V850E2/ML4 Microcontroller

Peripheral LibUSB Demo

R01AN1098EJ0100
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Introduction

This application note describes a sample program that uses the V850E2/ML4 microcontroller's USB function module to control the LEDs and potentiometers on the V850E2/ML4 CPU board from a PC.

Target Device

V850E2/ML4 (uPD70F4022)

Contents

1. Introduction

1.1 Specifications

The Peripheral LibUSB Demo program uses the V850E2/ML4 USB function module and can communicate with the LibUSB application running on a host PC. (Evaluation board: R0K0F4022C000BR)

This sample program performs the following operations between the PC and the V850E2/ML4.

(1) Connect
(2) Disconnect
(3) LED display (toggle)
(4) Acquire A/D converter value (read ADC)

See section 2 for details.

1.2 Functions Used

- Interrupts
- Ports
- USB function controller (USBF)
- A/D converter (ADCA)

1.3 Conditions

Item	Description
Microcontroller	V850E2/ML4
Operating frequency	Internal clock: 200 MHz
USB clock	Either an internal or an external clock may be selected Internal clock: External 9.6 MHz × (internal 20x multiplier) ÷ (divisor of 4) = 48 MHz. Or: External 7.2 MHz × (internal 20x multiplier) ÷ (divisor of 3) = 48 MHz. External clock: Input to the USBCLK pin (fUSB = 48 MHz)
Integrated development environment	Renesas Electronics Corporation CubeSuite+ V1.00.01
C complier	Renesas Electronics Corporation CubeSuite plus included CX compiler V 1.20
Supported operating systems	Windows® 7, Windows® Vista, Windows® XP

- Universal Serial Bus Revision 2.0 specification
  [http://www.usb.org/developers/docs/]
- V850E2/ML4 Hardware Manual
  [http://japan.renesas.com/products/mpumcu/v850/V850e2mx/Documentation.jsp#]
- Renesas web site
  [http://japan.renesas.com/homepage.jsp]
- USB device web page
  [http://japan.renesas.com/usb]

1.4 Related Application Notes

- V850E2/ML4 Microcontroller USB Multifunction Operation Example Application Note (R01AN1037EJ0100)

2. System Structure

This application, Peripheral LibUSB Demo (V850_LibUSB.exe), operates on a host PC with the V850E2/ML4 CPU board connected to the host PC by a USB cable and can manipulate the V850E2/ML4 CPU board.

See section 6 for the UI screens provided by this application.

Figure 2.1 shows the system structure of this sample application.

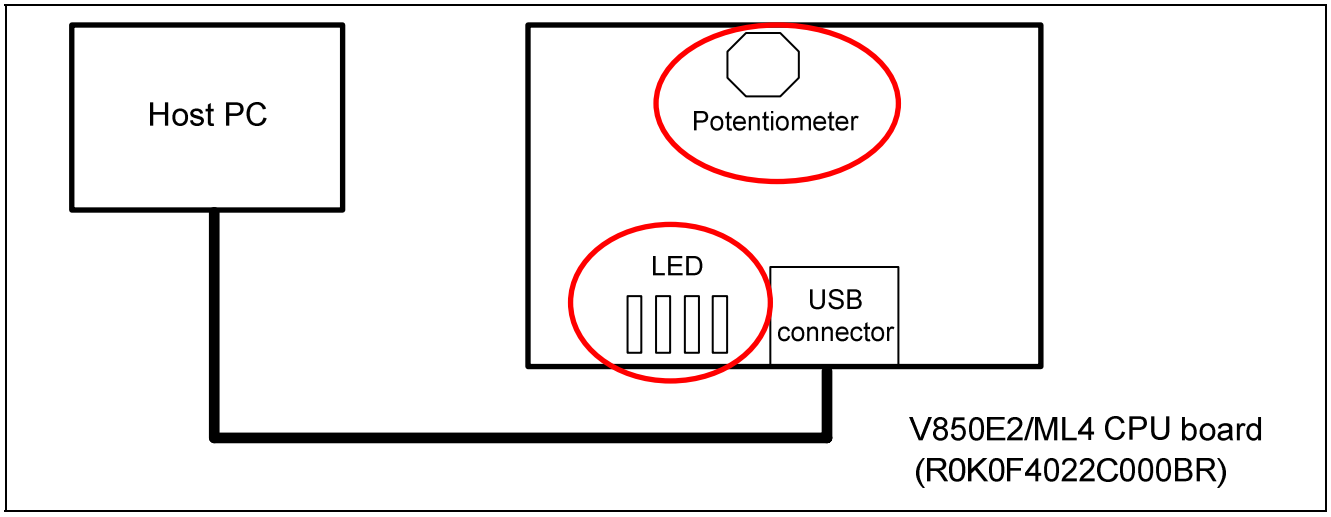

Figure 2.1 System Structure

The following functions can be manipulated.

(1) A USB enumeration is performed when the Connect button is clicked.
(2) The CPU board is disconnected when the Disconnect button is clicked.
(3) The LEDs are turned on or off when the Toggle LED button is clicked.
The LEDs shown in the figure above is turned on or inverted.
(4) An A/D conversion value is sent to the PC when the Read ADC button is clicked.
The potentiometer shown in the figure above is connected to the A/D converter. An A/D conversion value is read and transmitted to the host PC.

3. Sample Program for the V850E2/ML4

This sample program has the following directory structure.

Table 3.1 Sample Program Directory Structure

Folder	Overview
application	Holds the sample application
doc	Holds the application note
driver/inf	Holds the Windows®.inf file LIB_USB_Demonstration.inf
driver/V850E2ML4_usb_demo/prj	Holds the sample program project files
driver/V850E2ML4_usb_demo/src	Holds the sample program source code

The V850E2/ML4 sample program consists of a main function, a USB driver, an LED driver, and an A/D converter driver. A USB communication device class driver (CDC driver) is used for USB communication, and communication is implemented with a unique command protocol (see section 5.1.1). Although it operates as a vendor class USB device, the class driver component is the same as the CDC driver.

The source code is stored in the driver/V850E2ML4_usb_demo/src directory. The table below lists the source code file structure.

Table 3.2 Sample Program File Structure

Folder	File	Overview
/	cstart.asm	Bootstrap
	main.c	Main routine
	main.h	Prototype declarations for main.c
adc	adc.c	Unique ADCA processing
	adc.h	Unique header file for ADCA processing
led	led.c	Unique LED processing
	led.h	Unique header file for LED processing
usb	usbf850.c	USB initialization, endpoint control, bulk transfers, control transfers
	Usbf850.h	Prototype declarations for usbf850.c
	Usbf850_communication.c	Unique processing for the USB communication device class
	Usbf850_communication.h	Prototype declarations for usbf850_communication.c
	usbstrg_desc.h	Descriptor declarations
	Usbf850_errno.h	Error code definitions
	Usbf850_types.h	User type declarations
	reg_v850e2ML4.h	USB function register definitions

Figure 3.1 shows the structure of the V850E2/ML4 sample program. The arrows in the figure show the direction of control.

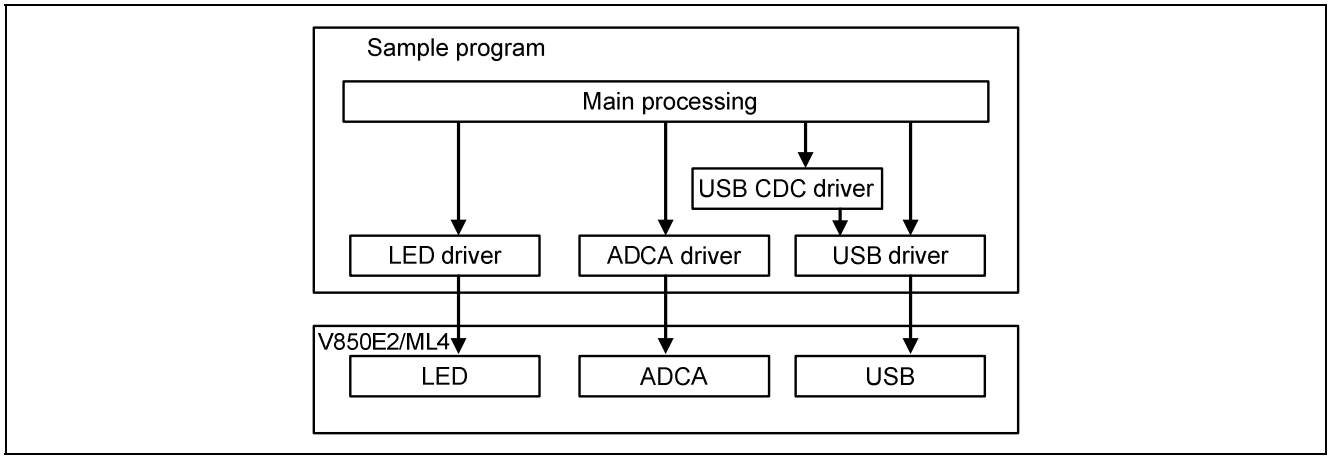

Figure 3.1 V850E2/ML4 Sample Program Structure

4. Descriptors

The following descriptors are used in the V850E2/ML4 sample program.

4.1 Device Descriptors

Field	Length (bits)	Hex Value	Description
bLength	8	0x12	Descriptor size is 18 bytes
bDescriptorType	8	0x01	DEVICE Descriptor Type
bcdUSB	16	0x0200	USB Specification version 2.00
bDeviceClass	8	0xFF	The device Class is vendor-specific
bDeviceSubClass	8	0xFF	The device Subclass is vendor-specific
bDeviceProtocol	8	0xFF	The device Protocol is vendor-specific
bMaxPacketSize0	8	0x40	Maximum packet size for endpoint zero is 64
idVendor*	16	0x045b	Vendor ID
idProduct*	16	0x0217	Product ID
bcdDevice	16	0x0100	The device release number is 1.00
iManufacturer	8	0x01	The manufacturer string descriptor index is 1
iProduct	8	0x02	The product string descriptor index is 2
iSerialNumber	8	0x03	The serial number string descriptor index is 3
bNumConfigurations	8	0x01	The device has 1 possible configurations

Note: Set the vendor ID and product ID appropriately for the actual user system.

4.2 Configuration Descriptors

Field	Length (bits)	Hex Value	Description
bLength	8	0x09	Descriptor size is 9 bytes
bDescriptorType	8	0x02	CONFIGURATION Descriptor Type
wTotalLength	16	0x0027	The total length of data for this configuration.
bNumInterfaces	8	0x01	This configuration supports 1 interfaces
bConfigurationValue	8	0x01	The value 1 should be used to select this configuration
iConfiguration	8	0x00	The string descriptor.
bmAttributes	8	0xC0	Configuration characteristics.
bMaxPower	8	0x1b	Maximum power. 54 mA

4.3 Interface Descriptors

Field	Length (bits)	Hex Value	Description
bLength	8	0x09	Descriptor size is 9 bytes
bDescriptorType	8	0x04	INTERFACE Descriptor Type
bInterfaceNumber	8	0x00	The number of this interface is 0.
bAlternateSetting	8	0x00	The value used to select the alternate setting.
bNumEndpoints	8	0x03	The number of endpoints used by this interface is 3
bInterfaceClass	8	0xFF	Unknown class
bInterfaceSubClass	8	0xFF	The interface Subclass is vendor-specific
bInterfaceProtocol	8	0xFF	The interface protocol is vendor-specific
iInterface	8	0x00	The string descriptor

4.4 Endpoint Descriptors

The endpoint addresses can be switched by enabling or disabling the following defines in the usbf850.h header file. Note that the default is enabled.

#define USE_EP_BKI1

#define USE_EP_BKO1

Setting	Bulk In	Bulk Out	Interrupt In
define enabled	EP1	EP2	EP7
define disabled	EP3	EP4	EP7

Field	Length (bits)	Hex Value	Description
bLength	8	0x07	Descriptor size is 7 bytes
bDescriptorType	8	0x05	ENDPOINT Descriptor Type
bEndpointAddress	8	0x81	This is an IN endpoint with endpoint number 1
bmAttributes	8	0x02	Types — BULK
wMaxPacketSize	16	0x0040	Maximum packet size for this endpoint is 64 Bytes.
bInterval	8	0x00	The polling interval value is every 0 Frames.

Field	Length (bits)	Hex Value	Description
bLength	8	0x07	Descriptor size is 7 bytes
bDescriptorType	8	0x05	ENDPOINT Descriptor Type
bEndpointAddress	8	0x02	This is an OUT endpoint with endpoint number 2
bmAttributes	8	0x02	Types — BULK
wMaxPacketSize	16	0x0040	Maximum packet size for this endpoint is 64 Bytes.
bInterval	8	0x00	The polling interval value is every 0 Frames.

Field	Length (bits)	Hex Value	Description
bLength	8	0x07	Descriptor size is 7 bytes
bDescriptorType	8	0x05	ENDPOINT Descriptor Type
bEndpointAddress	8	0x87	This is an IN endpoint with endpoint number 7
bmAttributes	8	0x03	Types — INTERRUPT
wMaxPacketSize	16	0x0040	Maximum packet size for this endpoint is 64 Bytes.
bInterval	8	0x0a	The polling interval value is every 10 Frames.

4.5 String Descriptors

(a) String0

Field	Length (bits)	Hex Value	Description
bLength	8	0x04	Descriptor size is 4 bytes
bDescriptorType	8	0x03	String Descriptor Type
bString	16	0x09, 0x04	LANGID: English (United States)

(b) String1

Field	Length (bits)	Hex Value	Description
bLength	8	0x40	Descriptor size is 64 bytes
bDescriptorType	8	0x03	String Descriptor Type
bString	496		Manufacturer: Renesas Electronics Corporation

(c) String2

Field	Length (bits)	Hex Value	Description
bLength	8	0x0E	Descriptor size is 14 bytes
bDescriptorType	8	0x03	String Descriptor Type
bString	90		Product: CDCDrv

(d) String3

Field	Length (bits)	Hex Value	Description
bLength	8	0x1A	Descriptor size is 26 bytes
bDescriptorType	8	0x03	String Descriptor Type
bString	192		Serial: 0217FFFFFF10

5. Basic Functions

The LibUSB sample program provides the following functions

(1) A USB enumeration is performed when the Connect button is clicked.
(2) The CPU board is disconnected when the Disconnect button is clicked.
(3) The LEDs are turned on or off when the Toggle LED button is clicked.
(4) An A/D conversion value is sent to the PC when the Read ADC button is clicked.

5.1 Main Processing

In the main loop, the USB receive data is checked by poling the USB receive buffer. When the USB data application starts, it goes to the wait for enumeration state.

If USB receive data is detected, the sample program analyzes the control command in the first byte of the receive data and processes that command.

Table 5.1 lists the control flags and buffers handled by the main processing.

Table 5.1 Flags and Buffers Handled in Main Processing

No.	Flag	Overview
1	ledControlFlg	LED display control flag
2	UserBuf	Send/receive data storage buffer
3	adcVal	A/D conversion value storage area
4	usbf850_rsuspd_flg	Resume/suspend flag

Figure 5.1 shows the flowchart for the main processing.

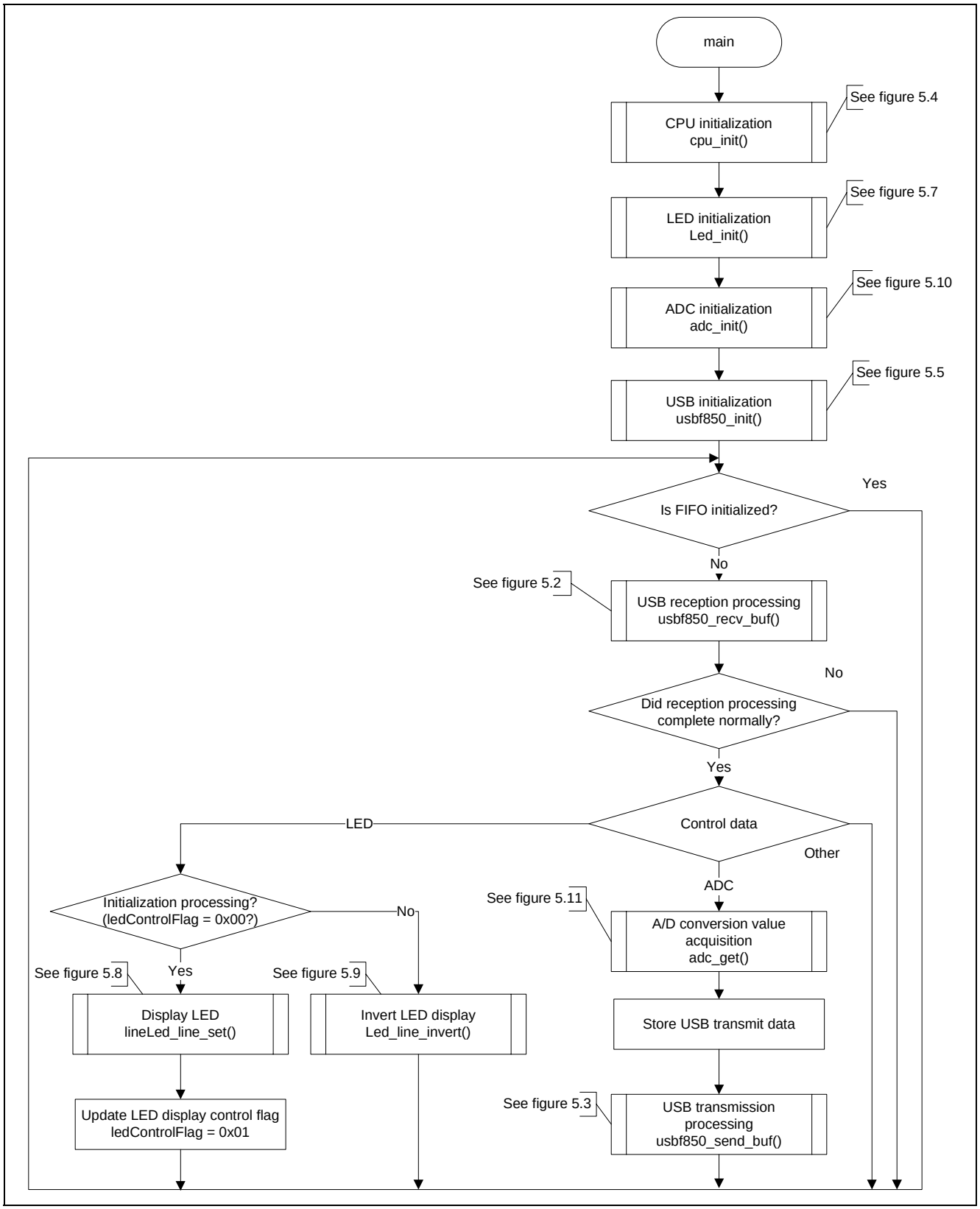

Figure 5.1 Main Processing Flowchart

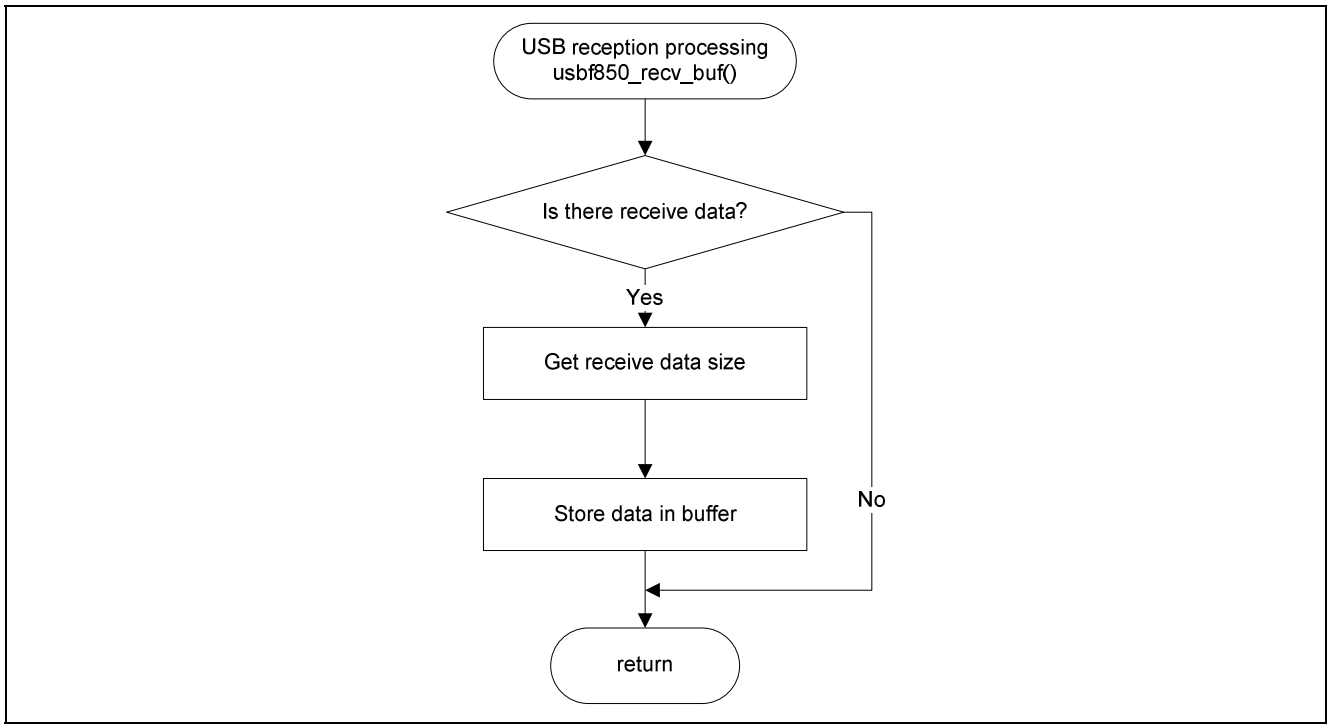

Figure 5.2 USB Reception Check Flowchart

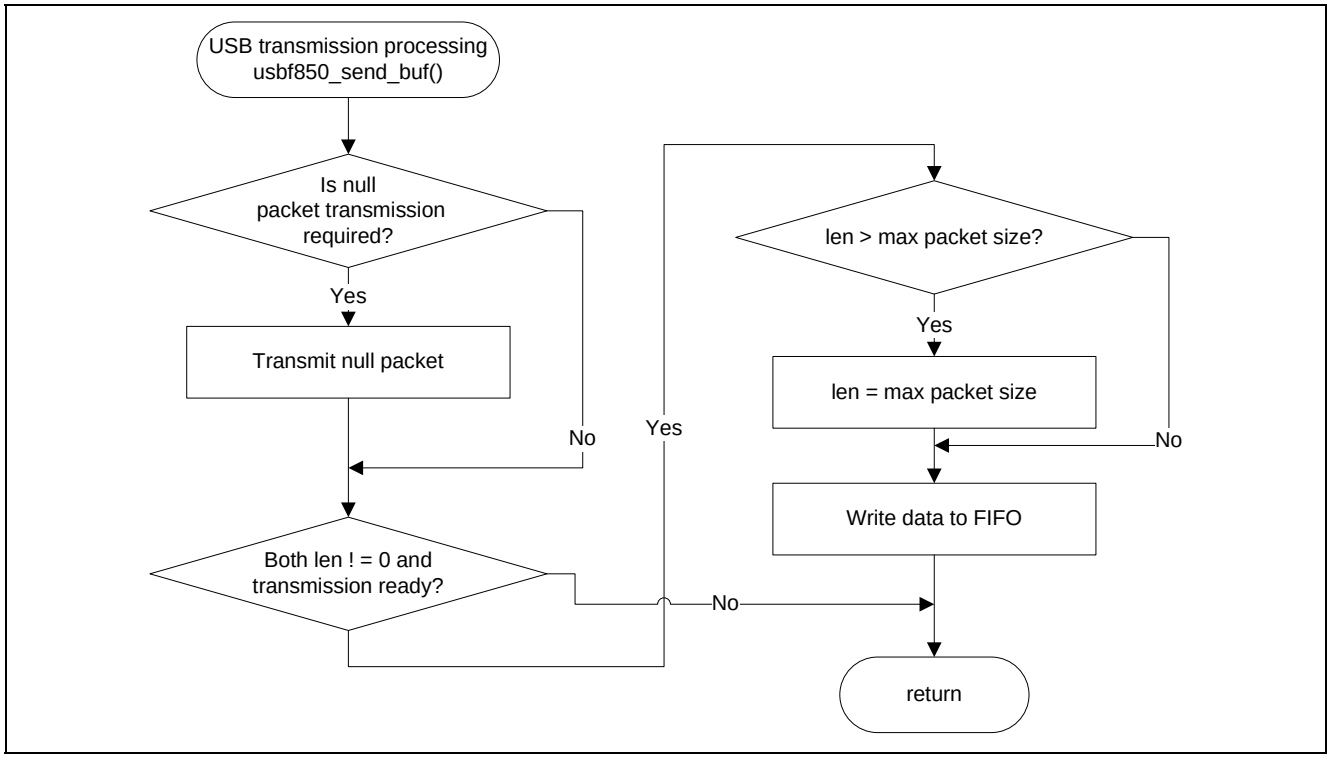

Figure 5.3 USB Transmission Flowchart

5.1.1 Details of the Command Protocol

There are two operations in the LibUSB command protocol: Toggle LED and Read ADC.

The details of these operations are shown below.

5.1.2 Toggle LED Protocol

HOST		LibUSB Application
Command (17 bytes) 0x01 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x??	→	Received by endpoint 2
		Command processing If the device is in the initial state, the initial pattern is displayed. If this is the second or later operation, the pattern is inverted and displayed. Note: Only the first byte is evaluated as a command. The remaining 16 bytes are ignored.

5.1.3 Read ADC Protocol

HOST		LibUSB Application
Command (17 bytes) 0x02 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x?? 0x??	→	Received by endpoint 2
		Command processing The A/D conversion data is read. Note: Only the first byte is evaluated as a command. The remaining 16 bytes are ignored.
	←	A/D conversion data (5 bytes) is transmitted with endpoint 1. 0x02 0x?? 0x?? 0x?? 0x?? The four bytes starting with the second byte are the A/D conversion value. (Four bytes of data in little endian order)

5.2 USB Driver

The USB driver is a group of functions that provide control transfers, bulk transfers, and serial conversion support processing using the V850E2/ML4 USB function module (USB).

Table 5.2 lists the USB driver control flags.

Table 5.2 USB Driver Control Flags

No.	Flag	Overview
1	usbf850_busrst_flg	Bus reset flag
2	usbf850_rsuspd_flg	Resume/suspend flag
3	usbf850_bufinit_flg	FIFO initialization flag

Table 5.3 lists the USB driver functions used from the sample program's main processing. Refer to the USB CDC (Communication Device Class) Driver manual for the V850E2/ML4 for details on the other USB driver functions.

Table 5.3 Used USB Driver Functions

No.	Function	Description
1	cpu_init	CPU initialization
2	usbf850_init	USB controller initialization
3	usbf850_get_bufinit_flg	Reports the execution state of FIFO initialization
4	usbf850_send_buf	Bulk in data transmission processing (See figure 5.3.)
5	usbf850_recv_buf	Bulk out data reception processing (See figure 5.2.)

Figures 5.4 to 5.6 show the flowcharts for these functions.

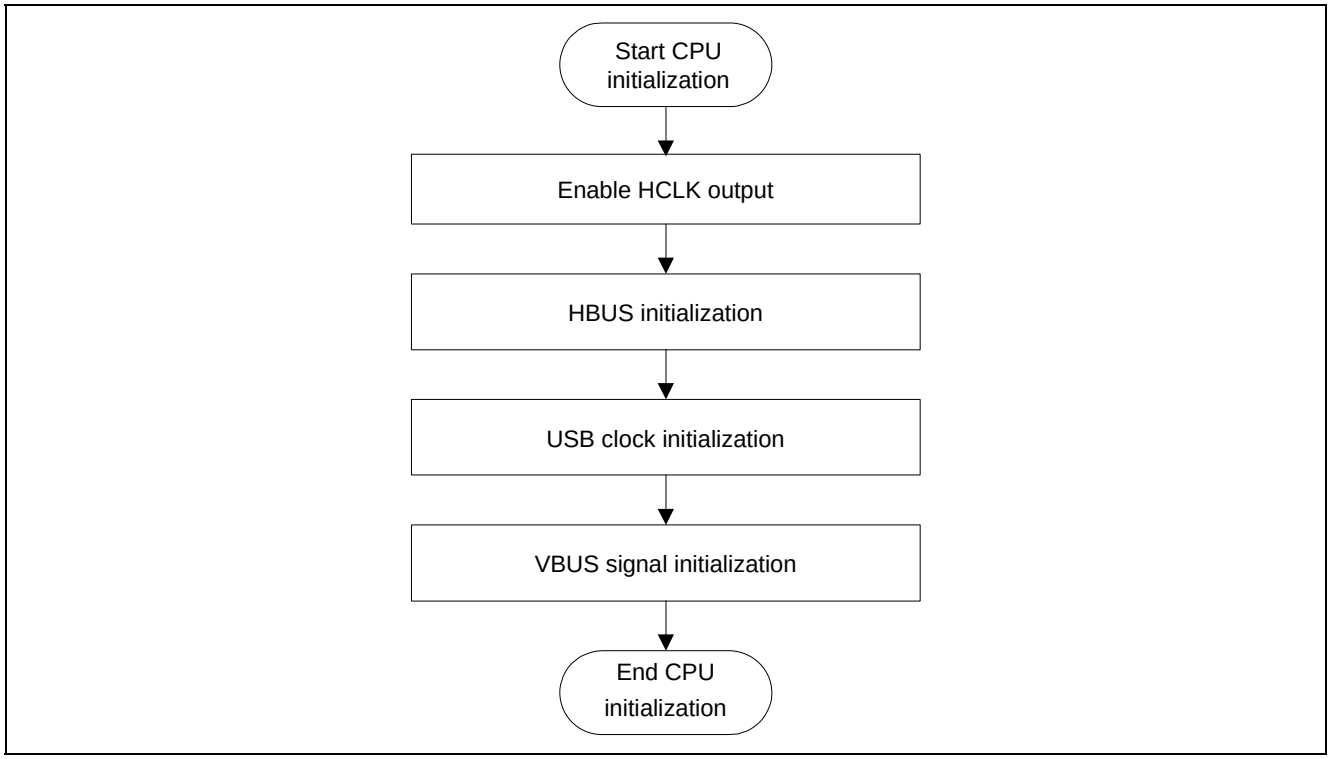

Figure 5.4 cpu_init() Flowchart

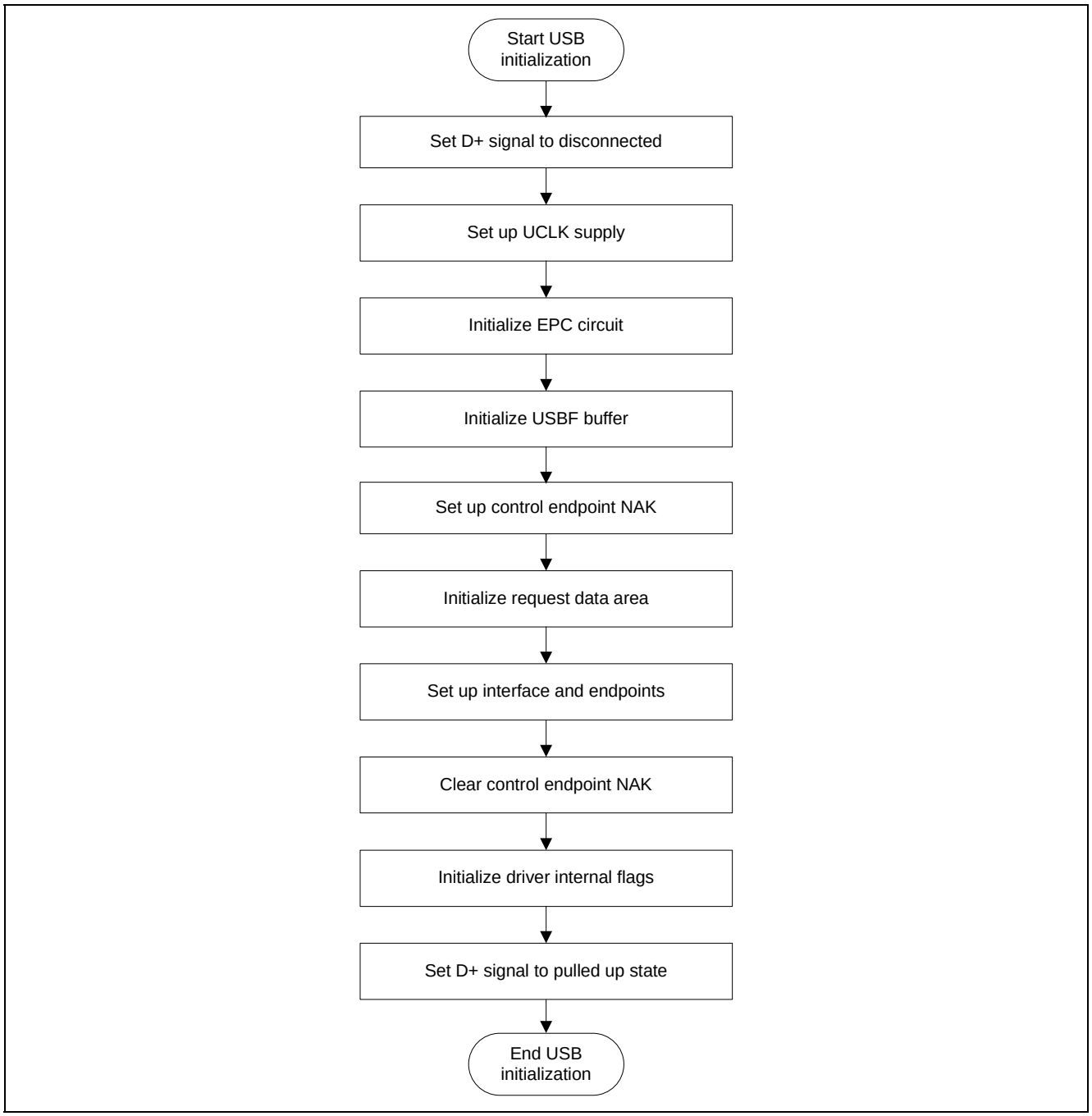

Figure 5.5 usbf850_init() Flowchart

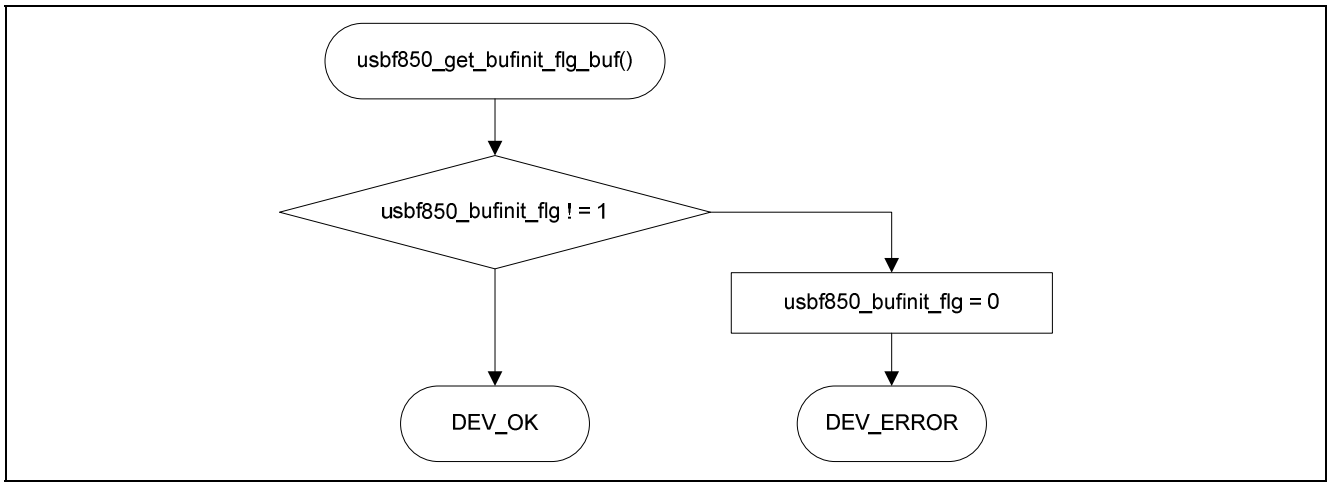

Figure 5.6 usbf850_get_bufinit_flg() Flowchart

5.3 LED Driver

The LED driver is a group of functions that provides LED on/off control using the V850E2/ML4 I/O ports.

Table 5.4 lists the LED driver functions.

Table 5.4 LED Driver Functions

No.	Function	Description
1	Led_init	I/O port initialization
2	Led_line_set	LED pattern setup
3	Led_line_invert	LED pattern display inversion

Figures 5.7 through 5.9 show the flowcharts for these functions.

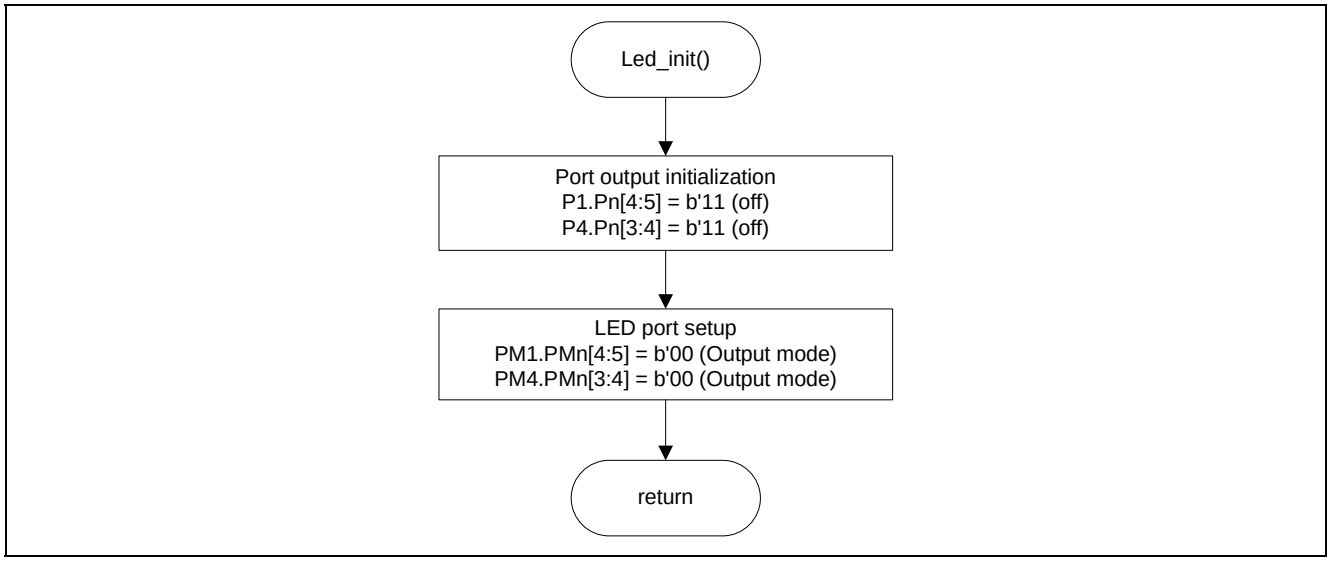

Figure 5.7 Led_init() Flowchart

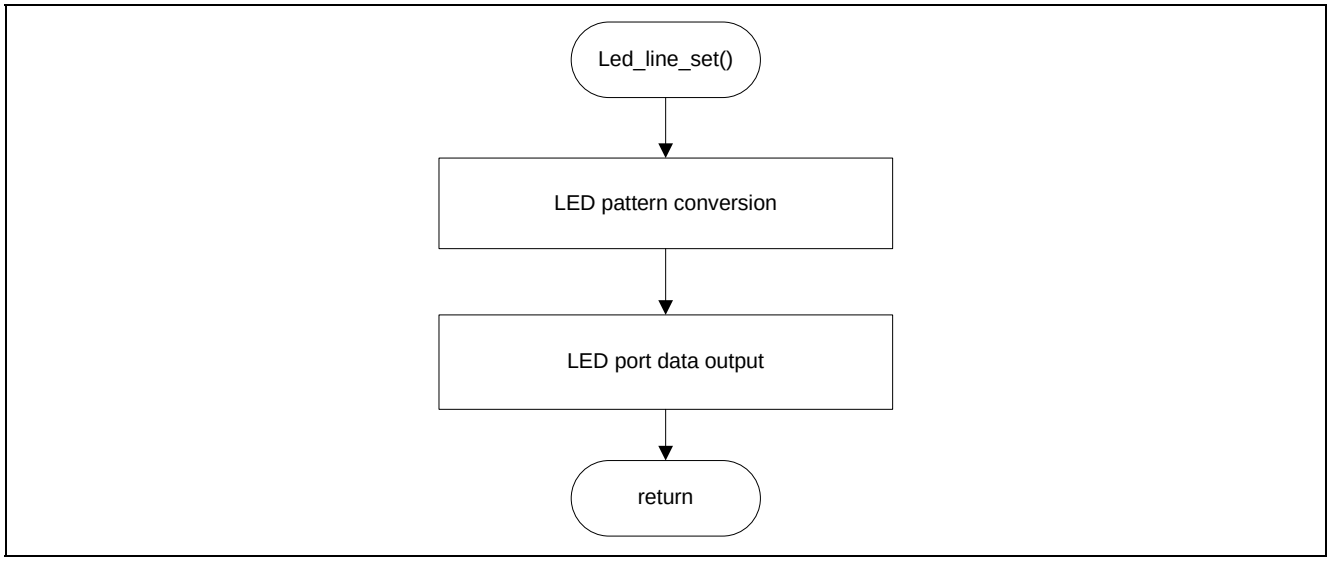

Figure 5.8 Led_line_set() Flowchart

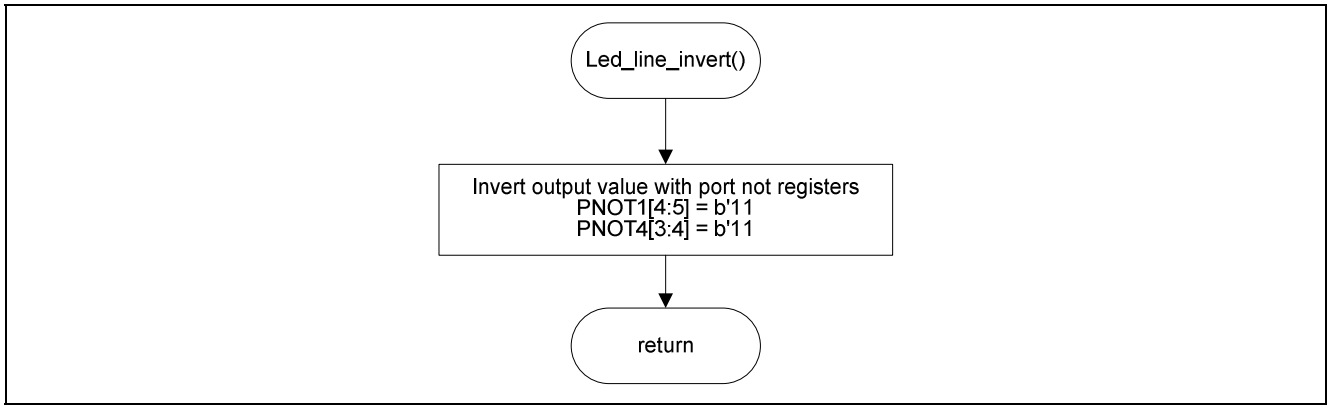

Figure 5.9 Led_line_invert() Flowchart

5.4 ADCA Driver

The ADCA driver is a group of functions that acquires an A/D conversion value using the V850E2/ML4 A/D converter (ADCA).

Table 5.5 lists the ADCA driver functions.

Table 5.5 LED Driver Functions

No.	Function	Description
1	adc_init	ADCA initialization
2	adc_get	A/D conversion value acquisition

Figures 5.10 and 5.11 show the flowcharts for these functions.

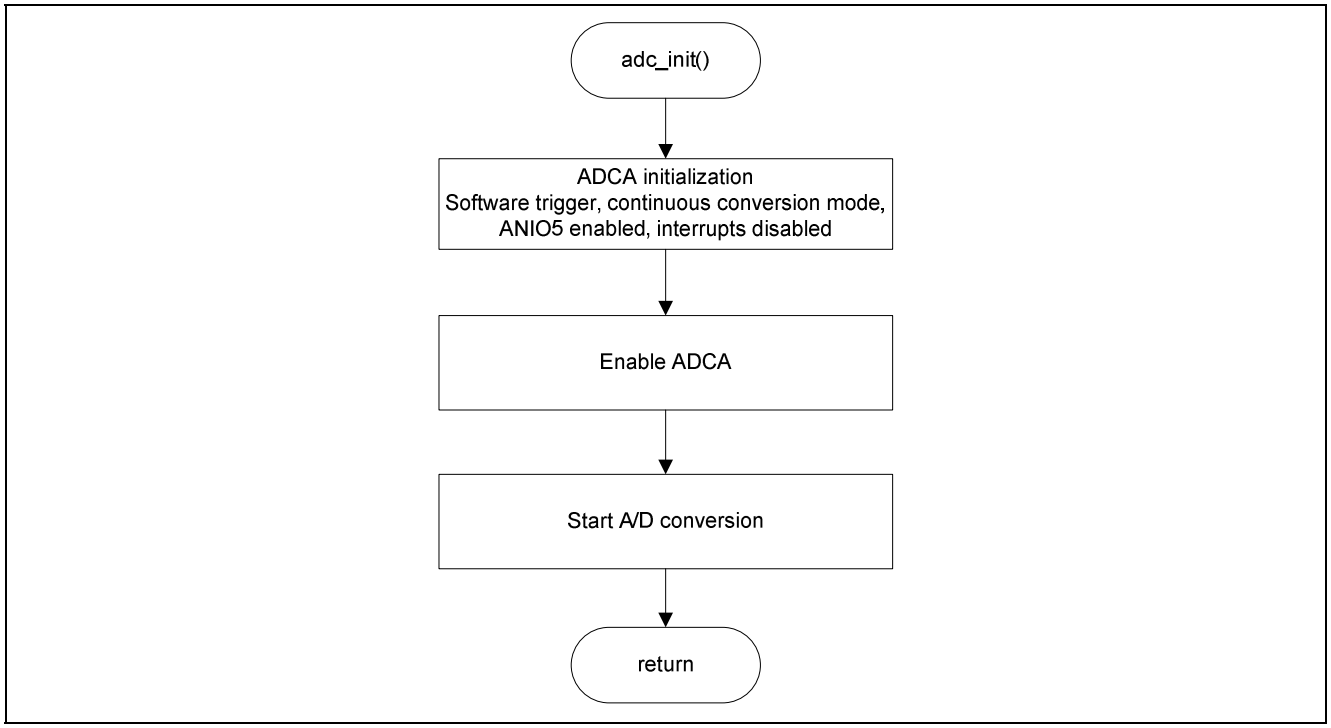

Figure 5.10 adc_init() Flowchart

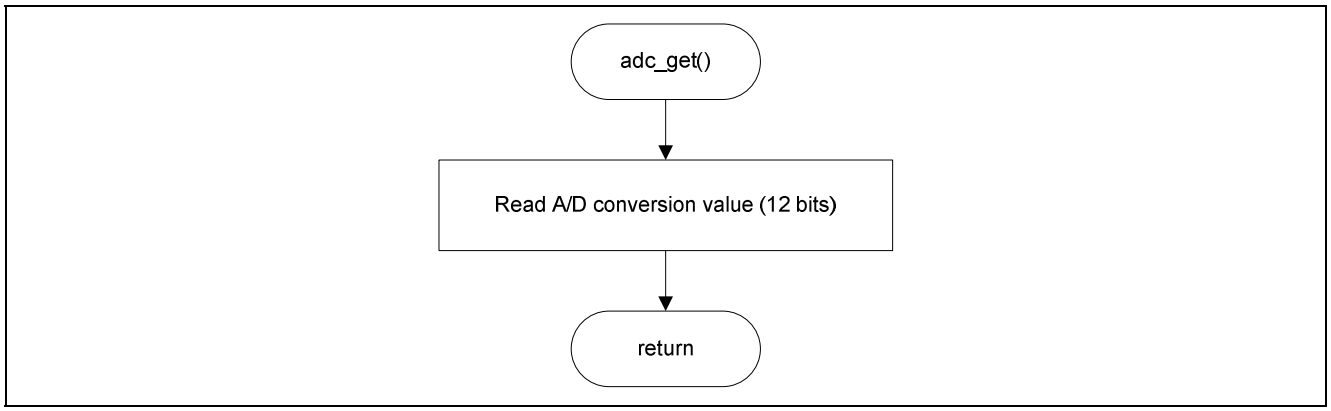

Figure 5.11 adc_get() Flowchart

6. Using the Sample Application

This sample application supports Windows® 7, Windows® Vista, and Windows® XP.

6.1 LibUSB Installation and Running the Application

1. Install LibUSB
   Download the file libusb-win32-devel-filter-x.x.x.x.zip from the following URL.
   http://sourceforge.net/apps/trac/libusb-win32/wiki
   Expand the downloaded .zip file and run libusb-win32-devel-filter-x.x.x.x.exe to install LibUSB.
2. Connect a USB cable to the V850E2/ML4 CPU board USB connector.
3. When the Found New Hardware Wizard starts, select the install from list or specified location option. Then specify the application note inf folder and select Next. (See section 6.2.)
4. If a dialog to specify either libusb0.sys or libusb0_x86.dll opens, specify the x86 folder under the inf folder in the V850E2/ML4_usb_demo folder.
5. Double click V850_LibUSB.exe in the application folder to start the sample application.

Caution

The Microsoft Visual C++ 2010 SP1 redistributable package (x86) must be installed to run this application. That package can be downloaded from the Microsoft Download Center.

6.2 USB Driver Installation

(1) Connect a USB cable to the V850E2/ML4 CPU board USB connector.
(2) The Found New Hardware Wizard will start. Select, "No, not this time."

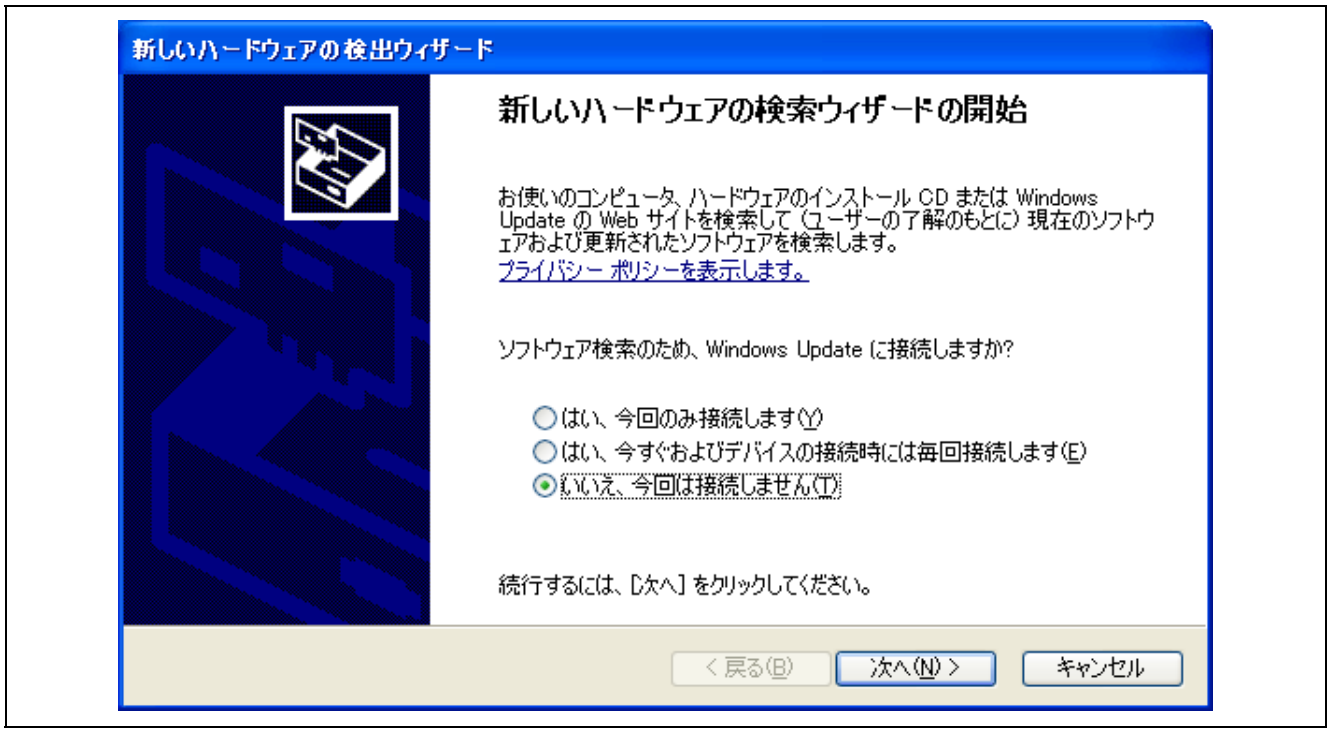

Figure 6.1 Found New Hardware Wizard (1)

(3) Select "Install from a list or specific location (Advanced)."

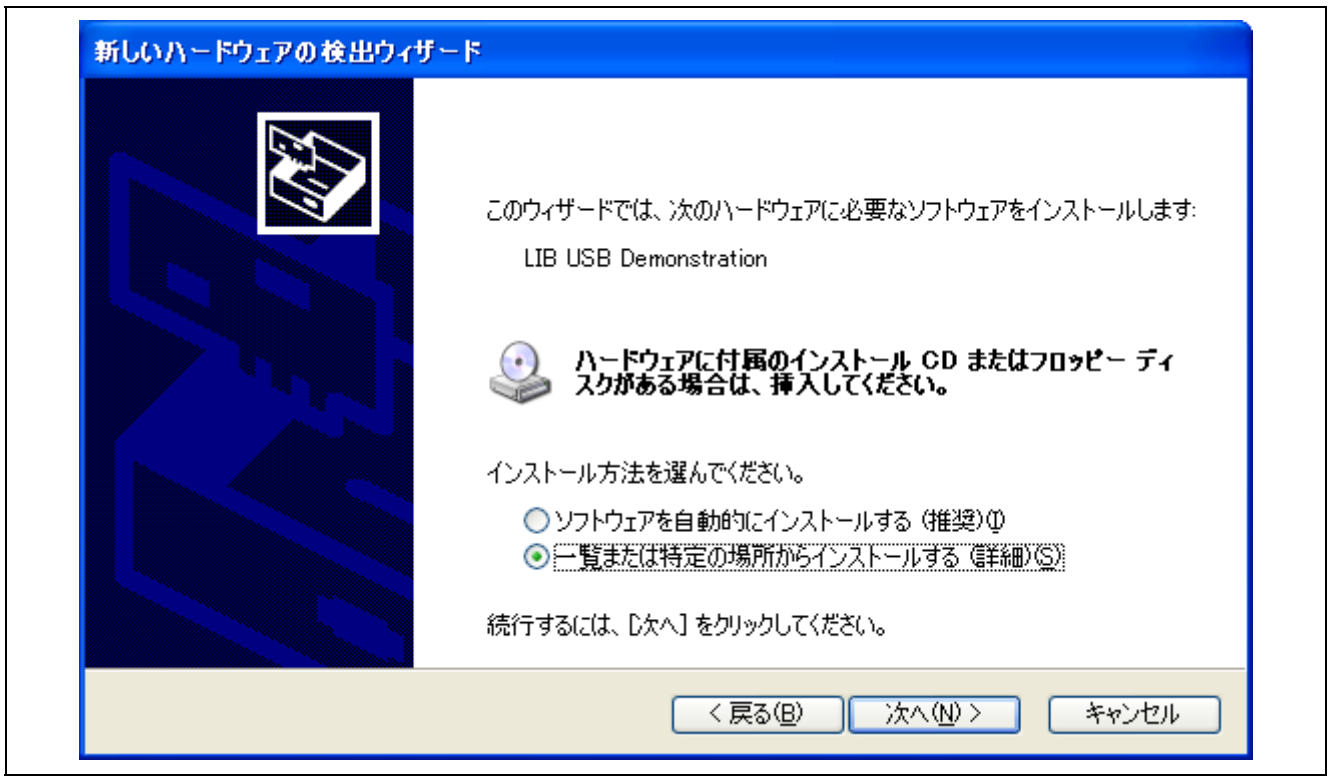

Figure 6.2 Found New Hardware Wizard (2)

(4) Select "Include this location in the search" and click Browse.

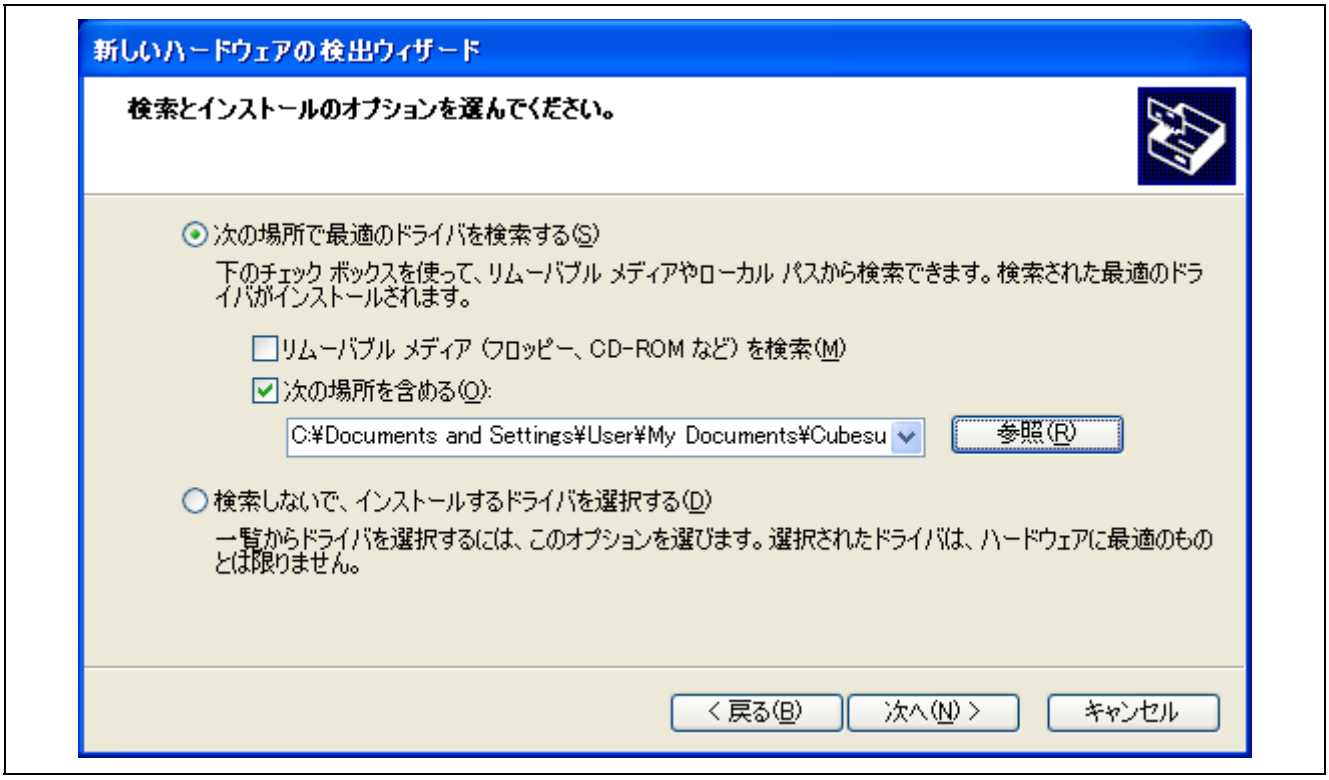

Figure 6.3 Found New Hardware Wizard (3)

(5) Select the folder that holds the .inf files. Specify the V850_ML4_USBLib\driver\inf folder.

Figure 6.4 Specifying the .inf File

(6) Click Next.

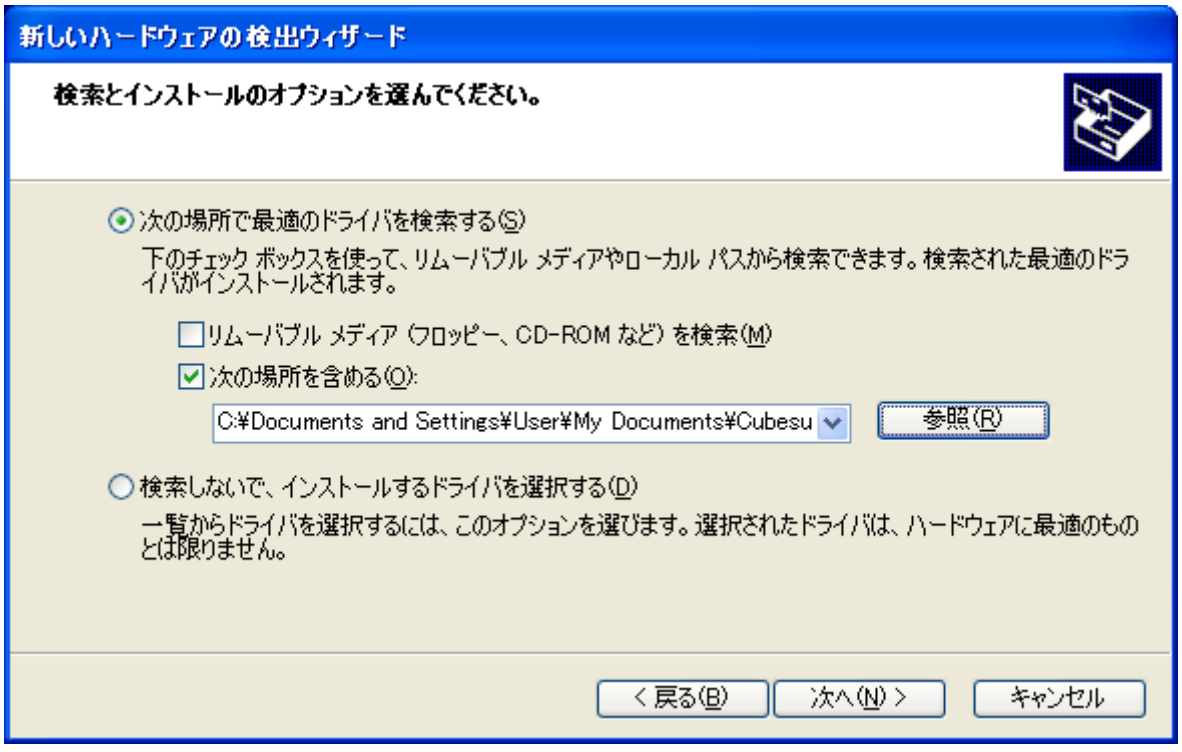

Figure 6.5 Found New Hardware Wizard (4)

(7) The install will start.

Figure 6.6 Found New Hardware Wizard (5)

(8) Lib USB Demonstration will have been added the Device Manager when the installation completes.

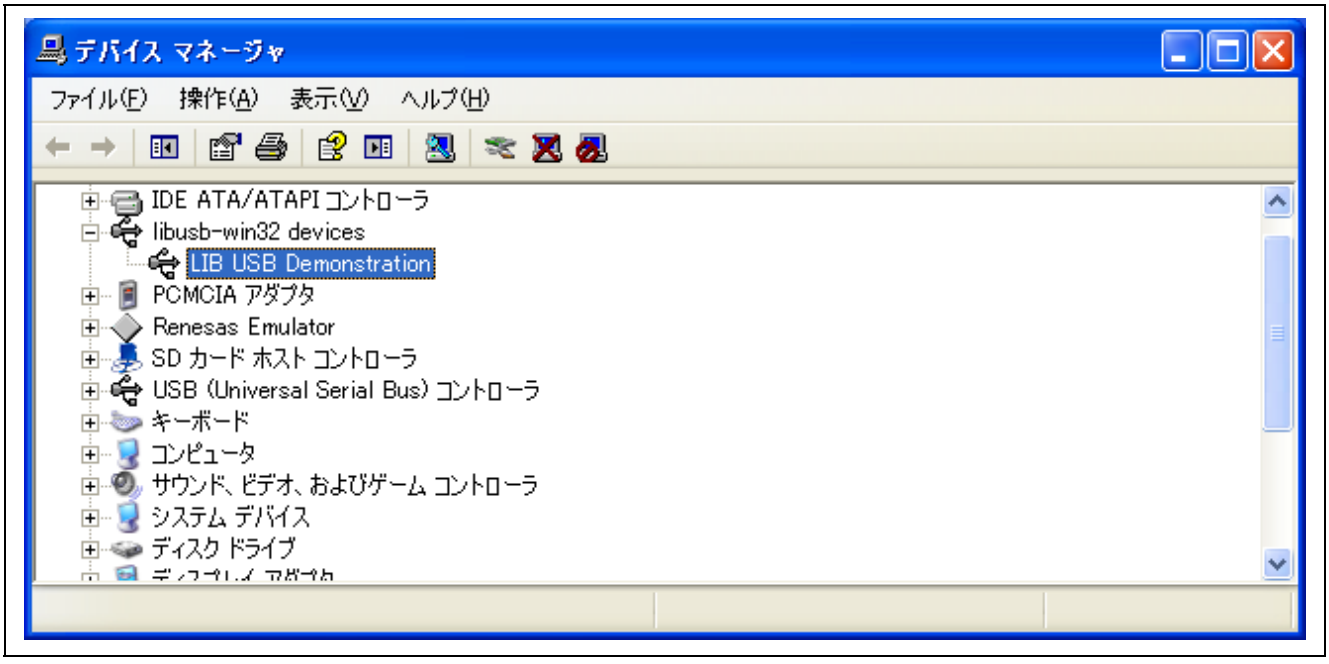

Figure 6.7 Device Manager

6.3 Example of Sample Application Operation

The Microsoft Visual C++ 2010 SP1 redistributable package (x86) must be installed to run this application. That package can be downloaded from the Microsoft Download Center.

6.3.1 At application startup

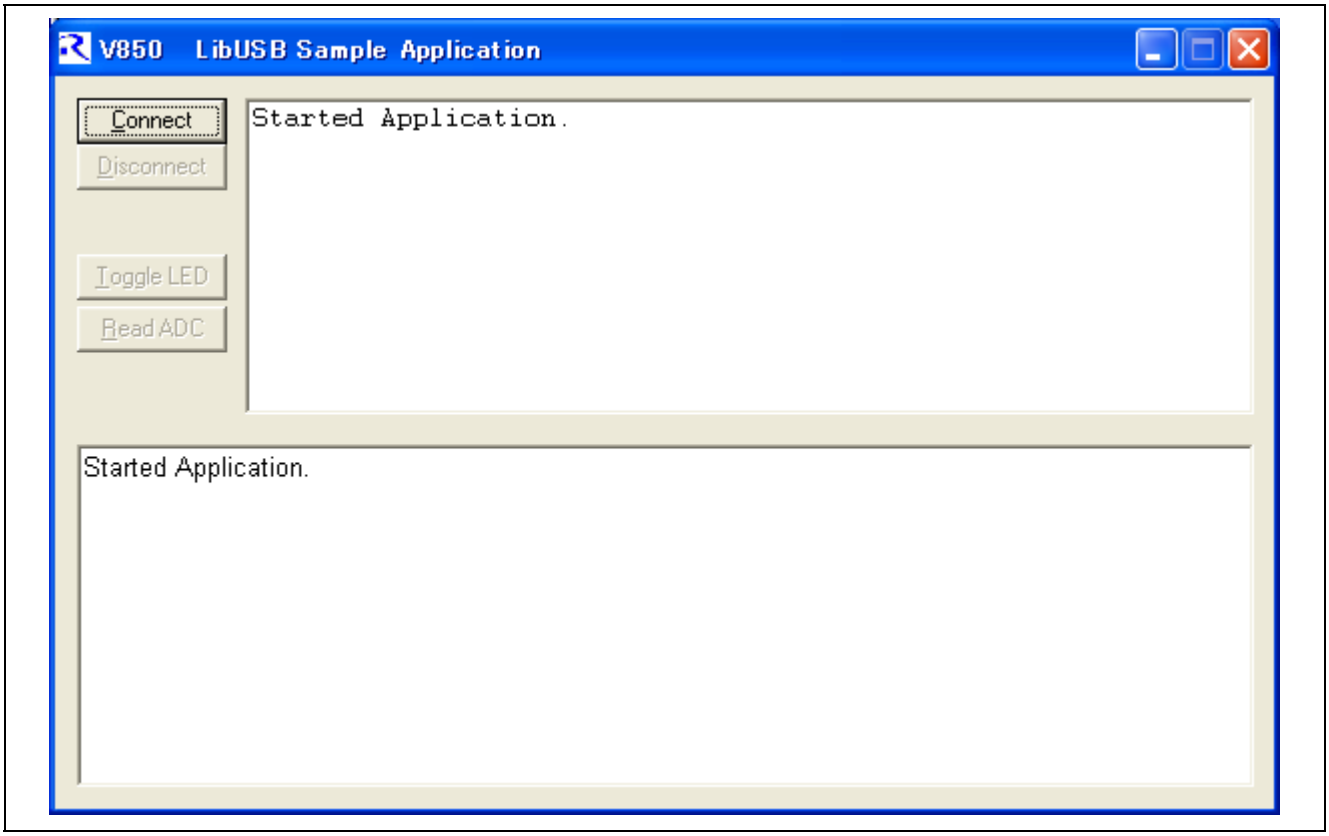

Figure 6.8 At Application Startup

6.3.2 When Connect is Clicked

Enter the following values for VID and PID.

VID = 0x045b

PID = 0x0217

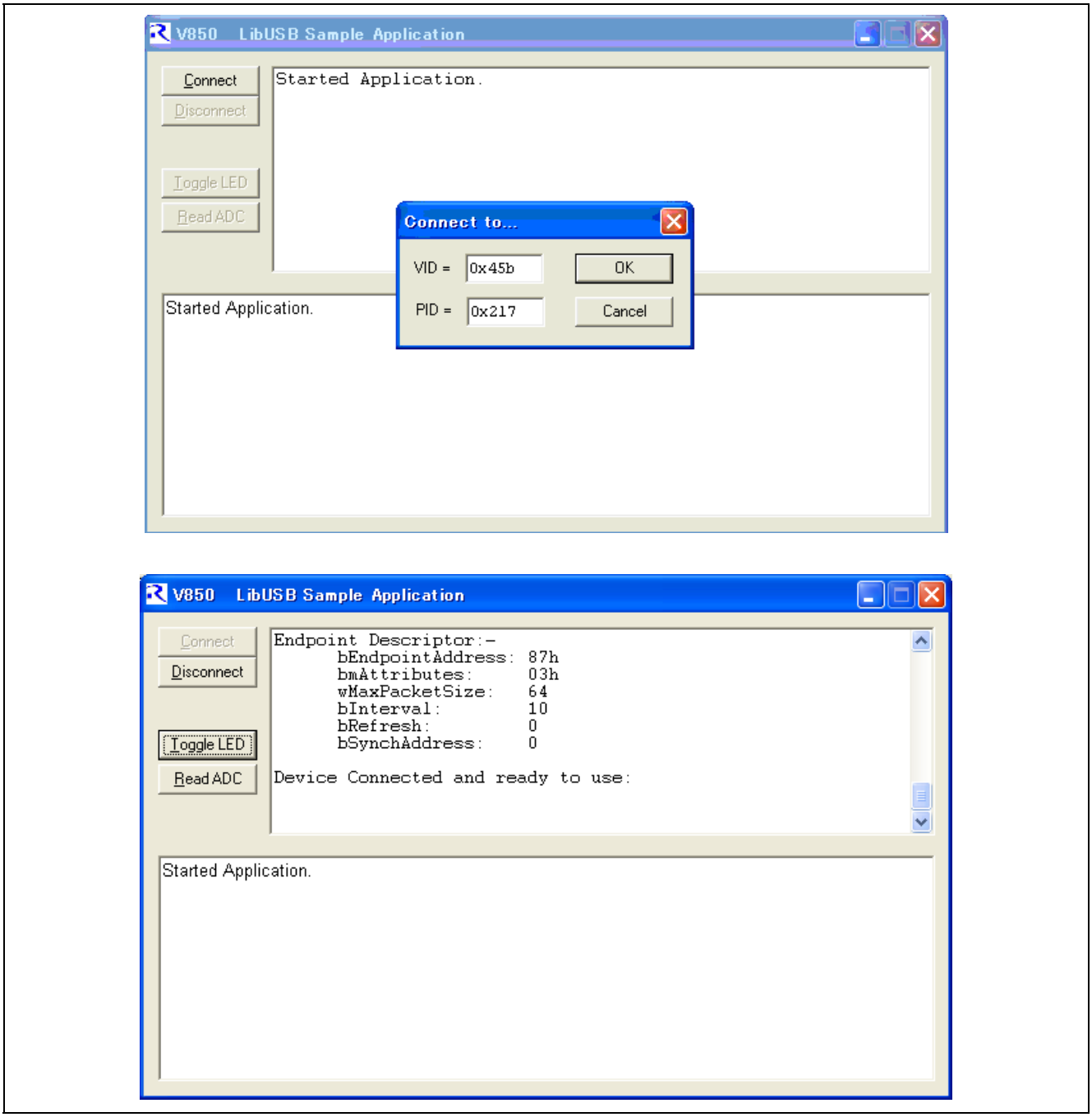

Figure 6.9 When Connect is Clicked

6.3.3 When Toggle LED is Clicked

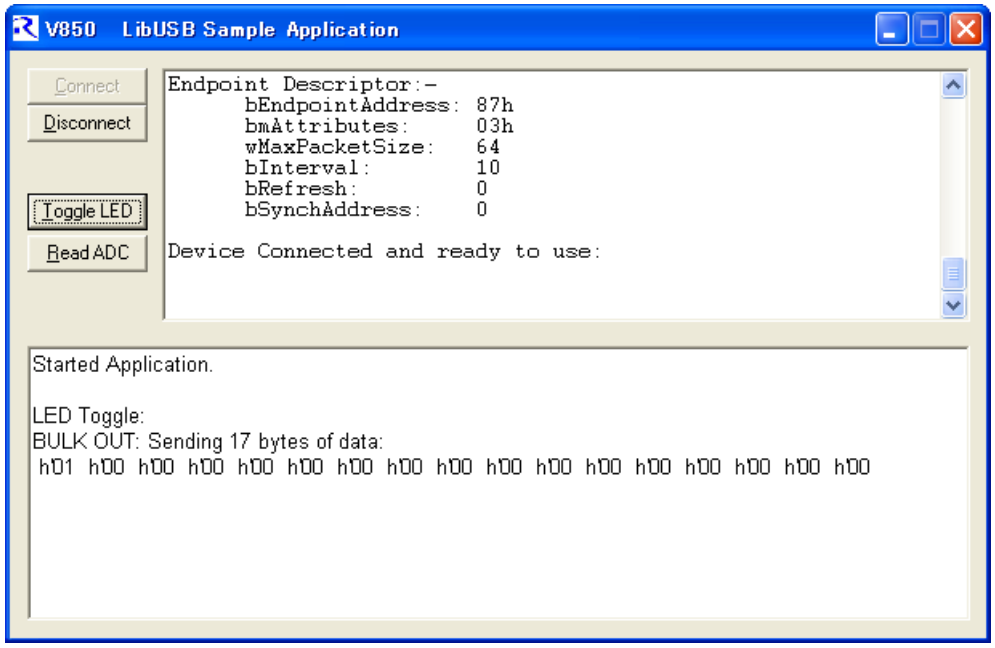

Figure 6.10 When Toggle LED is Clicked

6.3.4 When Read ADC is Clicked

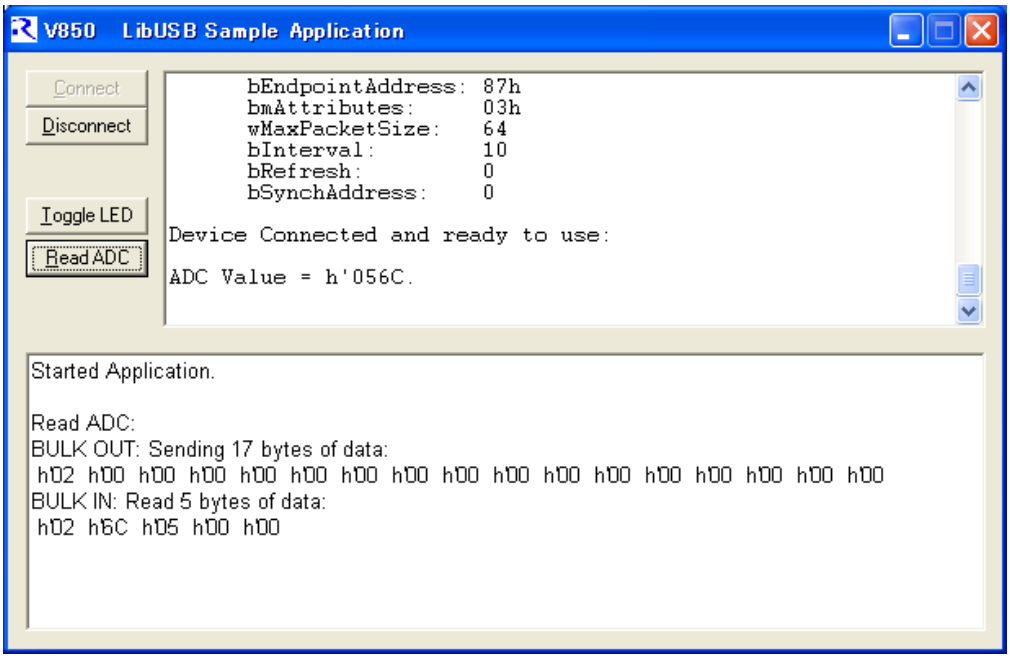

Figure 6.11 When Read ADC is Clicked

6.3.5 When Disconnect is Clicked

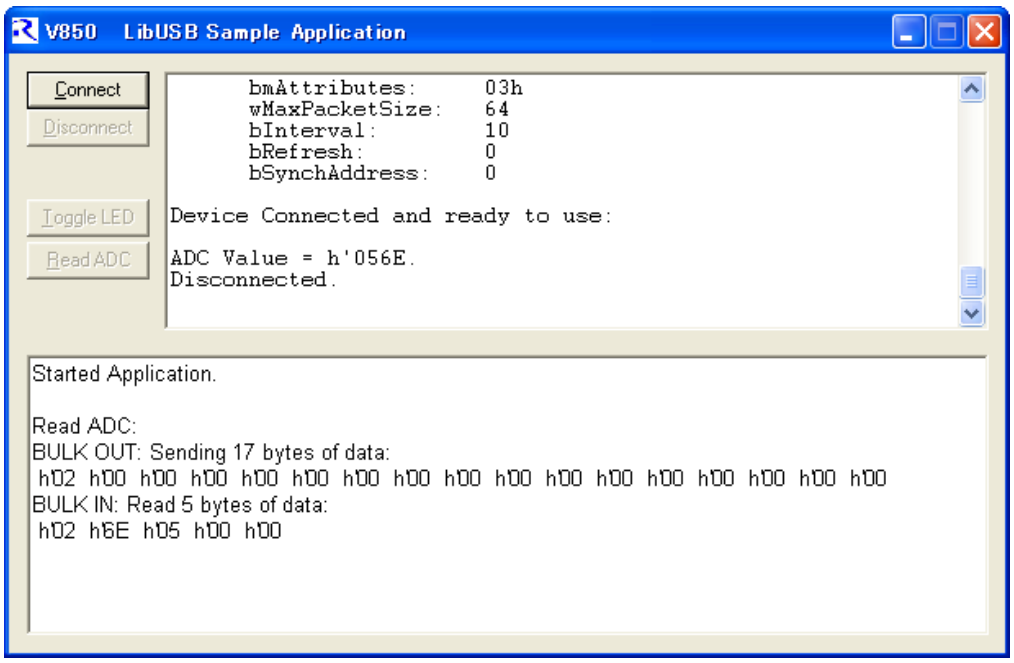

Figure 6.12 When Disconnect is Clicked

Website and Support

Renesas Electronics Website
http://www.renesas.com/

Inquiries
http://www.renesas.com/inquiry

Revision Record

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Mar.27.12	—	First edition issued

General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this manual, refer to the relevant sections of the manual. If the descriptions under General Precautions in the Handling of MPU/MCU Products and in the body of the manual differ from each other, the description in the body of the manual takes precedence.

1. Handling of Unused Pins
   Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.
   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.
2. Processing at Power-on
   The state of the product is undefined at the moment when power is supplied.
   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.
   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.
   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.
3. Prohibition of Access to Reserved Addresses
   Access to reserved addresses is prohibited.
   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.
4. Clock Signals
   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.
   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.
5. Differences between Products
   Before changing from one product to another, i.e. to one with a different type number, confirm that the change will not lead to problems.
   — The characteristics of MPU/MCU in the same group but having different type numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different type numbers, implement a system-evaluation test for each of the products.

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