SH7216 Group

Peripheral LibUSB Demo

R01AN0889EJ0100
Rev.1.00
Nov 02, 2011

Introduction

This application note describes a sample program (Peripheral LibUSB Demo) that controls an A/D converter and LEDs on an SH7216 evaluation board using the USB function module included in the SH7216.

Target Device

SH7216

Contents

1. Introduction

1.1 Specifications

The Peripheral LibUSB Demo program can communicate with a LibUSB Application running on a host PC using the SH7216 USB function module. (Evaluation board model number: R0K572167C001BR)

In this sample program, the PC and the SH7216 perform the following operations.

(1) Connect
(2) Disconnect
(3) LED display (Toggle)
(4) A/D converter value acquisition (Read ADC)

See section 2 for details.

1.2 Functions Used

- Interrupt controller (INTC)
- Pin function controller (PFC)
- USB function module (USB)
- I/O ports
- A/D converter (ADC)

1.3 Applicable Conditions

MCU	SH7216
Operating frequencies	Internal clock: 200 MHz Bus clock: 50 MHz Peripheral clock: 50 MHz
Integrated development environment	Renesas Electronics High-performance Embedded Workshop, Ver. 4.08.00.001
C compiler	Renesas Electronics SuperH RISC engine Family C/C++ Compiler Package, Ver. 9.03, Release 02
Compile options	High-performance Embedded Workshop default settings (-cpu=sh2afpu -include="$(WORKSPDIR)\C_Source", "$(WORKSPDIR)\C_Source\usb","$(WORKSPDIR)\C_Source\led" ,"$(WORKSPDIR)\C_Source\adc","$(WORKSPDIR)\C_Source\common" -object="$(CONFIGDIR)\$(FILELEAF).obj" -debug -gbr=auto -chgincpath -errorpath -global_volatile=1 -opt_range=all -infinite_loop=0 -del_vacant_loop=0 -struct_alloc=1 -nologo)

1.4 Related Application Notes

- SH7216 Group USB Function Module USB HID Class Application Note (REJ06B0898-0200)
- SH7216 Group User Program Mode Flash Programming Operation Example Application Note (R01AN0316EJ0110)
- SH7216 Group USB Function Module USB Mass Storage Class Application Note (REJ06B0897-0200)
- SH7216 Group Ethernet/USB Protocol Conversion Operation Example Application Note (R01AN0066EJ0110)
- SH7216 Group USB Function Module USB Multifunction Operation Example Application Note (R01AN0294EJ0110)

2. System Structure

The Peripheral LibUSB Demo allows an application (SH7216_LibUSB.exe) running on a host PC to manipulate the SH7216 evaluation board when the host PC and the SH7216 evaluation board are connected with a USB cable.

See section 6 for the PC application UI screens.

Figure 1 shows the structure of the system used in this sample application.

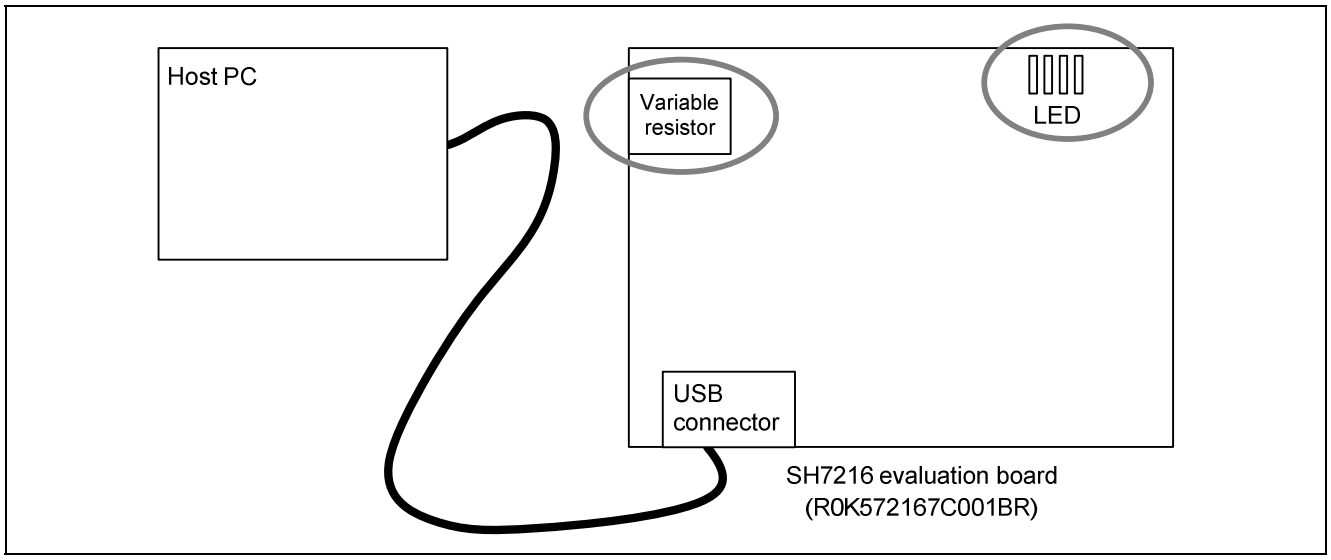

Figure 1 System Structure

The following functions can be used to manipulate the evaluation board.

(1) An enumeration is performed when the **Connect** button is clicked.
(2) A disconnect operation is performed when the **Disconnect** button is clicked.
(3) The LED on/off state is toggled when the **Toggle LED** button is clicked.
The LED shown in the figure above is turned on or off.
(4) The A/D converter value is transmitted to the host PC when the **Read ADC** button is clicked.
The value of the variable resistor shown in the figure above is read and transmitted to the host PC.

3. SH7216 Sample Program

The SH7216 sample program consists of a main routine, a USB driver, an LED driver and an A/D converter driver. Figure 2 shows the structure of the SH7216 sample program. The arrows in the figure indicate the direction of control.

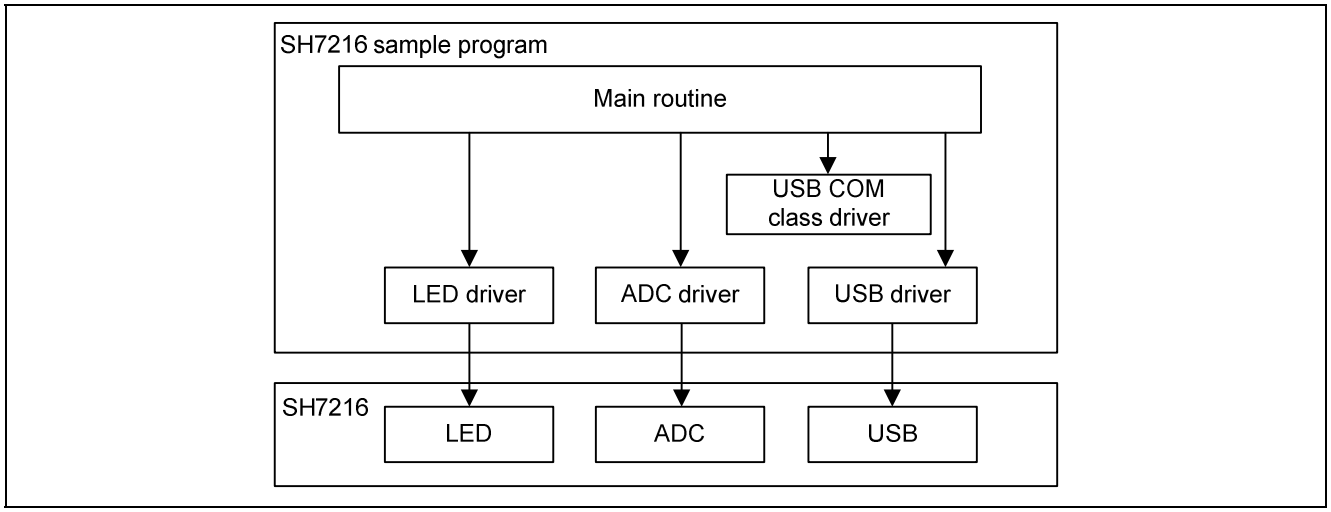

Figure 2 SH7216 Sample Program Structure

4. Descriptors

The descriptors used in the LibUSB Demo are shown below.

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		Vendor ID
idProduct	16		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

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	0x10	Maximum power. 32 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

Field	Length (bits)	Hex Value	Description
bLength	8	0x07	Descriptor size is 7 bytes
bDescriptorType	8	0x05	ENDPOINT Descriptor Type
bEndpointAddress	8	0x01	This is an OUT 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	0x82	This is an IN 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	0x83	This is an IN endpoint with endpoint number 3
bmAttributes	8	0x03	Types — INTERRUPT
wMaxPacketSize	16	0x0010	Maximum packet size for this endpoint is 16 Bytes.
bInterval	8	0x10	The polling interval value is every 16 Frames.

5. Basic Functions

LibUSB supports the following functions

(1) Performing an enumeration when the **Connect** button is clicked.
(2) Performing a disconnect operation when the **Disconnect** button is clicked.
(3) Toggling the LED on/off state when the **Toggle LED** button is clicked.
(4) Transmitting the A/D converter value to the host PC when the **Read ADC** button is clicked.

5.1 Main Function

The function main() checks for USB receive data by polling the USB receive buffer. When a USB data application is started, it will be in the enumeration wait state.

When USB receive data is detected, the control command in the first byte is analyzed and the processing for that command is performed.

Table 1 lists the control flags and buffers handled by main().

Table 1 Flags and Buffers Handled by main()

No.	Flag	Description
1	ledControlFlg	LED display control flag
2	usbRcvBuf	USB receive data storage buffer
3	usbSndBuf	USB transmit data storage buffer
4	adcVal	Acquired A/D converter value storage area

Figure 3 shows the flowchart of the main() function.

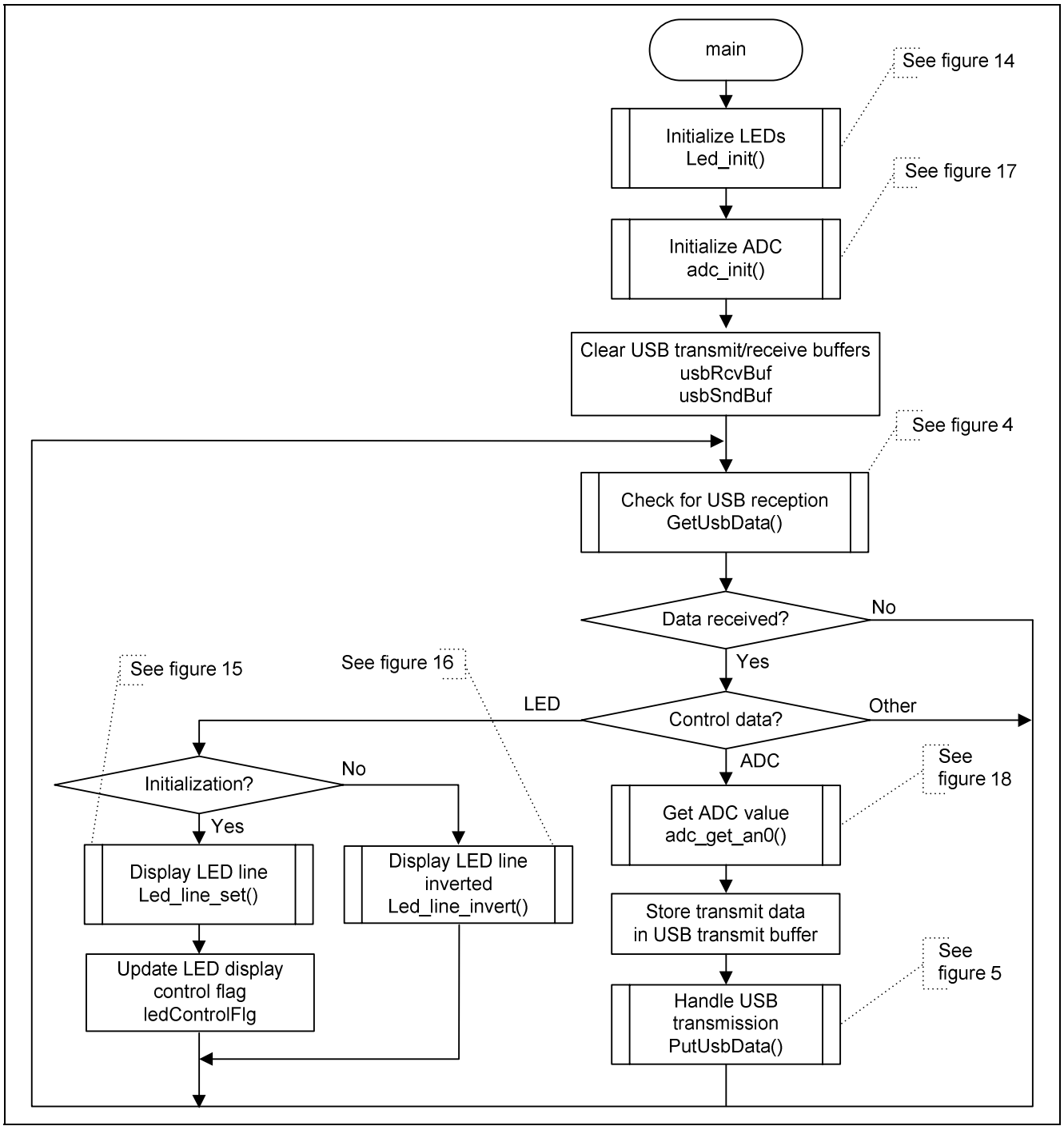

Figure 3 Function main() Flowchart

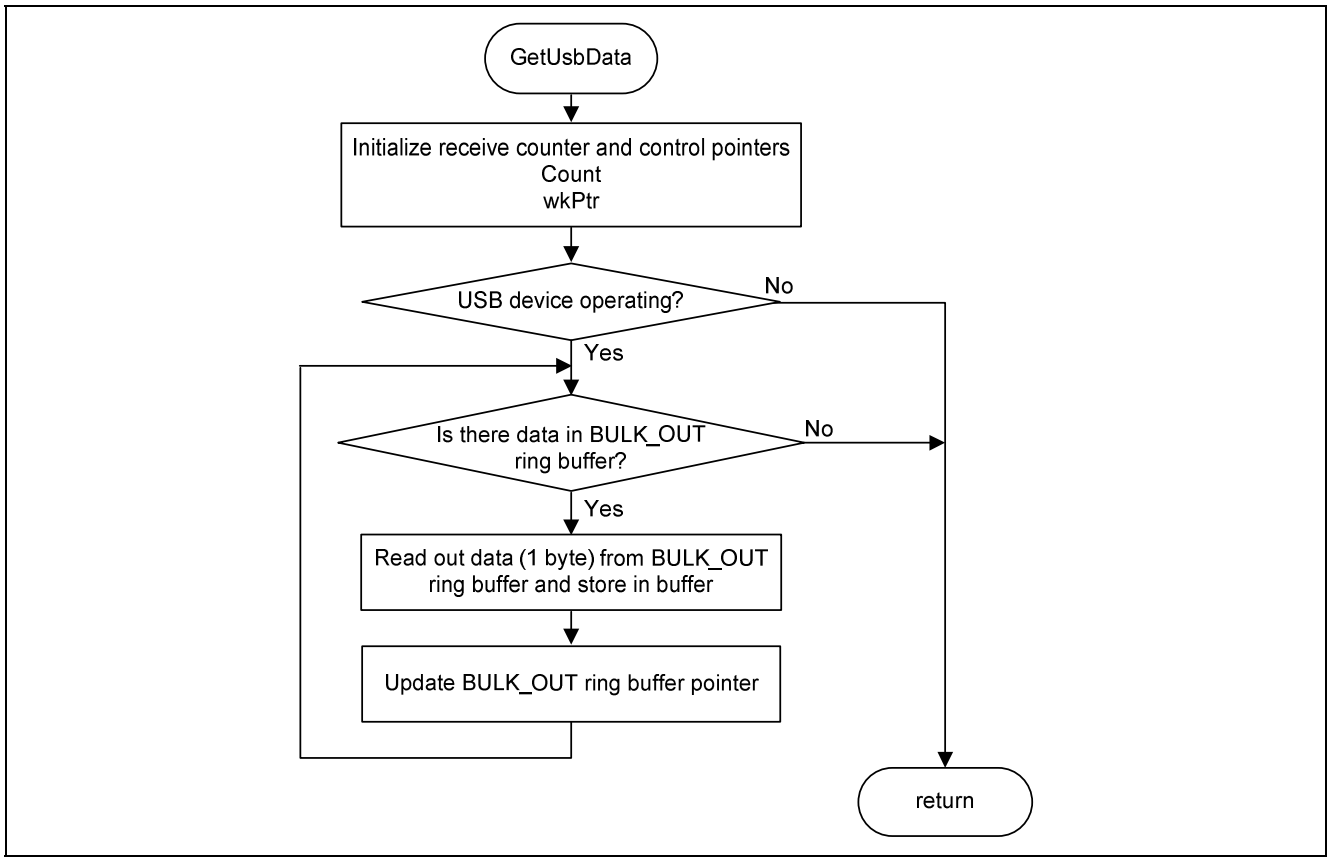

Figure 4 USB Reception Check Flowchart

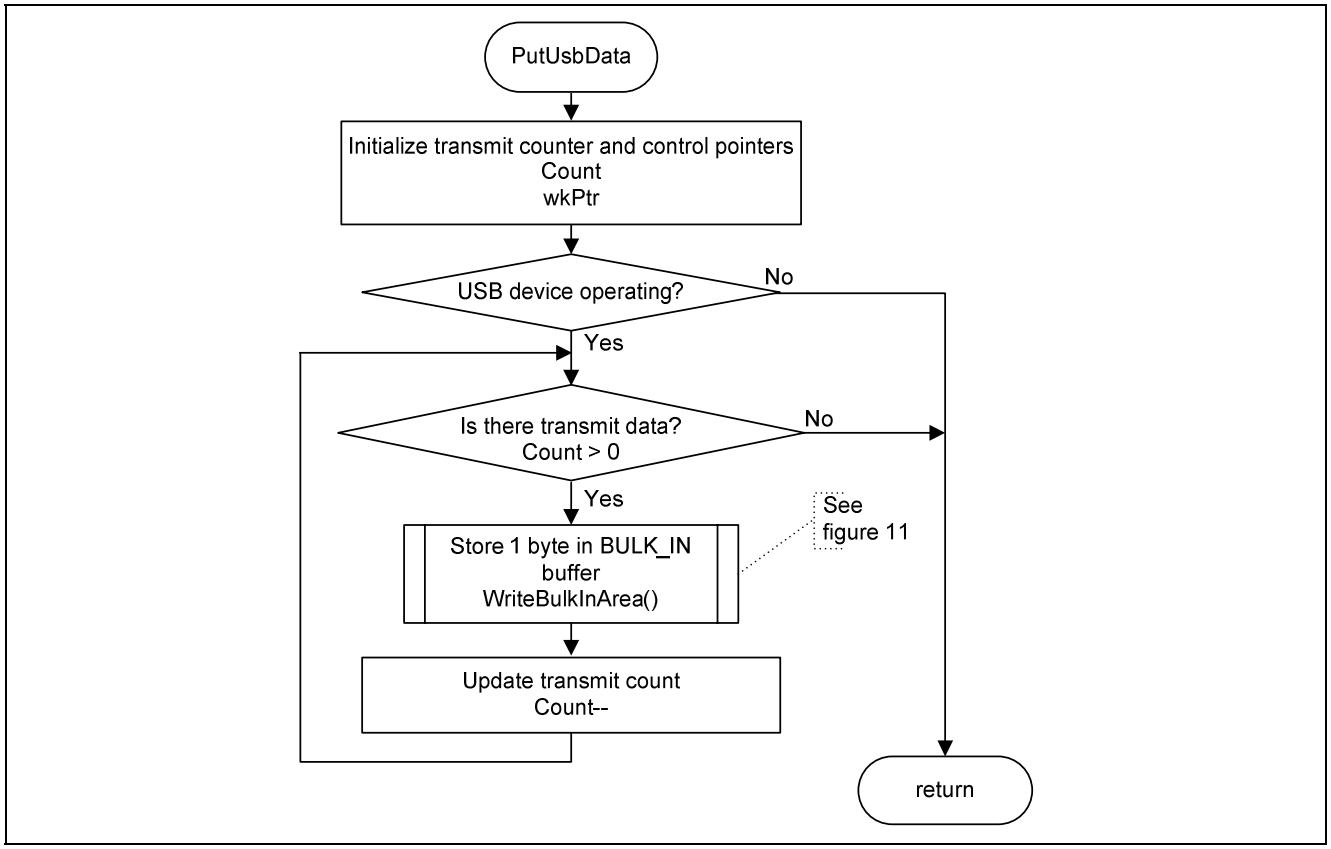

Figure 5 USB Transmission Flowchart

5.1.1 Details of the Command Protocols

LibUSB uses two command protocols: **Toggle LED** and **Read ADC**. The tables below describe these protocols in detail.

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??		Received on endpoint 1
		Command processing Displays the initial pattern from the initial state. In second and later invocations, inverts the pattern in the LEDs. Note: Data evaluated as commands consists of: Just the first byte. The second to 16th bytes are unused.

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??		Received on endpoint 1
		Command processing Reads out the A/D converter data. Note: Data evaluated as commands consists of: Just the first byte. The second to 16th bytes are unused.
		The A/D converter data (5 bytes) is transmitted using endpoint 2. 0x02 0x?? 0x?? 0x?? 0x?? The second through fourth bytes are the A/D converted value. (This is 4 bytes of data in little endian order.)

5.2 USB Driver

The USB driver is a group of functions that provide control transfer and bulk transfer support processing using the SH7216 USB function module (USB).

Table 2 lists the flags used for poling control, data send/receive control, and device present/absent control.

Table 2 USB Driver Control Flags

No.	Flag	Description
1	UsbDevEnableFlag	Indicates whether or not a USB device is present
2	BulkOutEnableFlag	Controls USB data transfers

Table 3 lists the USB driver functions.

Table 3 USB Driver Functions

No.	Function	Description
1	ActBusReset	Bus reset interrupt handling
2	ActBusVcc	USB bus connect/disconnect interrupt handling
3	ActControlInOut	Control in/control out processing
4	ActControl	Control transfer processing
5	ActBulkOut	Bulk out data reception processing
6	ActBulkIn	Bulk in data transmission processing
7	BranchOfInt0	USBIFR0 interrupt handling
8	BranchOfInt1	USBIFR1 interrupt handling

Figures 6 to 13 show the flowcharts for these functions.

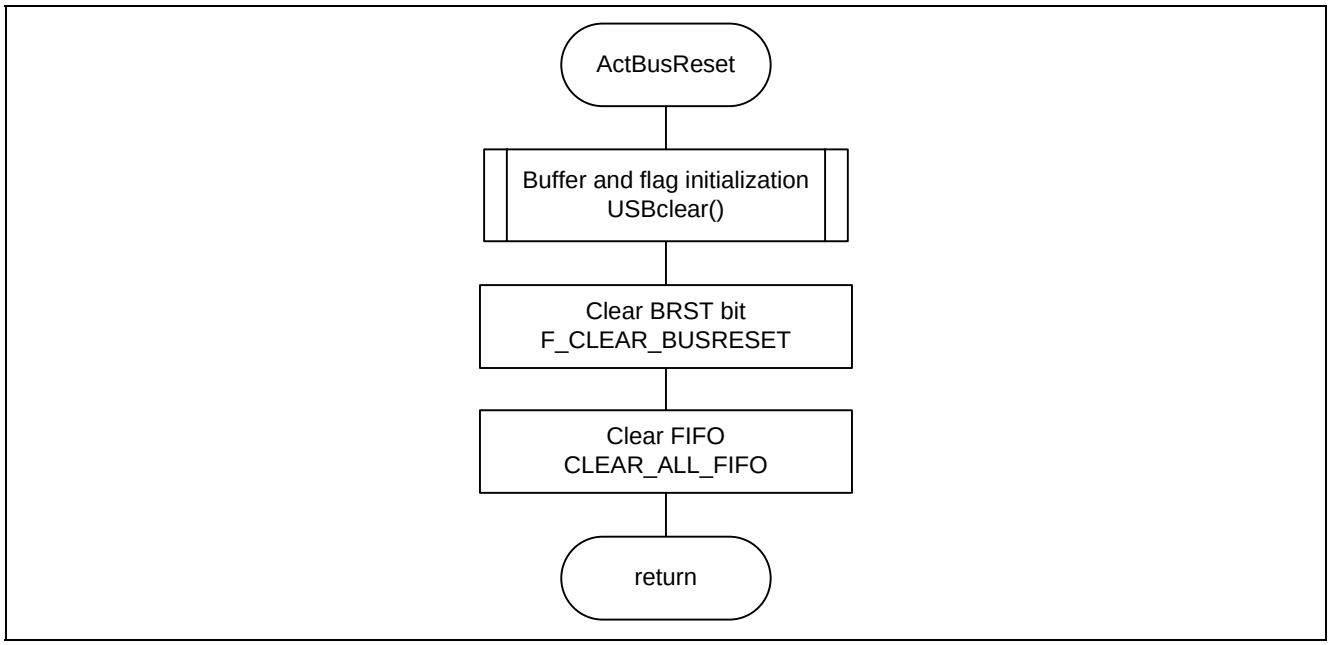

Figure 6 ActBusReset() Processing Flow

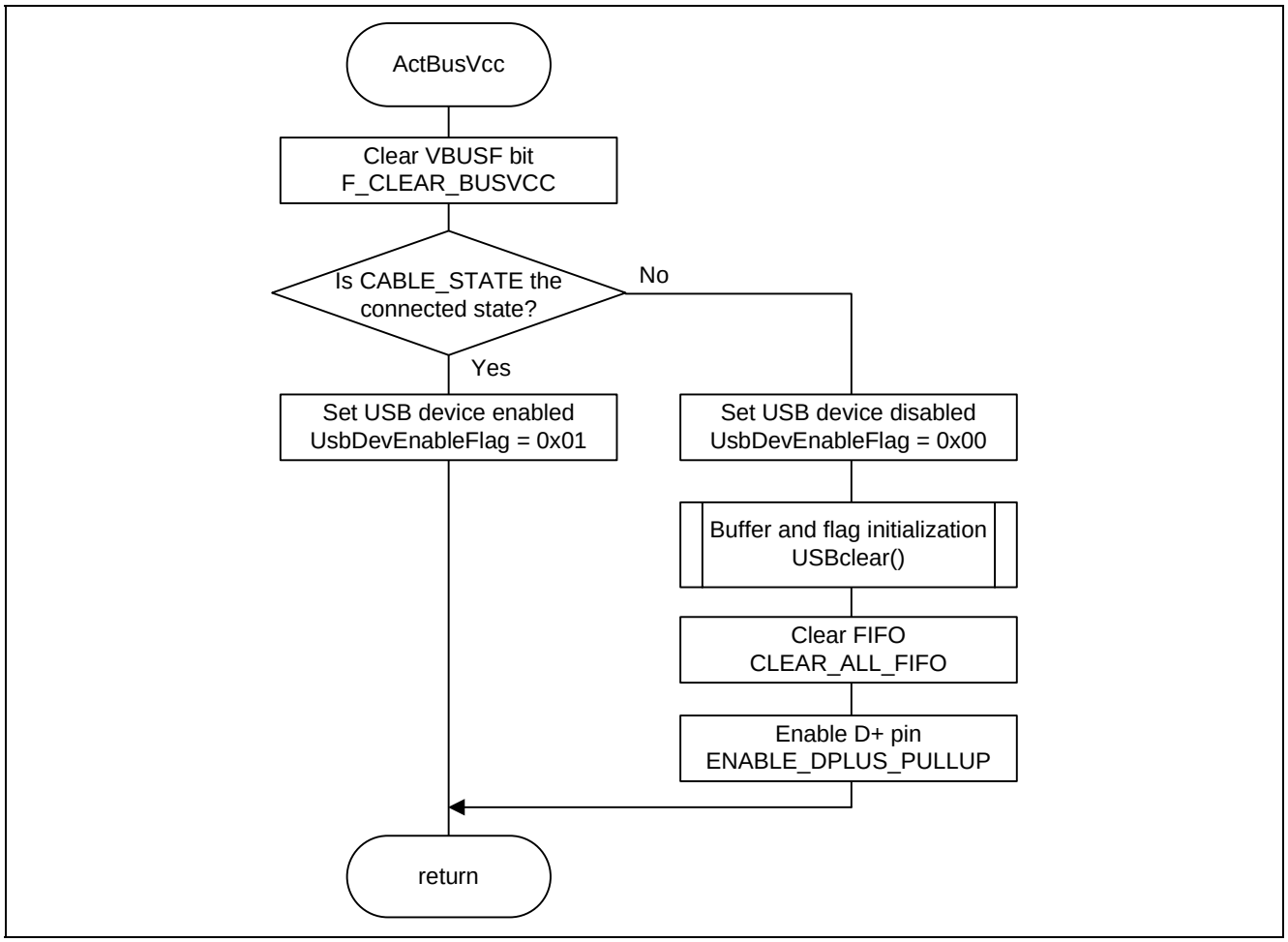

Figure 7 ActBusVcc() Processing Flow

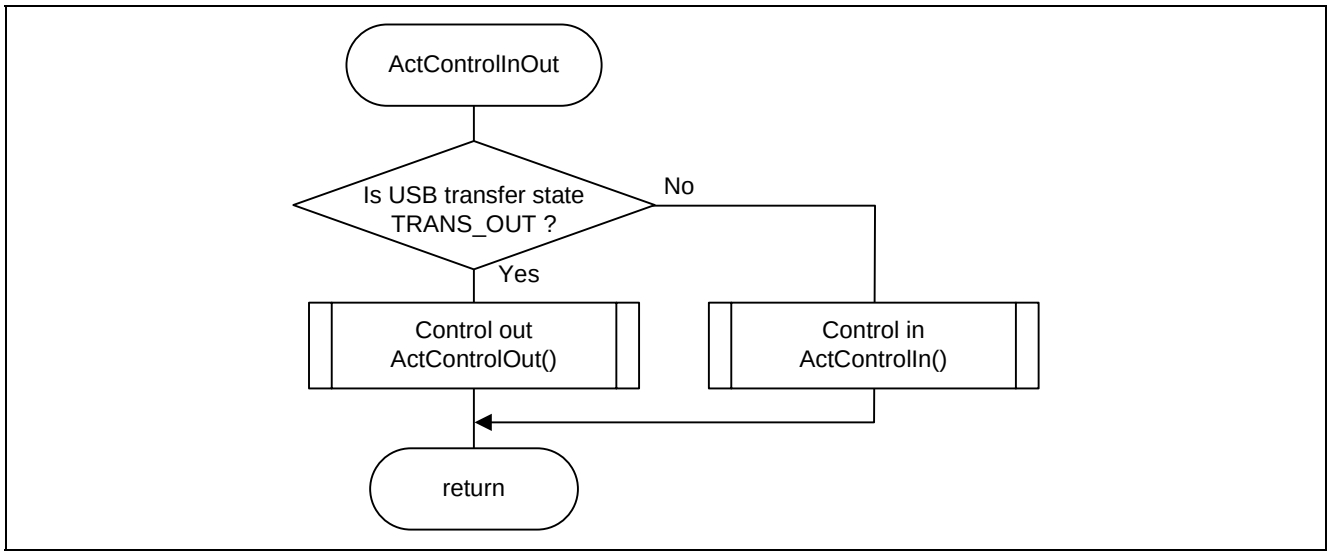

Figure 8 ActControlInOut() Processing Flow

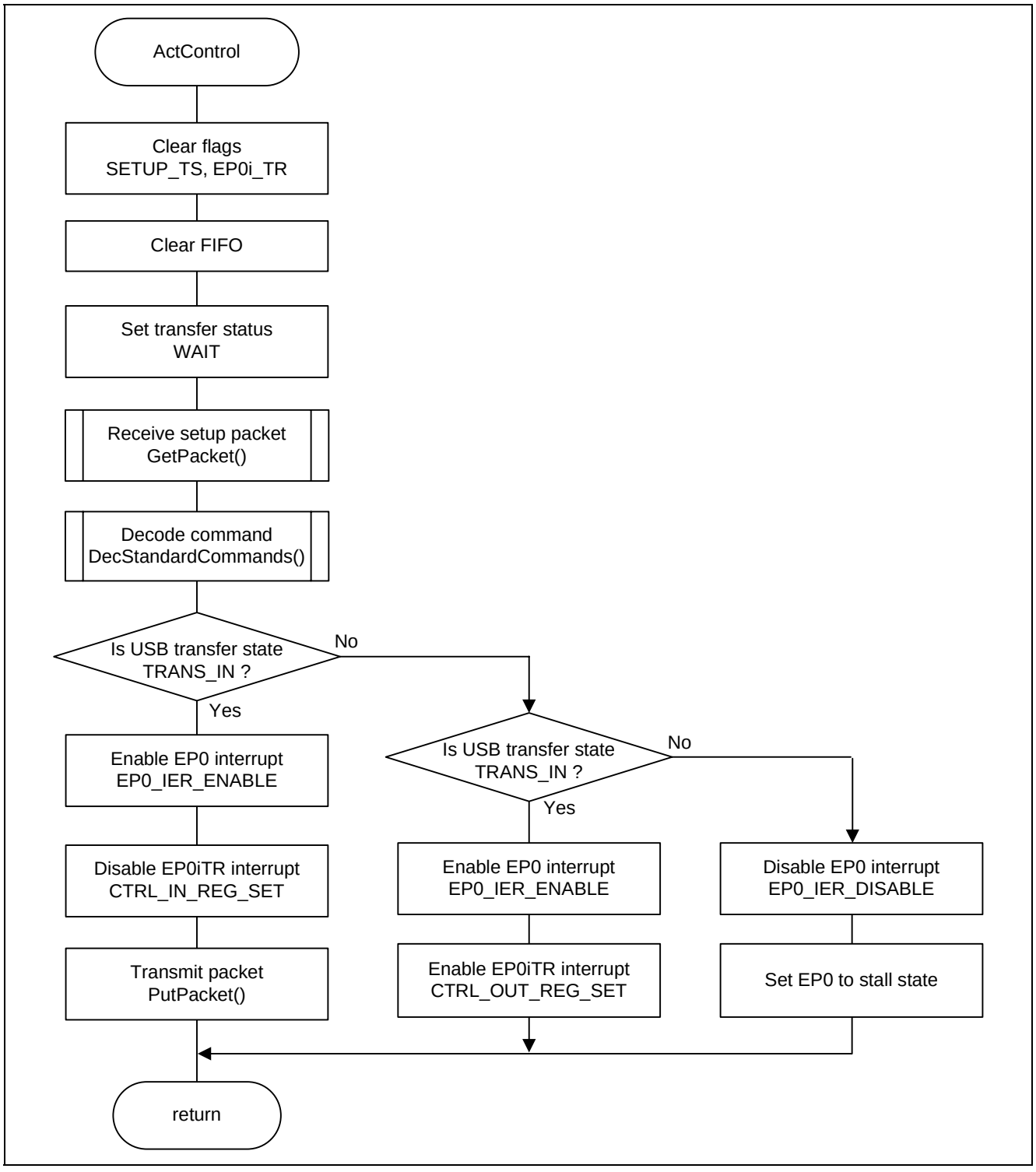

Figure 9 ActControl() Processing Flow

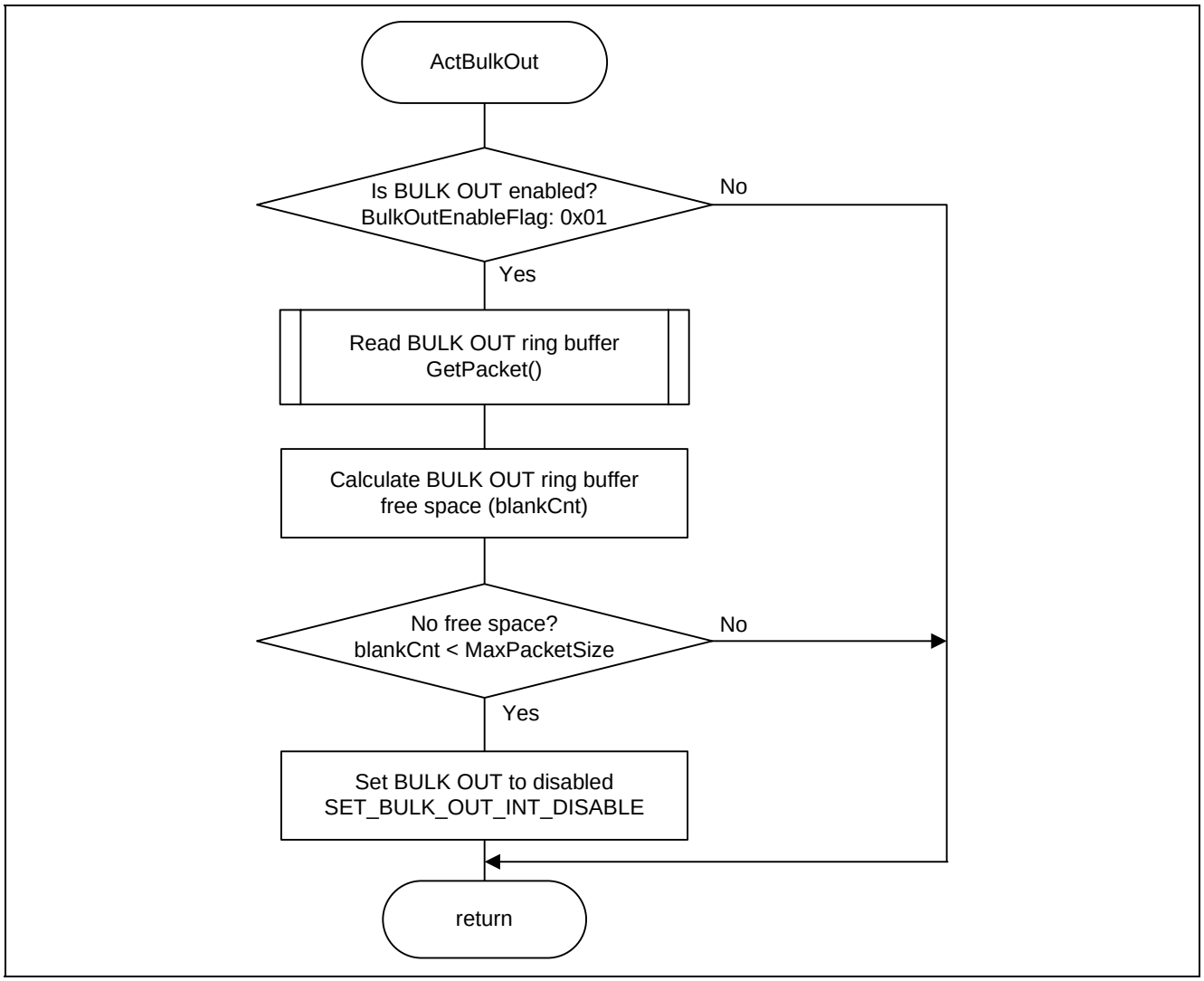

Figure 10 ActBulkOut() Processing Flow

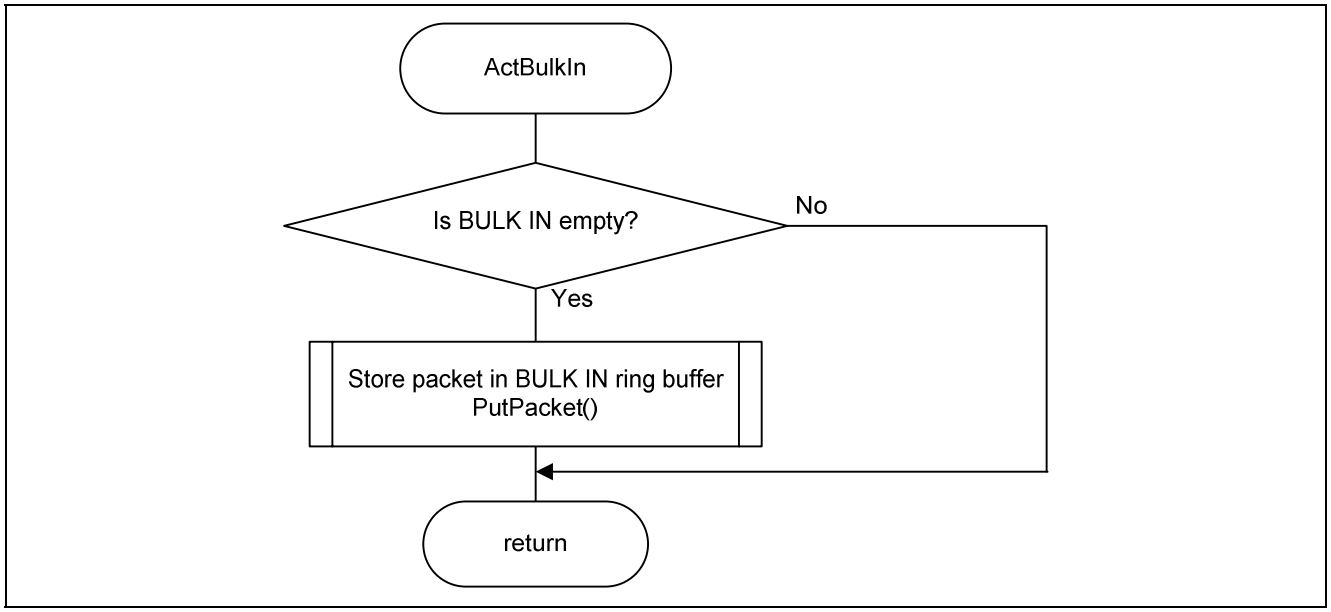

Figure 11 ActBulkIn() Processing Flow

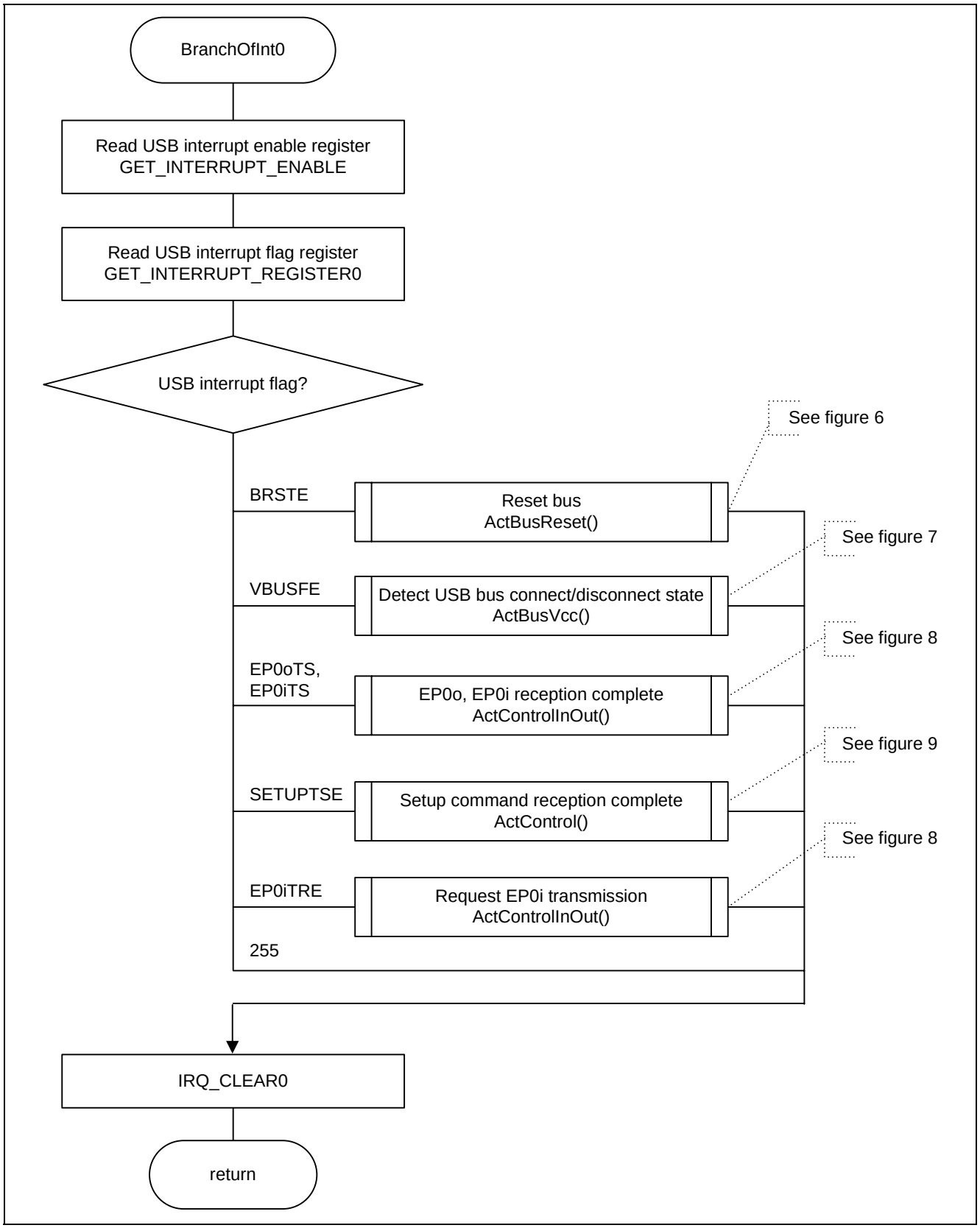

Figure 12 BranchOfInt0() Processing Flow

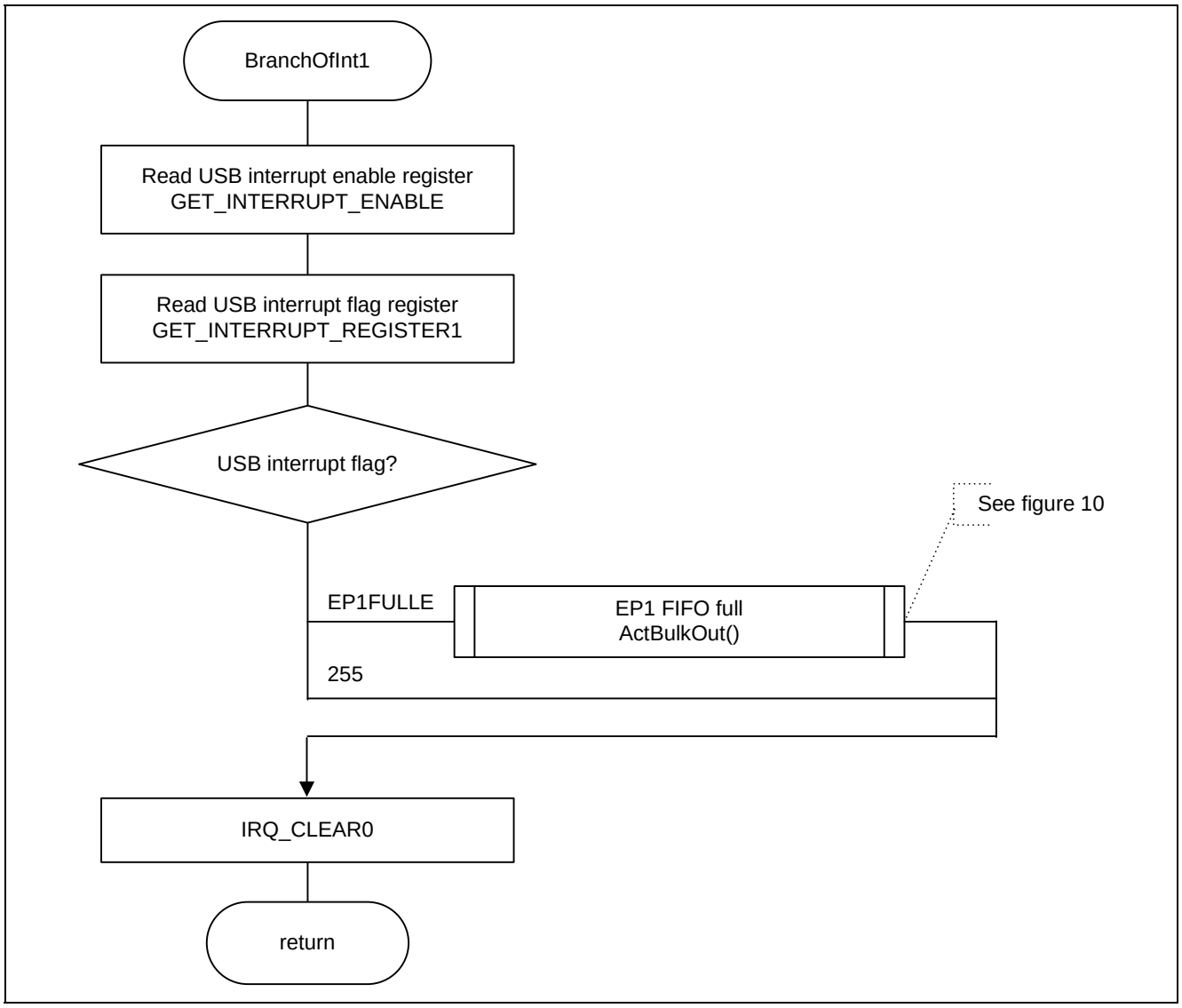

Figure 13 BranchOfInt1() Processing Flow

5.3 LED Driver

The LED driver is a set of functions that provide LED on/off control processing using an SH7216 I/O port.

Table 4 lists the LED driver functions.

Table 4 LED Driver Functions

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

Figures 14 to 16 show the flowcharts for these functions.

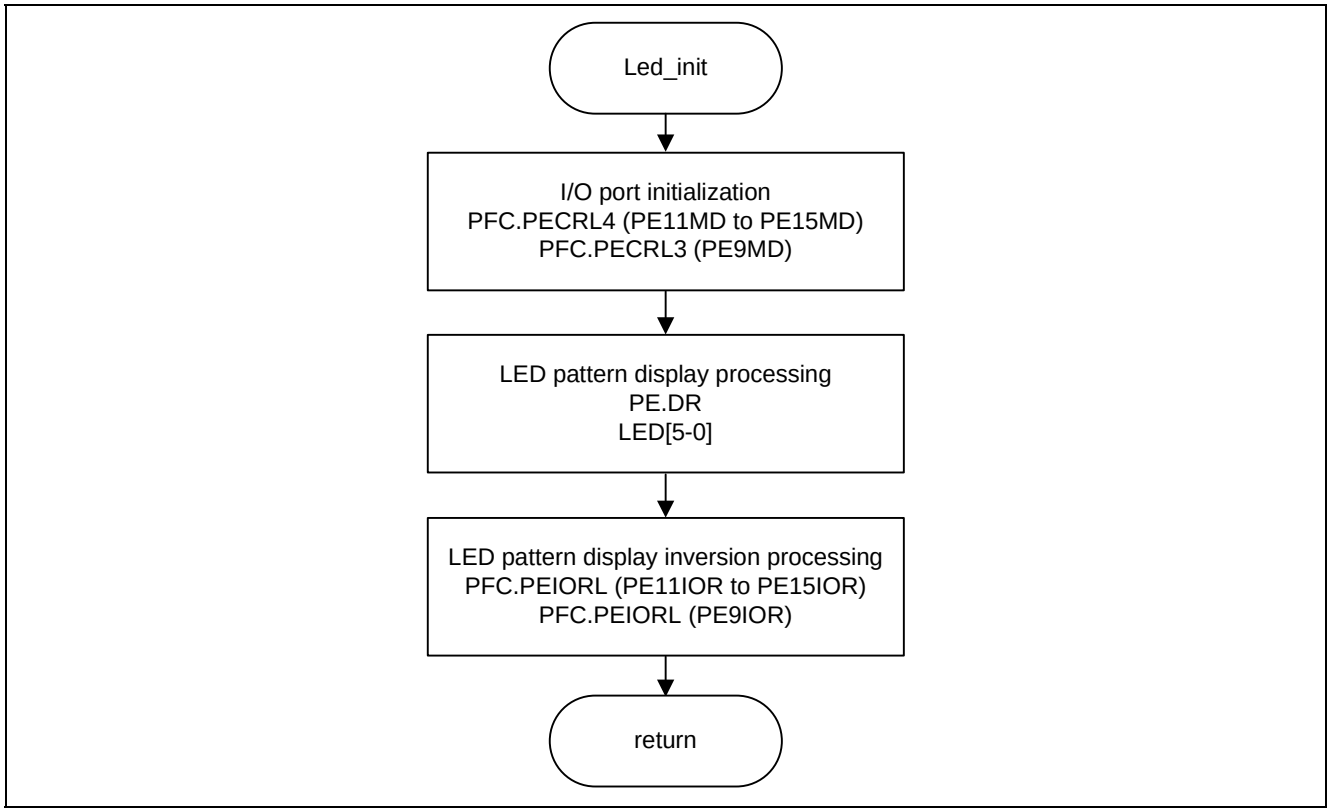

Figure 14 Led_init() Processing Flow

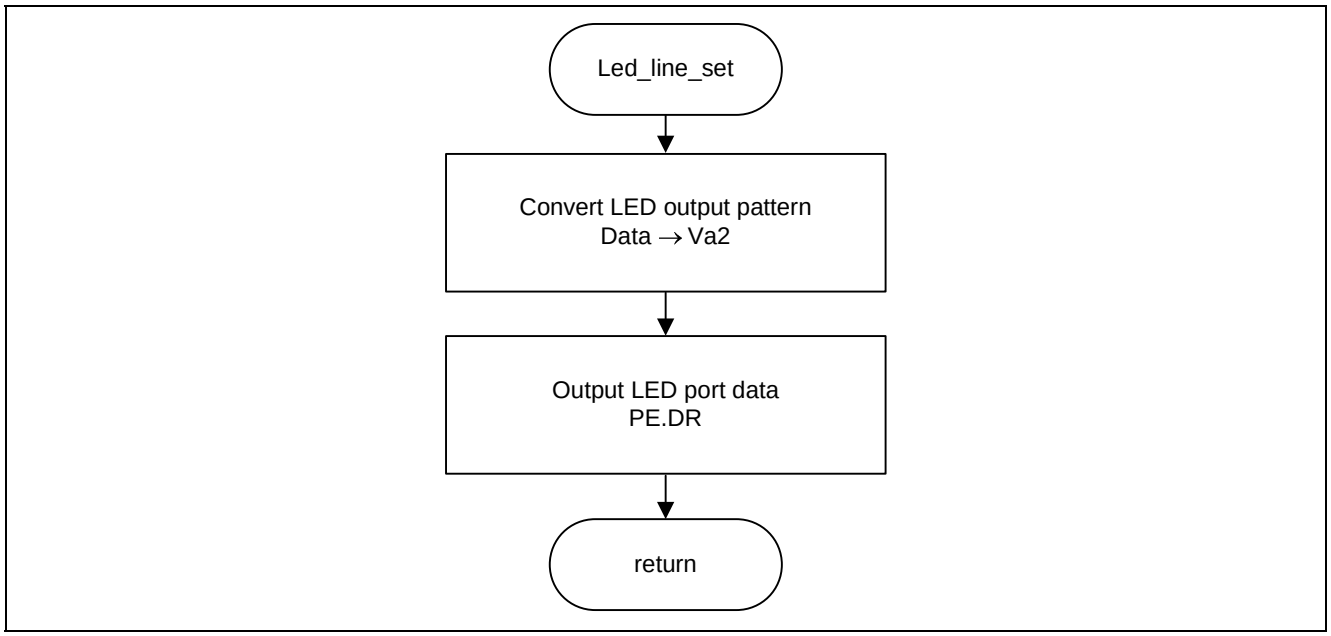

Figure 15 Led_line_set() Processing Flow

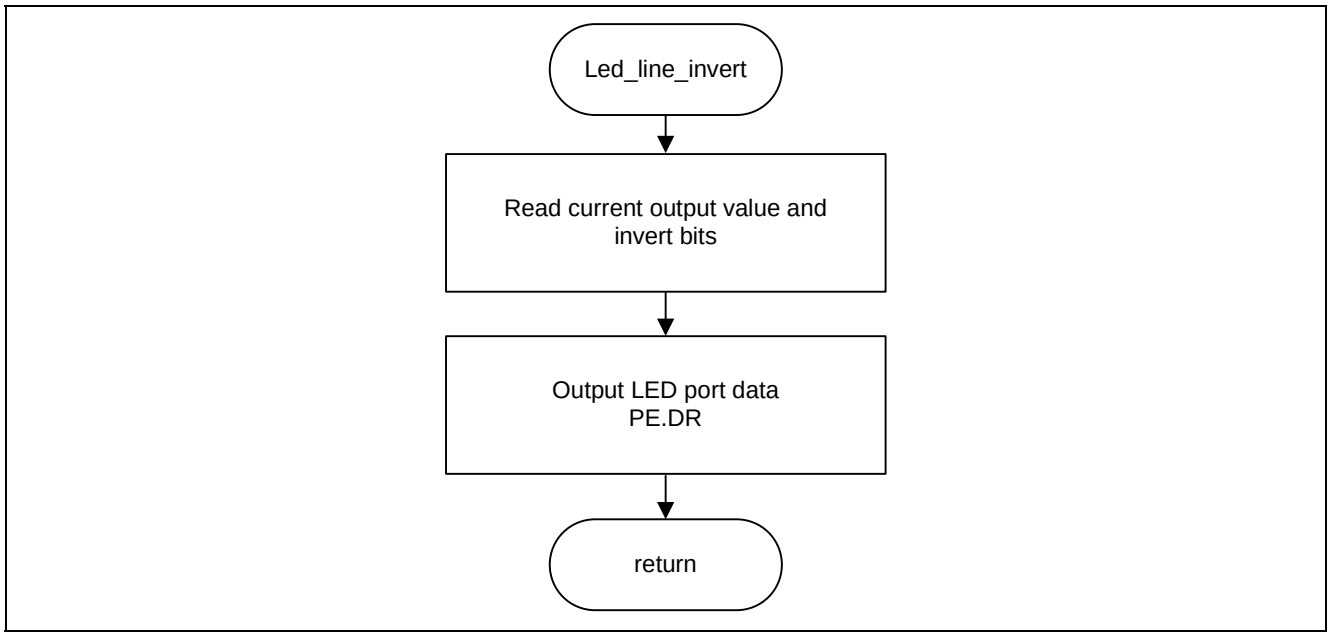

Figure 16 Led_line_invert() Processing Flow

5.4 A/D Converter Driver

The A/D converter driver is a set of functions that provide A/D converter current value acquisition using the SH7216 A/D converter (ADC).

Table 5 lists the A/D converter driver functions.

Table 5 A/D Converter Driver Functions

No.	Function	Description
1	adc_init	A/D converter initialization
2	adc_get_an0	A/D converter current value acquisition processing

Figures 17 and 18 show the flowcharts for these functions.

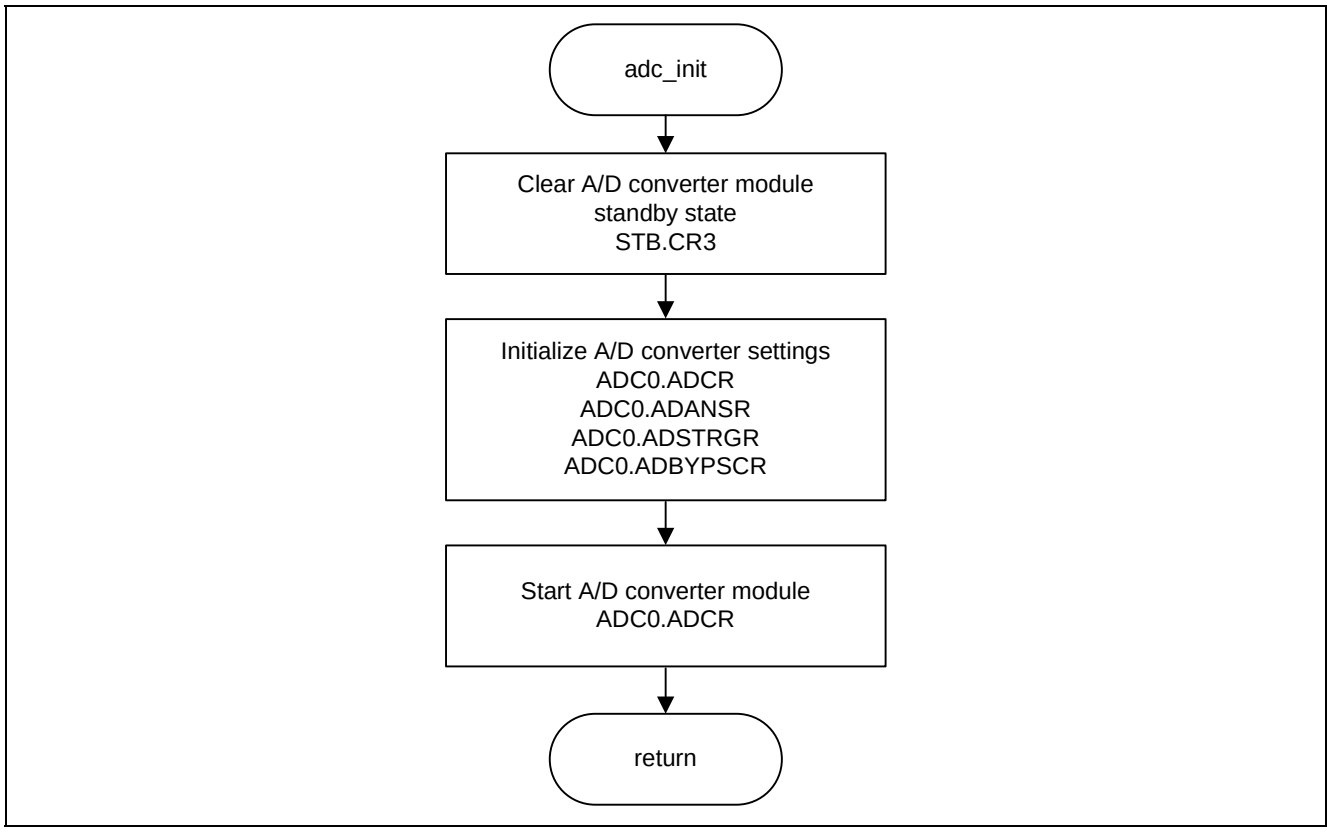

Figure 17 adc_init() Processing Flow

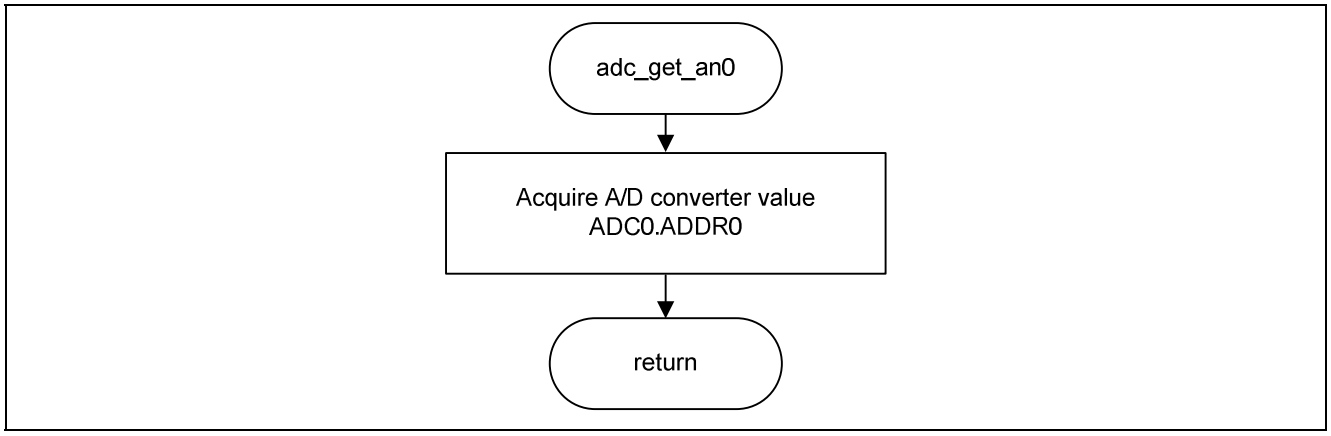

Figure 18 adc_get_an0() Processing Flow

6. SH7216_LibUSB Usage

6.1 LibUSB Installation and Application Startup

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
   Install LibUSB by uncompressing the downloaded .zip file and running **libusb-win32-devel-filter-x.x.x.x.exe**.

2. Connect the USB cable to the SH7216 evaluation board's USB connector.

3. When the hardware detection wizard starts, Select **Install from list or specify location**. Then, specify the application note's inf folder and click **Next**.

4. For Windows XP
   If either the **libusb0.sys** or **libusb0_x86.dll** specification window is displayed, specify the x86 folder from the sh7216_usb_demo folder under the inf folder.

5. Double click **SH7216_LibUSB.exe** in the application folder to run the program.

6.2 Sample Screens from the PC Application

6.2.1 At Startup

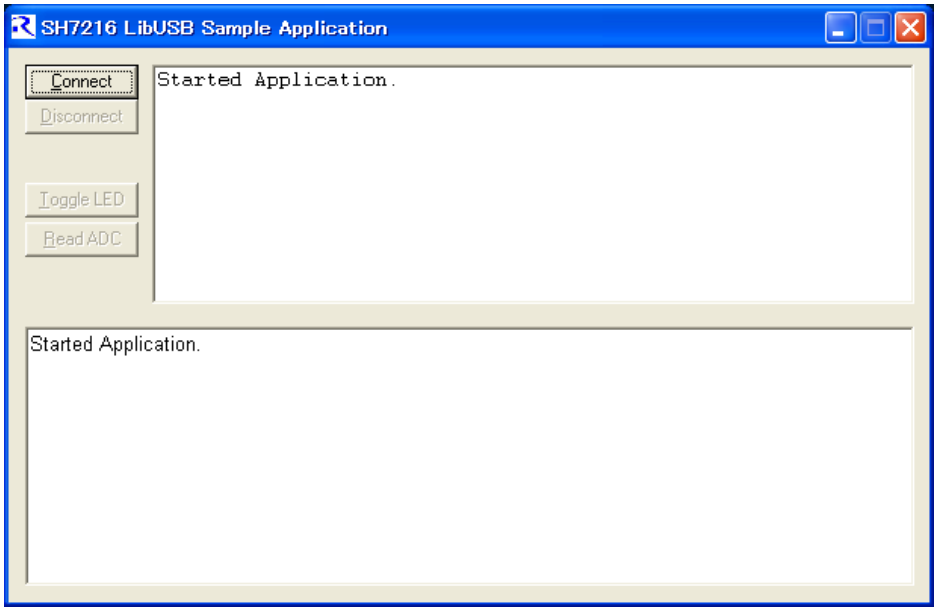

Figure 19 At Startup

6.2.2 After Clicking "Connect"

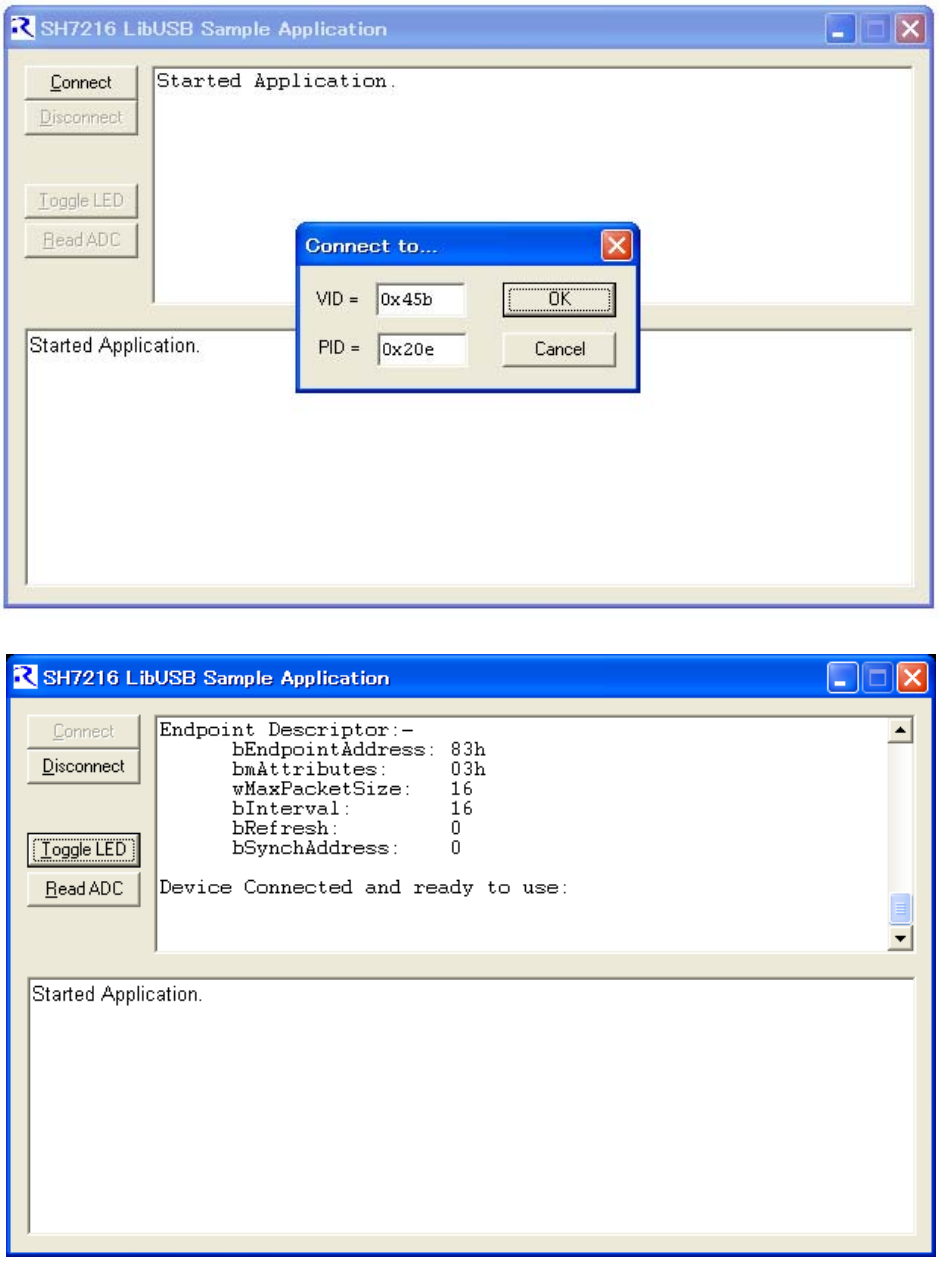

Figure 20 After Clicking "Connect"

6.2.3 After Clicking "Toggle LED"

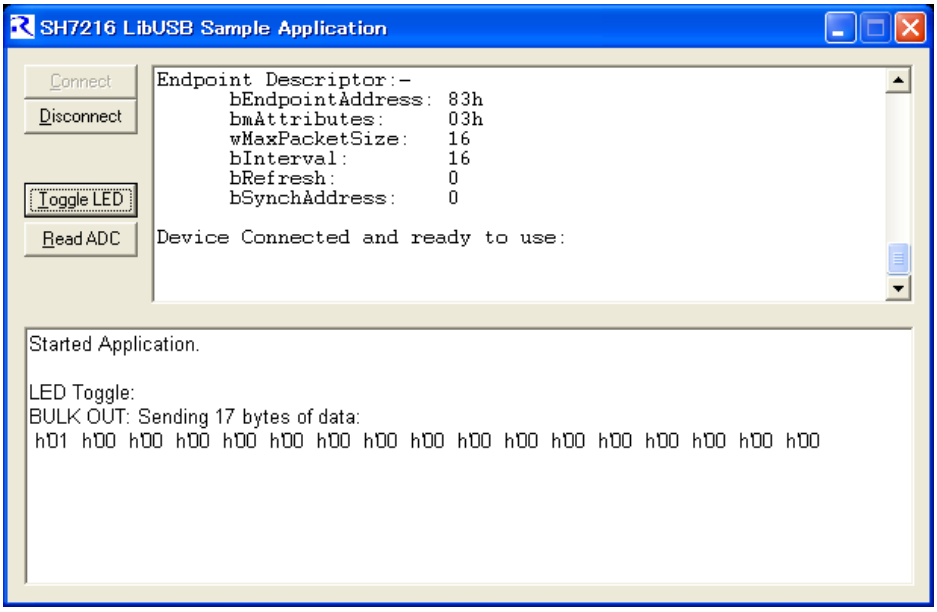

Figure 21 After Clicking "Toggle LED"

6.2.4 After Clicking "Read ADC"

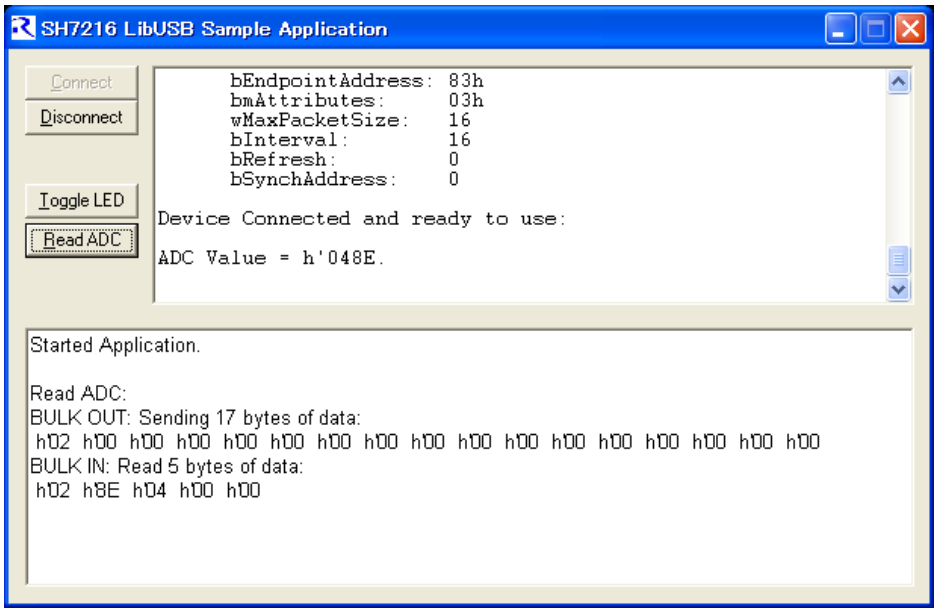

Figure 22 After Clicking "Read ADC"

6.2.5 After Clicking "Disconnect"

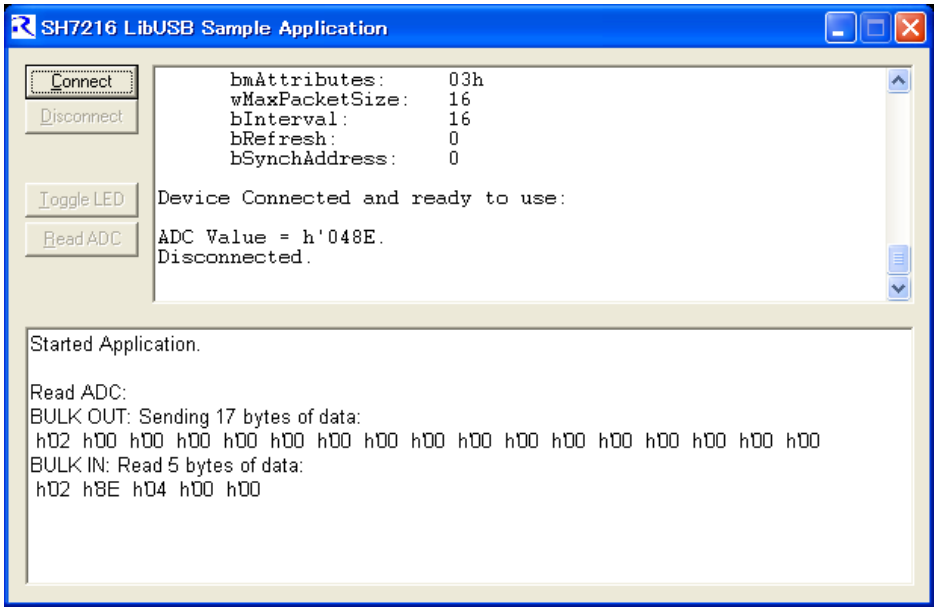

Figure 23 After Clicking "Disconnect"

Website and Support

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

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

Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	Nov.02.11	—	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.

Notice

1. All information included in this document is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas Electronics products listed herein, please confirm the latest product information with a Renesas Electronics sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas Electronics such as that disclosed through our website.
2. Renesas Electronics does not assume any liability for infringement of patents, copyrights, or other intellectual property rights of third parties by or arising from the use of Renesas Electronics products or technical information described in this document. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
3. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part.
4. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.
5. When exporting the products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. You should not use Renesas Electronics products or the technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. Renesas Electronics products and technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations.
6. Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors in or omissions from the information included herein.
7. Renesas Electronics products are classified according to the following three quality grades: "Standard", "High Quality", and "Specific". The recommended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below. You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application categorized as "Specific" without the prior written consent of Renesas Electronics. Further, you may not use any Renesas Electronics product for any application for which it is not intended without the prior written consent of Renesas Electronics. Renesas Electronics shall not be in any way liable for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for an application categorized as "Specific" or for which the product is not intended where you have failed to obtain the prior written consent of Renesas Electronics. The quality grade of each Renesas Electronics product is "Standard" unless otherwise expressly specified in a Renesas Electronics data sheets or data books, etc.
   - "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; and industrial robots.
   - "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; safety equipment; and medical equipment not specifically designed for life support.
   - "Specific": Aircraft; aerospace equipment; submersible repeaters; nuclear reactor control systems; medical equipment or systems for life support (e.g. artificial life support devices or systems), surgical implantations, or healthcare intervention (e.g. excision, etc.), and any other applications or purposes that pose a direct threat to human life.
8. You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damages arising out of the use of Renesas Electronics products beyond such specified ranges.
9. Although Renesas Electronics endeavors to improve the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please be sure to implement safety measures to guard them against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas Electronics product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.
10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. Please use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
11. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products, or if you have any other inquiries.

(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its majority-owned subsidiaries.

(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

RENESAS

SALES OFFICES Renesas Electronics Corporation http://www.renesas.com

Refer to "http://www.renesas.com/" for the latest and detailed information.

Renesas Electronics America Inc.
2880 Scott Boulevard Santa Clara, CA 95050-2554, U.S.A.
Tel: +1-408-588-6000, Fax: +1-408-588-6130

Renesas Electronics Canada Limited
1101 Nicholson Road, Newmarket, Ontario L3Y 9C3, Canada
Tel: +1-905-898-5441, Fax: +1-905-898-3220

Renesas Electronics Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-585-100, Fax: +44-1628-585-900

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-65030, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
7th Floor, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100083, P.R.China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 204, 205, AZIA Center, No.1233 Lujiazui Ring Rd., Pudong District, Shanghai 200120, China
Tel: +86-21-5877-1818, Fax: +86-21-6887-7858 / -7898

Renesas Electronics Hong Kong Limited
Unit 1601-1613, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2886-9318, Fax: +852 2886-9022/9044

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
1 harbourFront Avenue, #06-10, keppel Bay Tower, Singapore 098632
Tel: +65-6213-0200, Fax: +65-6278-8001

Renesas Electronics Malaysia Sdn.Bhd.
Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

Renesas Electronics Korea Co., Ltd.
11F., Samik Lavied' or Bldg., 720-2 Yeoksam-Dong, Kangnam-Ku, Seoul 135-080, Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5141

Colophon 1.1