

**M4G Group (1)**  
**Application Note**  
**Voltage Detection Circuit**  
**(LVD-C)**

**Outlines**

This application note is a reference material for developing products using voltage detection circuit (LVD) function of M4G Group (1). This document helps the user check operation of the product and develop its program.

Target sample program: LVD\_DEMO\_M4G9

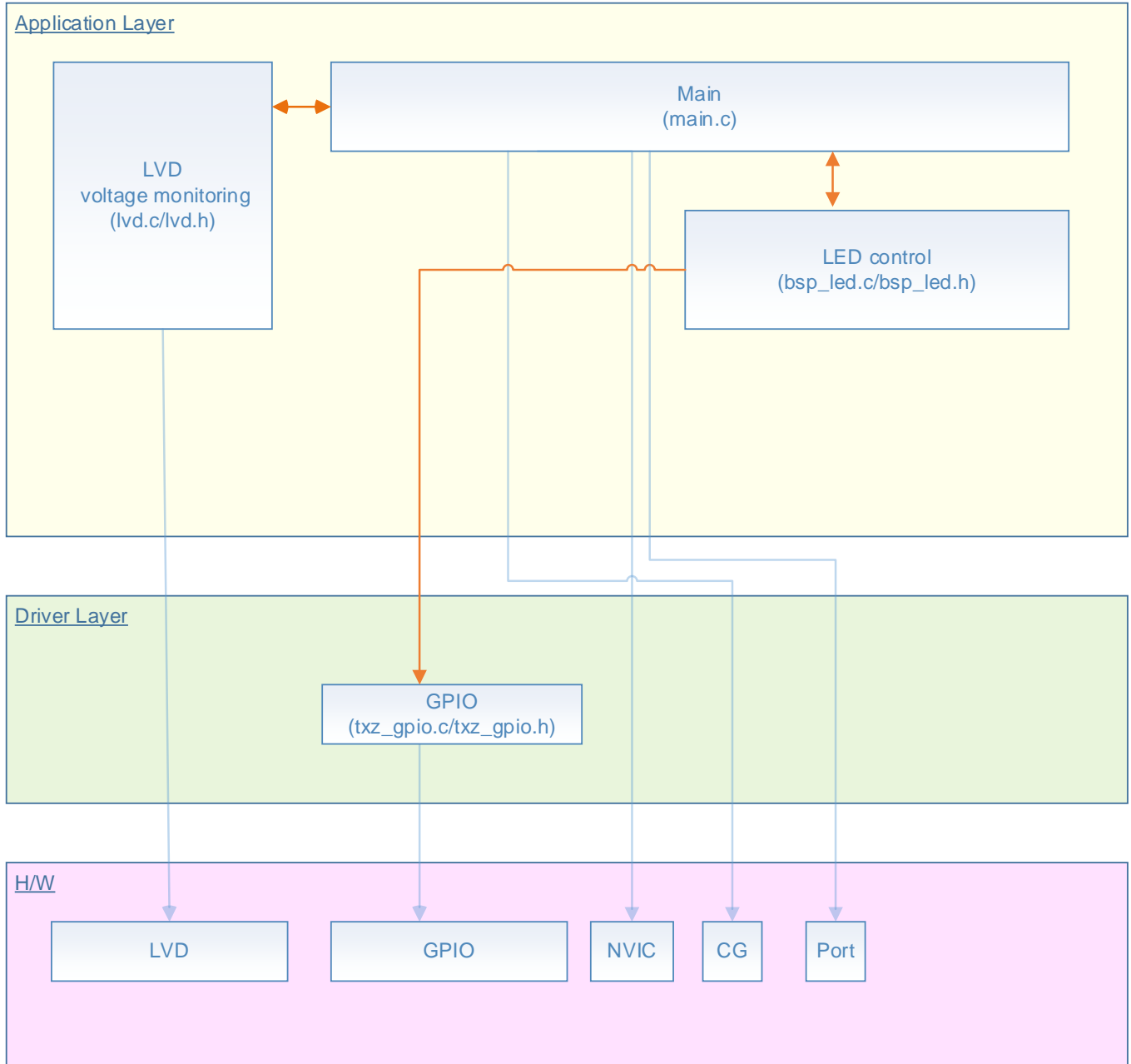
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## 1. Preface

This sample program should be used to check the operation of the voltage detection circuit. The voltage value of the power supply is detected. The lighting and the lights-out of the LED are controlled by the detection result.

Structure diagram of Sample program



### 2. Reference Document

- Datasheet  
     TMPM4G Group (1) datasheet Rev1.0 (Japanese edition)
- Reference manual  
     Voltage Detection Circuit (LVD-C) Rev2.0 (Japanese edition)  
     Input/Output Ports (PORT-M4G (1)) Rev1.0 (Japanese edition)  
     32-bit Timer Event Counter (T32A-B) Rev2.1 (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             |
|----------------------------|-------------|-------------------|-------------------------------------|
| Voltage Detection Circuit  | -           | -                 | Voltage detection of a power supply |
| 32-bit Timer Event Counter | Timer A ch0 | -                 | Interval timer                      |
| Input/Output Ports         | -           | PE4 (Output port) | Output                              |
|                            | -           | PE6 (Output port) |                                     |

### 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.

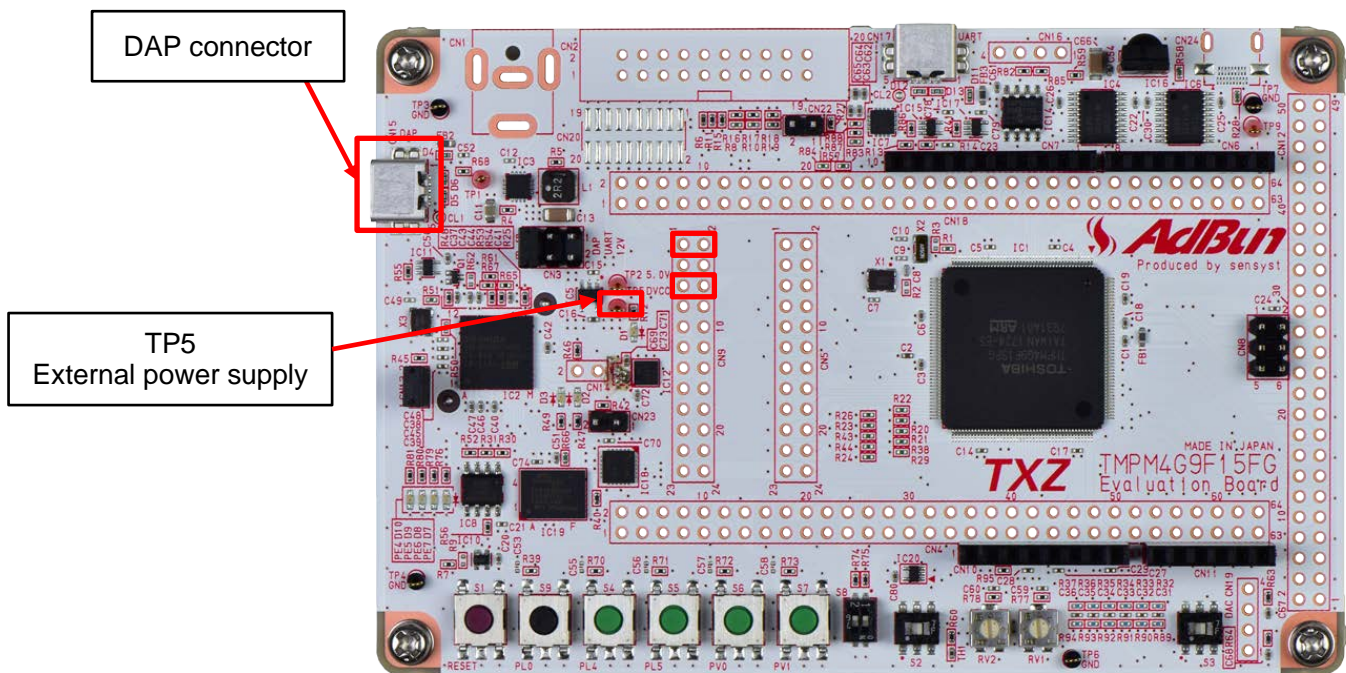




## 6. Evaluation Board Setting

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

| CN9            |                  |                  |
|----------------|------------------|------------------|
| Board function | Through-hole No. | Through-hole No. |
| LED (D10)      | 1: LED0          | 2: PE4           |
| LED (D8)       | 5: LED2          | 6: PE6           |



## 7. Operation of Evaluation Board

After the program is written to the evaluation board, the board should be disconnected with the PC for the power not to be supplied through the USB cable.

An external 3.3-V power is supplied on TP5.

The voltage of the external power supply should be changed to check the operation of the evaluation board.

The voltage of the external power supply is detected. When the voltage is more than the setting value, the LED (D10) lights and the LED (D8) lights out.

When the voltage is equal to or less than the setting value, the LED (D10) lights out and the LED (D8) blinks.

## 8. Outline of LVD function

The main functions of the voltage detection circuit (LVD) are shown in the following table.

| Function category                 | Function                   | Description                                                                    | Note                                                 |
|-----------------------------------|----------------------------|--------------------------------------------------------------------------------|------------------------------------------------------|
| Supply voltage detection function | Reset output               | Reset is generated at the set detection voltage or less.                       | Selectable from the reset and an interrupt.          |
|                                   | Interrupt request          | An interrupt request is generated at the set detection voltage or less.        |                                                      |
|                                   | Monitor                    | The status can be monitored using a status register for the voltage detection. | -                                                    |
|                                   | Detected voltage selection | The selection out of 7 kinds is possible.                                      | Supported for NORMAL/IDLE/STOP1 modes and STOP2 mode |

## 9. Sample Program

When an external power is supplied to the evaluation board, the sample program detects the voltage of the power using the voltage detection circuit.  
The detection result can be checked by the LED lighting and blinking.

### 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 BSP (Board Support Package) is initialized.  
The variables are initialized.  
The driver is initialized.  
The application initialization is done.

The timer should be started. And the setting of the LVD should be done.  
The detection voltage has been set to 3.1 V in the sample program.  
The status of the voltage detection of the LVD should be monitored to check whether the power supply voltage is more or less than the detection/release voltage.  
If the monitored result is the same as the previous one, the LVD circuit stays in the same state.  
When the state where the detected voltage is more than the LVD setting voltage is monitored 8 times continuously, the LED (D10) lights.  
When the state where the detected voltage is equal to or less than the LVD setting voltage is monitored 8 times continuously, the LED (D8) blinks at 1-second interval which is counted by the timer.

### 9.3. Detection Voltage Setting

The detection voltage can be set with the value "TSB\_LVD->LVL1" in the "int\_LVD" function in "lvd.c".  
The default value is "LVD\_VOLTAGE\_31". The detection voltage can be updated by changing the parameter.

Example: `TSB_LVD->LVL1 = (uint8_t)LVD_VOLTAGE_29;`  
The detection voltage is set to 2.9 V.

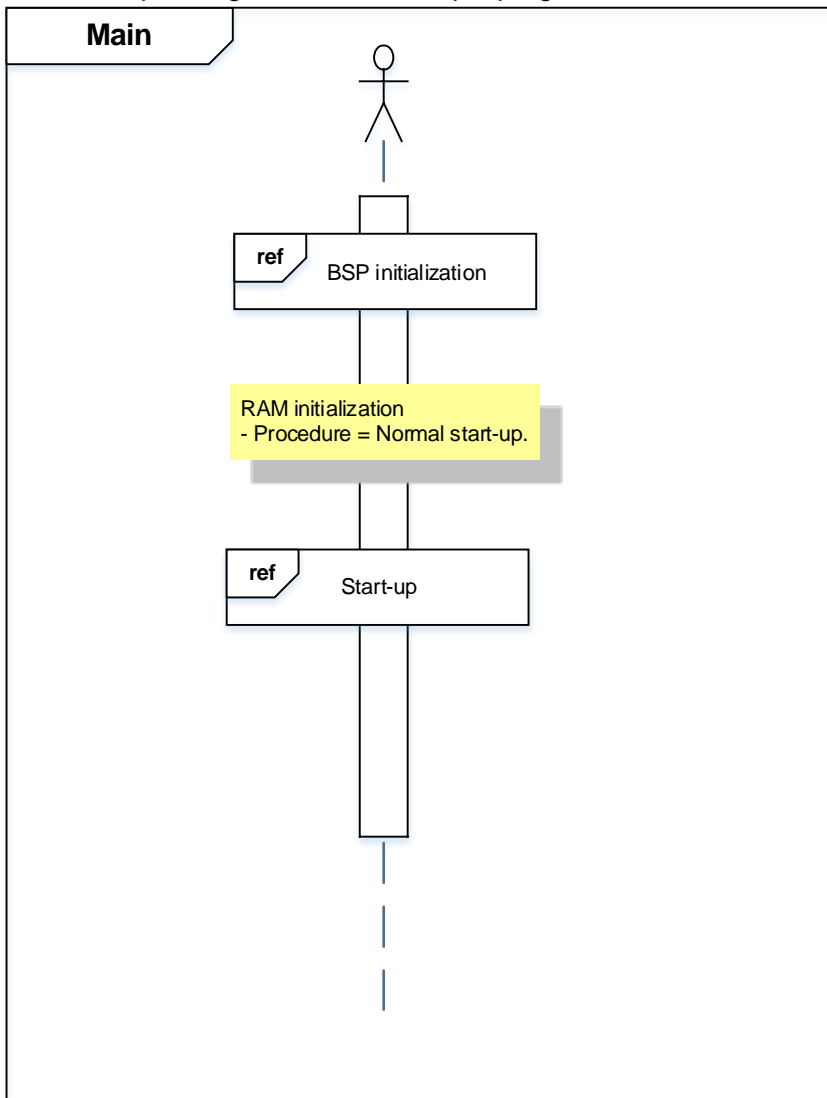
The detection voltages available are shown in the following table;

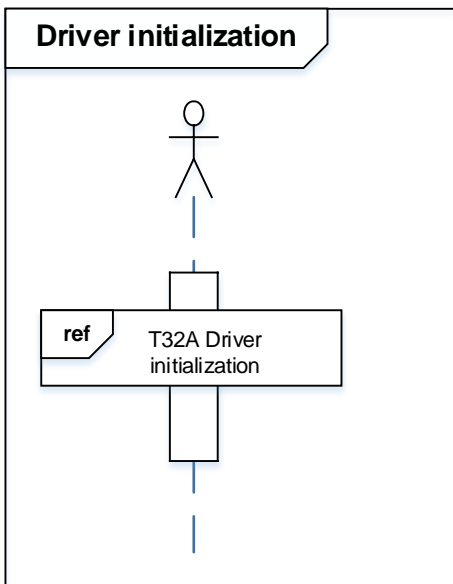
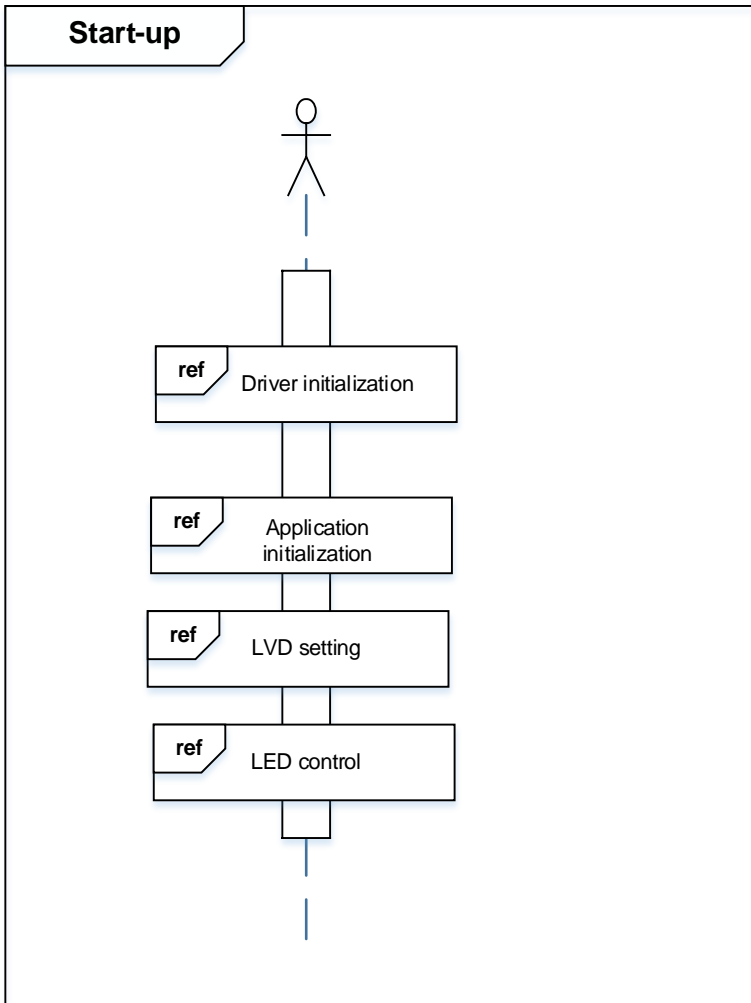
| Setting parameter | Detection voltage |
|-------------------|-------------------|
| LVD_VOLTAGE_26    | 2.6 V             |
| LVD_VOLTAGE_27    | 2.7 V             |
| LVD_VOLTAGE_28    | 2.8 V             |
| LVD_VOLTAGE_29    | 2.9 V             |
| LVD_VOLTAGE_30    | 3.0 V             |
| LVD_VOLTAGE_31    | 3.1 V             |

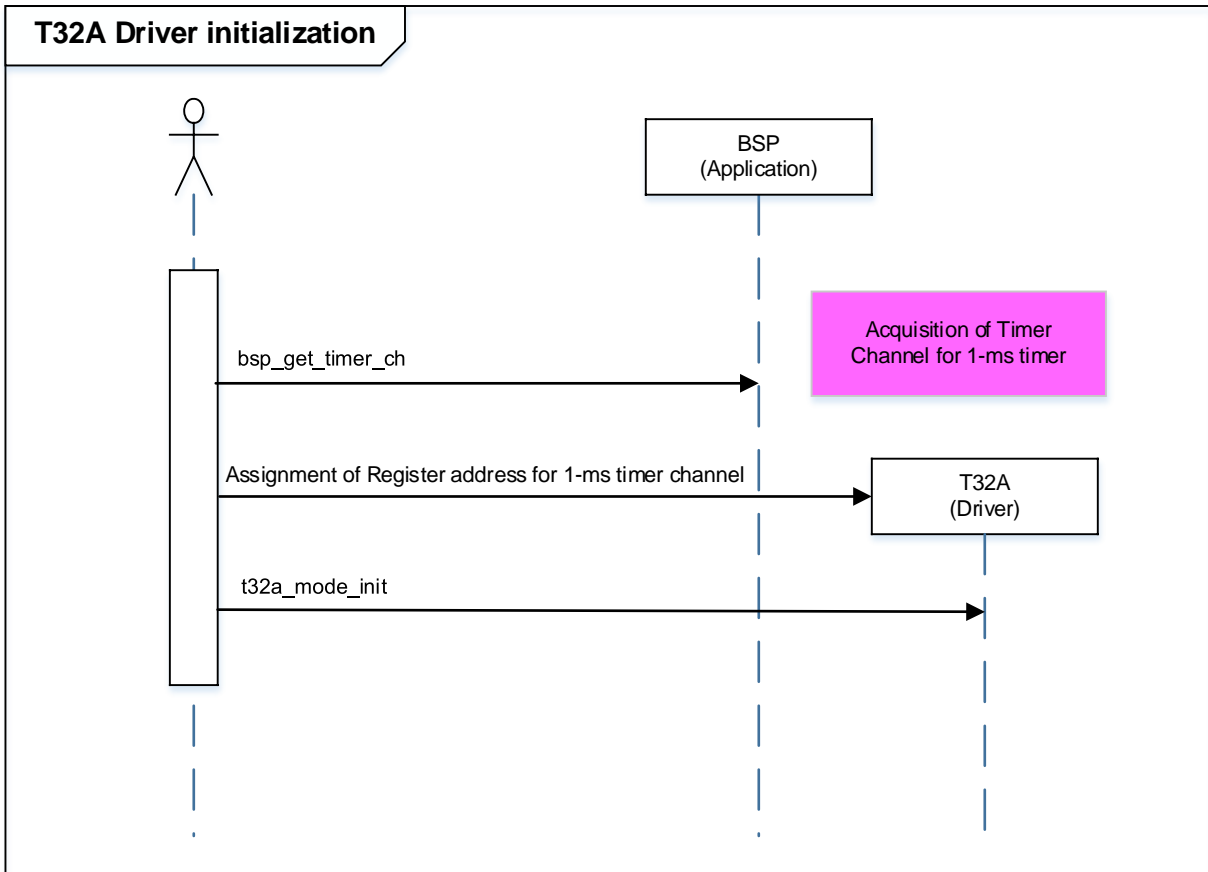


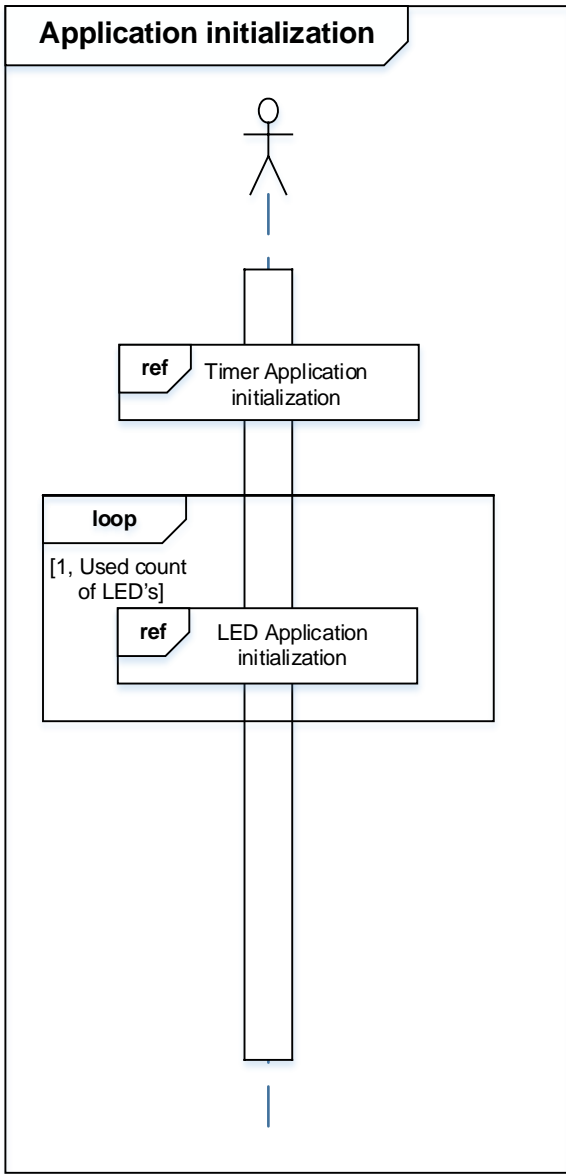
### 9.4. Operating Flow of Sample Program

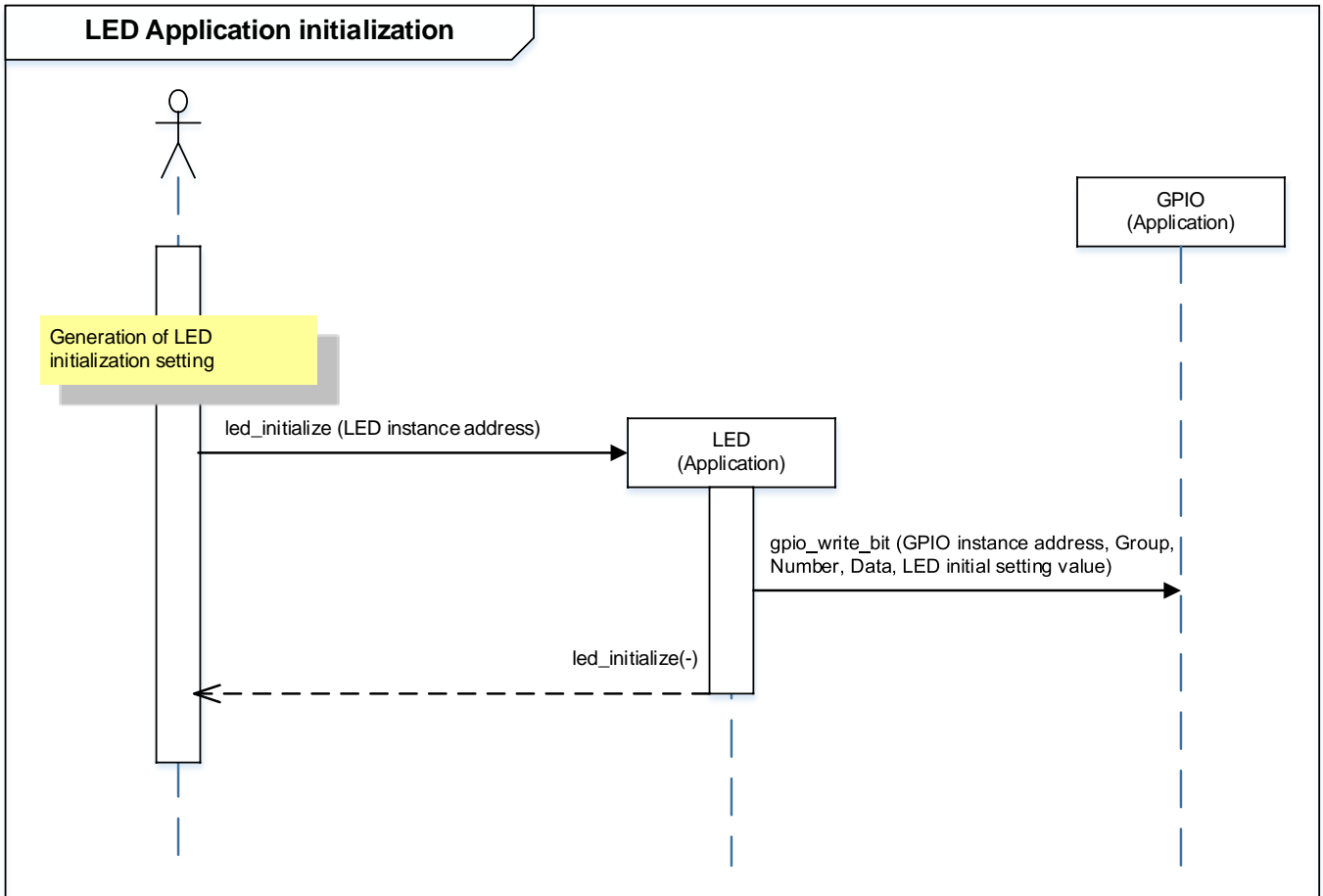
The basic operating flows of the sample program are shown in the following;

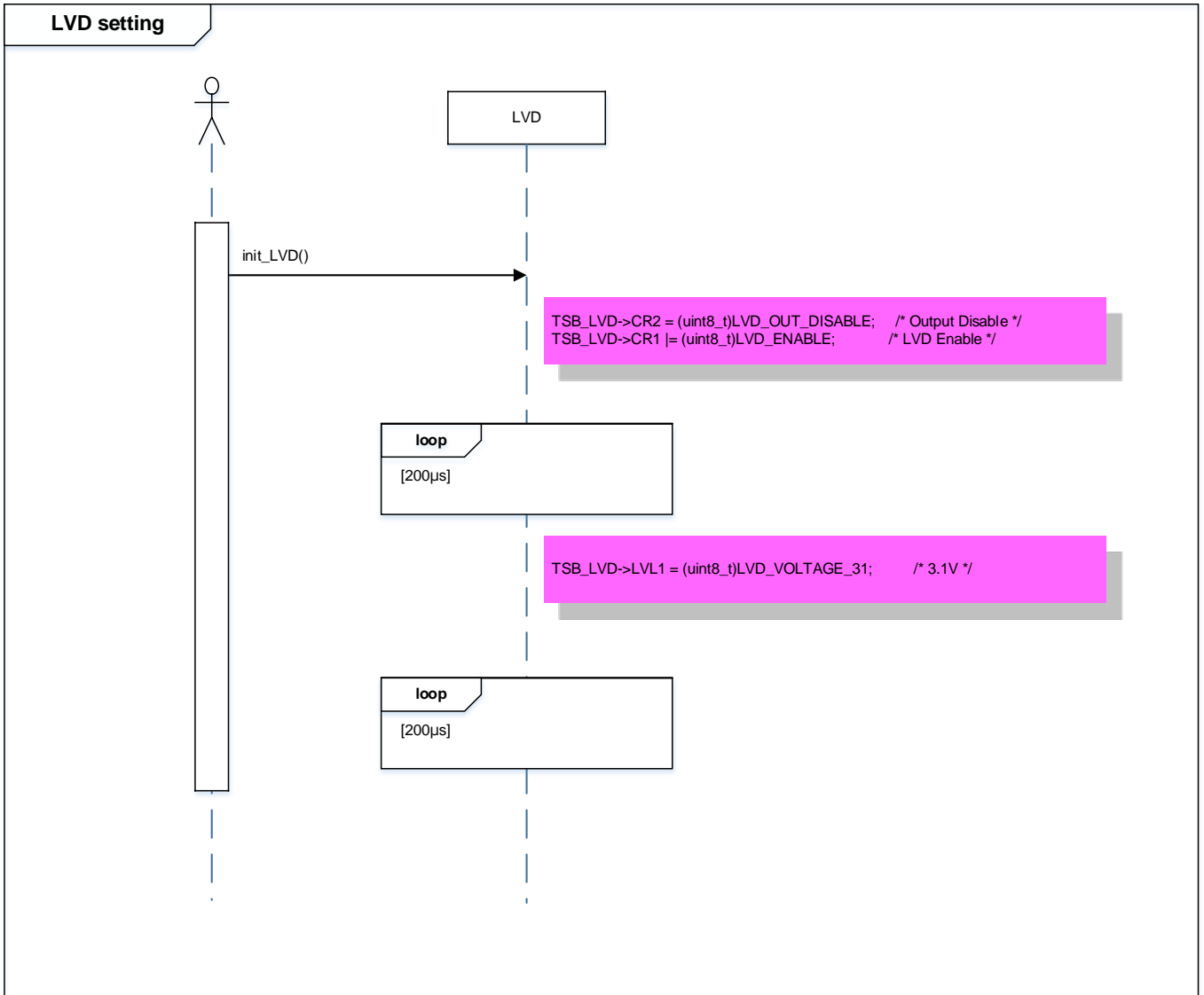




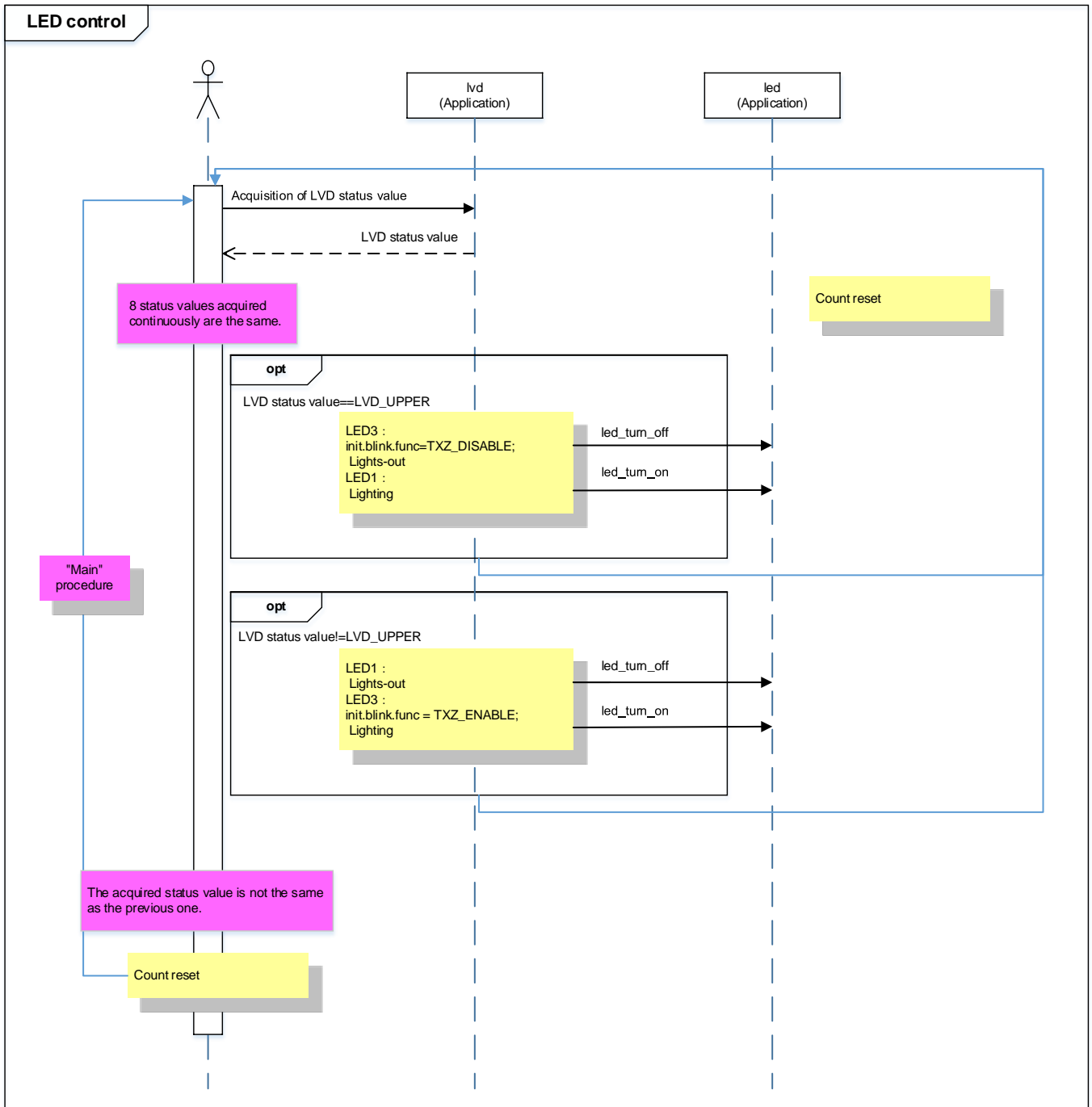












**10. Precaution**

When using the sample program with CPU other than TPM4G9F15, please check operation sufficiently.

**11. Revision History**

| Rev | Date       | Page | Description   |
|-----|------------|------|---------------|
| 1.0 | 2018-12-20 | -    | First release |

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