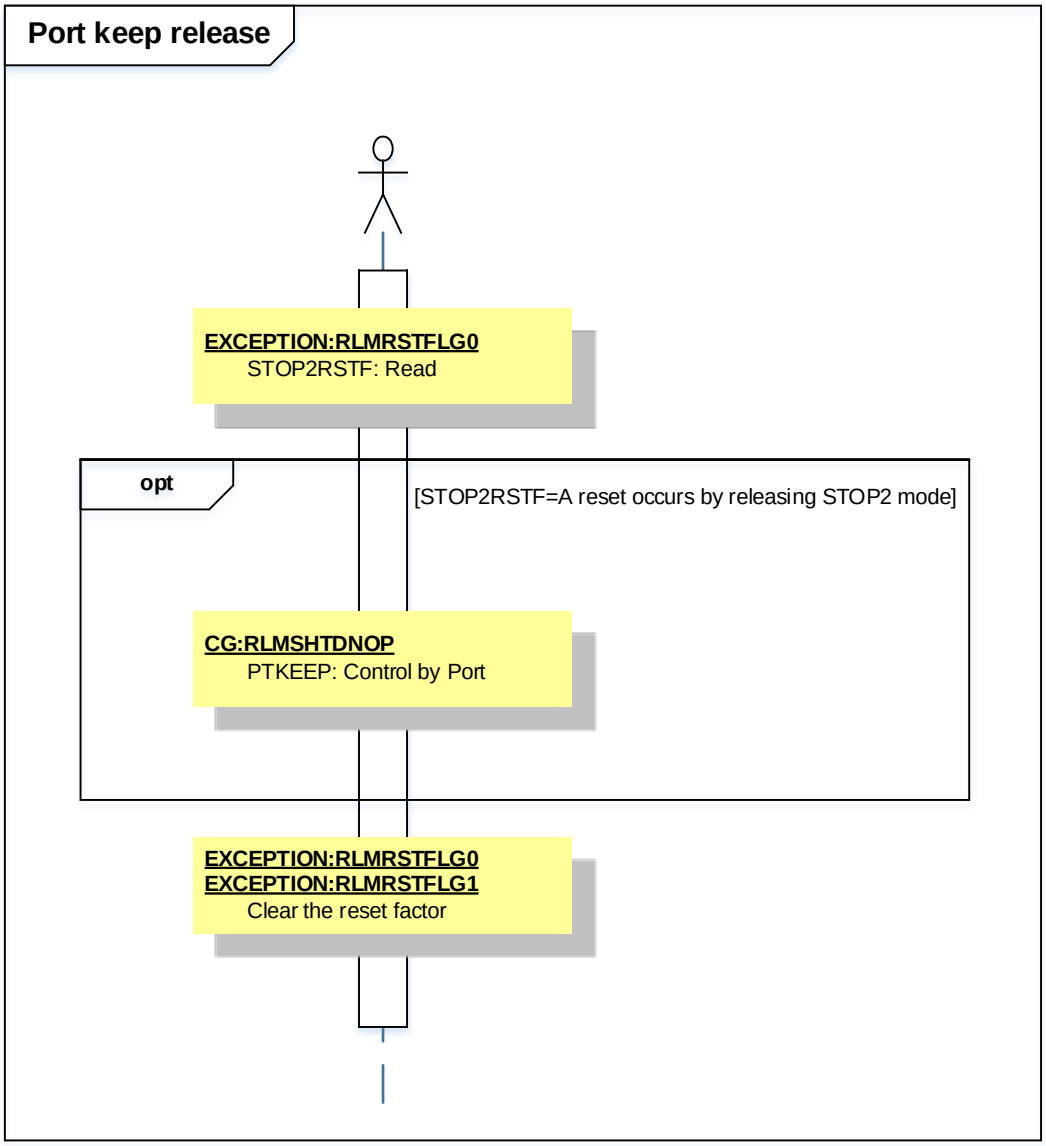

Low power STOP2 mode procedure
BSP initialization
BSP initialization for STOP2, if necessary
ref
STOP2 start-up
loop
WFI instruction
Reset by external interrupt


STOP2: Start-up
ref LED Application initializaton
Port setting for LED should be done before port keep setting
ref WDT disable
ref Wait for Flash Ready
ref Port keep setting
ref STOP2 mode setting
ref PLL stop
ref Internal high speed oscillator starts.
ref External high speed oscillator stops.
ref Internal high speed oscillator for OFD stops.
ref Stop of external high speed oscillator is checked.
ref Wait for stop of internal high speed oscillator for OFD
ref STOP2: Driver initialization
ref STOP2: Application initialization


LED control
1-ms timer interrupt
led
(Application)
gpio
(Driver)
led_1ms_timer_handler
(LED instance address)
opt
[Blinking interval time reached.]
LED status reversal
led_1ms_timer_handler(-)
Main
procedure
led_task(LED instance address)
gpio_read_bit
(Port instance address, group, num, and DATA)
opt
[Port status!=LED status]
gpio_write_bit
(Port instance address, group, num, DATA, and LED status)
led_task(-)


SW detection
1-ms timer interrupt
sw
(Application)
gpio
(Driver)
sw_1ms_timer_handler(SW instance address)
opt
[SW status check time is reached.]
SW status check flag ON
sw_1ms_timer_handler(-)
Main
procedure
sw_task(SW instance address)
opt
[SW status check flag=ON]
gpio_read_bit
(Port instance address, group, num, and DATA)
opt
Port state changed
Registration handler of SW status change notification
(SW instance address and Port status)
opt
[Port state = Push]
Low power mode assigned
Push SW is set.
Procedure=NORMAL end
Registration handler of SW status change notification)(-)
sw_task(-)


External interrupt detection
BSP
(Application)
Interrupt factor
(Rising edge detection)
TMPM4G9:INT01_IRQHandler(-)
opt
Interrupt factor flag clear.
Status value reversal.
irq_exint(Status value)


Port keep release
EXCEPTION:RLMRSTFLG0
STOP2RSTF: Read
opt
[STOP2RSTF=A reset occurs by releasing STOP2 mode]
CG:RLMSHTDNOP
PTKEEP: Control by Port
EXCEPTION:RLMRSTFLG0
EXCEPTION:RLMRSTFLG1
Clear the reset factor

10. Precaution

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

11. Revision History

Rev	Date	Description
1.0	2018-11-26	First release

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