M4G Group (1)
Application Note
Interval Sensor Detection Circuit
(ISD-A)

Outlines

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

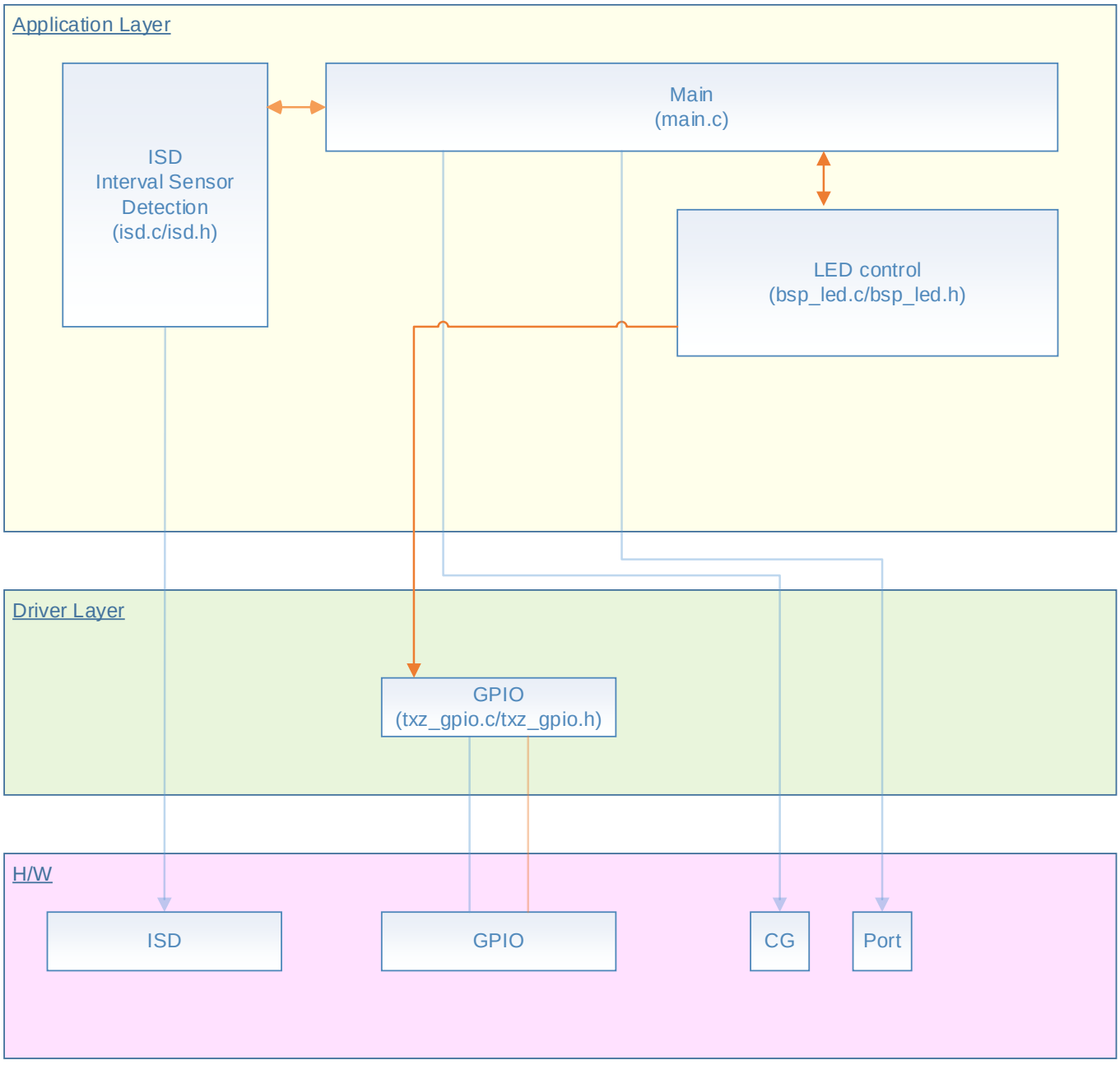
Target sample program: ISD_LED

Table of Contents

1. Preface

In this sample program, the signal is read by the interval sensor detection circuit and mode transition is performed.
After starting up with low power consumption mode, the pushing down of a button is detected by the interval sensor, and low power consumption mode is released.

Structure diagram of Sample program



2. Reference Document

- Datasheet
  TMPM4G group (1) datasheet Rev1.0 (Japanese edition)
- Reference manual
  Interval Sensor Detection Circuit (ISD-A) Rev1.0 (Japanese edition)
  Input/Output Ports (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. Function to Use

IP	Channel/Unit	Port	Function/Operation mode
Input/Output Ports	-	PE4(Output Port)	Output
		PE5(Output Port)	
		PE6(Output Port)	
		PE7(Output Port)	
Interval Sensor Detection Circuit	Unit B	PV0(ISDBIN0)	ISD interrupt

4. Target Device

The target devices of this application note are as follows;

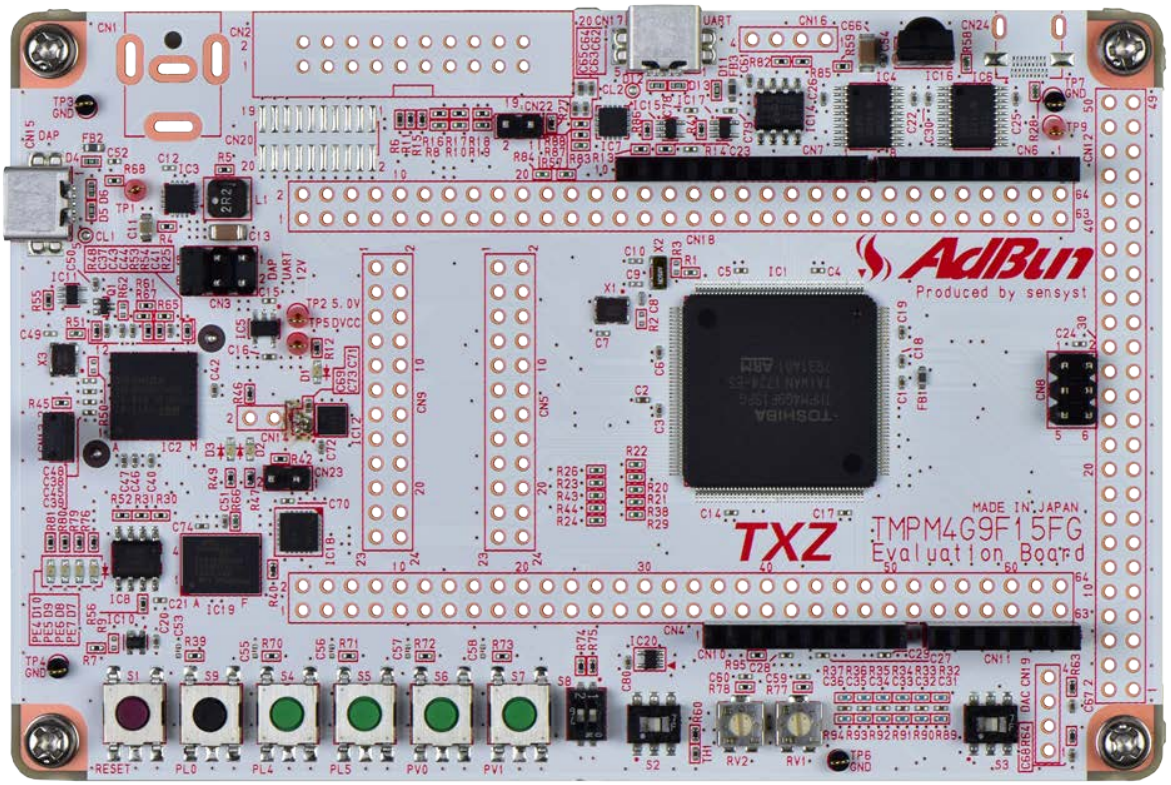
TMPM4G9F15FG	TMPM4G9F10FG	TMPM4G9FEFG	TMPM4G9FDFG
TMPM4G9F15XBG	TMPM4G9F10XBG	TMPM4G9FEXBG	TMPM4G9FDXBG
TMPM4G8F15FG	TMPM4G8F10FG	TMPM4G8FEFG	TMPM4G8FDFG
TMPM4G8F15XBG	TMPM4G8F10XBG	TMPM4G8FEXBG	TMPM4G8FDXBG
	TMPM4G7F10FG	TMPM4G7FEFG	TMPM4G7FDFG
	TMPM4G6F10FG	TMPM4G6FEFG	TMPM4G6FDFG

*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	TMPM4G9F15FGEvaluation Board by Senxyst
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

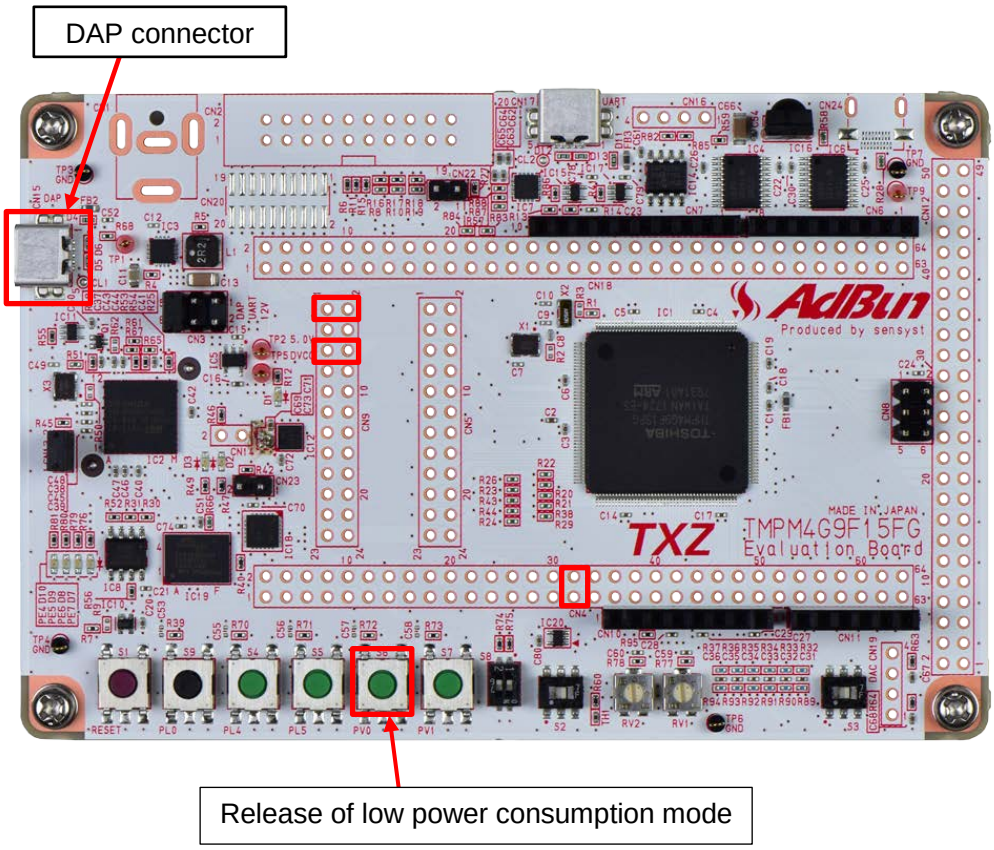


6. Evaluation Board Setting

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

CN4		
Board function	Through-hole No.	Through-hole No.
Push switch (S6)	31: ISD_SW0	32: PV0

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

The sample program shifts to the low power consumption mode after initialization processing. In the low power consumption mode, the LED (D8) lights on.
When low power consumption mode is released, the LED (10) lights on after entering Normal mode.

8. Outline of ISD

Interval sensor detection circuit (ISD) generates the control timing to operate intermittently an external device such as a sensor. It also detects the level of an input signal from an external device to generate an interrupt.
This interrupt is used to release the low power consumption mode.

The list of the functions of ISD is shown in the following table.

Function category	Function	Description
External circuit control	Reference clock	Reference clock (fisdclk) Low speed clock (32.768 kHz) or the clock that Timer trigger for Clock source (ISDxCLKTRG) is divided by 1, 2, 4, or 8.
	Control timing output	Control timing output (ISDxOUT): 1 output - Active level: Selectable from High and Low. - Active interval: Selectable from among 2 to 256 times of Reference clock cycle. - Active cycle: Selectable from among 1 to 256 times of Active interval.
	Level detection input	Level detection input (ISDxIN0 to 3): 4 inputs - An interrupt (INTISDx) is generated when change of an input level is detected. (The interrupt can release low power consumption mode.) - Detection level patterns of the input signal: One of followings can be selected per input signal. "Low level" "High level" "(Previous) Low level to (Current) High level" "(Previous) High level to (Current) Low level" "Current level is different from Previous one" - Detection timing of the input level: Any timing can be set during the active interval of the control timing output. The input level is stored in a buffer.
	Link operation	Multiple units can be linked and they can operate in the same timing. - Master: Supply slaves with the timing signals of Control timing output/Level detection input. - Slave: Operate at the timing controlled by Master.

9. Sample Program

Execution of the sample program shifts to the low power consumption mode. During the low power consumption mode, it detects pressing of the push switch S6 and transitions from low power consumption mode to Normal mode.

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.

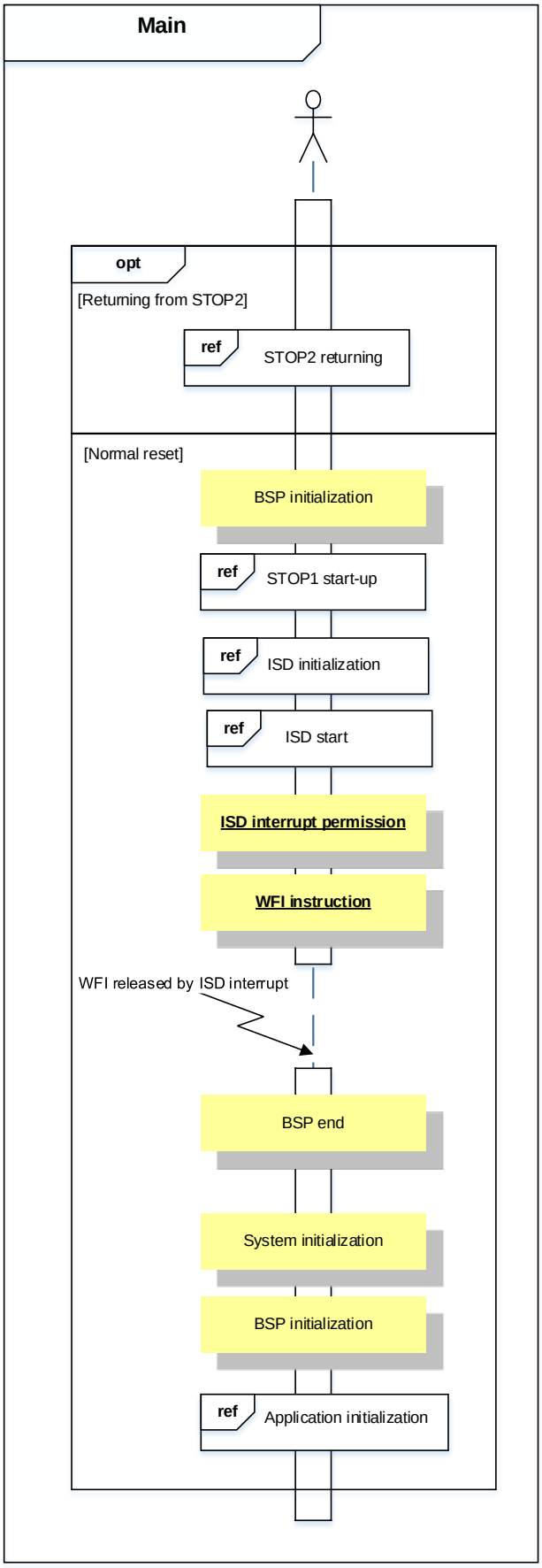
9.2. Sample Program Main Operation

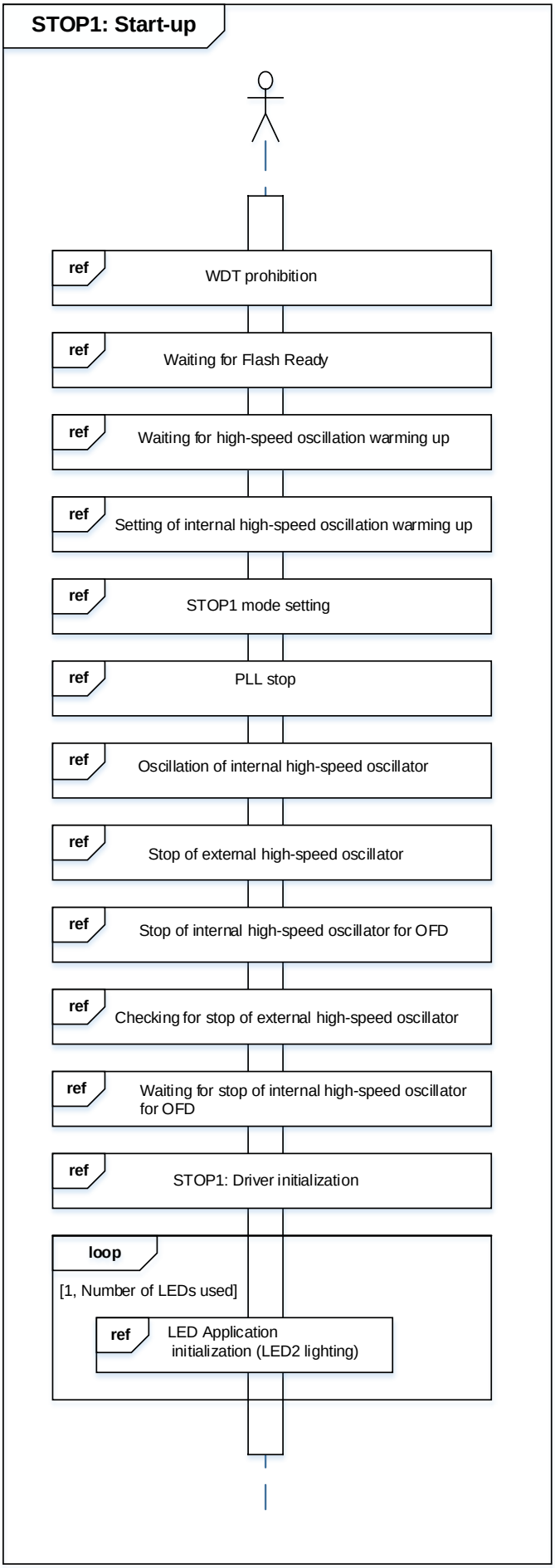
The initial setting of this sample program operates in STOP1 mode.
Here is the main operation.
As the initialization of the low power consumption STOP1 mode, the functions such as external oscillation are not used, the LED is initialized, and the warming-up time of internal oscillation is set.
Initialize ISD and start ISD.
ISD interrupt is enabled.
Shift to low power consumption mode and wait until push switch S6 is detected.

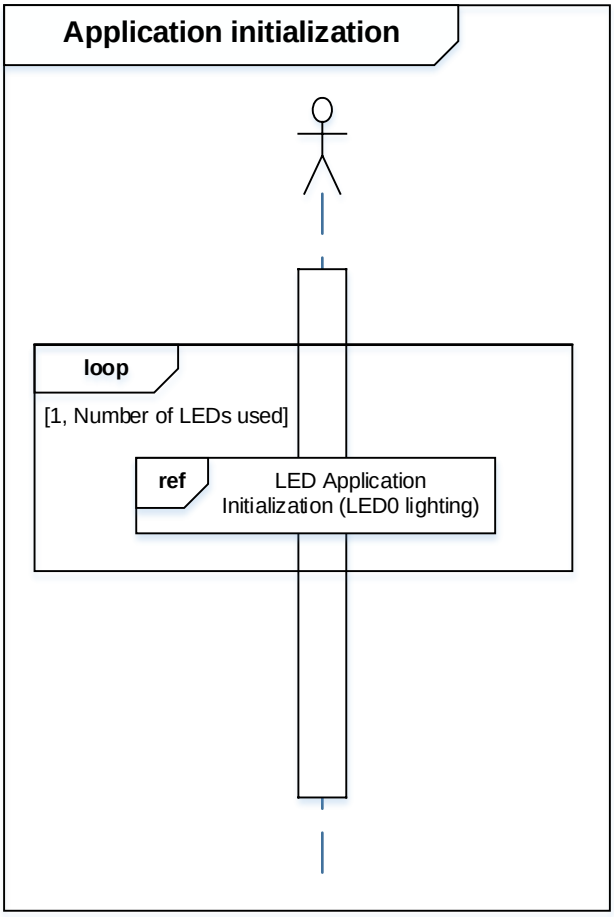
When the push switch is pressed down, the low power consumption mode is released.
After the set warm-up time has elapsed, it will shift to NORMAL mode.
The initialization of BSP is executed.
The initialization of LED is executed as application initialization.

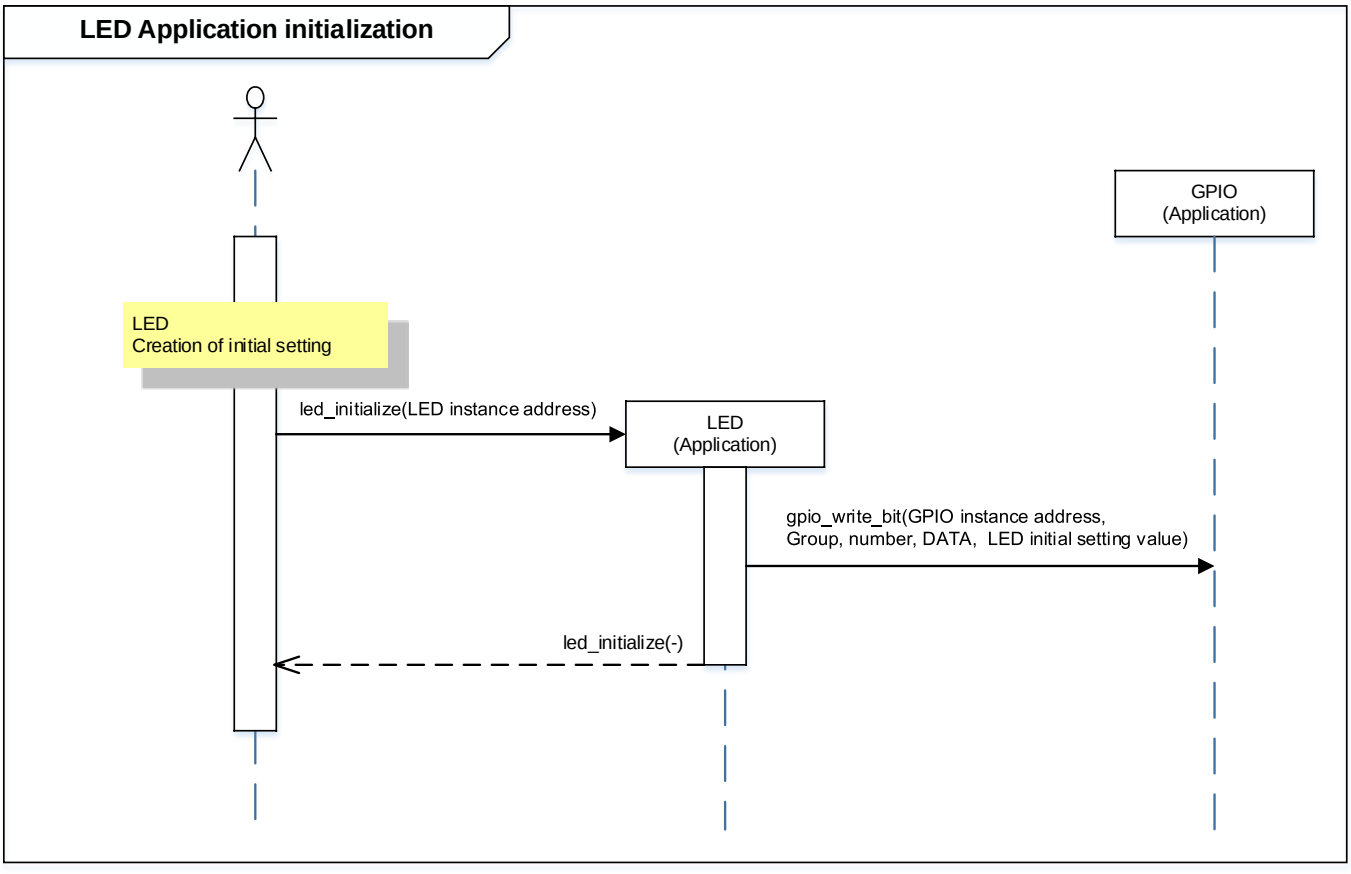
9.3. Operating Flow of Sample Program

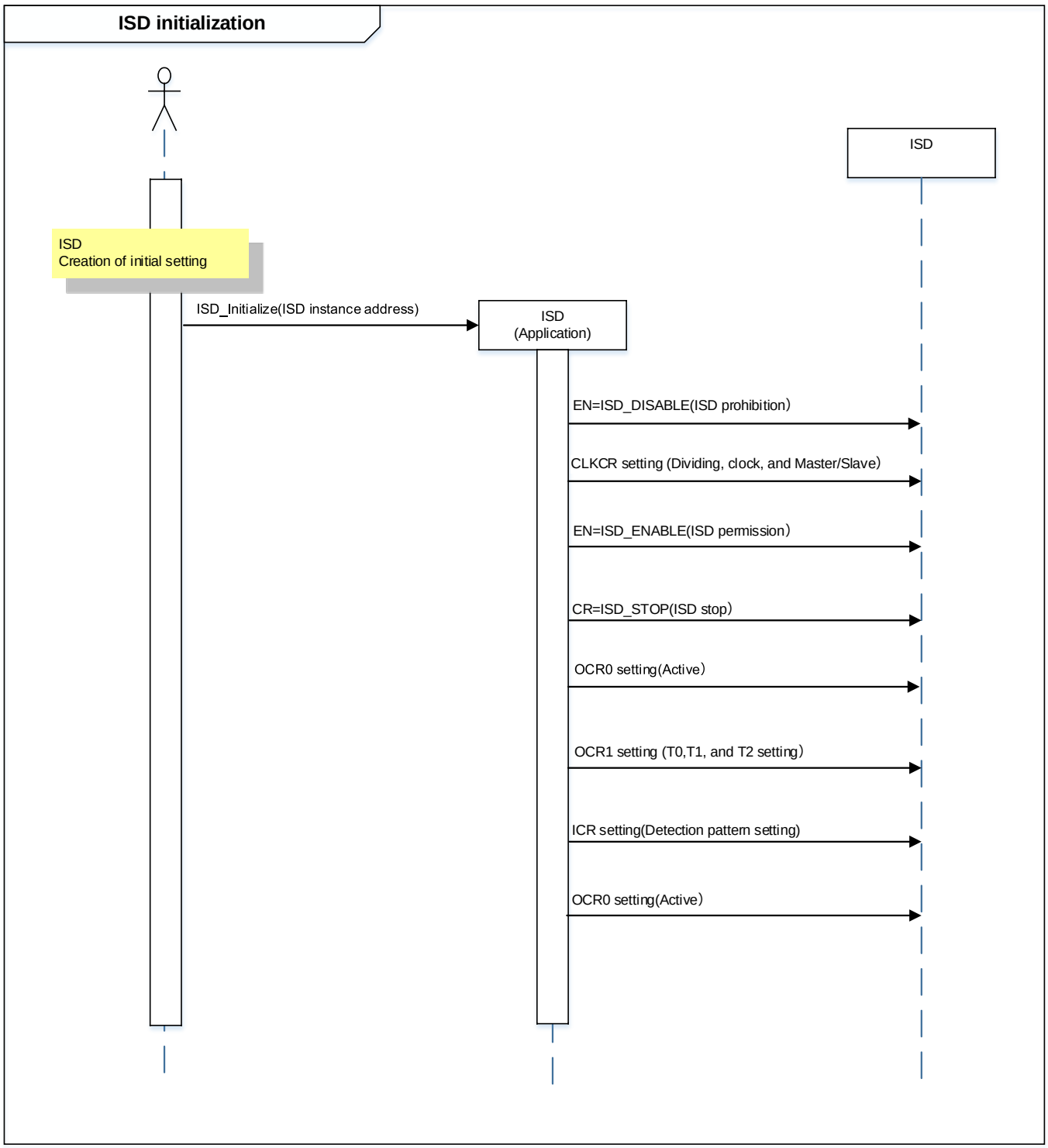
The basic operating flows of the sample program are shown in the following.
This sample program operates only in STOP1 mode.

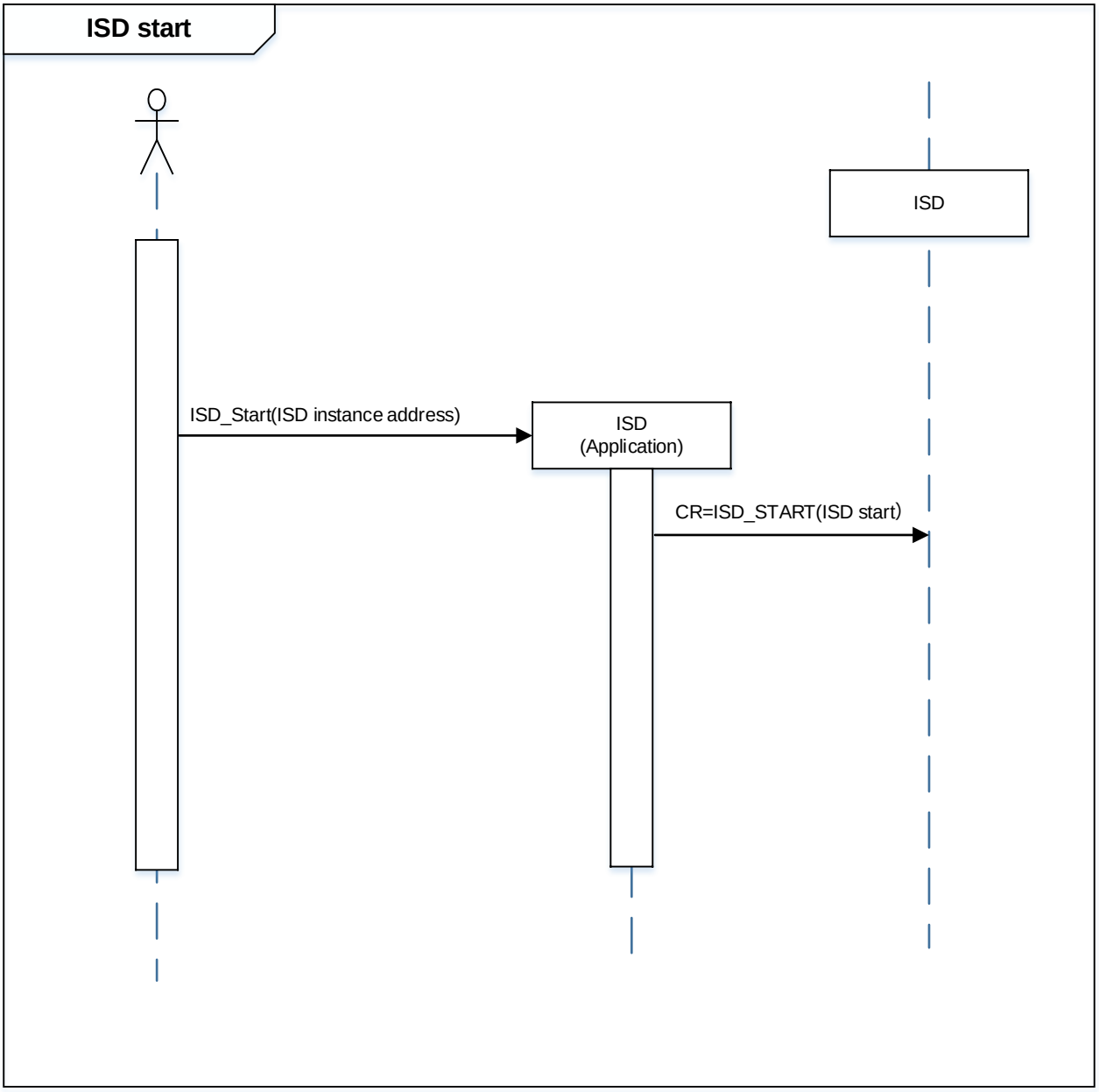


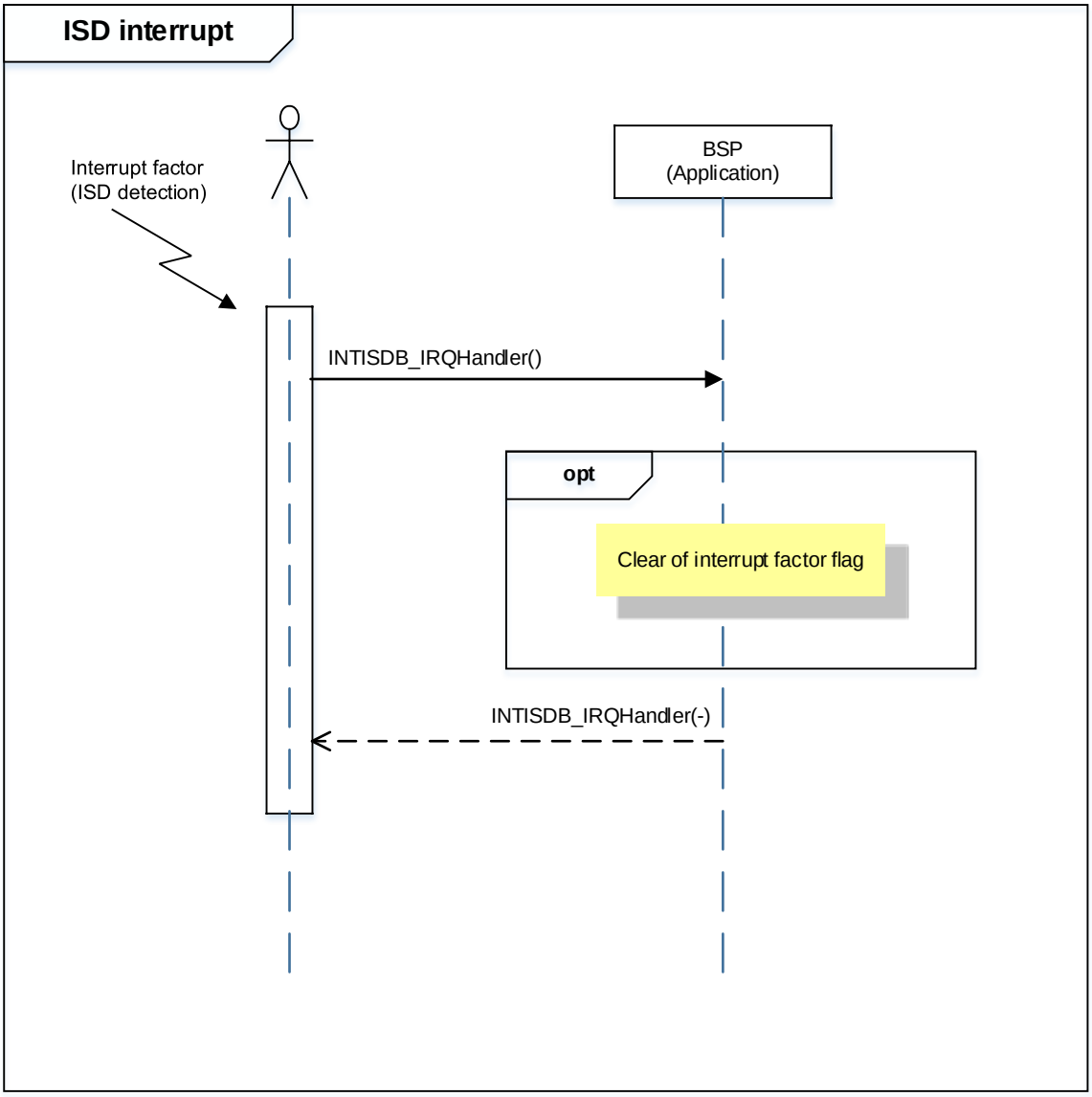

STOP1: Start-up
ref
WDT prohibition
ref
Waiting for Flash Ready
ref
Waiting for high-speed oscillation warming up
ref
Setting of internal high-speed oscillation warming up
ref
STOP1 mode setting
ref
PLL stop
ref
Oscillation of internal high-speed oscillator
ref
Stop of external high-speed oscillator
ref
Stop of internal high-speed oscillator for OFD
ref
Checking for stop of external high-speed oscillator
ref
Waiting for stop of internal high-speed oscillator for OFD
ref
STOP1: Driver initialization
loop
[1, Number of LEDs used]
ref
LED Application initialization (LED2 lighting)


Application initialization
loop
[1, Number of LEDs used]
ref
LED Application
Initialization (LED0 lighting)


LED Application initialization
GPIO
(Application)
LED
Creation of initial setting
led_initialize(LED instance address)
LED
(Application)
gpio_write_bit(GPIO instance address,
Group, number, DATA, LED initial setting value)
led_initialize(-)


ISD initialization
ISD
ISD
Creation of initial setting
ISD_Initialize(ISD instance address)
ISD
(Application)
EN=ISD_DISABLE(ISD prohibition)
CLKCR setting (Dividing, clock, and Master/Slave)
EN=ISD_ENABLE(ISD permission)
CR=ISD_STOP(ISD stop)
OCR0 setting(Active)
OCR1 setting (T0,T1, and T2 setting)
ICR setting(Detection pattern setting)
OCR0 setting(Active)


ISD start
ISD
ISD_Start(ISD instance address)
ISD
(Application)
CR=ISD_START(ISD start)


ISD interrupt
Interrupt factor
(ISD detection)
BSP
(Application)
INTISDB_IRQHandler()
opt
Clear of interrupt factor flag
INTISDB_IRQHandler(-)

10. Precaution

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

11. Revision History

Rev	Date	Description
1.0	2018-12-11	First release

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