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Application Note

V850ES/Jx3-L

Sample Program (Low-Voltage Detector (LVI))

Reset Generation When Low Voltage Detected

This document summarizes the operations of the sample program and describes how to use the sample program and how to set and use the low-voltage detector (LVI). In the sample program, an internal reset (LVI reset) signal is generated by detecting that V_{DD} is less than V_{LVI} (V_{LVI} = 2.80 V (typ.)). With an LVI reset, the LED lighting pattern immediately before the LVI reset is retained and then restored after LVI reset release.

Target devices
V850ES/JF3-L microcontroller
V850ES/JG3-L microcontroller

CONTENTS

Document No. U19496EJ1V0AN00 (1st edition)
Date Published January 2009 N

CHAPTER 1 OVERVIEW

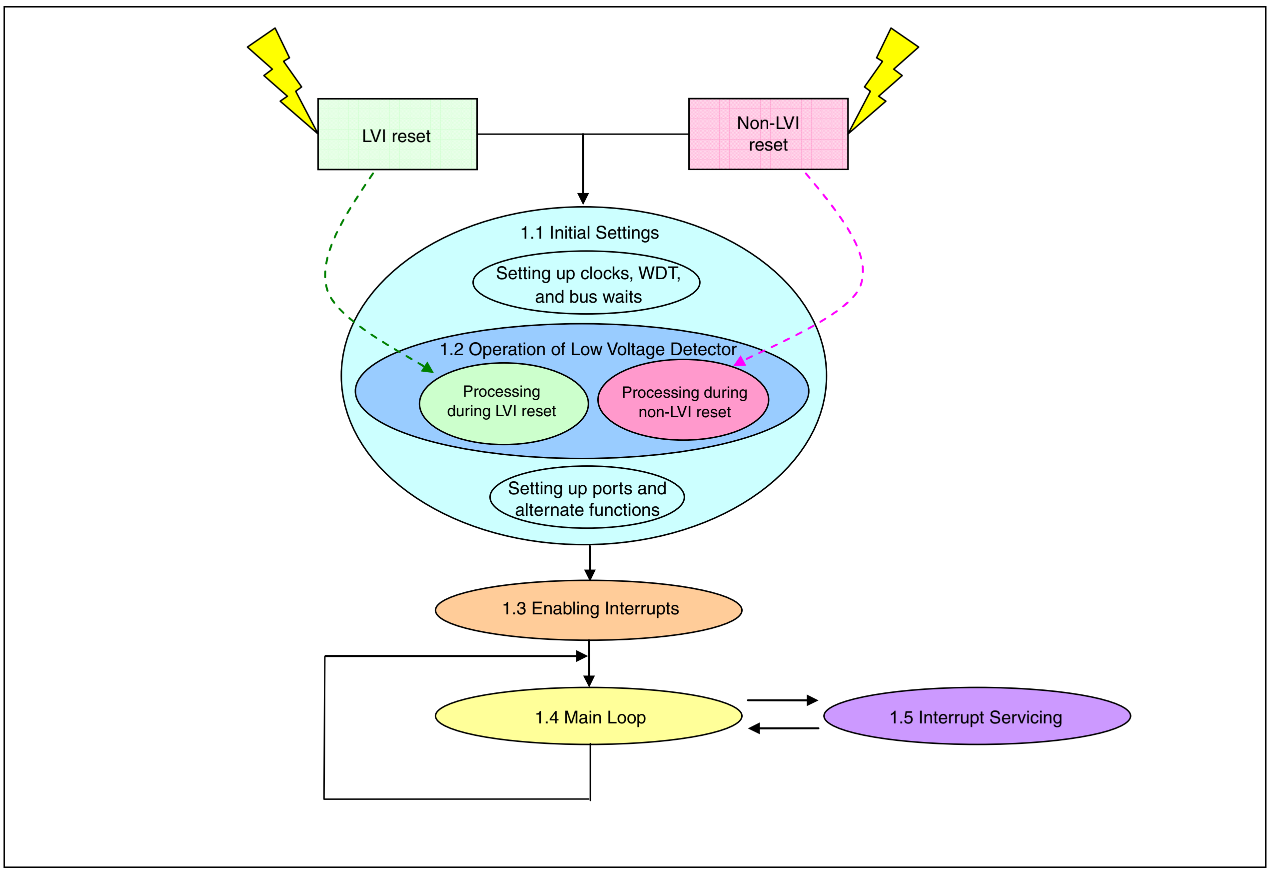
In this sample program, an example of using the low-voltage detector (LVI) is presented.

The low-voltage detector is used to detect that V_{DD} is less than V_{LVI} (V_{LVI} = 2.80 V (typ.)), and it is set to generate an internal reset (LVI reset) signal.

After completion of the initial setup, an LED lighting pattern is displayed according to the number of switch inputs by detecting the falling edge of the switch input and servicing interrupts. (This processing is the same as that described in the **V850ES/Jx3-L Sample Program (Interrupt) External Interrupt Generated by Switch Input Application Note**.)

When a non-LVI reset is generated, the program is used to initialize the LED lighting pattern data held in the internal RAM. When an LVI reset is generated, the LED lighting pattern data immediately before reset generation is retained and then restored and displayed after the LVI reset is released.

The main software processes are shown below.



1.1 Initial Settings

<Referencing option byte>

- Referencing the oscillation stabilization time after releasing reset

<Settings of on-chip peripheral functions>

- Setting wait operations <wait: 1> for bus access to on-chip peripheral I/O registers
- Setting on-chip debug mode <normal operation mode>
- Stopping the internal oscillator and watchdog timer
- Setting not to divide the CPU clock frequency
- Setting to PLL mode and setting to 20 MHz operation (5 MHz × 4)
- Setting V_{LVI} (low-voltage detection voltage) to 2.80 V (typ.) and setting <reset> operation when low-voltage is detected[Note]

Note No setting is made when the system is restarted by an LVI reset.

<Pin settings>

- Setting unused pins
- Setting external interrupt pins (edge specification, priority specification, unmasking)
- Setting LED output pins (specifying the value at which LED1 and LED2 are turned off when a non-LVI reset occurs and specifying the output value prior to reset when an LVI reset occurs)

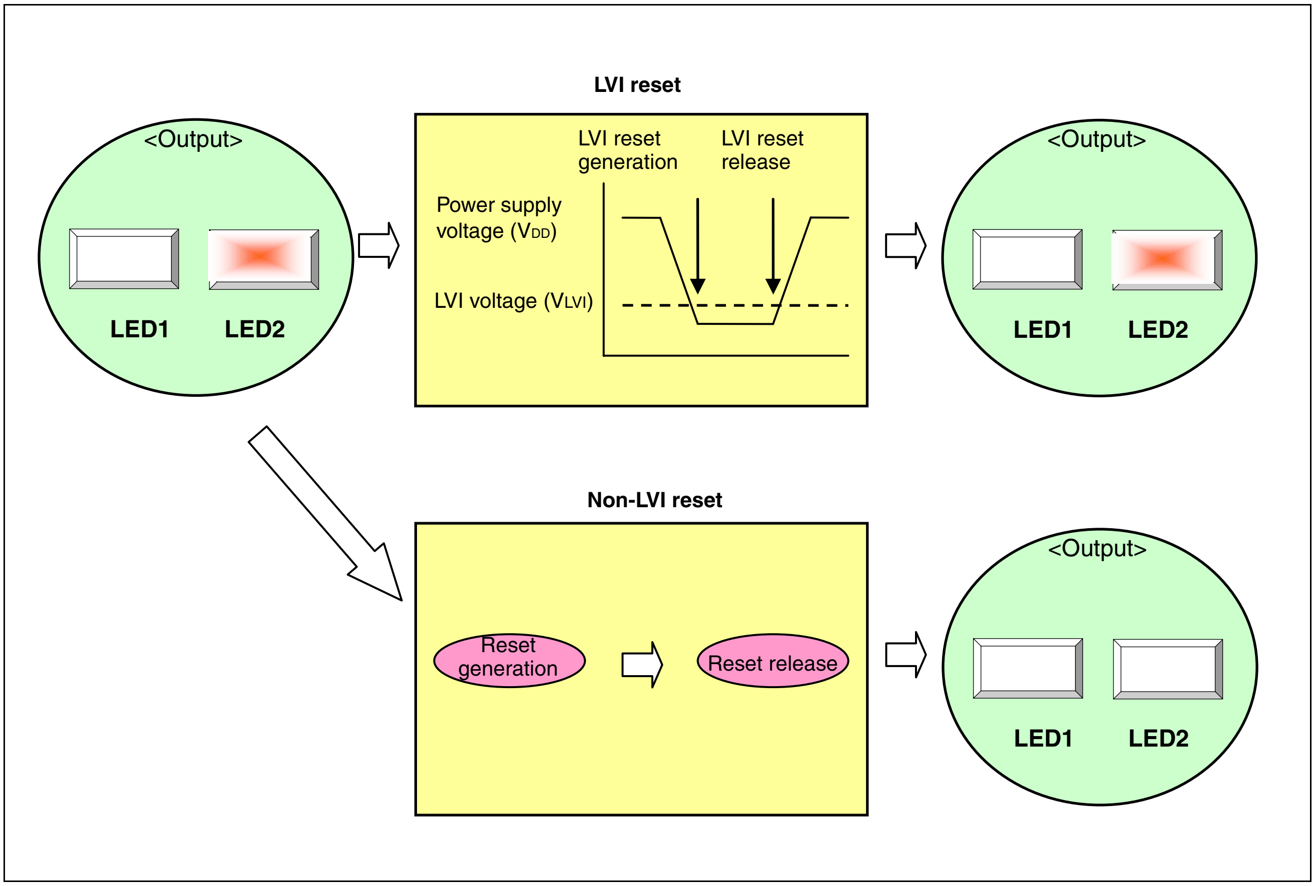
<ROMization>

- ROMization processing (initialization of variables with initial values)

1.2 Operation of Low-Voltage Detector (LVI)

In this sample program, an internal reset (LVI reset) is generated by the low-voltage detector (LVI) when V_{DD} becomes less than V_{LVI}.

At this time, register values are initialized, but the internal RAM retains the data immediately before the reset. Therefore, the LED lighting pattern immediately before the LVI reset is retained, enabling it to be restored after LVI reset release. When a reset is generated by other than LVI, the program initializes the LED lighting pattern and all LEDs are turned off.



1.3 Enabling Interrupts

- Enabling interrupts by using the EI instruction

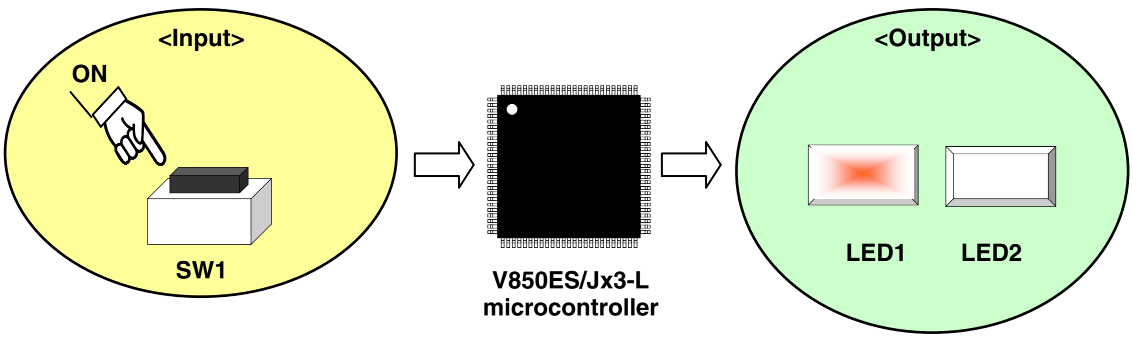
1.4 Main Loop

- Executing an infinite loop that executes no processing (waiting for an interrupt generated by switch input)

1.5 Interrupt Servicing

Interrupts are serviced by detecting the falling edge of the INTP0 pin, caused by switch input. In interrupt servicing, the LED lighting pattern is changed by confirming that the switch is on, after about 10 ms have elapsed after the falling edge of the INTP0 pin was detected.

The switch being off, after about 10 ms have elapsed after the falling edge of the INTP0 pin was detected, is identified as chattering noise and the LED lighting pattern is not changed.



Switch input and a change in the LED lighting pattern are repeated alternately.

Table 1-1. LED Lighting Patterns

Switch (SW1) Input Count[Note]	LED1	LED2
0	OFF	OFF
1	ON	OFF
2	OFF	ON
3	ON	ON

Note Inputs 0 to 3 are repeated from the fourth input.

Caution See the product user's manual (V850ES/Jx3-L) for cautions when using the device.

[Column] Chattering

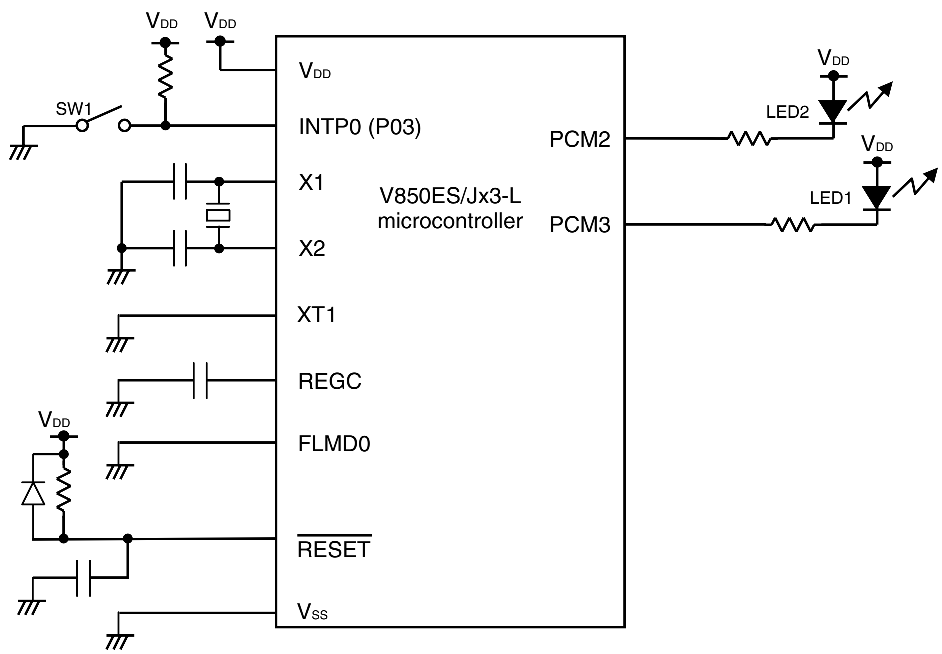
Chattering is a phenomenon in which the electric signal repeats turning on and off due to a mechanical flip-flop of the contacts, immediately after the switch has been pressed.

CHAPTER 2 CIRCUIT DIAGRAM

This chapter describes the circuit diagram and peripheral hardware to be used in this sample program.

2.1 Circuit Diagram

The circuit diagram is shown below.



Cautions 1. Connect the EV_{DD}, AV_{REF0}, and AV_{REF1} pins directly to V_{DD}.

2. Connect the EV_{SS} and AV_{SS} pins directly to GND.

3. Connect the FLMD0 pin to GND in normal mode.

4. Connect REGC to GND via a capacitor (recommended value: 4.7 μF).

5. Leave all unused ports open, because they will be handled as output ports.

2.2 Peripheral Hardware

The peripheral hardware to be used is shown below.

(1) Switch (SW1)

This switch is used as an interrupt input to control the lighting of the LEDs.

(2) LEDs (LED1, LED2)

The LEDs are used as outputs corresponding to the number of switch inputs.

CHAPTER 3 SOFTWARE

This chapter describes the file configuration of the compressed files to be downloaded, on-chip peripheral functions of the microcontroller to be used, and the initial settings and an operation overview of the sample program. A flowchart is also shown.

3.1 File Configuration

The following table shows the file configuration of the compressed files to be downloaded.

[C language version]

File Name (Tree Structure)			Description	Compressed (*.zip) Files Included	
					
c	conf	crtE.s	Startup routine file[Note 1]	–	●
		AppNote_LVI.dir	Link directive file[Note 2]	●	●
		AppNote_LVI.prj	Project file for integrated development environment PM+	–	●
		AppNote_LVI.prw	Workspace file for integrated development environment PM+	–	●
	src	main.c	C language source file including descriptions of hardware initialization processing and main processing of microcontroller	●	●
		minicube2.s	Source file for reserving area for MINICUBE2	●	●
		opt_b.s	Source file for setting option byte	●	●

Notes 1. This is the startup file copied when “Copy and Use the Sample file” is selected when “Specify startup file” is selected when creating a new workspace. (If the default installation path is used, the startup file will be a copy of C:\Program Files\NEC Electronics Tools\CA850*Version used*\lib850\r32\crtE.s.)

2. This is the link directive file automatically generated when “Create and Use the Sample file” is selected and “Memory Usage: Use Internal memory only” is checked when “Specify link directive file” is selected when creating a new workspace, and to which a segment for MINICUBE2 is added. (If the default installation path is used, C:\Program Files\NEC Electronics Tools\PM+*Version used*\bin\w_data\V850_i.dat is used as the reference file.)

Remark  : Only the source file is included.

 : The files to be used with integrated development environment PM+ are included.

3.2 On-Chip Peripheral Functions Used

The following on-chip peripheral functions of the microcontroller are used in this sample program.

- Low-voltage detector ($V_{DD} < V_{LVI}$): LVI
- External interrupt input (for switch input): INTP0 (SW1)
- Output ports (for lighting LEDs): PCM2 (LED2), PCM3 (LED1)

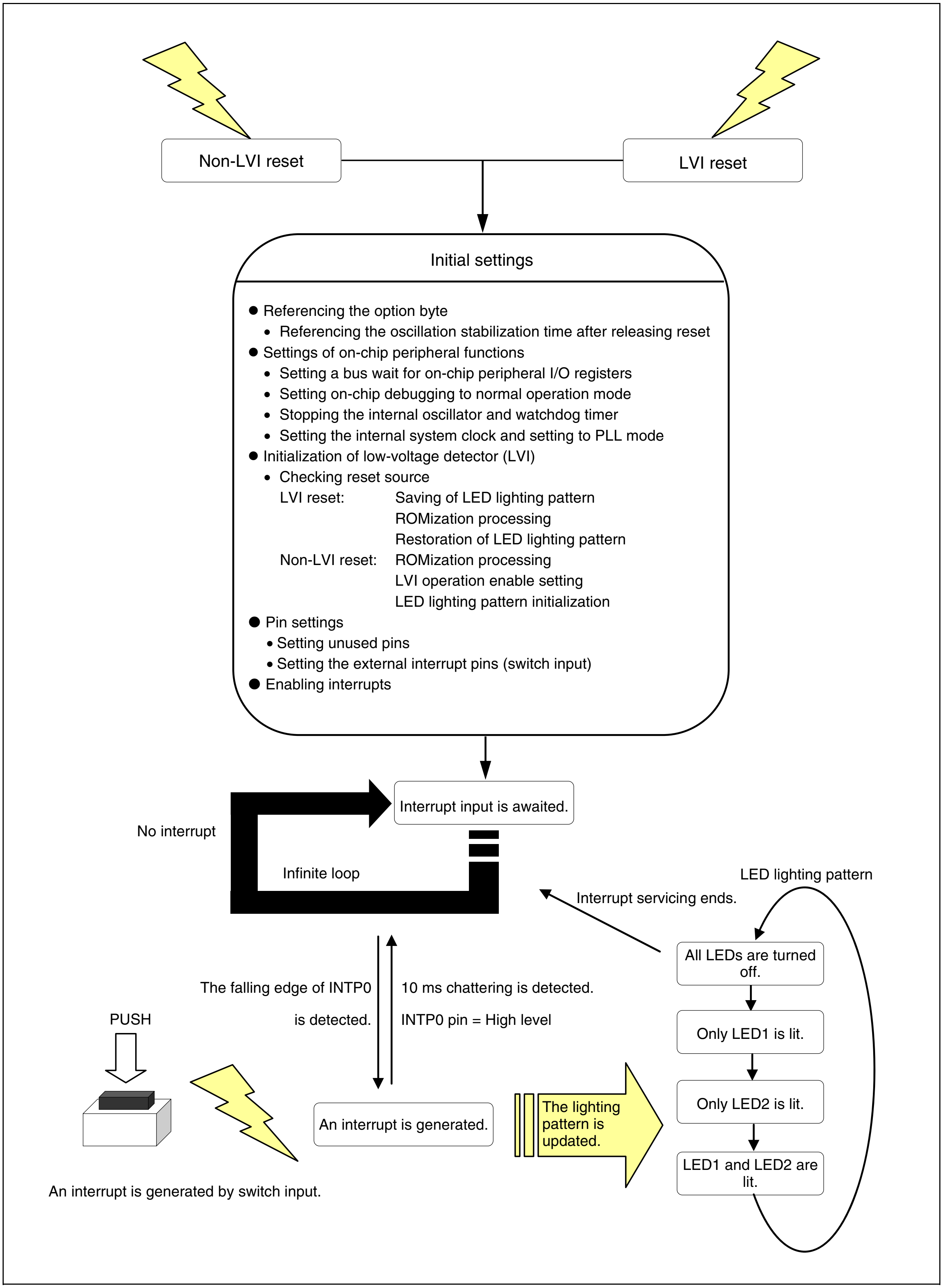
3.3 Initial Settings and Operation Overview

In this sample program, the selection of the clock frequency and settings such as the setting for stopping the watchdog timer, the setting of the I/O ports and external interrupt pins, setting of interrupts, and setting of LVI are performed as the initial settings.

After completion of the initial settings, the lighting pattern of two LEDs (LED1 and LED2) is controlled according to the number of switch (SW1) inputs, by detecting the falling edge of the switch input (SW1) and performing interrupt servicing. (This processing is the same as that described in the **V850ES/Jx3-L Sample Program (Interrupt) External Interrupt Generated by Switch Input Application Note**.)

In this sample program, variables without initial values are initialized in the startup routine. Therefore, in order to prevent the LED lighting pattern being initialized in the startup routine, the variables in the LED lighting pattern are defined as variables with initial values. If an LVI reset occurs during ROMization processing, the LED lighting pattern immediately before the LVI reset is retained in the internal RAM, enabling it to be restored after LVI reset release. When a reset is generated by other than LVI, the program initializes the LED lighting pattern and all LEDs are turned off.

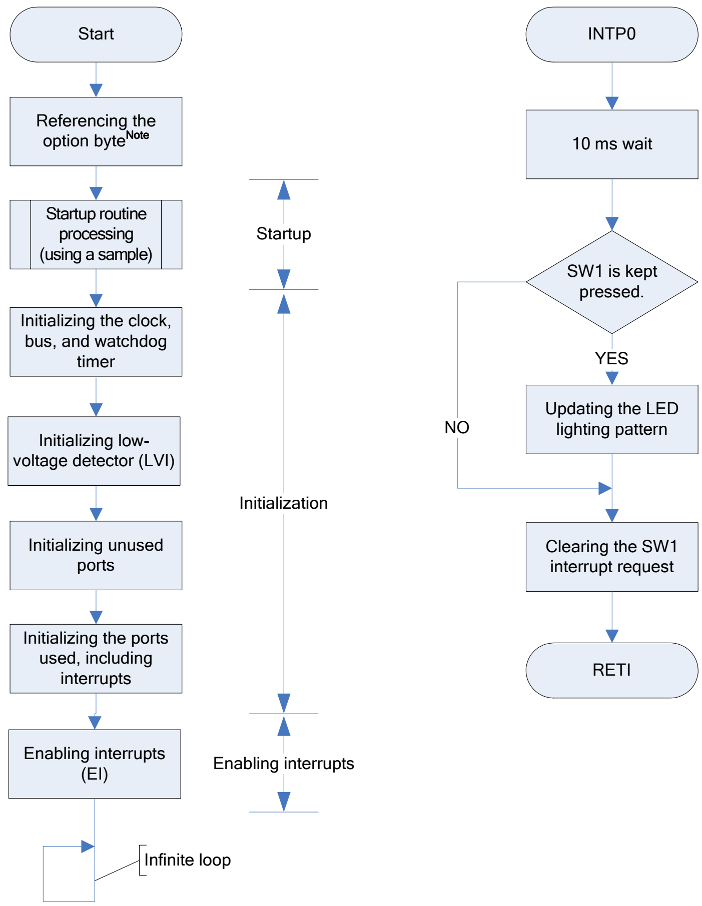
This is described in detail in the state transition diagram shown on the next page.



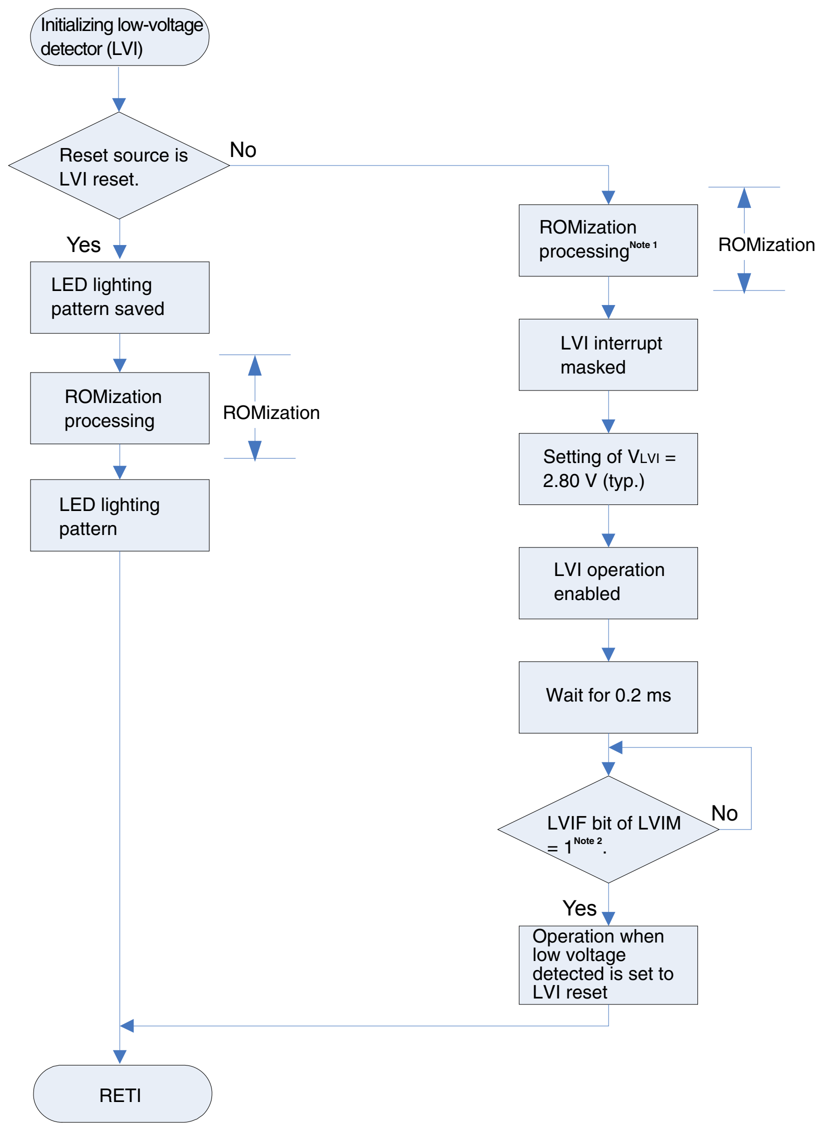
Non-LVI reset
LVI reset
Initial settings
● Referencing the option byte
• Referencing the oscillation stabilization time after releasing reset
● Settings of on-chip peripheral functions
• Setting a bus wait for on-chip peripheral I/O registers
• Setting on-chip debugging to normal operation mode
• Stopping the internal oscillator and watchdog timer
• Setting the internal system clock and setting to PLL mode
● Initialization of low-voltage detector (LVI)
• Checking reset source
LVI reset: Saving of LED lighting pattern
ROMization processing
Restoration of LED lighting pattern
Non-LVI reset: ROMization processing
LVI operation enable setting
LED lighting pattern initialization
● Pin settings
• Setting unused pins
• Setting the external interrupt pins (switch input)
● Enabling interrupts
Interrupt input is awaited.
No interrupt
Infinite loop
LED lighting pattern
Interrupt servicing ends.
All LEDs are turned off.
The falling edge of INTP0 is detected.
10 ms chattering is detected.
INTP0 pin = High level
PUSH
Only LED1 is lit.
Only LED2 is lit.
An interrupt is generated.
The lighting pattern is updated.
LED1 and LED2 are lit.
An interrupt is generated by switch input.

3.4 Flowchart

A flowchart for the sample program is shown below.



Note The option byte is automatically referenced by the microcontroller after reset is released. In this sample program, the oscillation stabilization time after releasing reset is set to 6.554 ms with the option byte.



Notes 1. If the reset source is a non-LVI reset, the LED lighting pattern is initialized as part of the ROMization processing.

2. The LVIF bit of LVIM is set when V_{DD} rises to greater than V_{LVI}.

[Column] Contents of the startup routine

The startup routine is a routine that is executed before executing the main function after reset of the V850 is released. Basically, the startup routine executes initialization so that the program written in C language can start operating.

Specifically, the following are performed.

- Securing the argument area of the main function
- Securing the stack area
- Setting the RESET handler when reset is issued
- Setting the text pointer (tp)
- Setting the global pointer (gp)
- Setting the stack pointer (sp)
- Setting the element pointer (ep)
- Setting mask values to the mask registers (r20 and r21)
- Clearing the sbss and bss areas to 0
- Setting the CTBP value for the prologue epilogue runtime library of the function
- Setting r6 and r7 as arguments of the main function
- Branching to the main function

3.5 Differences Between V850ES/JG3-L and V850ES/JF3-L

The V850ES/JG3-L is the V850ES/JF3-L with its functions, such as I/Os, timer/counters, and serial interfaces, expanded.

In this sample program, the port initialization range of P1, P3, P7, P9, and PDH in I/O initialization differs.

See **APPENDIX A PROGRAM LIST** for details of the sample program.

3.6 ROMization

In this sample program, the ROMization information is copied during initialization of LVI.

For details of ROMization, see the **V850ES/Jx3-L Sample Program (Interrupt) External Interrupt Generated by Switch Input Application Note**.

3.7 Security ID

The content of the flash memory can be protected from unauthorized reading by using a 10-byte ID code for authorization when executing on-chip debugging using an on-chip debug emulator.

For details of ID security, see the **V850ES/Jx3-L Sample Program (Interrupt) External Interrupt Generated by Switch Input Application Note**.

3.8 Notes on Operating Sample Program When Using MINICUBE2

When operating the sample program via the on-chip debug emulator, be aware that a program break will occur when an LVI reset is generated. Also, when the operating voltage of MINICUBE2 is less than 2.7 V, MINICUBE2 and the target device may not be able to communicate properly, which may lead to a malfunction.

For a detailed explanation of how to execute a program when using MINICUBE2, see the **QB-MINI2 On-Chip Debug Emulator with Programming Function User's Manual** and the **ID850QB Ver. 3.40 Integrated Debugger Operation User's Manual**.

The procedure for checking that an LVI reset has been executed correctly by this sample program when using MINICUBE2 is shown below for reference.

- Procedure for checking LVI reset
  <1> Check that the power supply voltage is 3.3 V and start the debugger via a reset.
  <2> Press the switch to light the LEDs.
  <3> Set the power supply voltage to about 2.75 V[Note 1].
  <4> Check that the LEDs are off.
  <5> Set the power supply voltage to 3.3 V, check that the debugger is in the stopped state, then start[Note 2] the debugger.
  <6> Check that the LED lighting pattern has been restored.

Notes 1. Take care to set a voltage between the value at which the LEDs are turned off when an LVI reset occurs (2.8 V typ.) and the value at which MINICUBE2 remains operating (2.7 V or higher).

2. Be aware that if the debugger is started via a reset here instead of simply started, the LED lighting pattern will not be able to be restored if a non-LVI reset occurs after an LVI reset.

CHAPTER 4 SETTING REGISTERS

This chapter describes the low-voltage detector (LVI) settings.

For other initial settings, refer to the **V850ES/Jx3-L Sample Program (Initial Settings) LED Lighting Switch Control Application Note**. For interrupt, refer to the **V850ES/Jx3-L Sample Program (Interrupt) External Interrupt Generated by Switch Input Application Note**.

Among the peripheral functions that are stopped after reset is released, those that are not used in this sample program are not set.

For how to set registers, see each product user's manual.

- V850ES/JG3-L 32-bit Single-Chip Microcontroller
  Hardware User's Manual
- V850ES/JF3-L 32-bit Single-Chip Microcontroller
  Hardware User's Manual

See the following user's manuals for details of extended descriptions in C and assembly languages.

- CA850 C Compiler Package C Language User's Manual
- CA850 C Compiler Package Assembly Language User's Manual

4.1 Setting Low-Voltage Detector (LVI)

The low-voltage detector has the following two types of operation modes.

- Using it as a reset (see [Example 1])
- Using it as an interrupt (see [Example 2])

The low-voltage detector is mainly controlled by the following two types of registers.

- Low-voltage detection register (LVIM)
- Low-voltage detection level select register (LVIS)

4.1.1 Settings regarding low-voltage detection

The low-voltage detection register (LVIM) is used to set the low-voltage detection operation mode and control the operation.

In this sample program, the LVIM register is set so that the internal reset signal is generated when a low voltage is detected.

The LVIM register can be read or written in 8-bit or 1-bit units. However, the LVIF flag can only be read.

The value of the LVIM register after reset is 0x82 in the case of a reset generated by the detection of a low voltage, and 0x00 in the case of a reset generated by another source.

Figure 4-1. Format of LVIM Register

Low-voltage detection register (LVIM)
Address: 0xFFFFF890

7	6	5	4	3	2	1	0
LVION	0	0	0	0	0	LVIMD	LVIF

LVION	Enabling or disabling of low-voltage detection operation
0	Disables operation
1	Enables operation

LVIMD	Low-voltage detection operation mode selection
0	The interrupt request signal INTLVI is generated when the power supply voltage drops or rises across the detection voltage value
1	The internal reset signal LVIRES is generated when the power supply voltage falls below the detection voltage.

LVIF	Low-voltage detection flag (read only)
0	When power supply voltage > detection voltage or when operation is prohibited
1	When connected power supply voltage < detection voltage

Remarks 1 The red values indicate the setting values used in the sample program.

2. The blue values indicate the bits to be checked in the sample program.

4.1.2 Settings regarding low-voltage detection level

The low-voltage detection level select register (LVIS) is used to set the low-voltage detection level.

In this sample program, the low-voltage detection level is set to 2.80 V (typ.).

The LVIS register can be read or written in 8-bit or 1-bit units.

The LVIS register retains the value it had immediately before the reset in the case of a reset generated by the detection of a low voltage; in the case of a reset generated by another source, the LVIS register is set to 0x00.

Figure 4-2 Format of LVIS Register

Low-voltage detection register (LVIS)
Address: 0xFFFFF891

7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	LVIS0

LVIS0	Control of low-voltage detection level
0	2.80 V (typ.)
1	2.30 V (typ.)

Remark The red values indicate the setting values used in the sample program.

[Example 1] Using the low-voltage detection as a reset by setting the low-voltage detection level (V_{LVI}) to 2.80 V (same content as the sample program)

• Setting procedure

<1> Mask the LVI interrupt.

<2> Set the detection voltage using the LVIS.LVIS0 bit.

<3> Set the LVIM.LVION bit to 1 (operation enabled).

<4> Use software to insert a wait of at least 0.2 ms (a wait of 0.25 ms is set in the program example).

<5> Check the LVIM.LVIF bit to see if the power supply voltage is higher than the detection voltage.

<6> Set the LVIMD bit to 1 (internal reset generated).

Caution Once the LVIMD bit has been set to 1, the LVIM and LVIS registers cannot be changed until a non-LVI reset occurs.

• Program example (same content as the sample program)

```
LVIMK = 1;            /* Mask the LVI interrupt                        */   } <1>
LVIS0 = 0;            /* Set the low-voltage detection level to 2.80 V */   } <2>
/* Enable the low-voltage detector operation */
#pragma asm
    push r10
    mov 0x80, r10
    st.b r10, PRCMD
    set1 LVION                                                              <3>
    pop r10
#pragma endasm

/* Wait of 250 µs(0.25 ms) */
for( loop_wait = 0 ; loop_wait < LIMIT_250us_WAIT ; loop_wait++ )            <4>
{
       __nop();
}

while( LVIF == 1 );   /* Note that the program enters an infinite      */   <5>
                      /* loop until the power supply voltage rises     */
                      /* above the detection voltage                   */
/* Setting operation when low voltage is detected to reset operation */
#pragma asm
    push r10
    mov 0x02, r10
    st.b r10, PRCMD
    set1 LVIMD                                                              <6>
    pop r10
#pragma endasm
```

[Example 2] Using the low-voltage detection function as an interrupt by setting the low-voltage detection level (V_{LVI}) to 2.80 V.

- Setting procedure

<1> Mask the LVI interrupt.

<2> Set the detection voltage using the LVIS.LVIS0 bit.

<3> Set the LVIM.LVION bit to 1 (operation enabled).

<4> Use software to insert a wait of at least 0.2 ms (a wait of 0.25 ms is set in the program example).

<5> Check the LVIM.LVIF bit to see if the power supply voltage is higher than the detection voltage.

<6> Clear the interrupt request flag of LVI.

<7> Release the interrupt mask of LVI

Caution Once the LVIMD bit has been set to 1, the LVIM and LVIS registers cannot be changed until a non-LVI reset occurs.

- Program example

```
LVIMK = 1;           /* Mask the LVI interrupt                          */ }  <1>
LVIS0 = 0;           /* Set the low-voltage detection level to 2.80 V   */ }  <2>
/* Enables the low-voltage detector operation /
#pragma asm
    push r10
    mov 0x80, r10
    st.b r10, PRCMD
    set1 LVION                                                               <3>
    pop r10
#pragma endasm

/* Wait of 250 µs(0.25 ms) */
for( loop_wait = 0 ; loop_wait < LIMIT_250us_WAIT ; loop_wait++ )            <4>
{
        __nop();
}

while( LVIF == 1 );  /* Note that the program enters an infinite         */   <5>
                     /* loop until the power supply voltage rises       */
                     /* above the detection voltage                     */

LVIIF = 0;           /* Clear the interrupt request flag of LVI            }  <6>

LVIMK = 0;           /* Release the interrupt mask of LVI                  }  <7>
```

4.2 Checking Detection of LVI Reset

When an LVI reset occurs, the LVIRF bit of the reset source flag register (RESF) is set. On the other hand, when a reset is generated by an input to the RESET pin, the LVIRF bit is cleared. Therefore, by checking the LVIRF bit after the reset is released, it is possible to ascertain whether the reset source was an LVI reset or an input to the RESET pin.

4.2.1 Reset source flag register (RESF)

The RESF register stores information on which reset signal—the reset signal from which source—generated a reset.

This register can be read or written in 8-bit or 1-bit units.

Note, however, that the RESF register can only be written using a combination of specific sequences.

A reset generated by an input to the RESET pin sets this register to 00H. A reset generated by any other source, such as watchdog timer 2 (WDT2), the low-voltage detector (LVI), or the clock monitor (CLM), sets the flag of the corresponding source (WDT2RF, CLMRF, LVIRF bits); the other source flags hold their previous values.

Figure 4-2. Format of RESF Register

Reset source flag register (RESF)
Address: 0xFFFFF888

7	6	5	4	3	2	1	0
0	0	0	WDT2RF	0	0	CLMRF	LVIRF

WDT2RF	Occurrence of reset signal from WDT2
0	Did not occur
1	Occurred

CLMRF	Occurrence of reset signal from CLM
0	Did not occur
1	Occurred

LVIRF	Occurrence of reset signal from LVI
0	Did not occur
1	Occurred

Caution The blue values indicate the bits to be checked in the sample program.

Remarks 1. Only 0 can be written to each bit. If writing 0 conflicts with the flag being set (due to the occurrence of a reset), flag setting takes precedence.

2. If watchdog timer 2 (WDT2), the low-voltage detector (LVI), and the clock monitor (CLM) are being used at the same time, the relevant reset source flag must be cleared after checking the reset source.

[Clearing the reset source flag]
As mentioned in Remark 2 on the previous page, there are cases when the reset source flag has to be cleared after checking the reset source. In this sample program, however, the reset source flag does not have to be cleared because only the low-voltage detector (LVI) is being used.

CHAPTER 5 RELATED DOCUMENTS

Document	English
V850ES/JF3-L Hardware User's Manual	PDF
V850ES/JG3-L Hardware User's Manual	PDF
PM+ Ver.6.30 User's Manual	PDF
CA850 Ver.3.20 C Compiler Package Operation User's Manual	PDF
CA850 Ver.3.20 C Compiler Package C Language User's Manual	PDF
CA850 Ver.3.20 C Compiler Package Assembly Language User's Manual	PDF
CA850 Ver.3.20 C Compiler Package Link Directive User's Manual	PDF
V850ES Architecture User's Manual	PDF
QB-MINI2 On-Chip Debug Emulator with Programming Function User's Manual	PDF
ID850QB Ver. 3.40 Integrated Debugger Operation User's Manual	PDF

APPENDIX A PROGRAM LIST

The V850ES/Jx3-L microcontroller source program is shown below as a program list example.

- opt_b.s

```
#--------------------------------------------------------------------------------
#
#    NEC Electronics     V850ES/Jx3-L series
#
#--------------------------------------------------------------------------------
#    V850ES/JG3-L JF3-L  sample program
#--------------------------------------------------------------------------------
#    Reset Generation When Low Voltage Detected
#--------------------------------------------------------------------------------
#[History]
#    2008.9.--   Released
#--------------------------------------------------------------------------------
#[Overview]
#    This sample program sets the option byte.
#--------------------------------------------------------------------------------

     .section "OPTION_BYTES"
     .byte 0b00000101 -- 0x7a (5 MHz: Sets the oscillation stabilization time to 6.554 ms.)
     .byte 0b00000000 -- 0x7b            ↑
     .byte 0b00000000 -- 0x7c            ↑
     .byte 0b00000000 -- 0x7d 0x00 must be set to addresses 0x7b to 0x7f.
     .byte 0b00000000 -- 0x7e            ↓
     .byte 0b00000000 -- 0x7f            ↓
```

● minicube2.s

```
#---------------------------------------------------------------------------
#
#    NEC Electronics     V850ES/Jx3-L series
#
#---------------------------------------------------------------------------
#    V850ES/JG3-L JF3-L sample program
#---------------------------------------------------------------------------
#    Reset Generation When Low Voltage Detected
#---------------------------------------------------------------------------
#[History]
#    2008.9.--   Released
#---------------------------------------------------------------------------
#[Overview]
#    This sample program secures the resources required when using MINICUBE2.
#       (Example of using MINICUBE2 via CSIB0)
#---------------------------------------------------------------------------

    -- Securing a 2 KB space as the monitor ROM section
    .section "MonitorROM", const
    .space 0x800, 0xff

    -- Securing an interrupt vector for debugging
    .section "DBG0"
    .space 4, 0xff

    -- Securing a reception interrupt vector for serial communication
    .section "INTCB0R"
    .space 4, 0xff

    -- Securing a 16-byte space as the monitor RAM section
    .section "MonitorRAM", bss
    .lcomm monitorramsym, 16, 4
```

- AppNote_LVI.dir

```
#   Sample link directive file (not use RTOS/use internal memory only)
#
#   Copyright (C) NEC Electronics Corporation 2002
#   All rights reserved by NEC Electronics Corporation.
#
#   This is a sample file.
#   NEC Electronics assumes no responsibility for any losses incurred by customers or
#   third parties arising from the use of this file.
#
#   Generated      : PM+ V6.31  [ 9 Jul 2007]
#   Sample Version : E1.00b [12 Jun 2002]
#   Device         : uPD70F3738 (C:\Program Files\NEC Electronics Tools\DEV\DF3738.800)
#   Internal RAM   : 0x3ffb000 - 0x3ffefff
#
#   NOTICE:
#        Allocation of SCONST, CONST and TEXT depends on the user program.
#
#        If interrupt handler(s) are specified in the user program then
#        the interrupt handler(s) are allocated from address 0 and
#        SCONST, CONST and TEXT are allocated after the interrupt handler(s).

SCONST  : !LOAD ?R {
        .sconst         = $PROGBITS     ?A .sconst;
};

CONST   : !LOAD ?R {
        .const          = $PROGBITS     ?A .const;
};

TEXT    : !LOAD ?RX {
        .pro_epi_runtime = $PROGBITS    ?AX .pro_epi_runtime;
        .text            = $PROGBITS    ?AX .text;
};

### For MINICUBE2###
MROMSEG : !LOAD ?R V0x03F800{
      MonitorROM = $PROGBITS ?A MonitorROM;
};
```

0x01F800 for products with 128 KB internal ROM

Difference from the default link directive file (additional code)

A reserved area for MINICUBE2 is secured.

```
SIDATA   : !LOAD ?RW V0x3ffb000 {
        .tidata.byte     = $PROGBITS     ?AW .tidata.byte;
        .tibss.byte      = $NOBITS       ?AW .tibss.byte;
        .tidata.word     = $PROGBITS     ?AW .tidata.word;
        .tibss.word      = $NOBITS       ?AW .tibss.word;
        .tidata          = $PROGBITS     ?AW .tidata;
        .tibss           = $NOBITS       ?AW .tibss;
        .sidata          = $PROGBITS     ?AW .sidata;
        .sibss           = $NOBITS       ?AW .sibss;
};

DATA     : !LOAD ?RW V0x3ffb100 {
        .data            = $PROGBITS     ?AW  .data;
        .sdata           = $PROGBITS     ?AWG .sdata;
        .sbss            = $NOBITS       ?AWG .sbss;
        .bss             = $NOBITS       ?AW  .bss;
};

### For MINICUBE2 ###
MRAMSEG : !LOAD ?RW V0x03FFEFF0{
        MonitorRAM = $NOBITS ?AW MonitorRAM;
};
```

Difference from the default link directive file (additional code)

A reserved area for MINICUBE2 is secured.

```
__tp_TEXT @ %TP_SYMBOL;
__gp_DATA @ %GP_SYMBOL &__tp_TEXT{DATA};
__ep_DATA @ %EP_SYMBOL;
```

● main.c

```
/*------------------------------------------------------------------------------*/
/*
/*  NEC Electronics     V850ES/Jx3-L series
/*
/*------------------------------------------------------------------------------*/
/*  V850ES/JG3-L sample program
/*------------------------------------------------------------------------------*/
/*  Reset Generation When Low Voltage Detected
/*------------------------------------------------------------------------------*/
/*[History]
/*  2008.09.--  Released
/*------------------------------------------------------------------------------*/
/*[Overview]
/* This sample program presents an example of using the low-voltage detector (LVI).
/* The low-voltage detector (LVI) is set so that an internal reset (LVI reset) signal
/* is generated when LVI detects that VDD is less than VLVI (2.80 V (typ.)).
/* After completion of the initial settings, interrupt servicing is executed at the
/* falling edge of the switch input and the LED lighting pattern is displayed in
/* accordance with the number of switch inputs.
/* If a reset is generated by other than LVI, the LED lighting pattern held in the
/* internal RAM is initialized. If a reset is generated by LVI, the LED lighting
/* pattern immediately before the LVI reset is retained in the internal RAM and then
/* restored and displayed after the LVI reset is released.
/*
/*
/*  Among the peripheral functions that are stopped after reset is released, those that
    are not used in this sample program are not set.
/*
/*
/* <Main setting contents>
/*  • Using pragma directives to enable setting the interrupt handler and describing
      peripheral I/O register names
/*  • Defining a wait adjustment value of 10 ms for chattering
/*  • Defining a wait adjustment value of 0.2 ms for setting the low-voltage detection
/*    register (LVIM)
/*  • Performing prototype definitions
/*  • Defining the LED lighting pattern table
/*  • Setting a bus wait for on-chip peripheral I/O registers, stopping the watchdog
      timer, and setting the clock
/*  • Executing low-voltage detector initialization
/*  • Initializing unused ports
/*  • Initializing external interrupt ports (falling edge) and LED output ports
/*  • ROMization
/* <Interrupt servicing>
/*  • Updating the LED lighting pattern
/*   (Chattering elimination time during switch input: 10 ms)
```

```
/*
/* <Switch input and LED lighting pattern>
/*
/* +----------------+----------------+------------+
/*  |Switch input count  |  LED2      |  LED1      |
/*  |    (P03/INTP0)     |  (PCM2)    |  (PCM3)    |
/*  |------------------------------------------ |
/*  |        0           |   OFF      |   OFF      |
/*  |        1           |   OFF      |   ON       |
/*  |        2           |   ON       |   OFF      |
/*  |        3           |   ON       |   ON       |
/* +----------------+----------------+------------+
/*      *Inputs 0 to 3 are repeated from the fourth input.
/*
/*
/*[I/O port settings]
/*
/* Input port      : P03(INTP0)
/* Output ports    : PCM2, PCM3
/* Unused ports    : P02, P04 to P06, P10 and P11, P30 to P39, P50 to P55, P70 to P711,
/*                   P90 to P915, PCM0 and PCM1, PCT0, PCT1, PCT4, PCT6, PDH0 to PDH5,
/*                   PDL0 to PDL15
/*                   *Preset all unused ports as output ports (low-level output).
/*
/*-------------------------------------------------------------------------------------*/



/*---------------------------*/
/* pragma directives      */
/*---------------------------*/
#pragma ioreg                      /* Enables describing to peripheral I/O registers. */
#pragma interrupt INTP0 f_int_intp0 /* Specifies the interrupt handler.                */



/*---------------------------*/
/* Constant definitions    */
/*---------------------------*/
#define LIMIT_10ms_WAIT (0x6EE7)       /* Defines the constant for a 10 ms wait
                                          adjustment.                              */
#define LIMIT_250us_WAIT (0x2c6)       /* Defines the constant for a 250 us (0.25 ms)
                                         wait adjustment */
```

```
/*----------------------------*/
/*  Prototype definitions  */
/*----------------------------*/
        void main( void );                /* Main function                        */
static    void f_init( void );             /* Initialization function              */
static    void f_init_clk_bus_wdt2( void ); /* Clock bus WDT initialization function */
static    void f_int_lvi( void );          /* Low-voltage detector initialization
                                              function */
static    void f_init_port_func( void );    /* Port/alternate-function initialization
                                              function    */


/*----------------------------------------*/
/* Setting the LED pattern table */
/*----------------------------------------*/
const unsigned char LED_TBL[] ={ 0x0C,      /* LED display pattern 0 [OFF][OFF]      */
                            0x04,           /* LED display pattern 1 [OFF][ON]       */
                            0x08,           /* LED display pattern 2 [ON] [OFF]      */
                            0x00 };         /* LED display pattern 3 [ON] [ON]       */


/*------------------------------*/
/* Setting global variables */
/*------------------------------*/
Static unsigned char g_led_ptn_cnt = 0;   /* Variables for saving LED lighting pattern */


/*****************************/
/*        Main module       */
/*****************************/
void main(void)
{
    f_init();                             /* Executes initialization.             */

    __EI();                               /* Enables interrupts.                  */

    while(1);                             /* Main loop (infinite loop)            */

    return;
}
```

```
/*------------------------------*/
/*  Initialization module   */
/*------------------------------*/
static void f_init( void )
{
    f_init_clk_bus_wdt2();    /* Sets a bus wait for on-chip peripheral I/O registers,
                                 stops WDT2, and sets the clock. */
/*

    f_int_lvi();                  /" Sets LVI                          */

    f_init_port_func();           /* Sets the port/alternate function. */

    return;
}


/*--------------------------------------*/
/* Initializing clock bus WDT2 */
/*--------------------------------------*/
static void f_init_clk_bus_wdt2( void )
{
    VSWC  = 0x01;                /* Sets a bus wait for on-chip peripheral I/O
                                    registers. */
                                 /* Specifies normal operation mode for OCDM. */
#pragma asm
    st.b    r0, PRCMD
    st.b    r0, OCDM
#pragma endasm
```

Caution must be exercised because access to a special register must be described in assembly language.

```
    RSTOP = 1;                   /* Stops the internal oscillator. */
    WDTM2  = 0x00;               /* Stops the watchdog timer.      */

                                 /* Sets not to divide the clock.  */
#pragma asm
   push  r10
   mov   0x80, r10
   st.b  r10, PRCMD
   st.b  r10, PCC
   pop   r10
#pragma endasm

    PLLCTL = 0x03;               /* Sets to PLL mode.              */

    return;
```

```
}



/*-------------------------------------------*/
/*   Initializing the low-voltage detector   */
/*-------------------------------------------*/
static void f_init_lvi( void )
{
    extern unsigned int _S_romp;          /* Externally references the ROMization
                                             symbols      */
    static unsigned char save_led_ptn;    /* Variables for saving LED lighting
                                             pattern      */
    unsigned int loop_wait;

    /* LVI reset */
    if( RESF.0 == 1 )
    {
        save_led_ptn = g_led_ptn_cnt;     /* Saves the LED lighting pattern      */

        _rcopy( &_S_romp, -1 );           /* Executes ROMization processing      */

        g_led_ptn_cnt = save_led_ptn;     /* Restores the LED lighting pattern   */
    }

    /* Reset generated by other than LVI */
    else
    {
        _rcopy( &_S_romp, -1 );     /* Executes ROMization processing             */
                                    /* ↑LED lighting pattern specifications
                                       initialized by ROMization                  */

        LVIMK = 1;                  /* Masks LVI interrupt                        */
        LVIS0 = 0;                  /* Sets low-voltage detection level to 2.80 V */

/* Enabling low-voltage detection operation */
#pragma asm
   push   r10
   mov    0x80, r10
   st.b   r10, PRCMD
   set1   LVION
    pop    r10
#pragma endasm
```

```
        /* Inserting 250 us (0.25 ms) wait */
        for( loop_wait = 0 ; loop_wait < LIMIT_250us_WAIT ; loop_wait++ )
        {
            __nop();
        }

        while( LVIF == 1 );
```

/* Note that the program enters an infinite loop until the */
/* power supply voltage rises above the detection voltage */

```
    /* Setting operation when low voltage is detected to reset operation */
    #pragma asm
        push    r10
        mov     0x02, r10
        st.b    r10, PRCMD
        set1    LVIMD
        pop     r10
    #pragma endasm

        }

        return;
    }


/*-------------------------------------------*/
/*   Setting the port/alternate function    */
/*-------------------------------------------*/
static void f_init_port_func( void )
{
    P0    = 0x00;           /* Sets P02 to P06 to output low level.       */
    PM0   = 0x8B;           /* Connects P03 to the input latch.
    PMC0  = 0x08;           /* Sets INTP0 input to P03.             */

    P1    = 0x00;           /* Sets P10 and P11 to output low level.      */
    PM1   = 0xFC;
    P3    = 0x0000;         /* Sets P30 to P39 to output low level.       */
    PM3   = 0xFC00;
    PMC3  = 0x0000;
```

With V850ES/JF3-L, the setting value is 0xFE.

With V850ES/JF3-L, only P10 is set.

With V850ES/JF3-L, the setting value is 0xFCC0.

With V850ES/JF3-L, P30 to P35, P38, and P39 are set.

```
#if(0) /* To use P4 as CSIB0 when using MINICUBE2,                      */
       /* P4 is not initialized as an unused pin (QB-V850ESJG3L-TB)  */
    P4    = 0x00;                  /* Sets P40 to P42 to output low level.          */
    PM4   = 0xF8;
    PMC4  = 0x00;
#endif

    P5    = 0x00;                  /* Sets P50 to P55 to output low level.          */
    PM5   = 0xC0;
    PMC5  = 0x00;

    P7H   = 0x00;                  /* Sets P70 to P711 to output low level.         */
    P7L   = 0x00;
    PM7H  = 0xF0;
    PM7L  = 0x00;

    P9    = 0x0000;                /* Sets P90 to P915 to output low level. */
    PM9   = 0x0000;
    PMC9  = 0x0000;

    PCM   = LED_TBL[g_led_ptn_cnt]; /* Sets PCM0 and PCM1 to output low level and
                                       values to turn off the LEDs to PCM2 and PCM3. */
    PMCM  = 0xF0;
    PMCCM = 0x00;

    PCT   = 0x00;              /* Sets PCT0, PCT1, PCT4, and PCT6 to output low level. */
    PMCT  = 0xAC;
    PMCCT = 0x00;

    PDH   = 0x00;                  /* Sets PDH0 to PDH5 to output low level.        */
    PMDH  = 0xC0;
    PMCDH = 0x00;

    PDL   = 0x0000;                        /* Sets PDL0 to PDL15 to output low level. */
    PMDL  = 0x0000;
    PMCDL = 0x0000;

    /* Setting the interrupt function */
    INTF0 = 0x08;                          /* Specifies the falling edge of INTP0.    */
    INTR0 = 0x00;                          /* ↓                                        */
    PIC0  = 0x07;                          /* Sets the priority of INTP0 to level 7
                                                 and unmasks INTP0.    */

    return;
```

Notes (for P7H and PM7H): With V850ES/JF3-L, these are not set because the registers do not exist.

Note (for P70 to P711): With V850ES/JF3-L, P70 to P77 are set.

Note (for PM9 = 0x0000): With V850ES/JF3-L, the setting value is 0x1C3C.

Note (for P90 to P915): With V850ES/JF3-L, P90, P91, P96 to P99, and P913 to P915 are set.

Note (for PMDH = 0xC0): With V850ES/JF3-L, the setting value is 0xFC.

Note (for PDH0 to PDH5): With V850ES/JF3-L, PDH0 and PDH1 are set.

```
}


/*****************************/
/*      Interrupt module    */
/*****************************/
__interrupt
void f_int_intp0( void )
{

    unsigned int loop_wait;

    /* 10 ms wait for chattering */
    for( loop_wait = 0 ; loop_wait < LIMIT_10ms_WAIT ; loop_wait++ )
    {
        __nop();
    }

    if( ( P0 & 0x08 ) == 0x00 )   /* Identifies that SW1 is being pressed after wait */

    {
        g_led_ptn_cnt++;            /* Changes the lighting pattern (4 types).       */
        g_led_ptn_cnt &= 3;
        PCM = LED_TBL[led_ptn_cnt]; /* Sets the updated lighting pattern.            */
    }

    PIC0 &= (unsigned char)~0x80;   /* FailSafe: Clears multiple requests.           */

    return;                         /* Goes to reti due to the __interrupt modifier. */
}
```

For further information, please contact:

NEC Electronics Corporation
1753, Shimonumabe, Nakahara-ku,
Kawasaki, Kanagawa 211-8668,
Japan
Tel: 044-435-5111
http://www.necel.com/

[America]

NEC Electronics America, Inc.
2880 Scott Blvd.
Santa Clara, CA 95050-2554, U.S.A.
Tel: 408-588-6000
800-366-9782
http://www.am.necel.com/

[Europe]

NEC Electronics (Europe) GmbH
Arcadiastrasse 10
40472 Düsseldorf, Germany
Tel: 0211-65030
http://www.eu.necel.com/

Hanover Office
Podbielskistrasse 166 B
30177 Hannover
Tel: 0 511 33 40 2-0

Munich Office
Werner-Eckert-Strasse 9
81829 München
Tel: 0 89 92 10 03-0

Stuttgart Office
Industriestrasse 3
70565 Stuttgart
Tel: 0 711 99 01 0-0

United Kingdom Branch
Cygnus House, Sunrise Parkway
Linford Wood, Milton Keynes
MK14 6NP, U.K.
Tel: 01908-691-133

Succursale Française
9, rue Paul Dautier, B.P. 52
78142 Velizy-Villacoublay Cédex
France
Tel: 01-3067-5800

Sucursal en España
Juan Esplandiu, 15
28007 Madrid, Spain
Tel: 091-504-2787

Tyskland Filial
Täby Centrum
Entrance S (7th floor)
18322 Täby, Sweden
Tel: 08 638 72 00

Filiale Italiana
Via Fabio Filzi, 25/A
20124 Milano, Italy
Tel: 02-667541

Branch The Netherlands
Steijgerweg 6
5616 HS Eindhoven
The Netherlands
Tel: 040 265 40 10

[Asia & Oceania]

NEC Electronics (China) Co., Ltd
7th Floor, Quantum Plaza, No. 27 ZhiChunLu Haidian
District, Beijing 100083, P.R.China
Tel: 010-8235-1155
http://www.cn.necel.com/

Shanghai Branch
Room 2509-2510, Bank of China Tower,
200 Yincheng Road Central,
Pudong New Area, Shanghai, P.R.China P.C:200120
Tel:021-5888-5400
http://www.cn.necel.com/

Shenzhen Branch
Unit 01, 39/F, Excellence Times Square Building,
No. 4068 Yi Tian Road, Futian District, Shenzhen,
P.R.China P.C:518048
Tel:0755-8282-9800
http://www.cn.necel.com/

NEC Electronics Hong Kong Ltd.
Unit 1601-1613, 16/F., Tower 2, Grand Century Place,
193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: 2886-9318
http://www.hk.necel.com/

NEC Electronics Taiwan Ltd.
7F, No. 363 Fu Shing North Road
Taipei, Taiwan, R. O. C.
Tel: 02-8175-9600
http://www.tw.necel.com/

NEC Electronics Singapore Pte. Ltd.
238A Thomson Road,
#12-08 Novena Square,
Singapore 307684
Tel: 6253-8311
http://www.sg.necel.com/

NEC Electronics Korea Ltd.
11F., Samik Lavied'or Bldg., 720-2,
Yeoksam-Dong, Kangnam-Ku,
Seoul, 135-080, Korea
Tel: 02-558-3737
http://www.kr.necel.com/

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