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

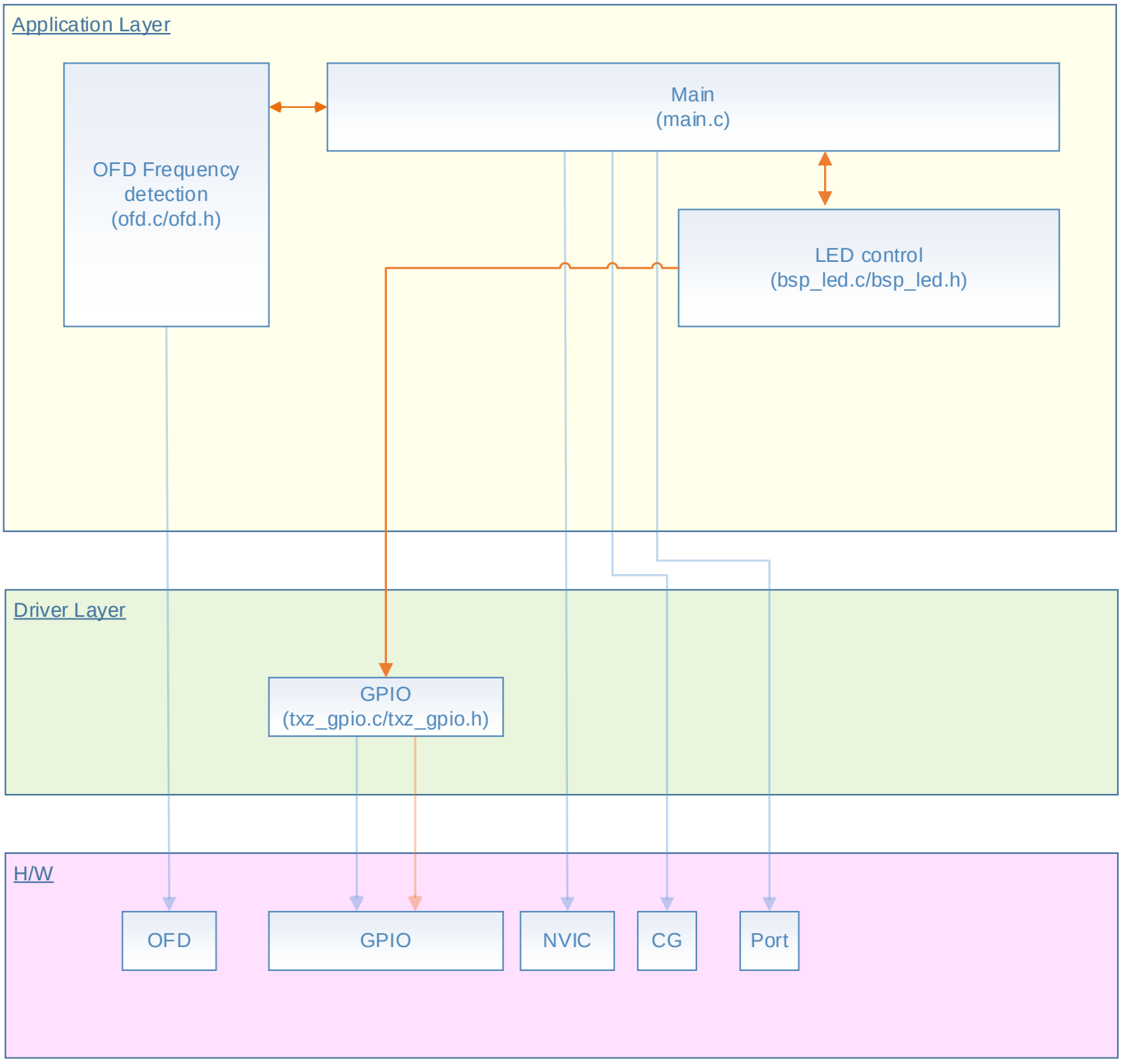
Target sample program: OFD_LED_M4G9

# Table of Contents

# 1. Preface

This sample program is used to check the operation of OFD.
The clock signal selected by OFD is monitored. Thereby it can be checked that the frequency range is normal.

Structure diagram of Sample program



## 2. Reference Document

- Datasheet
  TMPM4G Group (1) datasheet Rev1.0 (Japanese edition)
- Reference manual
  Oscillation Frequency Detector (OFD-A) Rev2.1 (Japanese edition)
  Input/Output Ports (PORT-M4G(1)) Rev.1.0 (Japanese edition)
  32-bit Timer Event Counter (T32A-B) Rev.2.1 (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 | Port | Function / Operation mode |
|---|---|---|---|
| Oscillation Frequency Detector | - | - | Abnormal detection of the clock frequency |
| 32-bit Timer Event Counter | Timer A ch0 | - | Interval timer |
| Input/Output Ports | - | PE4 (Output Port)<br>PE6 (Output Port) | Output |

## 4. Target Device

The target devices of this application note are as follows;

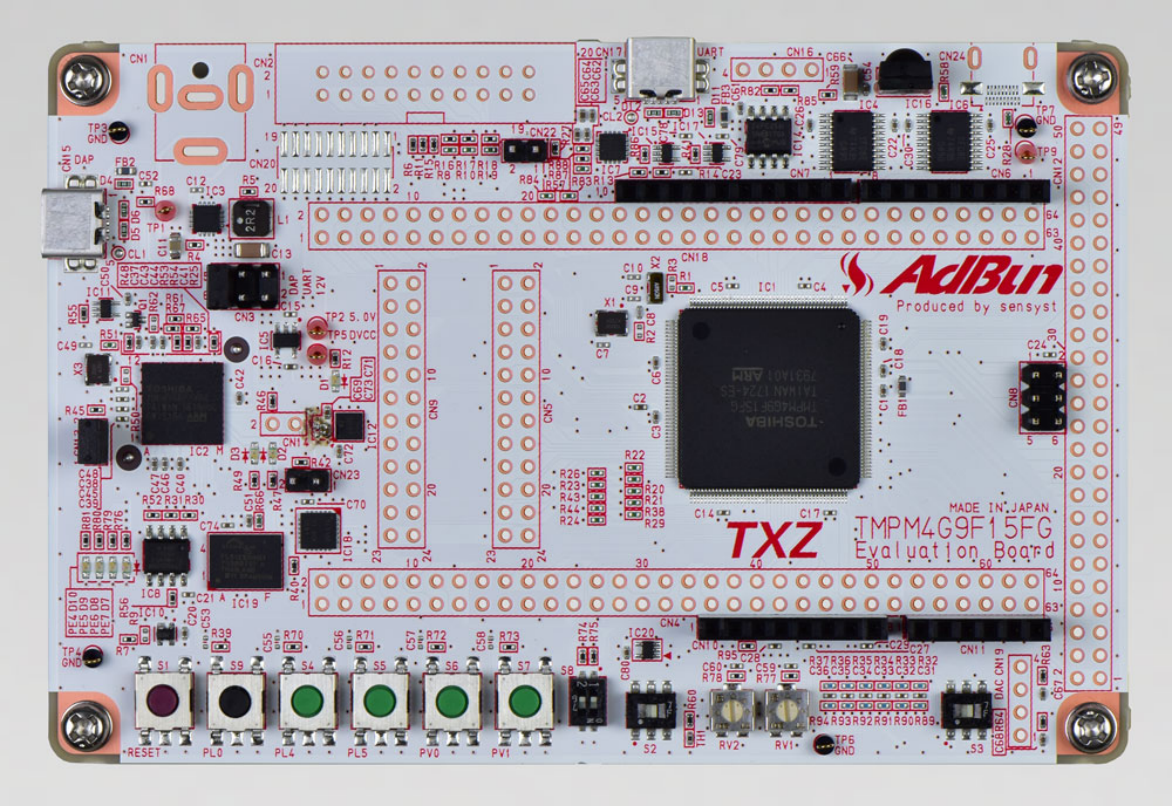
| | | | |
|---|---|---|---|
| TMPM4G9F15FG | TMPM4G9F10FG | TMPM4G9FEFG | TMPM4G9FDFG |
| TMPM4G9F15XBG | TMPM4G9F10XBG | TMPM4G9FEXBG | TMPM4G9FDXBG |
| TMPM4G8F15FG | TMPM4G8F10FG | TMPM4G8FEFG | TMPM4G8FDFG |
| TMPM4G8F15XBG | TMPM4G8F10XBG | TMPM4G8FEXBG | TMPM4G8FDXBG |
| | TMPM4G7F10FG | TMPM4G7FEFG | 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 |

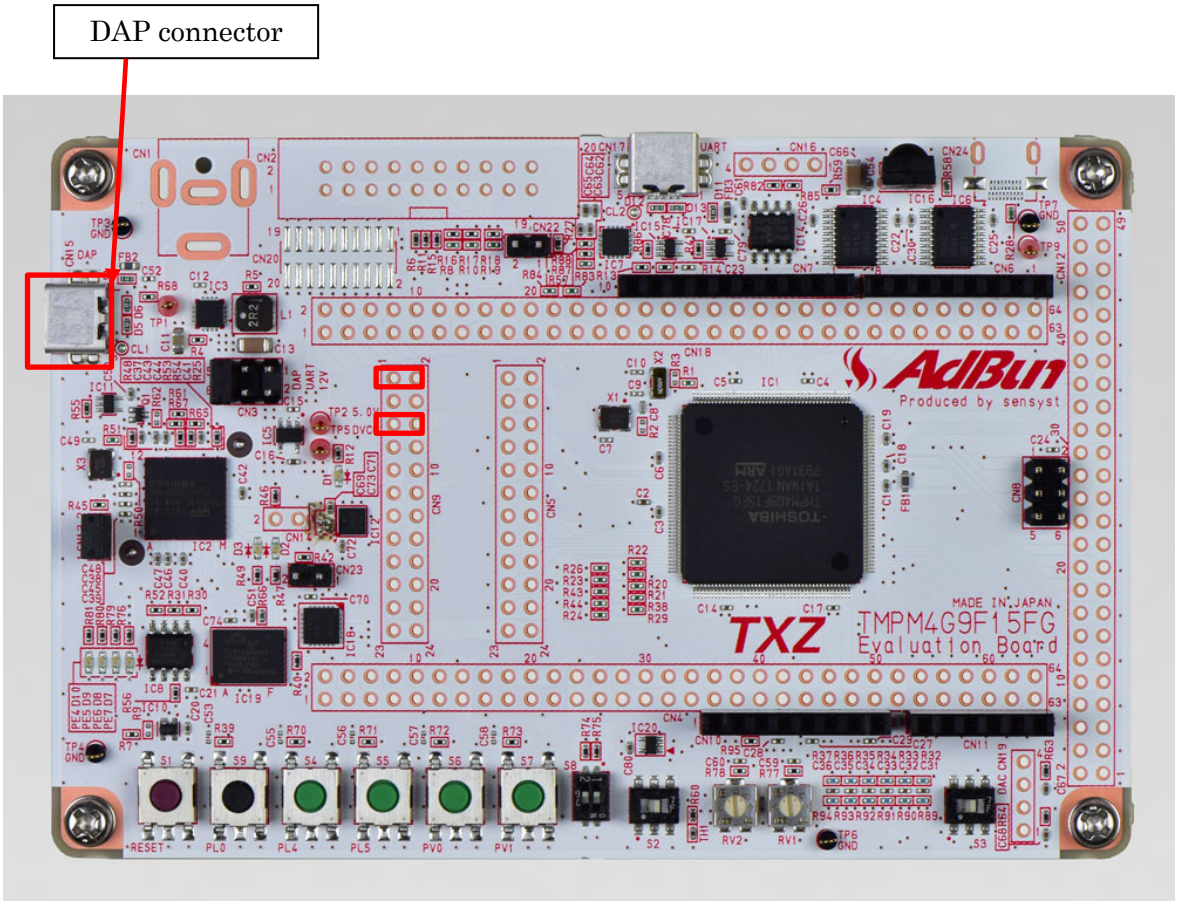
Evaluation board (TMPM4G9F15FG Evaluation Board) Top view



# 6. Evaluation Board Setting

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

| CN5 | | |
|---|---|---|
| Board function | Through-hole No. | Through-hole No. |
| LED (D10) | 1: LED0 | 2: PE4 |
| LED (D8) | 5: LED2 | 6: PE6 |



# 7. Outline of OFD

Oscillation Frequency Detector (OFD) detects abnormalities as the clock signal to monitor exceeding the range of the set-up frequency. The lists of functions are as follows.

| Function Classification | Function | Description |
|---|---|---|
| Abnormal detection of the clock frequency | Monitor clock | External high speed oscillator clock ($f_{EHOSC}$)<br>or<br>High speed clock (fc) |
| | Standard clock (Note) | Internal high speed oscillator 2 clock ($f_{IHOSC2}$) |
| | Frequency detective range | The maximum, the minimum are settable. |
| | State monitor | status register.<br>>operation / no operation<br>>abnormality / no abnormality |
| | Reset output | Prohibition/permission of a reset output are possible. |
| Protection | Protect function | Incorrect writing is prevented. |

Note:When stopping the standard clock during OFD operation (***[OFDRST]***<OFDRSTEN>=1), OFD reset occurs.(When stopping the standard clock before OFD operation, OFD reset does not occur.)

# 8. Sample Program

In this sample program, the LED shows the detection result of External Oscillation Frequency.

In the normal frequency range, the LED (D10) blinks.
If it exceeds the normal frequency range, the LED (D8) blinks.

## 8.1. 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.

## 8.2. Sample Program Main Operation

Initialization of BSP (Board Support Package) is executed.
The OFD reset flag should be checked and cleared.
Internal oscillation should be set Enable.
The application is initialized.
The driver is initialized.

After each initialization is set, the OFD should be set.
In the normal frequency range, the LED (D10) blinks.
If it exceeds the normal frequency range, the LED (D8) blinks.
The blinking cycle is 1 second.
Using 1-ms timer counter, turning the LED ON / OFF repeats with two kinds of counter value, 0 to 999 times and 1000 to 1999 times.

## 8.3. OFD Setting Change

When the OFD frequency range of sample program is changed, the following should be changed.

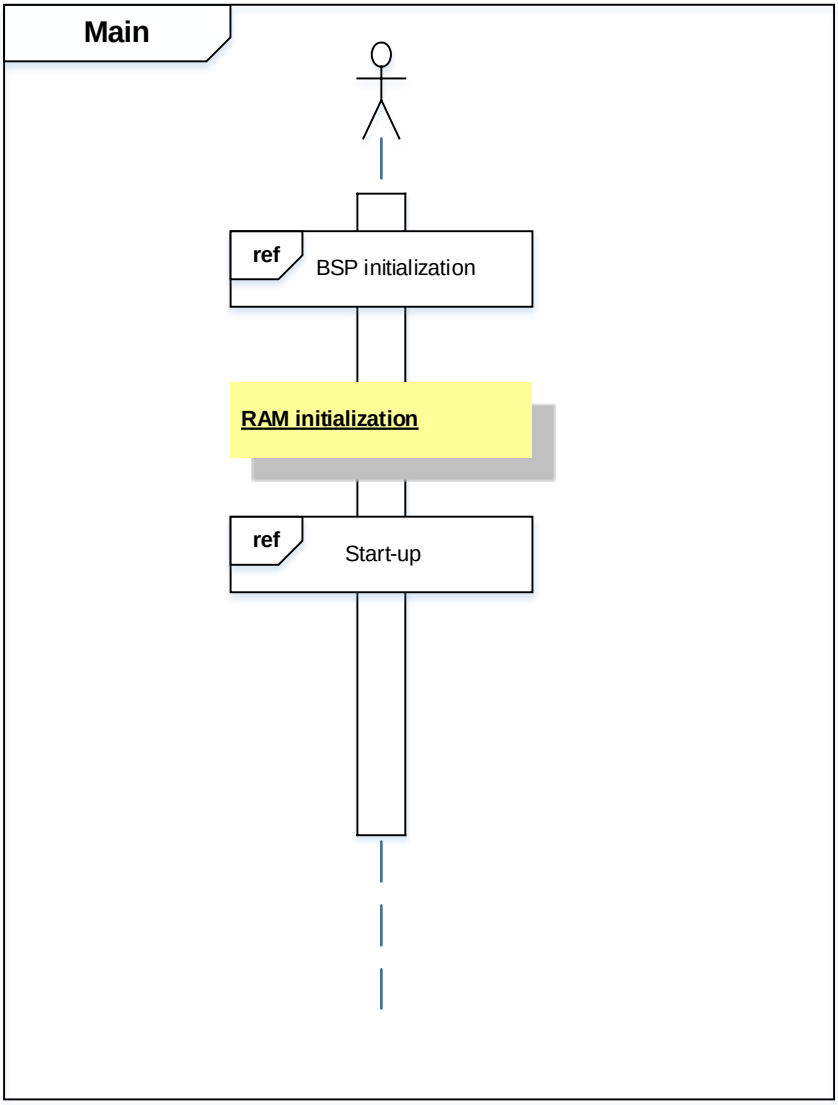
```
#define OFD_LOWER_COUNT_EXTERNAL ((uint32_t)0x01CU)
#define OFD_HIGHER_COUNT_EXTERNAL ((uint32_t)0x024U)
```

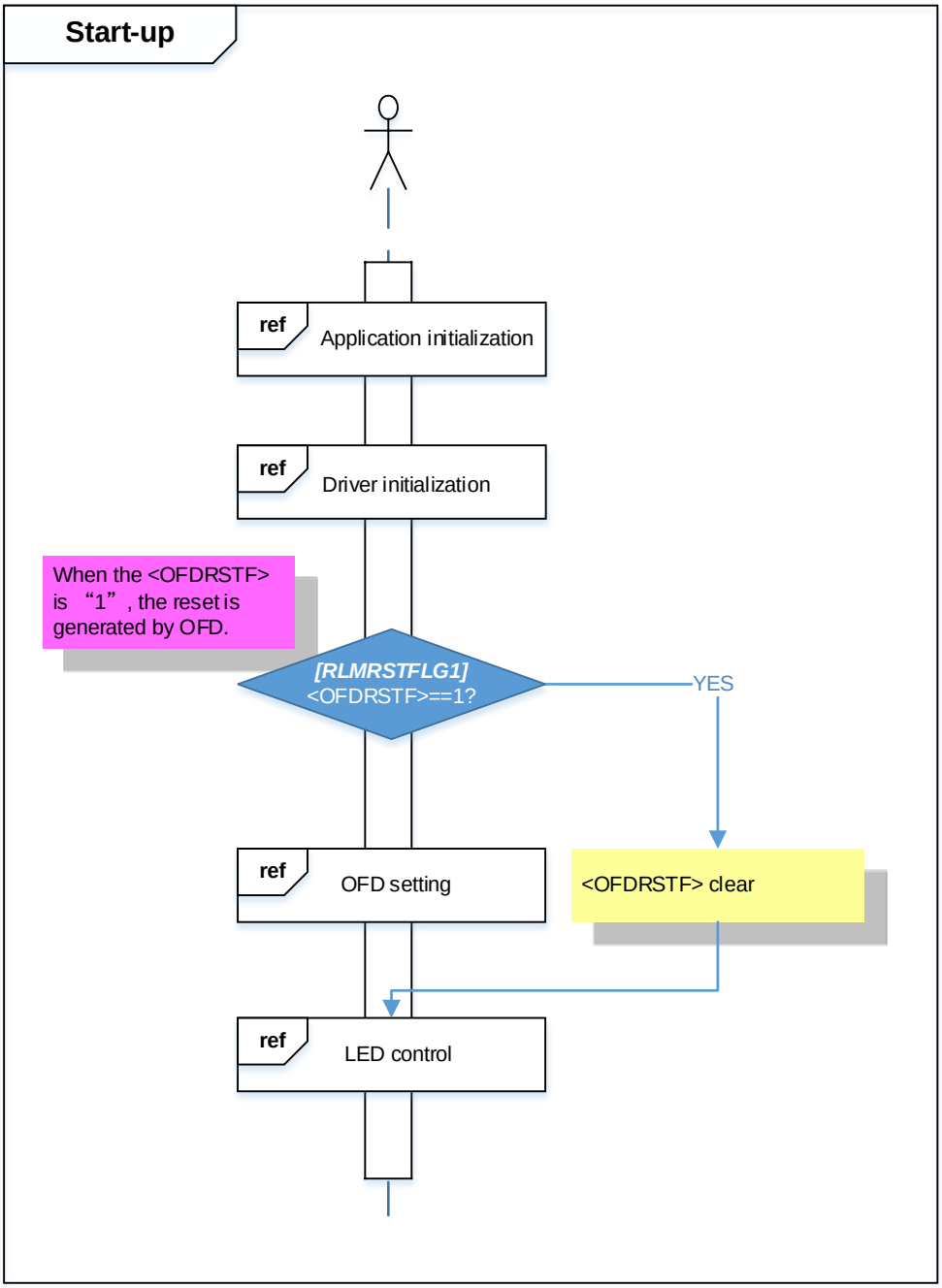
For the calculation of setting values, refer to the reference manual.

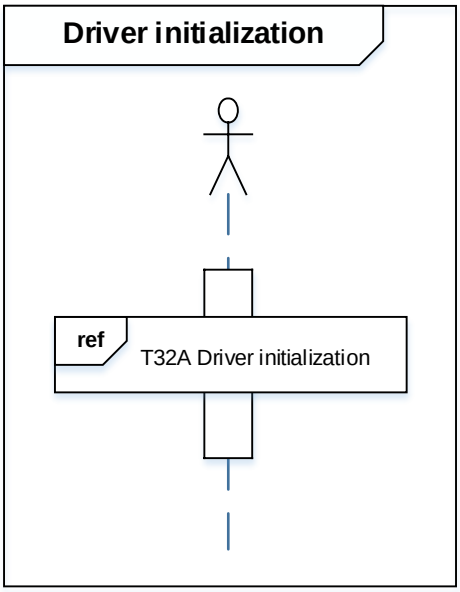
Calculating formula: Register setting value
= (Detective target clock frequency / 4) ÷ (Standard clock frequency / 128)
= (Detective target clock frequency ÷Standard clock frequency) × 32

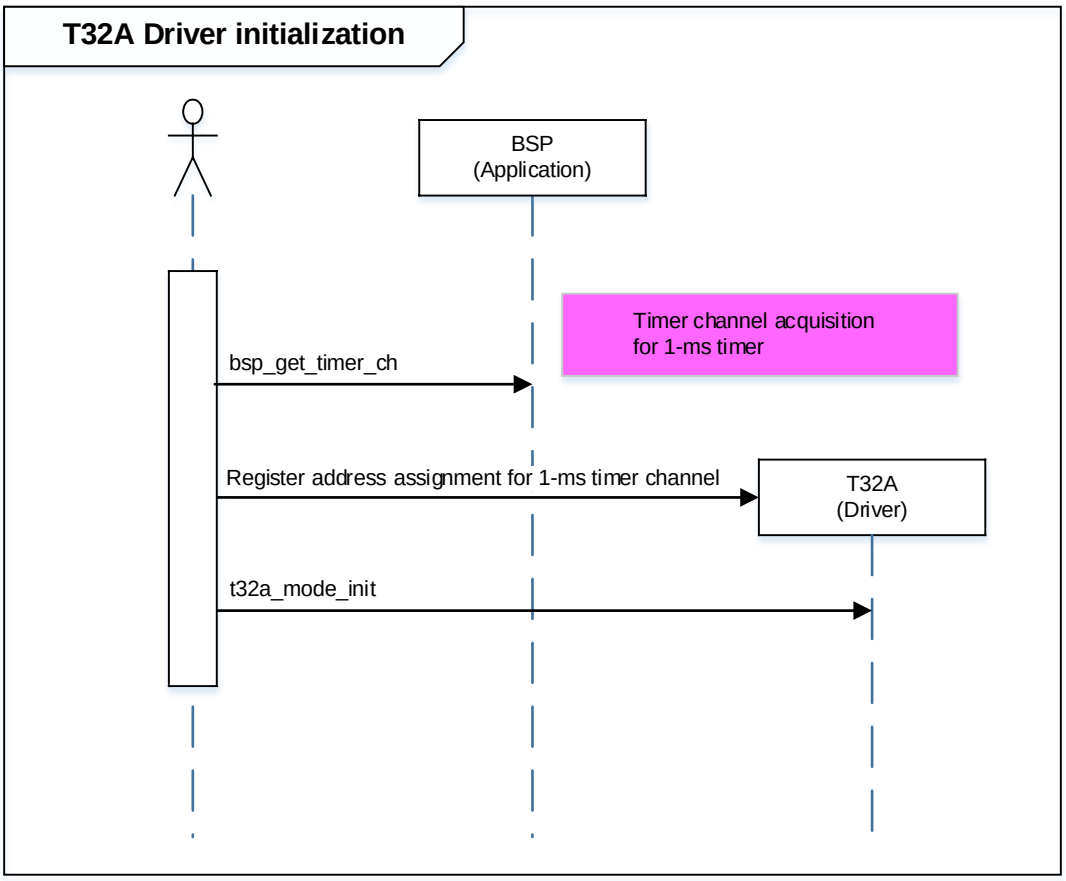
## 8.4. Operating Flow of Sample Program

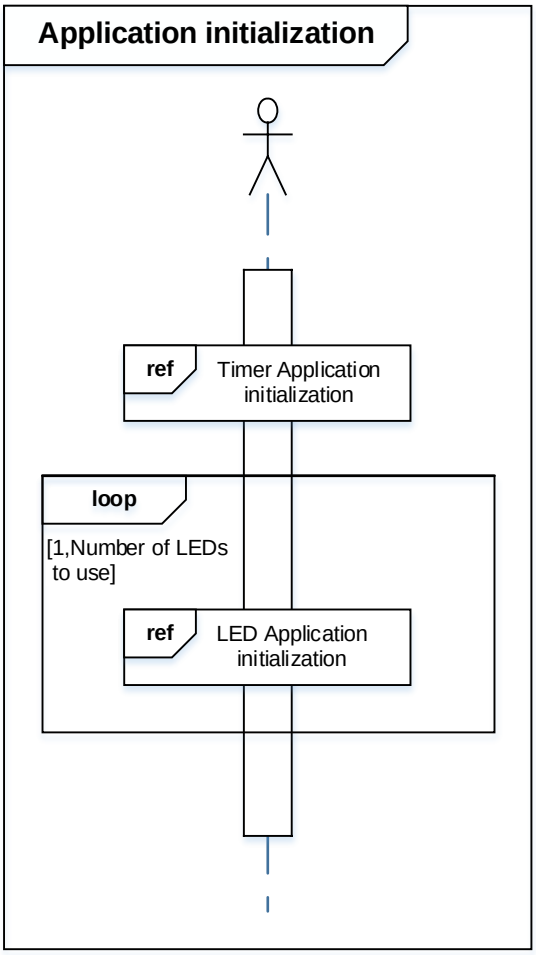
The basic operating flows of the sample program are shown in the following;

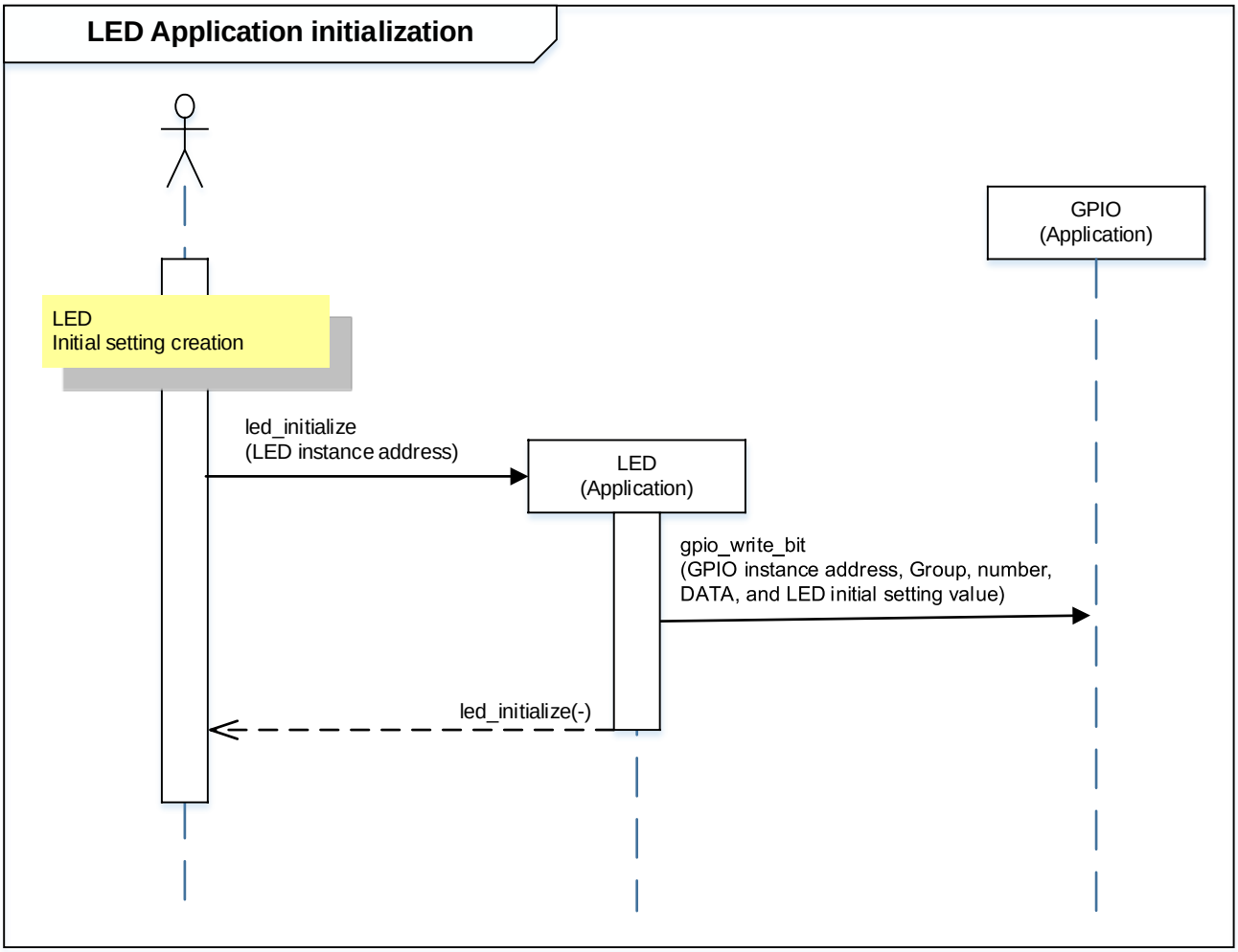


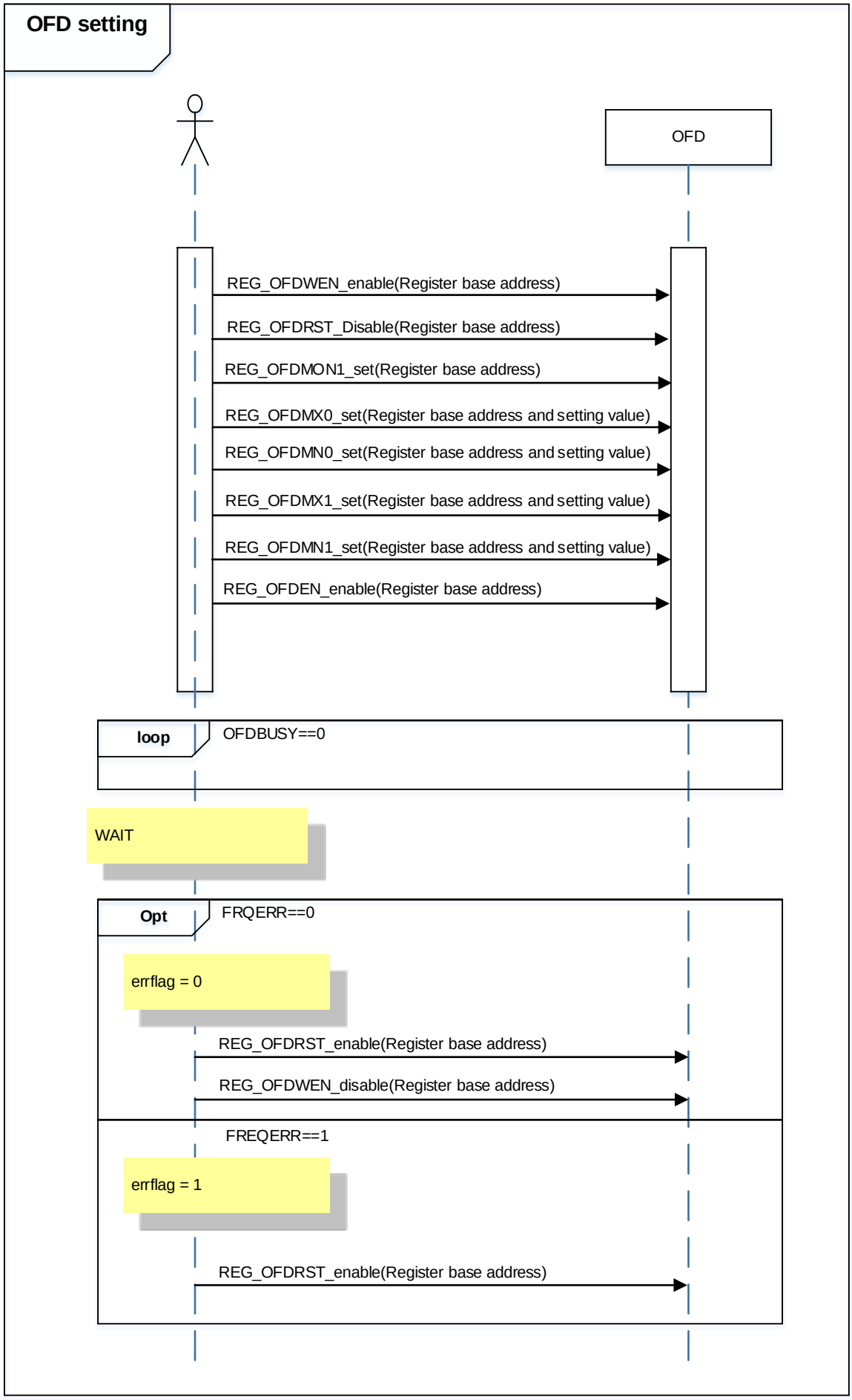

Start-up
ref
Application initialization
ref
Driver initialization
When the <OFDRSTF> is “1”, the reset is generated by OFD.
[RLMRSTFLG1]
<OFDRSTF>==1?
YES
ref
OFD setting
<OFDRSTF> clear
ref
LED control

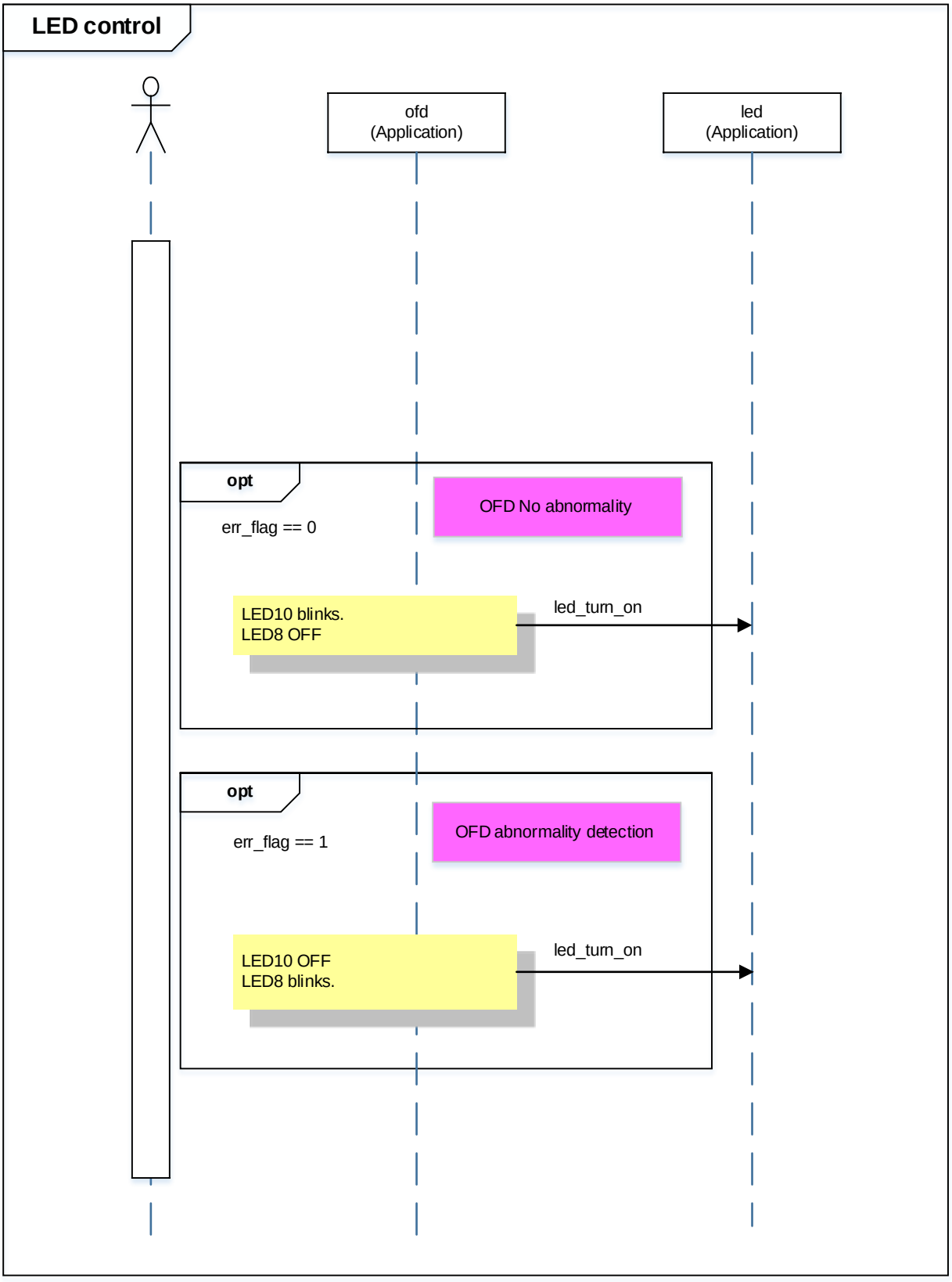

Driver initialization
ref
T32A Driver initialization


T32A Driver initialization
BSP
(Application)
Timer channel acquisition
for 1-ms timer
bsp_get_timer_ch
Register address assignment for 1-ms timer channel
T32A
(Driver)
t32a_mode_init


Application initialization
ref
Timer Application initialization
loop
[1,Number of LEDs to use]
ref
LED 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(-)


OFD setting
OFD
REG_OFDWEN_enable(Register base address)
REG_OFDRST_Disable(Register base address)
REG_OFDMON1_set(Register base address)
REG_OFDMX0_set(Register base address and setting value)
REG_OFDMN0_set(Register base address and setting value)
REG_OFDMX1_set(Register base address and setting value)
REG_OFDMN1_set(Register base address and 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
OFD No abnormality
LED10 blinks.
LED8 OFF
led_turn_on
opt
err_flag == 1
OFD abnormality detection
LED10 OFF
LED8 blinks.
led_turn_on

## 9. Precaution

When using the sample program with CPU other than TMPM4G9, please check operation sufficiently.

## 10. Revision History

| Rev | Date | Page | Description |
|---|---|---|---|
| 1.0 | 2018-12-12 | - | First release |

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