M4K Group (1)
Application Note
Oscillation Frequency Detector
(OFD-A)

Outlines

This application note is a reference material for developing products using the Oscillation Frequency Detector (OFD) of M4K Group (1).
This document helps the user check operation of the product and develop its program.

Target sample program: OFD_LED

Table of Contents

1. Preface

This sample program is used to check the operation of the OFD function.
The frequency of a selected clock signal is monitored and checked if it is in the specified range or not, by the oscillation frequency detector. The result is shown on the LED's.
When the frequency is in the specified range, the LED1 blinks.
When the frequency is an abnormal value, the LED2 lights.

2. Reference Document

1. Datasheet
   TMPM4K Group (1) datasheet Rev2.0 (Japanese edition)
2. Reference manual
   Oscillation Frequency Detector (OFD-A) Rev2.1 (Japanese edition)
   32-bit Timer Event Counter (T32A-B) 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
Oscillation Frequency Detector	—	—	Abnormality detection of Clock frequency
32-bit Timer Event Counter	Timer A ch0	—	Interval timer
Input/Output Ports	—	PJ0 (Output Port) PJ2 (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

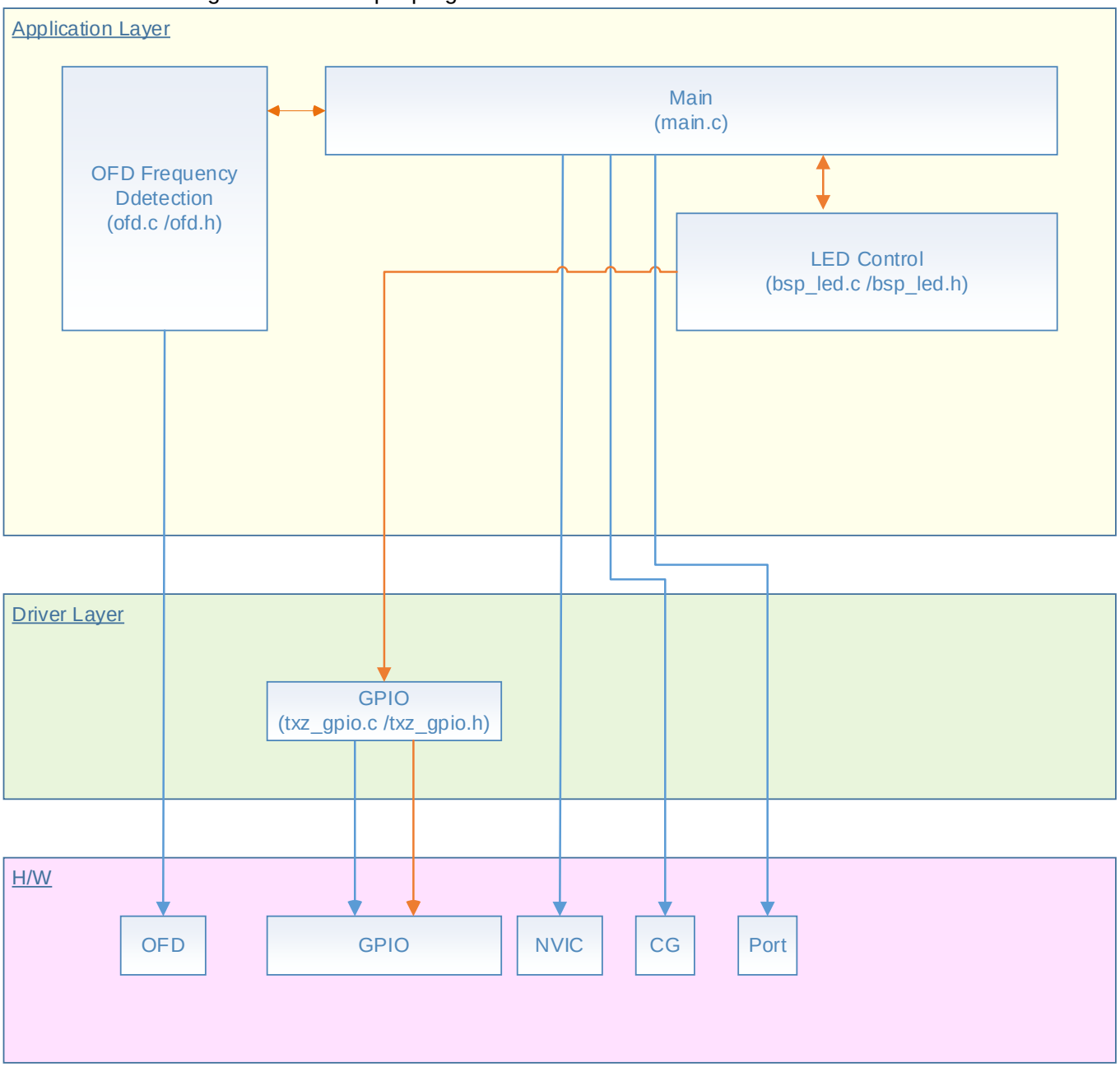
The check result of the frequency is shown on the LED's on the evaluation board.
When the frequency is in the detection region, the LED1 blinks.
When the frequency is not in the detection region, the LED2 lights.

The region of the initial value of the external oscillation is from 9.9 MHz to 10.1 MHz.

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 reset flag is checked.
The timer interval is set to 1 second as the initialization of the Timer driver.
The initialization of the LED's is done as the initialization of the application software.

The detection range of the OFD should be set. An abnormal frequency is detected.

The timer for the LED's starts after the detection of the frequency completes.
When the frequency is in the detection region, the LED1 blinks.
When the frequency is not in the detection region, LED2 lights.

7.4. Setting of OFD

The followings should be modified when the range of the frequency of OFD is changed in the sample program.

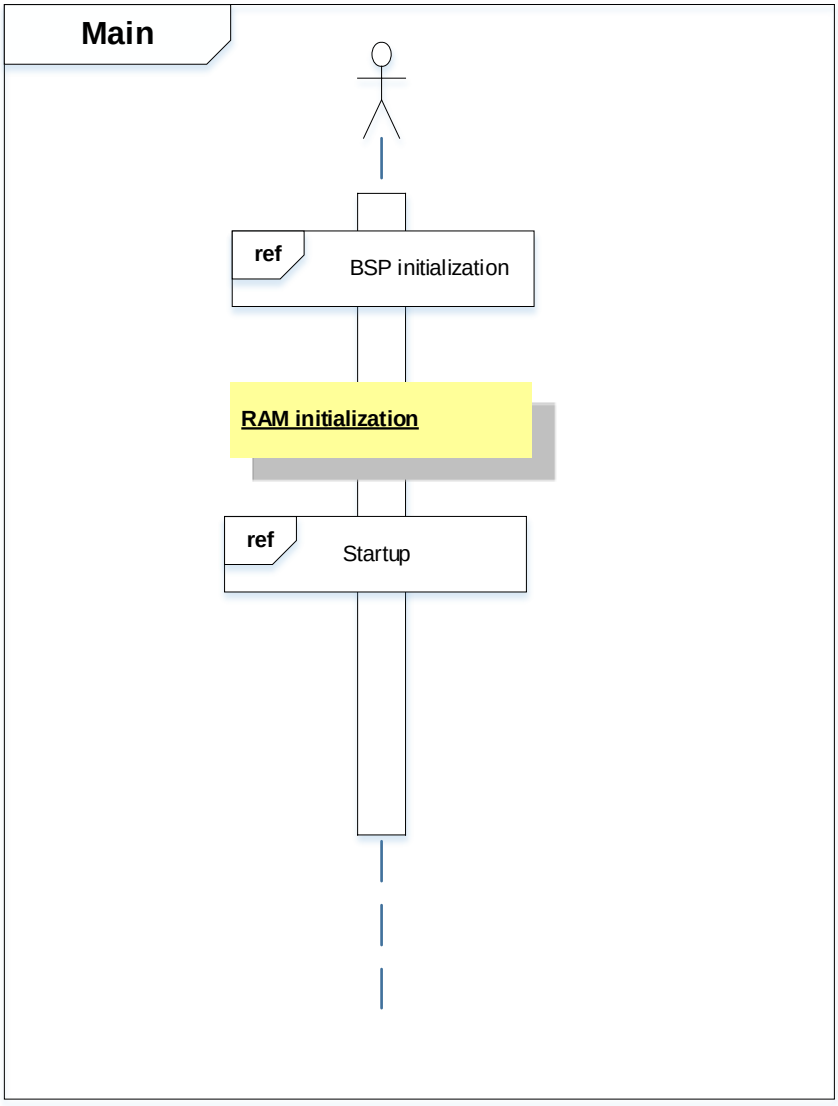
○ TMPM4K4 (the 86th to 90th lines in "main.c")

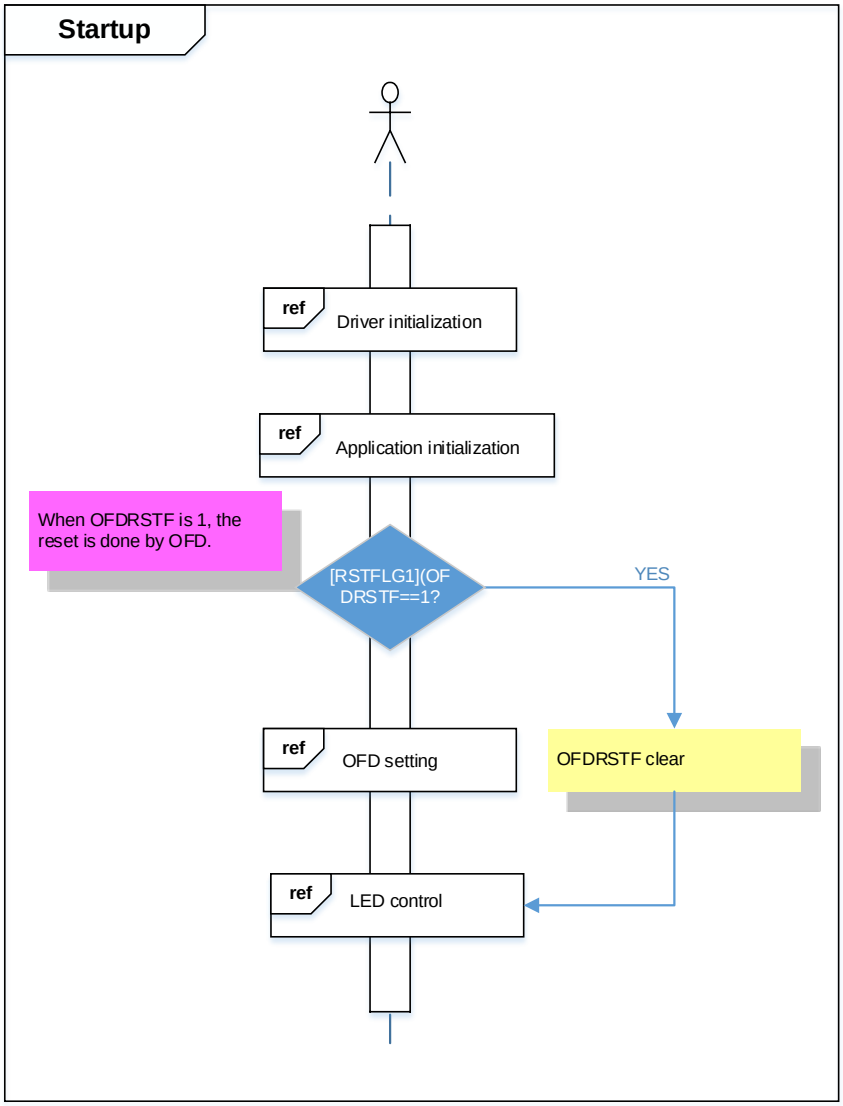
```
#define OFD_LOWER_COUNT ((uint32_t) 0x1CDU)
#define OFD_HIGHER_COUNT ((uint32_t) 0x23EU)
#define OFD_LOWER_COUNT_EXTERNAL ((uint32_t) 0x39U)
#define OFD_HIGHER_COUNT_EXTERNAL ((uint32_t) 0x48U)
```

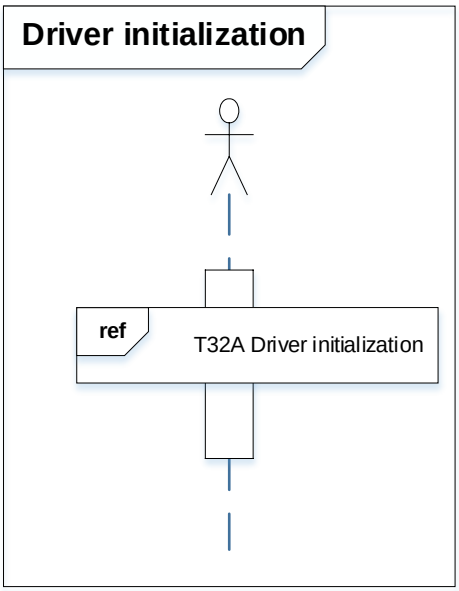
The range of the detection frequency can be changed by modifying the setting values above.
For the details of the calculation of the setting values, refer to the Reference manual.

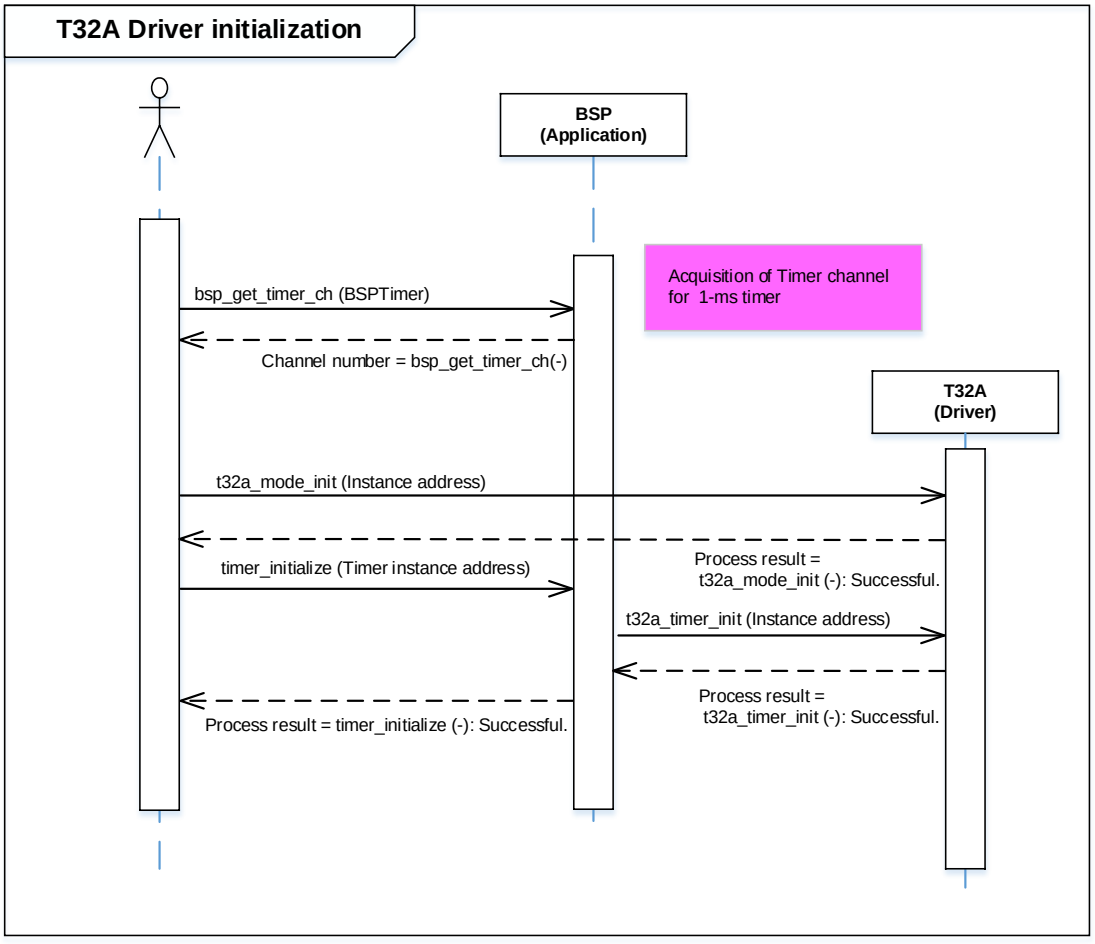
7.5. Operating Flow of Sample Program

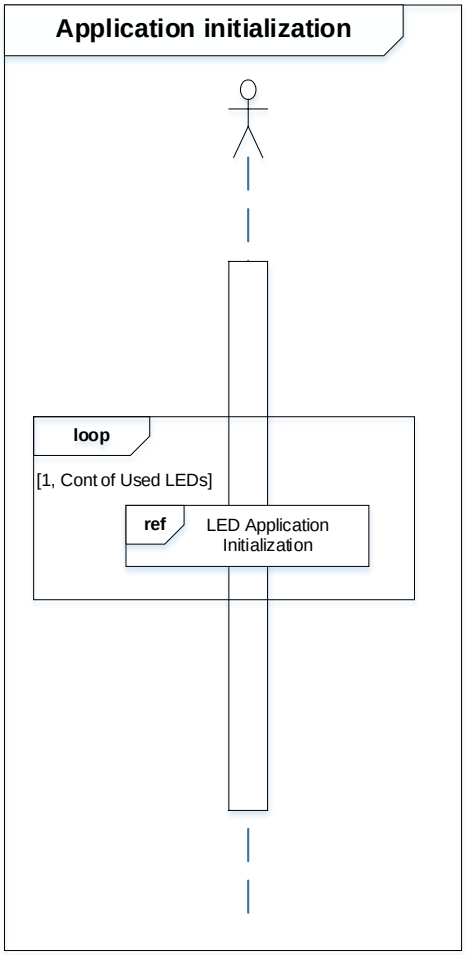
The basic operating flows of the sample program are shown in the following;

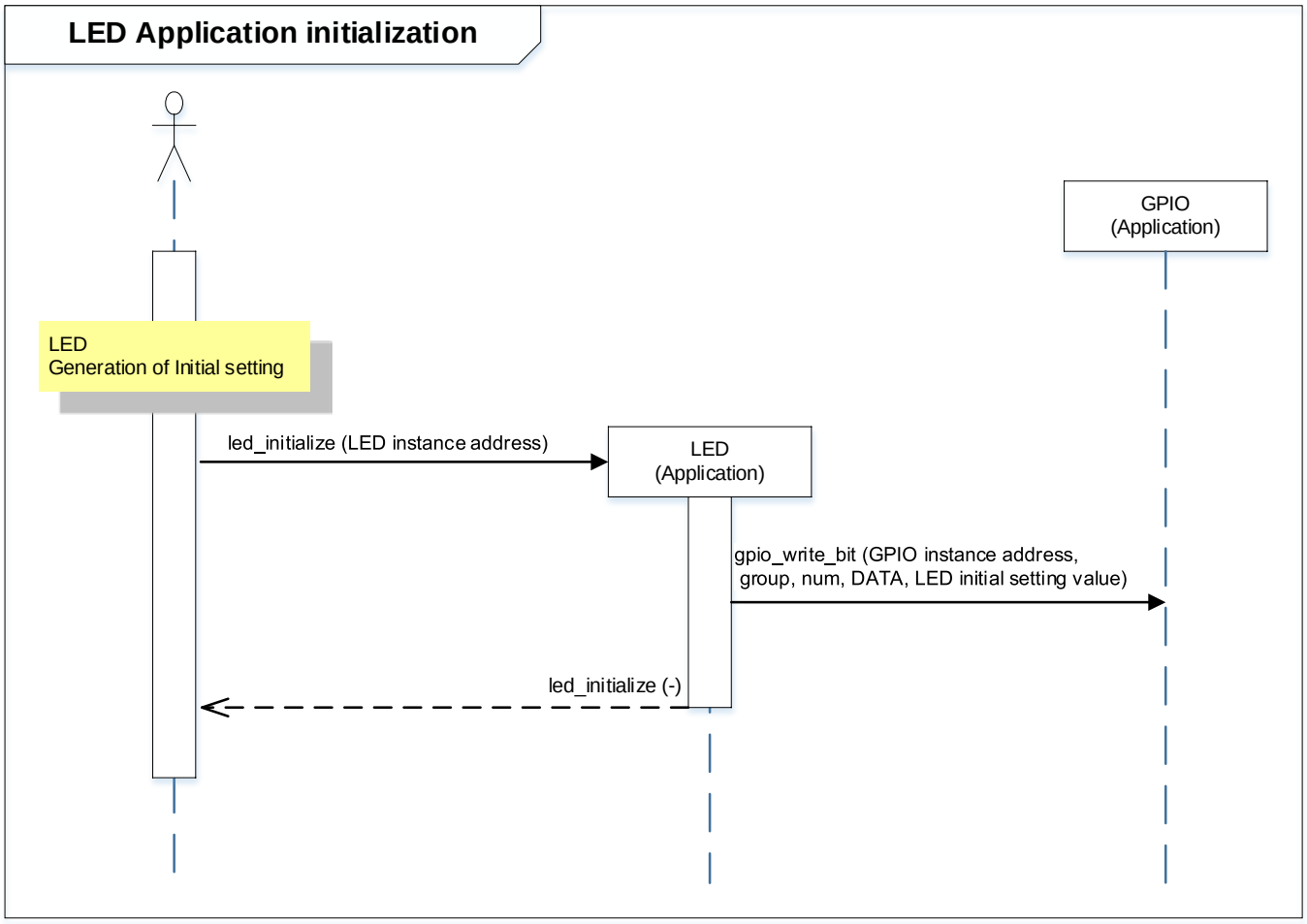


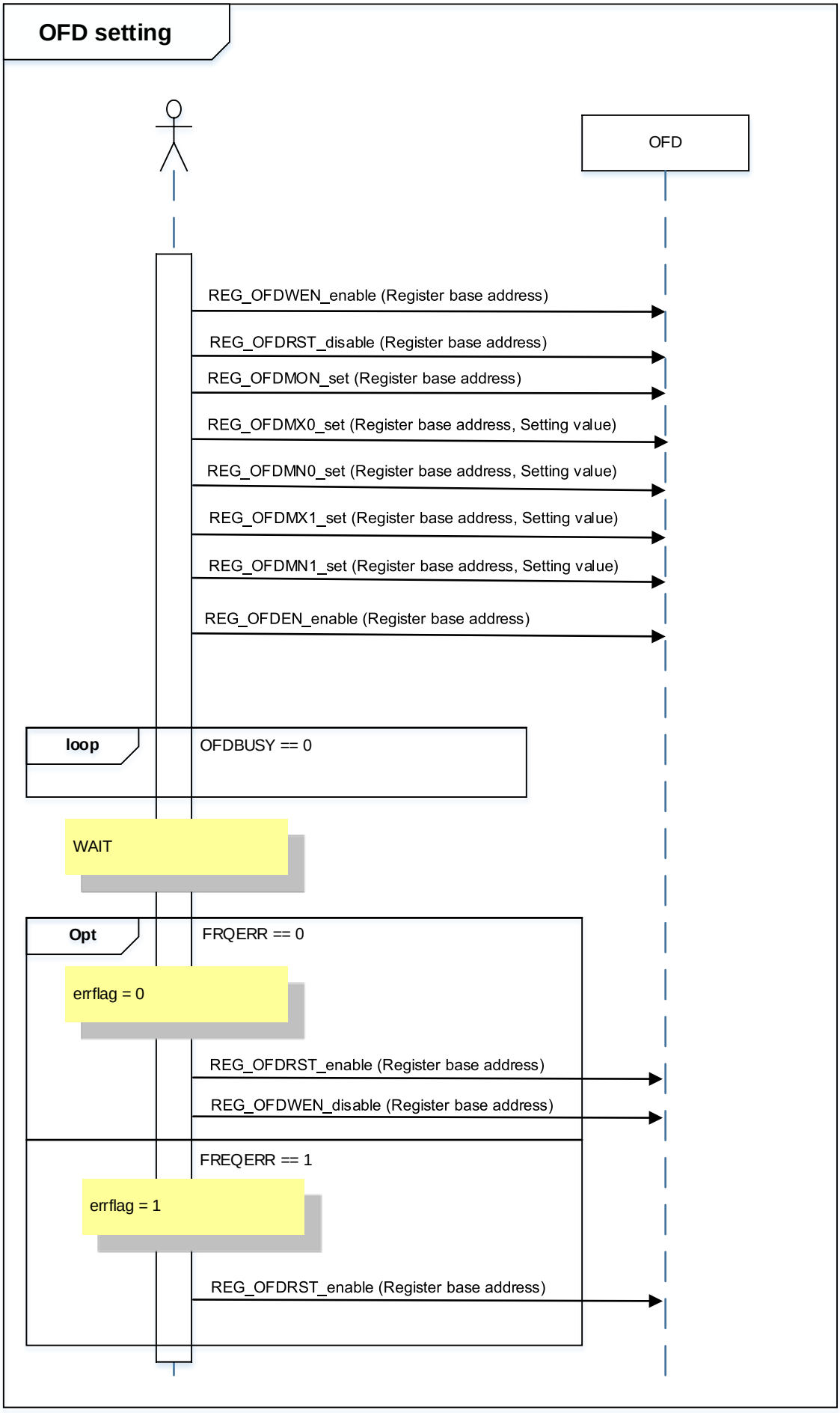

Startup
ref
Driver initialization
ref
Application initialization
When OFDRSTF is 1, the reset is done by OFD.
[RSTFLG1](OFDRSTF==1?
YES
ref
OFD setting
OFDRSTF clear
ref
LED control

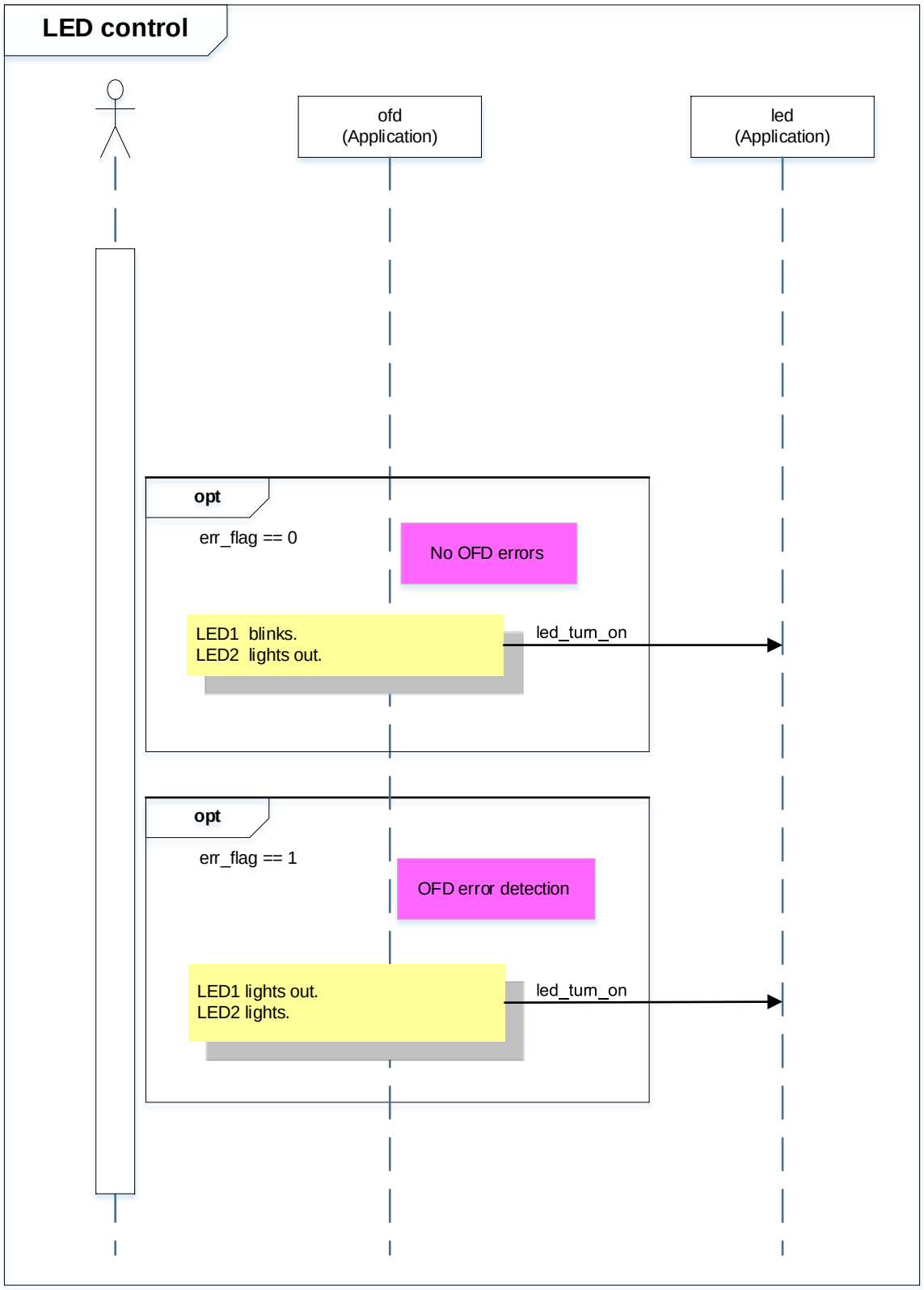

Driver initialization
ref
T32A Driver initialization


T32A Driver initialization
BSP
(Application)
Acquisition of Timer channel
for 1-ms timer
bsp_get_timer_ch (BSPTimer)
Channel number = bsp_get_timer_ch(-)
T32A
(Driver)
t32a_mode_init (Instance address)
Process result =
t32a_mode_init (-): Successful.
timer_initialize (Timer instance address)
t32a_timer_init (Instance address)
Process result =
t32a_timer_init (-): Successful.
Process result = timer_initialize (-): Successful.


Application initialization
loop
[1, Cont of Used LEDs]
ref
LED Application Initialization


LED Application initialization
GPIO
(Application)
LED
Generation of Initial setting
led_initialize (LED instance address)
LED
(Application)
gpio_write_bit (GPIO instance address,
group, num, DATA, LED initial setting value)
led_initialize (-)


OFD setting
OFD
REG_OFDWEN_enable (Register base address)
REG_OFDRST_disable (Register base address)
REG_OFDMON_set (Register base address)
REG_OFDMX0_set (Register base address, Setting value)
REG_OFDMN0_set (Register base address, Setting value)
REG_OFDMX1_set (Register base address, Setting value)
REG_OFDMN1_set (Register base address, Setting value)
REG_OFDEN_enable (Register base address)
loop
OFDBUSY == 0
WAIT
Opt
FRQERR == 0
errflag = 0
REG_OFDRST_enable (Register base address)
REG_OFDWEN_disable (Register base address)
FREQERR == 1
errflag = 1
REG_OFDRST_enable (Register base address)


LED control
ofd
(Application)
led
(Application)
opt
err_flag == 0
No OFD errors
LED1 blinks.
LED2 lights out.
led_turn_on
opt
err_flag == 1
OFD error detection
LED1 lights out.
LED2 lights.
led_turn_on

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	2019-10-16	First release

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