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Application Note

78K0R/KC3-L, 78K0R/KE3-L
（On-Chip USB Controller)

16-bit Single-Chip Microcontroller
USB CDC (Communication Device Class) Driver

μPD78F1022
μPD78F1023
μPD78F1024
μPD78F1025
μPD78F1026

Document No R01AN0003EJ0100(U20312EJ1V0AN00)
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[Memo]

NOTES FOR CMOS DEVICES

(1) VOLTAGE APPLICATION WAVEFORM AT INPUT PIN: Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between VIL (MAX) and VIH (MIN) due to noise, etc., the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between VIL (MAX) and VIH (MIN).

(2) HANDLING OF UNUSED INPUT PINS: Unconnected CMOS device inputs can be cause of malfunction. If an input pin is unconnected, it is possible that an internal input level may be generated due to noise, etc., causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using pull-up or pull-down circuitry. Each unused pin should be connected to VDD or GND via a resistor if there is a possibility that it will be an output pin. All handling related to unused pins must be judged separately for each device and according to related specifications governing the device.

(3) PRECAUTION AGAINST ESD: A strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it when it has occurred. Environmental control must be adequate. When it is dry, a humidifier should be used. It is recommended to avoid using insulators that easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors should be grounded. The operator should be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with mounted semiconductor devices.

(4) STATUS BEFORE INITIALIZATION: Power-on does not necessarily define the initial status of a MOS device. Immediately after the power source is turned ON, devices with reset functions have not yet been initialized. Hence, power-on does not guarantee output pin levels, I/O settings or contents of registers. A device is not initialized until the reset signal is received. A reset operation must be executed immediately after power-on for devices with reset functions.

(5) POWER ON/OFF SEQUENCE: In the case of a device that uses different power supplies for the internal operation and external interface, as a rule, switch on the external power supply after switching on the internal power supply. When switching the power supply off, as a rule, switch off the external power supply and then the internal power supply. Use of the reverse power on/off sequences may result in the application of an overvoltage to the internal elements of the device, causing malfunction and degradation of internal elements due to the passage of an abnormal current. The correct power on/off sequence must be judged separately for each device and according to related specifications governing the device.

(6) INPUT OF SIGNAL DURING POWER OFF STATE : Do not input signals or an I/O pull-up power supply while the device is not powered. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Input of signals during the power off state must be judged separately for each device and according to related specifications governing the device.

PREFACE

Readers

This application note is intended for users, who understand the features of the 78K0R/KC3-L, KE3-L, and who try to design and develop the application system and application program using this product.

Target products are given below.

Generic Name	Standard product	USB controller built-in product
78K0R/KC3-L	μPD78F1000, 78F1001, 78F1002, 78F1003	μPD78F1022, 78F1023, 78F1024
78K0R/KE3-L	μPD78F1007, 78F1008, 78F1009	μPD78F1025, 78F1026

Purpose

This manual is intended to give users an understanding of the functions mentioned in following organization.

Organization

This application note is broadly divided into the following sections.

- o An overview of 78K0R/KC3-L, KE3-L USB function controller
- o An overview of the USB standard
- o The specifications for the sample driver
- o The specifications for the sample application
- o Development environment
- o How to use the sample driver

How to Read This Manual

It is assumed that the readers of this application note have general knowledge in the fields of electrical engineering, logic circuits, and microcontrollers.

To learn about the hardware features and electrical specifications of the 78K0R/KC3-L, KE3-L.

→ See the separately provided **78K0R/KC3-L, KE3-L Hardware User's Manual.**

To learn about the instructions of the 78K0R/KC3-L, KE3-L

→ See the separately provided **78K0R Architecture User's Manual.**

Conventions

Data significance: Higher digits on the left and lower digits on the right

Note: Footnote for item marked with **Note** in the text

Caution: Information requiring particular attention

Remark: Supplementary information

Numeric representation: Binary or decimal ... XXXX

Hexadecimal ... 0xXXXX

Prefix indicating power of 2 (address space, memory capacity)

K (kilo): 2^{10} = 1,024

M (mega): 2^{20} = $1,024^2$

G (giga): 2^{30} = $1,024^3$

T (tera): 2^{40} = $1,024^4$

P (peta): 2^{50} = $1,024^5$

E (exa): 2^{60} = $1,024^6$

CONTENTS

CHAPTER 1 OVERVIEW

This application note describes the USB (communication device class) sample driver created for the USB function controller incorporated in the 78K0R/KC3-L, 78K0R/KE3-L (78K0R/Kx3-L) microcontrollers. This application note provides the following information:

- The specifications for the sample driver
- Information about the environment used to develop an application program by using the sample driver
- The reference information provided for using the sample driver

This chapter provides an overview of the sample driver and describes the microcontrollers for which the sample driver can be used.

1. 1 Overview

1. 1. 1 Features of the USB function controller

The USB function controller that is incorporated in the 78K0R/Kx3-L and is to be controlled by the sample driver has the following features:

- Conforms to the Universal Serial Bus Rev. 2.0 Specification
- Operates as a full-speed (12 Mbps) device.
- Includes the following endpoints:

Table 1-1 Configuration of the Endpoints of the 78K0R/Kx3-L

Endpoint Name	FIFO Size (Bytes)	Transfer Type	Remark
Endpoint0 Read	64	Control transfer (IN)	Single buffer configuration
Endpoint0 Write	64	Control transfer (OUT)	Single buffer configuration
Endpoint1	64x2	Bulk transfer 1 (IN)	Dual-buffer configuration
Endpoint2	64x2	Bulk transfer 1 (OUT)	Dual-buffer configuration
Endpoint3	64x2	Bulk transfer 2 (IN)	Dual-buffer configuration
Endpoint4	64x2	Bulk transfer 2 (OUT)	Dual-buffer configuration
Endpoint7	64	Interrupt transfer 1 (IN)	Single buffer configuration
Endpoint8	64	Interrupt transfer 2 (IN)	Single buffer configuration

- Automatically responds to standard USB requests (except some requests).
- Can operate as a bus-powered device or self-powered device[Note 1]
- The internal or external clock can be selected[Note 2]

  Internal clock: 20 MHz External clock divided by 5 internal clock multiplied by 12 internal clock / 16 MHz external clock divided by 4 internal clock multiplied by 12 internal clock.

  12 MHz external clock divided by 2 internal multiplied by 8 internal (48 MHz)

Notes 1. The sample driver selects bus power.

2. The sample driver selects the internal clock.

1. 1. 2 Features of the sample driver

The USB communication device class sample driver for the 78K0R/Kx3-L has the features below. For details about the features and operations, see **CHAPTER 3 SAMPLE DRIVER SPECIFICATIONS**.

- Conforms to the USB communication device class Ver.1.1 Abstract Control Model
- Operates as a virtual COM device
- Exclusively uses the following amounts of memory (excluding the vector table):
    - ROM:About 3.0 KB
    - RAM:About 0.4 KB

1. 1. 3 Files included in the sample driver

The sample driver includes the following files:

Table 1-2 Files Included in the Sample Driver

Folder	File	Overview
src	main.c	Main routine, initialization, sample application
	usbf78k0r.c	USB initialization, endpoint control, bulk transfer, control transfer
	usbf78k0r_communication.c	Communication device class specific processing
include	main.h	main.c function prototype declarations
	usbf78k0r.h	usbf78k0r. function prototype declarations
	usbf78k0r_communication.h	usbf78k0r_communication.c function prototype declarations
	usbf78k0r_desc.h	Descriptor definitions
	usbf78k0r_errno.h	Error code definitions
	usbf78k0r_types.h	User declarations
Inf file	K0R_CDC_XP.inf	INF file for Windows XP

Remarks In addition, the project-related files generated when creating a development environment by using the PM+ (an integrated development tool made by NEC Electronics) are also included. For details see 5.2.1 **Preparing the host environment.**

1. 2 Overview of 78K0R/Kx3-L

This section describes the 78K0R/KC3-L, KE3-L which are controlled by using the sample driver.
The 78K0R/KC3-L, KE3-L are products in the low-power series of single chip 78K0R microcontroller, made by NEC Electronics. They use 78K0R CPU core and have peripheral functions such as ROM/RAM, timers/counters, POC/LVI, a serial interface, A/D converter, DMA controller, USB function controller. For details, see the 78K0R/KC3-L, KE3-L **USB controller built-in products Hardware User's manual.**

1. 2. 1 Applicable products

The sample driver can be used for the following products.

Table 1-2 78K0R/Kx3-L Products

Generic Name	Part Number	Internal Memory		Incorporated USB Function	Interrupt	
		Flash Memory	RAM		Internal	External
78K0R/KC3-L (48pin)	μPD78F1022	64 KB	6 KB	Function controller	36	7
	μPD78F1023	96KB	8 KB	Function controller	36	7
	μPD78F1024	128KB	8 KB	Function controller	36	7
78K0R/KE3-L (64pin)	μPD78F1025	96KB	8 KB	Function controller	41	11
	μPD78F1026	128KB	8 KB	Function controller	41	11

Caution: In this application note, all target microcontrollers are collectively indicated as the 78K0R/Kx3-L, unless distinguishing between them is necessary.

1. 2. 2 Features

The main features of 78K0R/Kx3-L are as follows. For details, see 78K0R/Kx3-L user's manual.

Memory space:

- 1M byte linear address space (for programs and data)

Internal memory

- RAM:6K/ 8K byte
- Flash memory : 64K/ 96K/ 128K byte

Multiplication/division function

- 16 bit x16 bit = 32 bit(multiplication)
- 32 bit ÷ 32 bit = 32 bit (division)

Key interrupt

- 4 channels
- 8 channels

DMA controller

- 2 channels

Serial interface

- CSI:1 channel/ UART :1 channel
- CSI:1 channel/UART:1 channel/simple I2C: 1channel
- CSI:1 channel note/UART:1 channel note/simple I2C: 1channel note
- UART(for LIN-bus):1 channel
- I2C:1 channel

USB controller

- USB function (full speed):1 channel

A/D converter

- 10 bit resolution A/D converter(AVREF = 1.8~3.6 V):8 channel

Power supply voltage

- VDD = 1.8~3.6 V(when USB is not used)
- VDD = 3.0~3.6 V(when USB is used)

Clock output/buzzer output

- 2.44 kHz, 4.88 kHz, 9.76 kHz, 1.25 MHz, 2.5 MHz, 5 MHz, 10 MHz(peripheral hardware clock:at f_{MAIN} = 20 MHz operation)
- 256 Hz, 512 Hz, 1.024 kHz, 2.048 kHz, 4.096 kHz, 8.192 kHz, 16.384 kHz, 32.768 kHz (Subsystem clock: at f_{SUB} = 32.768 kHz operation)

With built-in on chip debugging function

Note: only 78K0R/KE3-L

CHAPTER 2 OVERVIEW OF USB

This chapter provides an overview of the USB standard, which the sample driver conforms to.
USB (Universal Serial Bus) is an interface standard for connecting various peripherals to a host computer by using the same type of connector. The USB interface is more flexible and easier to use than older interfaces in that it can connect up to 127 devices by adding a branching point known as a hub and supports the hot-plug feature, which enables devices to be recognized by Plug & Play. The USB interface is provided in most current computers and has become the standard for connecting peripherals to a computer.

The USB standard is formulated and managed by the USB Implementers Forum (USB-IF). For details about the USB standard, see the official USB-IF website (www.usb.org).

2. 1 Transfer Format

Four types of transfer formats (control, bulk, interrupt and isochronous) are defined in the USB standard. Table 2-1 shows the features of each transfer format.

Table 2-1 USB Transfer Format

Item \ Transfer Format		Control Transfer	Bulk Transfer	Interrupt Transfer	Isochronous Transfer
Feature		Transfer format used to exchange information required for controlling peripheral devices	Transfer format used to aperiodically handle large amounts of data	Periodic data transfer format that has a low band width	Transfer format used for a real-time transfer
Specifiable packet size	High speed 480 Mbps	64 bytes	512 bytes	1 to 1,024 bytes	1 to 1,024 bytes
	Full speed 12 Mbps	8, 16, 32, or 64 bytes	8, 16, 32, or 64 bytes	1 to 64 bytes	1 to 1,023 bytes
	Low speed 1.5 Mbps	8 bytes	–	1 to 8 bytes	–
Transfer priority		3	3	2	1

2. 2 Endpoints

An endpoint is an information unit that is used by the host device to specify a communicating device and is specified using a number from 0 to 15 and a direction (IN or OUT). An endpoint must be provided for every data communication path that is used for a peripheral device and cannot be shared by multiple communication paths[Note]. For example, a device that can write to and read from an SD card and print out documents must have a separate endpoint for each purpose. Endpoint 0 is used to control transfers for any type of device.

During data communication, the host uses a USB device address, which specifies the device, and an endpoint (a number and direction) to specify the communication destination in the device.

Peripheral devices have buffer memory that is a physical circuit to be used for the endpoint and functions as a FIFO that absorbs the difference in speed of the USB and communication destination (such as memory).

Note An endpoint can be exclusively switched by using the alternative setting.

2. 3 Device Class

Various device classes, such as the mass storage class (MSC), communication device class (CDC), and human interface device class (HID) are defined according to the functions of the peripheral devices connected via USB (the function devices). A common host driver can be used if the connected devices conform to the standard specifications of the relevant device class, which is defined by a protocol.

The Communication Device Class (CDC) is intended for communication devices connected to hosts, such as modems, FAX machines and network cards. The class is increasingly used for devices that are used for USB-to-serial conversion performing UART communication with a computer, because recent computers do not have an RS-232C interface. Note that a different CDC model is defined depending on the device to connect. The sample driver uses the Abstract Control Model.

2. 4 Requests

For the USB standard, communication starts with the host issuing a command, known as a request, to a function device. A request includes data such as the direction and type of processing and address of the function device.

2. 4. 1 Types

There are three types of requests: standard requests, class requests and vendor requests.
The sample driver supports the following requests.

Standard requests

Standard requests are used for all USB-compatible devices.

Table 2-2 Standard Requests

Request Name	Target Descriptor	Overview
GET_STATUS	Device	Reads the settings of the power supply (self or bus) and remote wakeup.
	Endpoint	Reads the halt status.
CLEAR_FEATURE	Device	Clears remote wakeup.
	Endpoint	Cancels the halt status (DATA PID = 0).
SET_FEATURE	Device	Specifies remote wakeup or test mode.
	Endpoint	Specifies the halt status.
GET_DESCRIPTOR	Device	Reads the target descriptor.
	Configuration	
	string	
SET_DESCRIPTOR	Device	Changes the target descriptor (optional).
	Configuration	
	string	
GET_CONFIGURATION	Device	Reads the currently specified configuration values
SET_CONFIGURATION	Device	Specifies the configuration values.
GET_INTERFACE	Interface	Reads the alternatively specified value among the currently specified values of the target interface.
SET_INTERFACE	Interface	Specifies the alternatively specified value of the target interface.
SET_ADDRESS	Device	Specifies the USB address
SYNCH_FRAME	Endpoint	Reads frame-synchronous data.

Class requests

Class requests are unique to device classes. For the sample driver, processing to respond to class requests that support the CDC Abstract Control Model is implemented. The following requests can be responded to

- SendEncapsulatedCommand
  This request is used to issue commands in the format of the protocol for controlling the communication class interface.

- GetEncapsulatedResponse
  This request is used to request a response in the format of the protocol for controlling the communication class interface.

- SetLineCoding
  This request is used to specify the serial communication format.

- GetLineCoding
  This request is used to acquire the communication format settings on the device side.

- SetControlLineState
  This request is used for RS-232/V.24 format control signals.

2. 4. 2 Format

USB requests have an 8-byte length and consist of the following fields.

Table 2-3 USB Request Format

Offset	Field		Description
0	bmRequestType		Request attribute
		Bit 7	Data transfer direction
		Bits 6 and 5	Request type
		Bits 4 to 0	Target descriptor
1	bRequest		Request code
2	wValue	Lower	Any value used by the request
3		Higher	
4	wIndex	Lower	Index or offset used by the request
5		Higher	
6	wLength	Lower	Number of bytes transferred at the data stage
7		Higher	(the data length)

2. 5 Descriptor

For the USB standard, a descriptor is information that is specific to a function device and is encoded in a specified format. A function device transmits a descriptor in response to a request transmitted from the host.

2. 5. 1 Types

The following five types of descriptors are defined.

- Device descriptor
  This descriptor exists in every device and includes basic information such as the supported USB specification version, device class, protocol, maximum packet length that can be used when transferring data to endpoint 0, vendor ID, and product ID.
  This descriptor is transmitted in response to a GET_DESCRIPTOR_Device request.

- Configuration descriptor
  At least one configuration descriptor exists in every device and includes information such as the device attribute (power supply method) and power consumption. This descriptor is transmitted in response to a GET_DESCRIPTOR_Configuration request.

- Interface descriptor
  This descriptor is required for each interface and includes information such as the interface identification number, interface class, and supported number of endpoints. This descriptor is transmitted in response to a GET_DESCRIPTOR_Configuration request.

- Endpoint descriptor
  This descriptor is required for each endpoint specified for an interface descriptor and defines the transfer type (direction), maximum packet length that can be used for a transfer, and transfer interval. However, endpoint 0 does not have this descriptor.
  This descriptor is transmitted in response to a GET_DESCRIPTOR_Configuration request.

- String descriptor
  This descriptor includes any character string.
  This descriptor is transmitted in response to a GET_DESCRIPTOR_String request.

2. 5. 2 Format

The size and fields of each descriptor type vary as described below.

Remark The data sequence of each field is in little endian format.

Table 2-4 Device Descriptor Format

Field	Size (Bytes)	Description
bLength	1	Descriptor size
bDescriptorType	1	Descriptor type
bcdUSB	2	USB specification release number
bDeviceClass	1	Class code
bDeviceSubClass	1	Subclass code
bDeviceProtocol	1	Protocol code
bMaxPacketSize0	1	Maximum packet size of endpoint 0
idVendor	2	Vendor ID
idProduct	2	Product ID
bcdDevice	2	Device release number
iManufacturer	1	Index to the string descriptor representing the manufacturer
iProduct	1	Index to the string descriptor representing the product
iSerialNumber	1	Index to the string descriptor representing the device production number
bNumConfigurations	1	Number of configurations

Remark Vendor ID: The identification number each company that develops a USB device acquires from USB-IF
Product ID: The identification number each company assigns to a product after acquiring the vendor ID

Table 2-5 Configuration Descriptor Format

Field	Size (Bytes)	Description
bLength	1	Descriptor size
bDescriptorType	1	Descriptor type
wTotalLength	2	Total number of bytes of the configuration, interface, and endpoint descriptors
bNumInterfaces	1	Number of interfaces in this configuration
bConfigurationValue	1	Identification number of this configuration
iConfiguration	1	Index to the string descriptor specifying the source code for this configuration
bmAttributes	1	Features of this configuration
bMaxPower	1	Maximum current consumed in this configuration (in 2 μA units)

Table 2-6 Interface Descriptor Format

Field	Size (Bytes)	Description
bLength	1	Descriptor size
bDescriptorType	1	Descriptor type
bInterfaceNumber	1	Identification number of this interface
bAlternateSetting	1	Whether the alternative settings are specified for this interface
bNumEndpoints	1	Number of endpoints of this interface
bInterfaceClass	1	Class code
bInterfaceSubClass	1	Subclass code
bInterfaceProtocol	1	Protocol code
iInterface	1	Index to the string descriptor specifying the source code for this interface

Table 2-7 Endpoint Descriptor Format

Field	Size (Bytes)	Description
bLength	1	Descriptor size
bDescriptorType	1	Descriptor type
bEndpointAddress	1	Transfer direction of this endpoint Address of this endpoint
bmAttributes	1	Transfer type of this endpoint
wMaxPacketSize	2	Maximum packet size of this transfer
bInterval	1	Polling interval of this endpoint

Table 2-8 String Descriptor Format

Field	Size (Bytes)	Description
bLength	1	Descriptor size
bDescriptorType	1	Descriptor type
bString	Any	Any data string

CHAPTER 3 SAMPLE DRIVER SPECIFICATIONS

This chapter provides details about the features and processing of the USB Communication Device Class sample driver for the 78K0R/Kx3-L and the specifications of the functions provided in the 78K0R/Kx3-L.

3. 1 Overview

3. 1. 1 Features

The sample driver can perform the following processing.

(1) Initialization

The USB function controller is set up for use by manipulating various registers. This setup includes specifying settings for the CPU registers of the 78K0R/Kx3-L and specifying settings for the registers of the USB function controller. For details, see **3. 2. 1 CPU Initialization, 3. 2. 2 3. 2. 2 USB function controller initialization processing**

(2) Monitoring endpoints

The status of transfer endpoints in USB function controller is notified from INTUSB interrupt. There are CPUDEC interrupt expressing the request of decode by FW for the control transfer endpoint (Endpoint0) and BKO1DT interrupt showing the normal reception of data for bulk-out transfer (reception) endpoint (Endpoint2). During the processing of Endpoint0, requests are responded too. For details, see **3.2.3 INTUSB interrupt processing**.

(3) Sample application

The data at the endpoint for bulk-out transfer (reception) is read, and then the data is written to the endpoint for bulk-in transfer (transmission). For details, **see CHAPTER 4 SAMPLE APPLICATION SPECIFICATIONS.**

3. 1. 2 Supported requests

This section describes the USB requests supported by the sample driver.

(1) Standard requests

The sample driver returns the following responses for requests to which the 78K0R/Kx3-L does not automatically respond.

(a) **GET_DESCRIPTOR_string**

The host issues this request to acquire the string descriptor of the function device. If this request is received, the sample driver transmits the requested string descriptor to the host through a control read transfer.

(b) Other requests

The sample driver returns a STALL.

(2) Class requests

The sample driver responds to class requests of the CDC by using the following class requests.

(a) SendEncapsulatedCommand

This request is used to issue a command in the format of the CDC interface control protocol. If this request is received, the sample driver retrieves the data related to the request and then transmits them through bulk-in transfer.

(b) GetEncapsulatedResponse

This request is used to request a response in the format of the CDC interface control protocol. Currently, the sample driver does not support this request.

(c) SetLineCoding

This request is used to specify the serial communication format. If this request is received, the sample driver retrieves the data related to the request to specify settings such as the communication rate and then transmits a NULL packet through control read transfer.

(d) GetLineCoding

This request is used to acquire the current communication format settings on the device side. If this request is received, the sample driver reads settings such as the communication rate and then transmits them through control read transfer.

(e) SetControlLineState

This request is used for RS-232/V.24 format control signals. If this request is received the sample driver transmits a NULL packet through control read transfer.

3. 1. 3 Descriptor settings

The settings of each descriptor specified by the sample driver are shown below. These settings are included in header file "usbf78k0r_desc.h".

(1) Device descriptor

This descriptor is transmitted in response to a GET_DESCRIPTOR_device request.
The settings are stored in the UF0DDn registers (where n = 0 to 17) when the USBF is initialized, because the hardware automatically responds to a GET_DESCRIPTOR_device request.

Table 3-1 Device Descriptor Settings

Field	Size (Bytes)	Specified Value	Description
bLength	1	0x12	Descriptor size: 18 bytes
bDescriptorType	1	0x01	Descriptor type: device
bcdUSB	2	0x0200	USB specification release number: USB 2.0
bDeviceClass	1	0x02	Class code: CDC
bDeviceSubClass	1	0x00	Subclass code: none
bDeviceProtocol	1	0x00	Protocol code: No unique protocol is used
bMaxPacketSize0	1	0x40	Maximum packet size of endpoint 0: 64
idVendor	2	0x0409	Vendor ID:NEC
idProduct	2	0x01CD	Product ID:78K0R /Kx3-L
bcdDevice	2	0x0001	Device release number:1st version
iManufacturer	1	0x01	Index to the string descriptor representing the manufacturer: 1
iProduct	1	0x02	Index to the string descriptor representing the product: 2
iSerialNumber	1	0x03	Index to the string descriptor representing the device production number:3
bNumConfigurations	1	0x01	Number of configurations:1

(2) Configuration descriptor

This descriptor is transmitted in response to a GET_DESCRIPTOR_configuration request.
The settings are stored in the UF0CIEn registers (where n = 0 to 255) when the USB function controller is initialized, because the hardware automatically responds to a GET_DESCRIPTOR_configuration request.

Table 3-2 Configuration Descriptor Settings

Field	Size (Bytes)	Specified Value	Description
bLength	1	0x09	Descriptor size: 9 bytes
bDescriptorType	1	0x02	Descriptor type: configuration
wTotalLength	2	0x0030	Total number of bytes of the configuration, interface, and endpoint descriptors: 48 bytes
bNumInterfaces	1	0x02	Number of interfaces in this configuration: 2
bConfigurationValue	1	0x01	Identification number of this configuration:1
iConfiguration	1	0x00	Index to the string descriptor specifying the source code for this configuration:0
bmAttributes	1	0x80	Features of this configuration: bus-powered, no remote wakeup
bMaxPower	1	0x1B	Maximum current consumed in this configuration: 54 mA

(3) Interface descriptor

This descriptor is transmitted in response to a GET_DESCRIPTOR_configuration request.
The settings are stored in the UF0CIEn registers (where n = 0 to 255) when the USB function controller is initialized, because the hardware automatically responds to a GET_DESCRIPTOR_configuration request.
Two types of descriptors are set up because the sample driver uses two interfaces.

Table 3-3 Interface Descriptor Settings for Interface 0

Field	Size (Bytes)	Specified Value	Description
bLength	1	0x09	Descriptor size: 9 bytes
bDescriptorType	1	0x04	Descriptor type: interface
bInterfaceNumber	1	0x00	Identification number of this interface: 0
bAlternateSetting	1	0x00	Whether the alternative settings are specified for this interface: no
bNumEndpoints	1	0x01	Number of endpoints of this interface: 1
bInterfaceClass	1	0x02	Class code: communications interface class
bInterfaceSubClass	1	0x02	Subclass code: Abstract Control Model
bInterfaceProtocol	1	0x00	Protocol code: No unique protocol is used.
iInterface	1	0x00	Index to the string descriptor specifying the source code for this interface: 0

Table 3-4 Interface Descriptor Settings for Interface 1

Field	Size (Bytes)	Specified Value	Description
bLength	1	0x09	Descriptor size: 9 bytes
bDescriptorType	1	0x04	Descriptor type: interface
bInterfaceNumber	1	0x01	Identification number of this interface: 1
bAlternateSetting	1	0x00	Whether the alternative settings are specified for this interface: no
bNumEndpoints	1	0x02	Number of endpoints of this interface: 2
bInterfaceClass	1	0x0A	Class code: communications interface class
bInterfaceSubClass	1	0x00	Subclass code: Abstract Control Model
bInterfaceProtocol	1	0x00	Protocol code: No unique protocol is used.
iInterface	1	0x00	Index to the string descriptor specifying the source code for this interface: 0

(4) Endpoint descriptor

This descriptor is transmitted in response to a GET_DESCRIPTOR_configuration request. The settings are stored in the UF0CIEn registers (where n = 0 to 255) when the USB function controller is initialized, because the hardware automatically responds to a GET_DESCRIPTOR_configuration request. Three descriptor types are specified because the sample driver uses three endpoints.

Table 3-5 Endpoint Descriptor Settings for Endpoint 7

Field	Size (Bytes)	Specified Value	Description
bLength	1	0x07	Descriptor size: 7 bytes
bDescriptorType	1	0x05	Descriptor type: endpoint
bEndpointAddress	1	0x87	Transfer direction of this endpoint: IN Address of this endpoint: 7
bmAttributes	1	0x03	Transfer type of this endpoint: interrupt
wMaxPacketSize	2	0x0008	Maximum packet size of this transfer: 8 bytes
bInterval	1	0x0A	Polling interval of this endpoint: 10 ms

Table 3-6 Endpoint Descriptor Settings for Endpoint 1

Field	Size (Bytes)	Specified Value	Description
bLength	1	0x07	Descriptor size: 7 bytes
bDescriptorType	1	0x05	Descriptor type: endpoint
bEndpointAddress	1	0x81	Transfer direction of this endpoint: OUT Address of this endpoint: 2
bmAttributes	1	0x02	Transfer type of this endpoint: bulk
wMaxPacketSize	2	0x0040	Maximum packet size of this transfer: 64 bytes
bInterval	1	0x00	Polling interval of this endpoint: 0 ms

Table 3-7 Endpoint Descriptor Settings for Endpoint 2

Field	Size (Bytes)	Specified Value	Description
bLength	1	0x07	Descriptor size: 7 bytes
bDescriptorType	1	0x05	Descriptor type: endpoint
bEndpointAddress	1	0x02	Transfer direction of this endpoint: IN Address of this endpoint: 2
bmAttributes	1	0x02	Transfer type of this endpoint: bulk
wMaxPacketSize	2	0x0040	Maximum packet size of this transfer: 64 bytes
bInterval	1	0x00	Polling interval of this endpoint: 0 ms

(5) String descriptor

This descriptor is transmitted in response to a GET_DESCRIPTOR_string request.
If a GET_DESCRIPTOR_string request is received, the sample driver stores the settings of this descriptor into the UF0E0W register of the USB function controller.

Table 3-8 String Descriptor Settings

(a)String 0

Field	Size (Bytes)	Specified Value	Description
bLength	1	0x04	Descriptor size: 4 bytes
bDescriptorType	1	0x03	Descriptor type: string
bString	2	0x09, 0x04	Language code: English (U.S.)

(b)String 1

Field	Size (Bytes)	Specified Value	Description
bLength Note1	1	0x2A	Descriptor size: 42 bytes
bDescriptorType	1	0x03	Descriptor type: string
bString Note 2	40	-	Vendor: NEC Electronics Corporation

Notes 1. The specified value depends on the size of the bString field.
2. The vendor can freely set up the size and specified value of this field.

(c)String 2

Field	Size (Bytes)	Specified Value	Description
bLength Note1	1	0x0E	Descriptor size: 14 bytes
bDescriptorType	1	0x03	Descriptor type: string
bString Note 2	12	-	Product type: CDCDrv (CDC driver)

Notes 1. The specified value depends on the size of the bString field.
2. The vendor can freely set up the size and specified value of this field.

(d)String 3

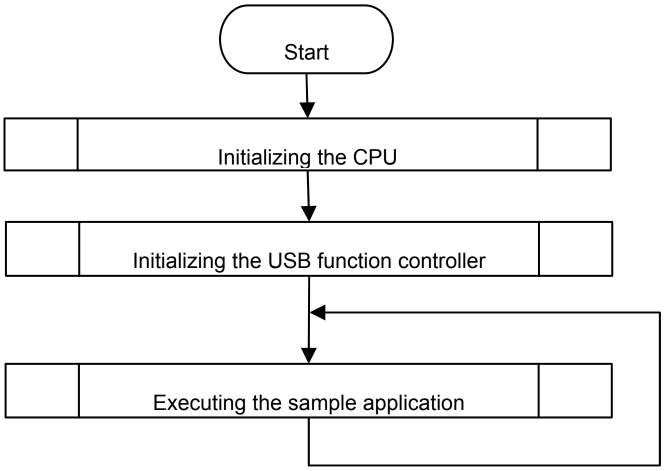
Field	Size (Bytes)	Specified Value	Description
bLength Note1	1	0x16	Descriptor size: 22 bytes
bDescriptorType	1	0x03	Descriptor type: string
bString Note2	20	-	Serial number: 0_98765432

Notes1. The specified value depends on the size of the bString field
2. The vendor can freely set up the size and specified value of this field.

3. 2 Operation of Each Section

The processing sequence below is performed when the sample driver is executed. This section describes each processing. For details about the sample application, see CHAPTER 4 SAMPLE APPLICATION SPECIFICATIONS.

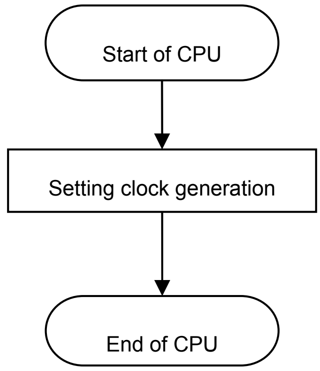
Figure 3-1 Sample Driver Processing Flowchart



3. 2. 1 CPU Initialization

The settings necessary to use the USB function controller are specified.

Figure 3-2 CPU Initialization Flowchart



(1) Clock generation settings

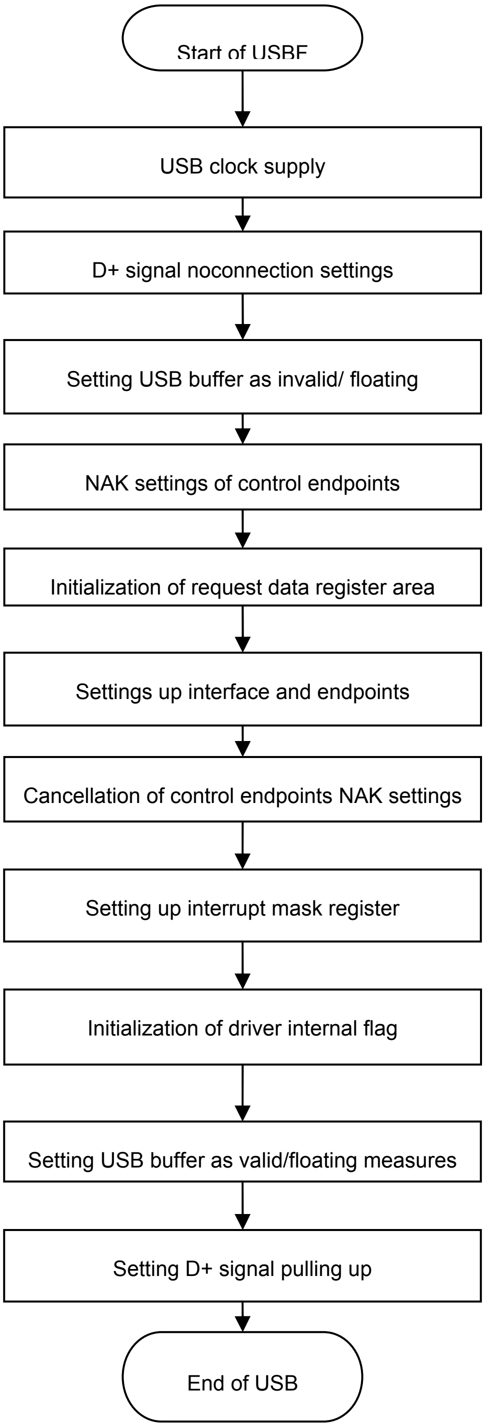
Operation of internal clock of CPU is set.
Here, five registers are set.

(a) "0x41" is written to CMC register to specify X1 oscillation mode, 10MHz < f_{MX} <= 20MHz.
(b) "0" is written to the MSTOP bit of CSC register to start the operation of X1 oscillation circuit.
(c) Oscillation stability time is verified according to OSTC register.
(d) "0x01" is written in PLLC register to stop the PLL operation.
(e) "0x38" is written to the CKC register to specify CPU/peripheral hardware clock to main system clock (f_{MAIN}), main system clock to high speed system clock (f_{MX}) and ratio of dividing frequency to f_{MX} .
(f) "1" is written to the HIPSTOP bit of CSC register to stop high speed built-in oscillation circuit.
(g) "1" is written to PLLM bit of PLLC register to multiply the frequency of the clock provided to PLL by 12.
(h) "0" is written to PLLSTOP bit of PLLC register to stat the operation of PLL.

3. 2. 2 USB function controller initialization processing

The settings necessary to use the USB function controller are specified.

Figure 3-3USB function controller Initialization Processing Flowchart



(1) USB clock supply

“0x80” is set in UCKC register so that USB clock is supplied to USB function controller.

(2) D+ Signal no-connection settings

”0x02” is set to UF0GPR register in order to avoid being detected by the host.

(3) Invalidate USB buffer as and validate the floating measures
"0x00" is set to UF0BC register to disable the operations of USB function controller set as valid USB buffer and invalid floating measures.

(4) NAK settings of control endpoints
In order to avoide the unintended response before registering the data which are used for automatic respose by the hardware. 1 is written to the EP0NKA bit of the UF0E0NA register so that the hardware responds to all requests, including requests that are automatically responded to, with a NAK.

(5) Initializing the request data register area
The descriptor data transmitted in auto response to a GET_DESCRIPTOR request is added to the following registers.

(a) 0x00 is written to the UF0DSTL register to disable remote wakeup and operate the USB function controller as a bus-powered device.
(b) 0x00 is written to the UF0EnSL registers (where n = 0 to 2) to indicate that endpoint n operates normally.
(c) The total data length (number of bytes) of the required descriptor is written to the UF0DSCL register to determine the range of the UF0CIEn registers (where n = 0 to 255).
(d) The device descriptor data is written to the UF0DDn registers (where n = 0 to 7).
(e) The data of the configuration, interface, and endpoint descriptors is written to the UF0CIEn registers (where n = 0 to 255).
(f) 0x00 is written to the UF0MODC register to enable automatic responses to GET_DESCRIPTOR_configuration requests.

(6) NAK settings of interface and endpoints
Information such as the number of supported interfaces, whether the alternative setting is used, and the relationship between the interfaces and endpoints are specified for various registers. The following registers are accessed.

(a) 0x80 is written to the UF0AIFN register to enable two interfaces.
(b) 0x00 is written to the UF0AAS register to disable the alternative setting.
(c) 0x40 is written to the UF0E1IM register to link endpoint 1 to interface 1.
(d) 0x40 is written to the UF0E2IM register to link endpoint 2 to interface 1.
(e) 0x20 is written to the UF0E7IM register to link endpoint 7 to interface 0.

(7) Disabling NAK settings of control endpoints
The NAK response operations for all requests are cancelled. 0 is written to the EP0NKA bit of the UF0E0NA register to restart responses corresponding to each request, including requests that are automatically responded to.

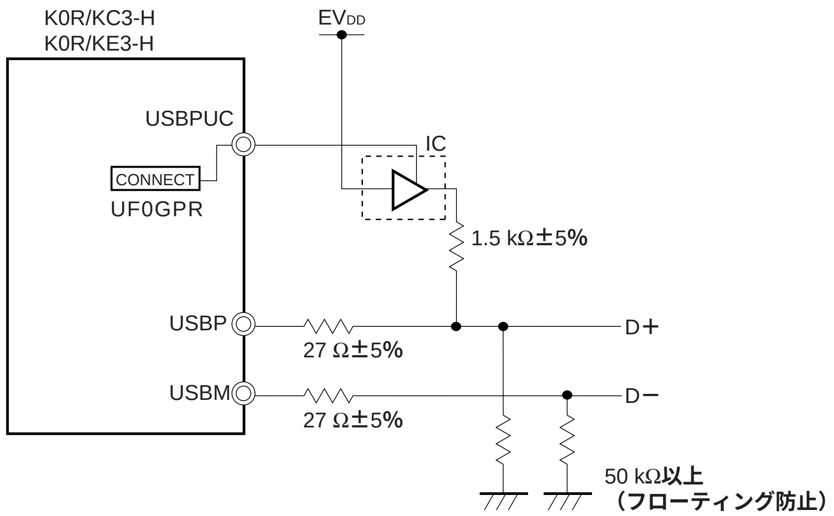
(8) Setting up the interrupt mask registers
Masking is specified for each USB function controller interrupt source. The following registers are accessed:
(a) 0x00 is written to the UF0Icn registers (where n = 0 to 7) to clear all interrupt sources.
(b) 0x00 is written to the UF0FICn registers (where n = 0 and 1) to clear all transfer FIFOs.
(c) 0x7B is written to the UF0IM0 register to mask all interrupt sources other than BUSRST interrupt and SETRQ interrupt from the interrupt sources indicated by the UF0IS0 register.
(d) 0x7E is written to the UF0IM1 register to mask all interrupt sources other than CPUDEC interrupt from the interrupt sources indicated by the UF0IS1 register.
(e) 0xF3 is written to the UF0IM2 register to mask all interrupt sources indicated by the UF0IS2 register.
(f) 0xFE is written to the UF0IM3 register to mask interrupt sources indicated by the UF0IS3 register other than those of the BKO1DT interrupt.
(g) 0xFF is written to the UF0IM4 register to mask all interrupt sources indicated by the UF0IS4 register.
(h) "0" is written to the USBIF bit of CPU to clear INTUSB interrupt.
(i) "0" is written to the USBMK bit of CPU to disable mask of INTUSB interrupt.

(9) Initialization of driver internal flag
A high level signal is output from the D+ pin to report to the host that a device has been connected. For the sample driver, the connections shown in Figure 3-4 are assumed and the following registers are accessed.

(10)USB buffer enabled/ floating measures disabled
"0x03" is set to UF0BC register to enable USB buffer, to disable floating measures and to enable USB function controller operations.

(11)Pulling up the D+ signal
"0x02" is set to UF0GPR register to report to the host that a device has been connected.

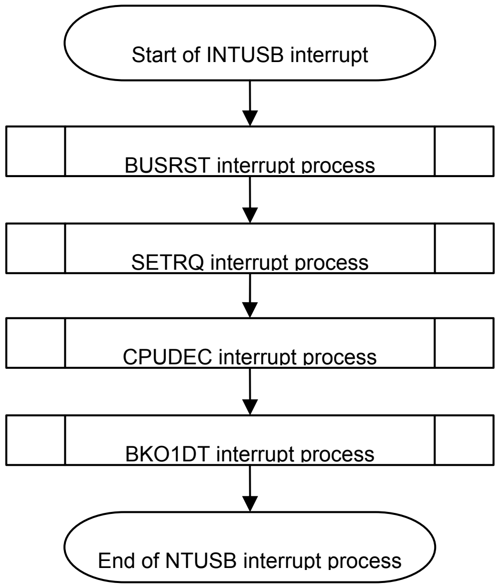
Figure 3-4 USB function controller Connection Example



3. 2. 3 INTUSB interrupt process

Interrupt request (INTUSB) from USB function controller reports only about the interrupts which are masked. Disable mask at the initialization for the necessary interrupts. Respective necessary processes are executed for the reported interrupts.

Figure 3-5 Process flow of Endpoint0 monitoring



(1) BUSRST interrupt process

It is reports when Bus Reset is generated.

Process is executed in the following order.

(a) “0x7F” is written to the UF0IC0 to clear BUSRST interrupt.
(b) “1” is written to usbf78k0r_busrst_flg flag.
(c) usbf78k0r_buff_init () function is called.

(2) SETRQ interrupt process

SET_XXXX request for auto process is received and it is reported at auto processing.

Process is executed in the following order.

(a) “0xFB” is written to the UF0IC0 to clear SETRQ interrupt.
(b) Both SETCON bit of UF0SET register and CONF bit of UF0MODS register are set to “1” is verified. “1” is set to CONFIGURATION by the SET_CONFIGURATION request is indicated.
(c) “0” is written to the usbf78k0r_busrst_flg flag to report that it is switched from reset state to normal state.

(3) CPUDEC interrupt process

It is reported when FW process request is received.

Process is executed in the following order.

(a) “0xFD” is written to UF0IC1 register to clear PROT interrupt.
(b) UF0E0ST register is read for 8 times then request data is acquired and decoded.
(c) If request is class request, usbf78k0r_classreq () function is called and class request process is executed.
(d) If request is not class request, usbf78k0r_standardreq () function is called and standard request process is executed.

(4) BKO1DT interrupt process

It is reported when data is received in UF0BO1 register normally.

Process is executed in the following order.

(a) “0xFE” is written to the UF0IC3 register to clear BKO1DT interrupt.
(b) “1” is set to (usbf78k0r_rdata_flg) flag indicating existence of received data to indicate that there is received data in bulk out endpoint in the drive. This flag is originally defined by the sample driver.

3. 3 Function Specifications

This section describes the functions implemented in the sample driver.

3. 3. 1 Functions

The functions of each source file included in the sample driver are described below.

Table 3-9 Functions in the Sample Driver

Source File	Function Name	Description
main.c	cpu_init	Initializes the CPU.
	main	Main routine
usbf78k0r.c	usbf78k0r_init	Initializes the USB function controller
	usbf78k0r_intusbf0	Processing INTUSB interrupt
	usbf78k0r_standardreq	Processes standard requests.
	usbf78k0r_getdesc	Processes GET_DESCRIPTOR(String)
	usbf78k0r_send_EP0	Transmits Endpoint0
	usbf78k0r_receive_EP0	Receives Endpoint0
	usbf78k0r_sendnullEP0	Transmits a NULL packet for endpoint 0.
	usbf78k0r_sendstallEP0	Transmit a STALL for endpoint 0.
	usbf78k0r_ep_status	Notifies FIFO status of bulk/interrupt Inn end point
	usbf78k0r_send_null	Transmits a NULL packet of bulk/interrupt inn endpoint
	usbf78k0r_data_send	Transmits bulk/interrupt Inn end point
	usbf78k0r_rdata_length	Acquires the bulk out endpoint received data length
	usbf78k0r_data_receive	Receives bulk out endpoint
	usbf78k0r_fifo_clear	Clears bulk/interrupt Inn end point and bulk out endpoint FIFO
usbf78k0r_communication.c	usbf78k0r_classreq	Processes CDC class/request
	usbf78k0r_send_encapsulated_command	Processes SendEncapsulatedCommand requests
	usbf78k0r_get_encapsulated_response	Processes Get Encapsulated Response requests
	usbf78k0r_set_line_coding	Processes SetLineCoding requests.
	usbf78k0r_get_line_coding	Processes GetLineCoding requests.
	usbf78k0r_set_control_line_state	Processes SetControlLineState requests.
	usbf78k0r_buff_init	Clears FIFO of endpoint for CDC data transfer
	usbf78k0r_get_bufinit_flg	Notifies execution state of FIFO initialization process
	usbf78k0r_send_buf	Transmits CDC data
	usbf78k0r_recv_buf	Receives CDC data

3. 3. 2 Correlation of the functions

Some functions call other functions during the processing. The following figures show the correlation of the functions.

Figure 3-6 Calling Functions in the Main Routine

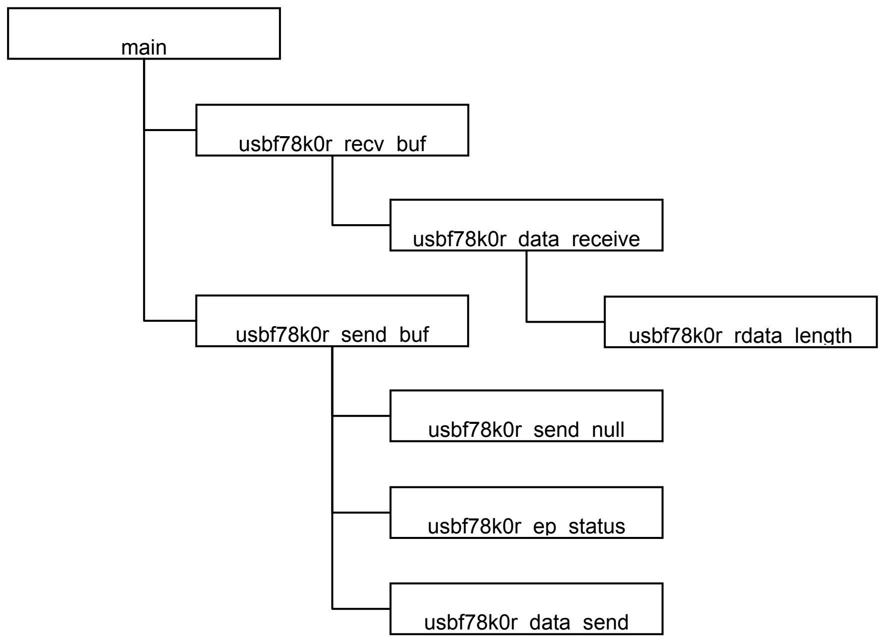


Figure 3-7 Calling Functions during the Processing for the USB function controller

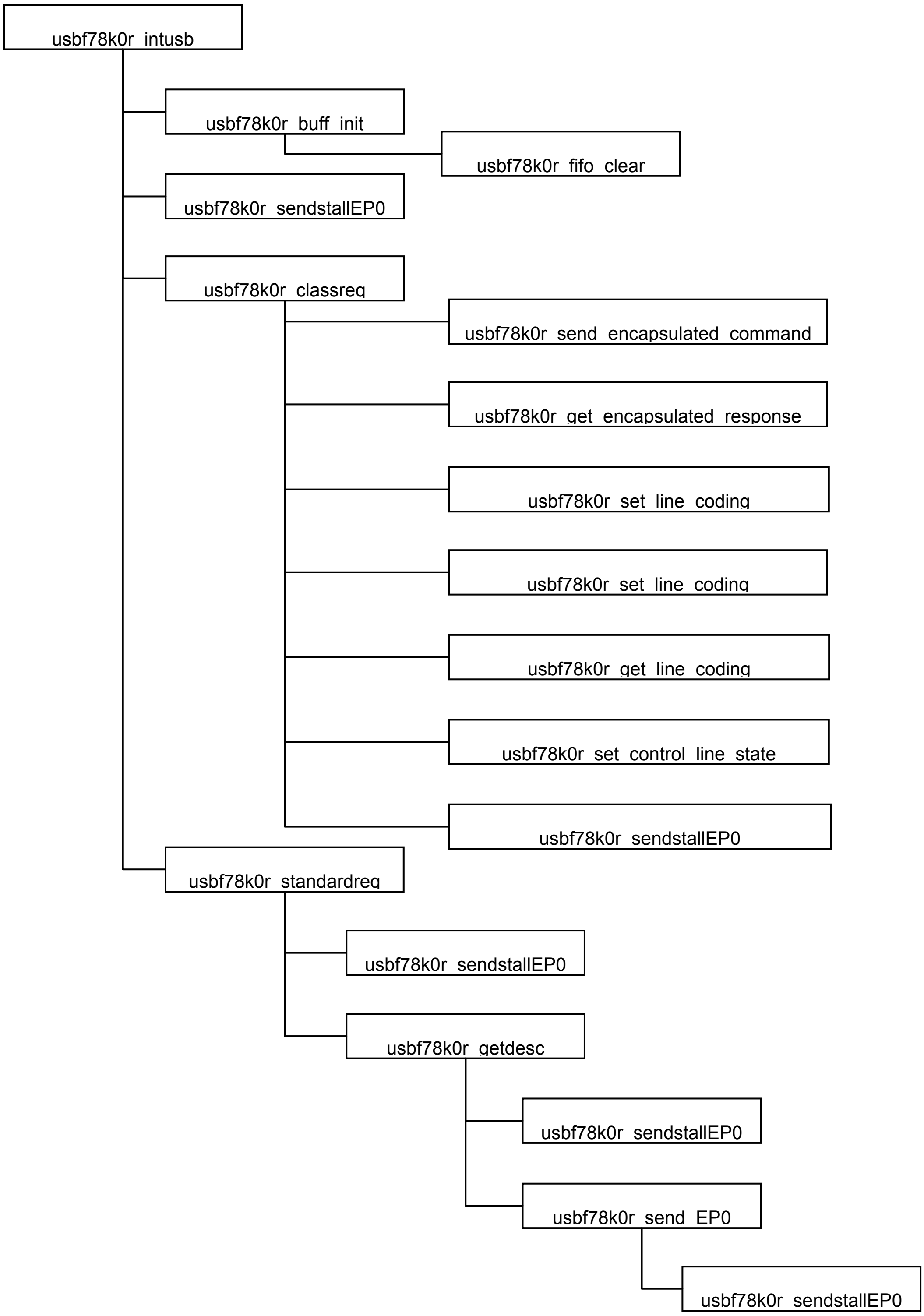


Figure 3-8 Calling Functions during the Processing for the USB Communication Class (1)

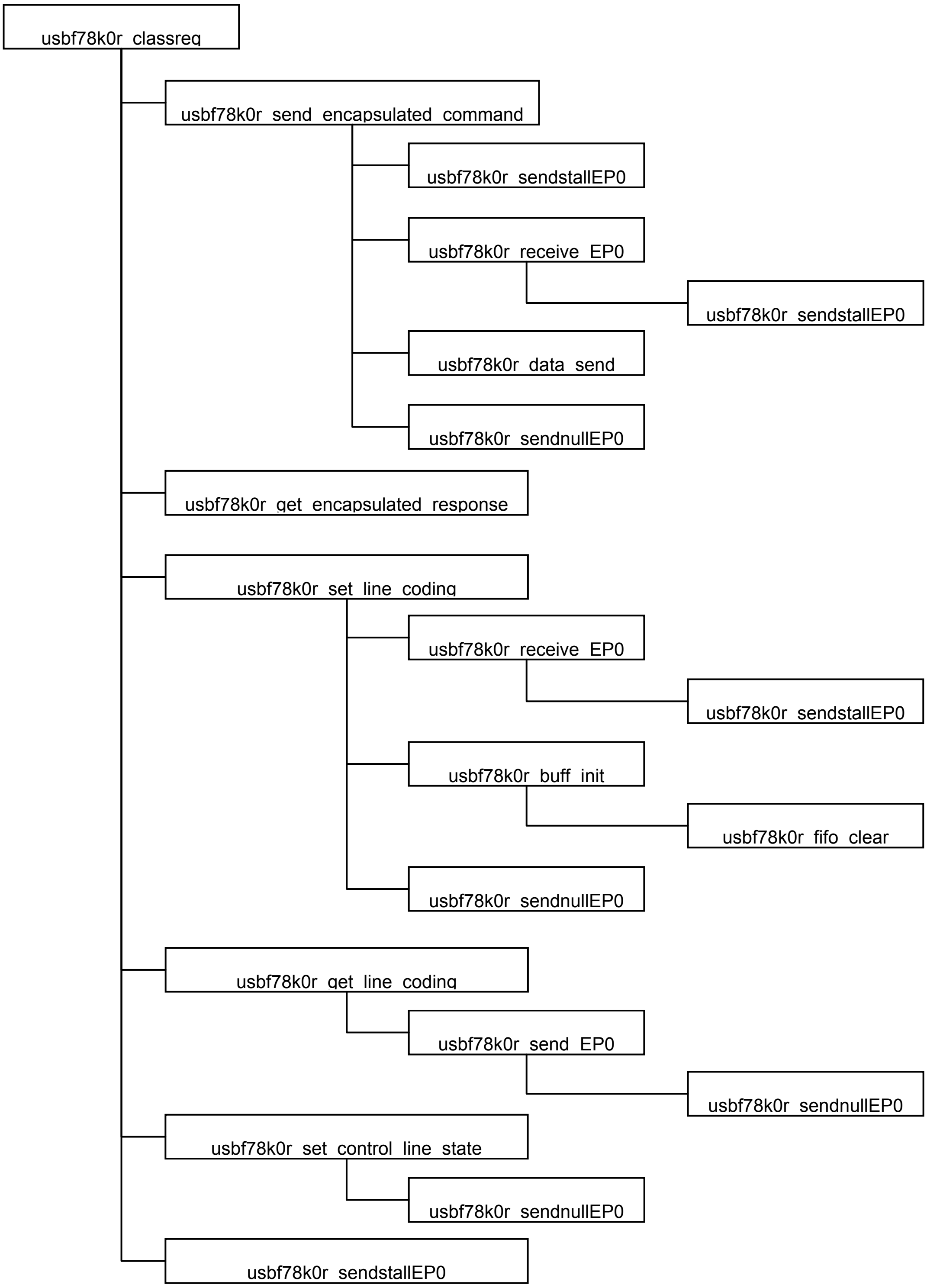
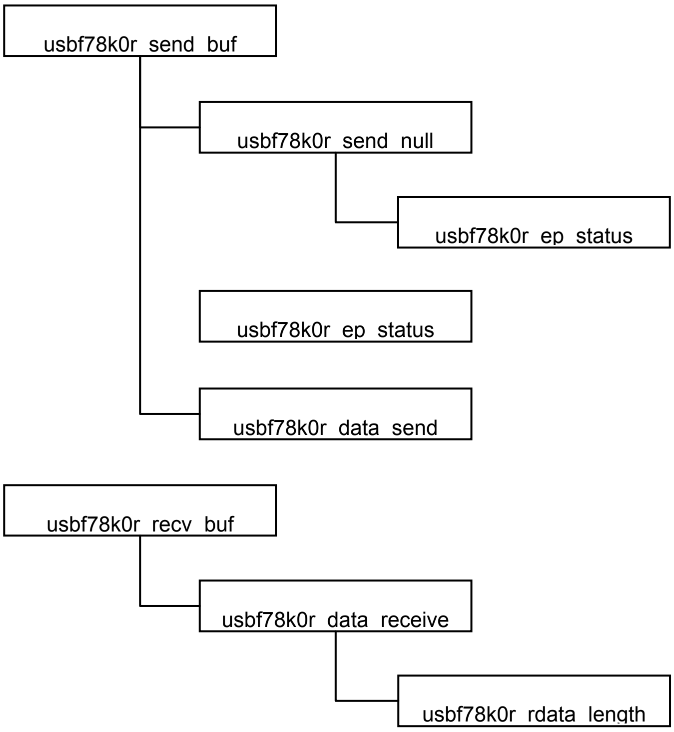


Figure 3-9 Calling Functions during the Processing for the USB Communication Class (2)



3. 3. 3 Function features

This section describes the features of the functions implemented in the sample driver.

(1) Function description format

The functions are described in the following format.

Function name

[Overview]

An overview of the function is provided

[C description format]

The format in which the function is written in C is provided.

[Parameters]

The parameters (arguments) of the function are described.

Parameter	Description
Parameter type and name	*Parameter summary*

[Return values]

The values returned by the function are described.

Symbol	Description
Return value type and name	*Return value summary*

[Description]

The feature of the function is described

Functions for the main routine

main

[Overview]
Main processing

[C description format]
void main(void)

[Parameters]
None

[Return value]
None

[Description]
This function is called first when the sample driver is executed. This function calls the initialization function of CPU, initialization function of USB function controller and then the sample application processing function sequentially.

cpu_init

[Overview]
Initializes the CPU.

[C description format]
void cpu_init(void)

[Parameters]
None

[Return value]
None

[Description]

This function is called in the main processing.
The settings those are necessary to use the USB function controller in the 78K0R/Kx3, such as the clock frequency, and operation mode.

Functions for the USB function controller

usbf78k0r_init

[Overview]
Initializes the USB function controller

[C description format]
void usbf78k0r_init(void)

[Parameters]
None

[Return value]
None

[Description]

This function is called during initialization processing.

This function specifies the settings required for using the USBF, such as allocating and specifying the data area and masking interrupt requests.

usbf78k0r_intusbf0

[Overview]

INTUSB interrupt processing

[C description format]

```
__interrupt void usbf78k0r_intusbf0 (void)
```

[Parameters]

None

[Return value]

None

[Description]

This function is an interrupt service routine called from INTUSBF0 interrupt.

Generated interrupt processing is done while verifying about the interrupt requests about the interrupt which are not masked of USB function controller.

usbf78k0r_standardreq

[Overview]
Processes standard requests to which the USB function controller does not automatically respond

[C description format]
void usbf78k0r_standardreq (USB_SETUP *req_data)

[Parameters]

Parameter	Description
USB_SETUP *req_data	Request data storage pointer address

[Return value]
None

[Description]

This function is called from the CPUDEC interrupt cause process of INTUSB interrupt process.

If a GET_DESCRIPTOR request is decoded, this function calls the GET_DESCRIPTOR request processing function (usbf78k0r_getdesc). For other requests, this function calls the function for returning STALL responses for endpoint 0 (usbf78k0r_sendstallEP0).

usbf78k0r_getdesc

[Overview]

Processes GET_DESCRIPTOR requests

[C description format]

void usbf78k0r_getdesc (USB_SETUP *req_data)

[Parameters]

Parameter	Description
USB_SETUP *req_data	Request data storage pointer address

[Return value]

None

[Description]

This function is called during the processing of standard requests to which the USB function controller does not automatically respond. If a decoded request requests a string descriptor, this function calls the USB data transmission function (usbf78k0r_send_EP0) for endpoint 0 and transmits a string descriptor from endpoint 0. If a decoded request requests any other descriptor, this function calls the function for processing STALL responses (usbf78k0r_sendstallEP0) for endpoint 0.

usbf78k0r_send_EP0

[Overview]

Transmits USB data for Endpoint0

[C description format]

INT32 usbf78k0r_send_EP0(UINT8* data, INT32 len)

[Parameters]

Parameter	Description
UINT8* data	Transmission data buffer pointer
INT32 len	Transmission data length

[Return value]

Symbol	Description
DEV_OK	Normal completion
DEV_ERROR	Abnormal termination

[Description]

This function stores the data stored in the transmission data buffer into the FIFO for the specified Endpoint0, byte by byte.

usbf78k0r_receive_EP0

[Overview]
Receives USB data for Endpoint0

[C description format]
INT32 usbf78k0r_receive_EP0(UINT8* data, INT32 len)

[Parameters]

Parameter	Description
UINT8* data	Reception data buffer pointer
INT32 len	Reception data length

[Return value]

Symbol	Description
DEV_OK	Normal completion
DEV_ERROR	Abnormal termination

[Description]

This function reads data from the FIFO for the specified endpoint byte by byte and stores the data into the reception data buffer.

usbf78k0r_sendnullEP0

[Overview]
Transmits a NULL packet for endpoint 0

[C description format]
void usbf78k0r_sendnullEP0(void)

[Parameters]
None

[Return value]
None

[Description]

This function clears the FIFO for endpoint 0 and transmits a NULL packet from the USBF by setting the bit that indicates the end of data to 1.

usbf78k0r_sendstallEP0

[Overview]

Returns a STALL for endpoint 0

[C description format]

void usbf78k0r_sendstallEP0(void)

[Parameters]
None

[Return value]
None

[Description]

This function makes the USBF return a STALL by setting the bit that indicates the use of STALL for Endpoint 0 to 1.

usbf78k0r_ep_status

[Overview]

Notifies FIFO status for bulk/interrupt inn endpoint

[C description format]

INT32 usbf78k0r_ep_status(INT8 ep)

[Parameters]

Parameter	Description
INT8 ep	Data transmission endpoint number

[Return value]

Symbol	Description
DEV_OK	Normal completion (FIFO empty)
DEV_ERROR	Abnormal termination (FIFO full)
DEV_RESET	During Bus Reset processing

[Description]

This function notifies the FIFO status of specified endpoint (for transmission).

usbf78k0r_send_null

[Overview]

Transmits a NULL packet for bulk/interrupt inn endpoint

[C description format]

INT32 usbf78k0r_send_null(INT8 ep)

[Parameters]

Parameter	Description
INT8 ep	Data transmission end point number

[Return value]

Symbol	Description
DEV_OK	Normal completion
DEV_ERROR	Abnormal termination

[Description]

This function transmits a NULL packet from USB function controller by clearing the FIFO of specified Endpoint (for transmission) and setting the bit that indicates the end of data to 1.

usbf78k0r_data _send

[Overview]

Transmits USB data for bulk/interrupt Inn end point

[C description format]

INT32 usbf78k0r_data_send(UINT8* data, INT32 len, INT8 ep)

[Parameters]

Parameter	Description
UINT8* data	Transmission data buffer pointer
INT32 len	Transmission data length
INT8 ep	Data transmission end point number

[Return value]

Symbol	Description
len (>= 0)	Normal transmission data size
DEV_ERROR	Abnormal termination

[Description]

This function stores the data stored in the transmission data buffer into the FIFO for the specified endpoint, byte by byte.

usbf78k0r_rdata _length

[Overview]
Acquires the USB reception data length

[C description format]
void usbf78k0r_rdata_length(INT32 *len , INT8 ep)

[Parameters]

Parameter	Description
INT32* len	Pointer to the storage address of the received data length
INT8 ep	Data reception endpoint number

[Return value]
None

[Description]
This function reads the received data length of the specified endpoint. (For reception).

usbf78k0r_data _receive

[Overview]

Receives USB data for bulk end point

[C description format]

INT32 usbf78k0r_data_receive(UINT8* data, INT32 len, INT8 ep)

[Parameters]

Parameter	Description
UINT8* data	Reception data buffer pointer
INT32 len	Reception data length
INT8 ep	Data reception endpoint number

[Return value]

Symbol	Description
len (>= 0)	Normal transmission data size
DEV_ERROR	Abnormal termination

[Description]

This function reads data from the FIFO for the specified endpoint byte by byte and stores the data into the reception data buffer.

usbf78k0r_fifo_clear

[Overview]

Clears the FIFO for bulk/interrupt Endpoint

[C description format]

void usbf78k0r_fifo_clear(INT8 in_ep, INT8 out_ep)

[Parameters]

Parameter	Description
INT8 in_ep	Data transmission end point number
INT8 out_ep	Data reception end point number

[Return value]

None

[Description]

This function clears the FIFO of Endpoint specified in bulk/interrupt Endpoint and clears (0) data reception flag (usbf78k0r_rdata_flg).

Functions for USB communication device class processing

usbf78k0r_classreq

[Overview]

Processes class request

[C description format]

void usbf78k0r_classreq(USB_SETUP *req_data)

[Parameters]

Parameter	Description
USB_SETUP *req_data	Request data storage pointer address

[Return value]

None

[Description]

This function is called from the CPUDEC interrupt cause process of INTUSB interrupt process.

If a decoded request is communication class request, this function calls the each request processing function. For other requests, this function calls the function for returning a STALL for Endpoint0 (usbf78k0r_sendstallEP0).

usbf78k0r_send_encapsulated_command

[Overview]

Processes SendEncapsulatedCommand requests

[C description format]

void usbf78k0r_send_encapsulated_command(USB_SETUP *req_data)

[Parameters]

Parameter	Description
USB_SETUP *req_data	Request data storage pointer address

[Return value]

None

[Description]

If request decoded in the class request process is Send Encapsulated Command, this function is called. This function calls the data reception function (usbf78k0r_receive_EP0) to retrieve the data received at endpoint 0, and then calls the data transmission function (usbf78k0r_data_send) to transmit data from endpoint 2 via bulk-in transfer (transmission) and calls the NULL packet transmission function (usbf78k0r_sendnullEP0) for Endpoint0.

usbf78k0r_set_line_coding

[Overview]

Processes SetLineCoding requests

[C description format]

void usbf78k0r_set_line_coding(USB_SETUP *req_data)

[Parameters]

Parameter	Description
USB_SETUP *req_data	Request data storage pointer address

[Return value]

None

[Description]

This function is called if request decoded at class request process is Set Line Coding. This function calls the data reception function (usbf78k0r_receive_EP0) to retrieve the data received at endpoint 0, and then writes the data to the UART_MODE_INFO structure. This function calls the FIFO initialization function (usbf78k0r_buff_init) for user data and then calls the NULL packet transmission function for endpoint 0 (usbf78k0r_sendnullEP0).

usbf78k0r_get_control_line_coding

[Overview]

Processes GetLineCoding requests

[C description format]

void usbf78k0r_get_line_coding(USB_SETUP *req_data)

[Parameters]

Parameter	Description
USB_SETUP *req_data	Request data storage pointer address

[Return value]

None

[Description]

This function is called if request decoded at class request process is Get Line Coding. This function transmits the UART_MODE_INFO structure value from Endpoint0 by calling USB data transmission function (usbf78k0r_send_EP0) for Endpoint0.

usbf78k0r_set_control_line_state

[Overview]

Processes SetControlLineState requests.

[C description format]

void usbf78k0r_set_control_line_state(USB_SETUP *req_data)

[Parameters]

Parameter	Description
USB_SETUP *req_data	Request data storage pointer address

[Return value]

None

[Description]

This function is called if request decoded in the class request process is “Set Control Line State”. This function calls the NULL packet transmission function for endpoint 0 (usbf78k0r_sendnullEP0).

usbf78k0r_buff_init

[Overview]

Initializes the FIFO for user data

[C description format]
void usbf78k0r_buff_init(void)

[Parameters]
None

[Return value]
None

[Description]
This function initializes the FIFO for communication class user data by calling FIFO clear function (usbf78k0r_fifo_clear) for bulk/interrupt Endpoint and sets the flag (usbf78k0r_bufinit_flg) that indicates transmission packet size of internal driver as clear (0) and FIFO initialization to 1.

usbf78k0r_get_bufinit_flg

[Overview]

Notifies FIFO status for user data

[C description format]

INT32 usbf78k0r_get_bufinit_flg(void)

[Parameters]

None

[Return value]

Symbol	Description
DEV_OK	Normal status
DEV_ERROR	FIFO initialization status

[Description]

This function notifies the internal driver flag (usbf78k0r_bufinit_flg) status that indicates the initialization of FIFO. If flag is set as 1, it indicates that FIFO is initialized and then it notifies the initialization status and clears flag to 0.

usbf78k0r_send_buf

[Overview]

Transmits user data for communication class

[C description format]

INT32 usbf78k0r_send_buf(UINT8* data, INT32 len)

[Parameters]

Parameter	Description
UINT8* data	Transmission data buffer pointer
INT32 len	Transmission data length

[Return value]

Symbol	Description
len (>= 0)	Normal transmission data length
DEV_ERROR	Abnormal termination

[Description]

This function transmits NULL packet that calls the NULL packet transmission function (usbf78k0r_send_null) for bulk/interrupt inn Endpoint, if transmission data size (Parameter:len) is 0 and size of the packet transmitted earlier (g_send_size) is Max Packet Size. If transmission data size (Parameter:len) is greater than 0 and transmission FIFO has null status (return value of usbf78k0r_ep_status is DEV_OK), this function calls the USB data transmission function (usbf78k0r_data_send). If data transmission is completed normally, it stores the size of the data transmitted to transmission completion packet size (g_send_size) defined in the driver.

usbf78k0r_recv_buf

[Overview]

Receives user data for communication class

[C description format]

INT32 usbf78k0r_recv_buf(UINT8* data, INT32 len)

[Parameters]

Parameter	Description
UINT8*　data	Reception data buffer pointer
INT32　len	Reception data length

[Return value]

Symbol	Description
len (>= 0)	Normal transmission data length
DEV_ERROR	Abnormal termination

[Description]

This function calls USB data reception function (usbf78k0r_data_receive).

CHAPTER 4 SAMPLE APPLICATION SPECIFICATIONS

This chapter describes the sample application included with the sample driver.

4. 1 Overview

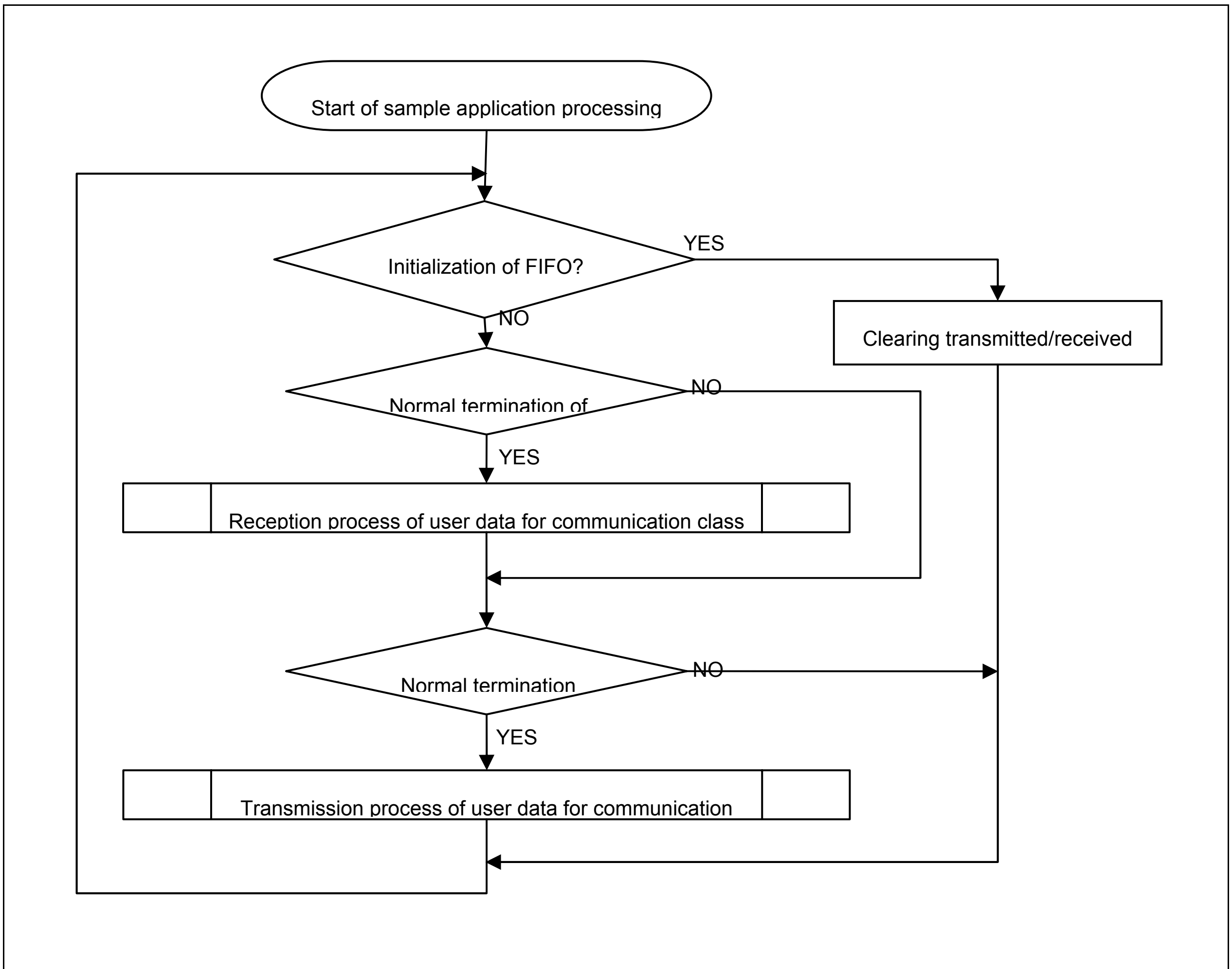
The sample application is provided as a simple example of using the USB communication device class driver and is incorporated in the main routine of the sample driver.

The sample application reads the data received by the USB function controller and then transmits the read data. Various functions of the sample driver are used during this processing.

4. 2 Operation

The sample application performs the processing shown in the following flowchart.

Figure 4-1 Flowchart for the Sample Application Processing



(1) Verifying FIFO initialization for user data

FIFO status notification function (usbf78k0r_get_bufinit_flg) for user data is called and if it is in normal state, verification process of transmission processing result is executed and if it is in the initialization state, transmission/reception result clear process (clearing transmission/reception process result of user data for communication class to 0) is executed.

(2) Verifying transmission process result of user data for communication class

If transmission process result of user data for communication class is Normal completion (and initial state), control shifts over to reception process of user data for communication class and if it is abnormal termination state, shifts to reception process result confirmation process.

(3) Reception process of user data for communication class

Buffer address, buffer size storing reception data is specified and reception function (usbf78k0r_recv_buf) of user data for communication class is called.

(4) Verifying reception process result of user data for communication class

If reception process result of user data for communication class is Normal completion (and initial state), control shifts over to transmission process of user data for communication class and if it is abnormal termination state, shifts to FIFO initialization confirmation process for user data.

(5) Transmission process of user data for communication class

Buffer size where data to be transmitted is stored and transmission data size are specified and transmission function (usbf78k0r_send_buf) of user data for communication class is called.

4. 3 Using Functions

The main.c source file that includes this sample application is coded as follows in order to call sample driver functions. For details about the functions, see **3. 3 Specifications of Functions.**

(1) Definitions and declarations

2 header files “usbf78k0r.h” and “usbf78k0r_communication.h” are included in order to use the sample driver functions. User buffer (UserBuf) of size sufficient to process the 1 packet data for user data is set. (Maximum packet size of bulk endpoint in Full Speed USB is set to 64Byte)

(2) Initialization processing of CPU

Initialization processing of CPU function (cpu_init) is called.

(3) Initialization process of USB function controller

USB function controller initialization function (usbf78k0r_init) is called.

(4) Verification of FIFO status for user data

FIFO state notification function (usbf78k0r_get_bufinit_flg) for user data is called and FIFO status is verified.

(5) Reception process of user data

User data reception function (usbf78k0r_recv_buf) for communication class is called and result is stored.

(6) Transmitting user data

User data transmission function (usbf78k0r_send_buf) for communication class is called and result is stored.

(7) Clearing process of transmission/reception process result

If FIFO for user data is initialized, transmission/reception process result stored in (5), (6) is cleared to 0.

List 4-1 Sample Application Code (Portion)

```
void main(void)
    {
        INT32 rcv_ret = 0;
        INT32 snd_ret = 0;

        cpu_init();

        DI();
        usbf78k0r_init();        /* initial setting of the USB Function */
        EI();

        while(1)
        {
            if (usbf78k0r_get_bufinit_flg() != DEV_ERROR) {
                if (snd_ret >= 0) {
                    rcv_ret = usbf78k0r_recv_buf(&UserBuf[0], USERBUF_SIZE);
                }
                if (rcv_ret >= 0) {
                    snd_ret = usbf78k0r_send_buf(&UserBuf[0], rcv_ret);
                }
            }
            else {
                snd_ret = 0;
                rcv_ret = 0;
            }
        }
    }
```

CHAPTER 5 DEVELOPMENT ENVIRONMENT

This chapter provides an example of creating an environment for developing an application program that uses the USB communication device class sample driver for the 78K0R/Kx3-L and the procedure for debugging the application.

5. 1 Development environment

This section describes the used hardware and software tool products.

5. 1. 1 Program development

The following hardware and software are necessary to develop a system that uses the sample driver.

Table 5-1 Example of the Components Used in a Program Development Environment

Components		Product Example	Remark
Hardware	Host machine	-	PC/AT compatible computer (OS : Windows XP)
Software	Integrated development tool	PM+	V6.31
	Compiler	CC78K0R	W2.12
	Assembler	RA78K0R	W1.33

5. 1. 2 Debugging

The following hardware and software are necessary to debug a system that uses the sample driver.

Table 5-2 Example of the Components Used in a Debugging Environment

Components		Product Example	Remark
Hardware	Host machine	-	PC/AT compatible computer (OS : Windows XP)
	Target device	TK-78K0R/KE3L+USB	
	Inn circuit emulator	MINICUBE2	
	USB cables	-	miniB-to-A connector cable
Software	Integrated development tool	PM+	V6.31
	Debugger	ID78K0R-QB	V3.60
Files	Device file	DF78102664.78K	For the 78K0R/Kx3-L
	Project files	-	Note1

Notes 1. For details about products and how to obtain them, contact NEC Electronics.

2. A file that is used when creating a system using PM+ is included with the sample driver.

5. 2 Setting up the Environment

This section describes the preparations required for developing and debugging a system by using the products described in **5. 1 Development environment.**

5. 2. 1 Preparing the host environment

Create a dedicated workspace on the host for debugging.

Installing an integrated development tool

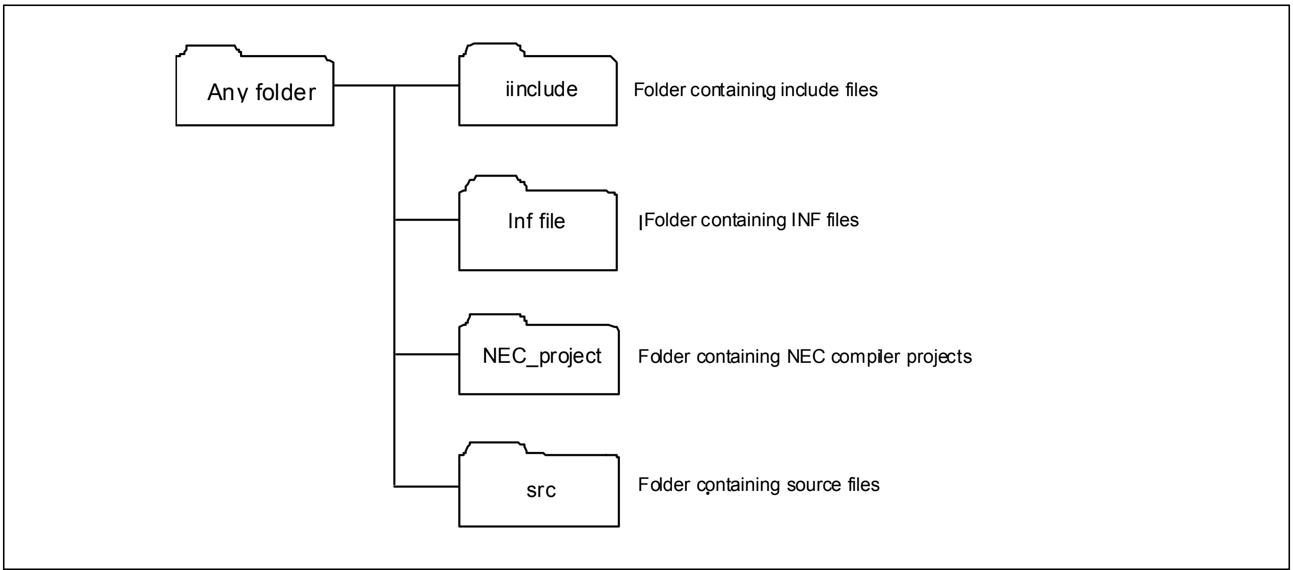
Install PM+. For details, see the **PM+ User's Manual**.

Downloading drivers

Store the set of files provided with the sample driver in any directory without changing the folder structure.

Store the device driver in any directory.

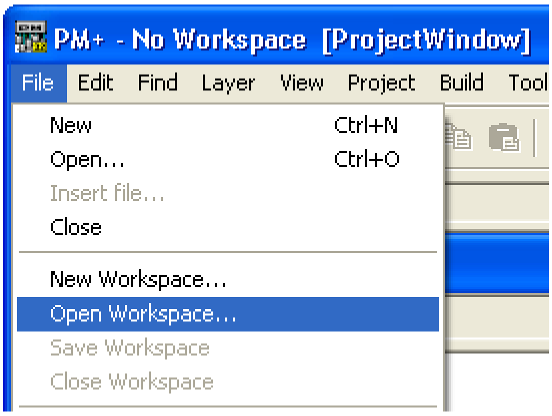
Figure 5-1 Folder Structure of the Sample Driver



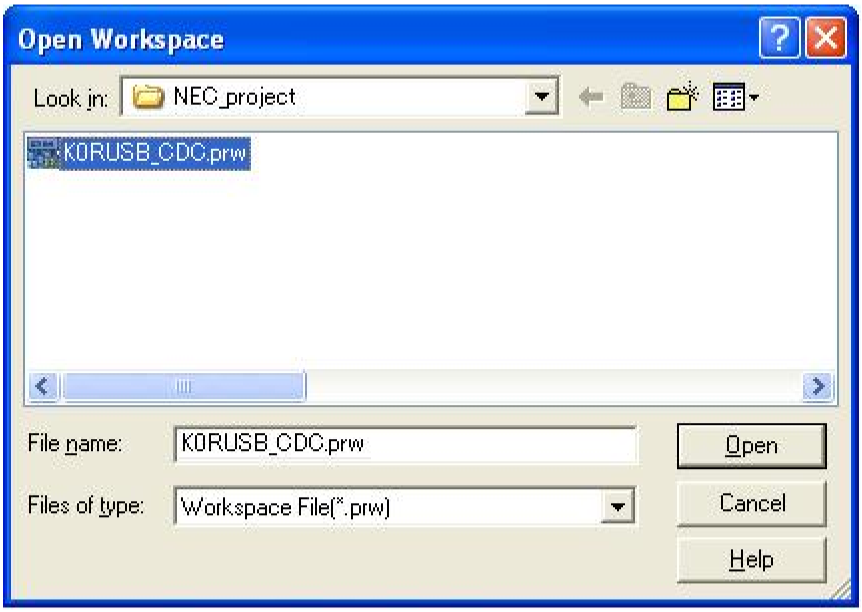
Setting up the workspace

The procedure for using project files included with the sample driver is described below.

<1> Start PM+, and then select "**Open Workspace**" in the "**File**" menu.



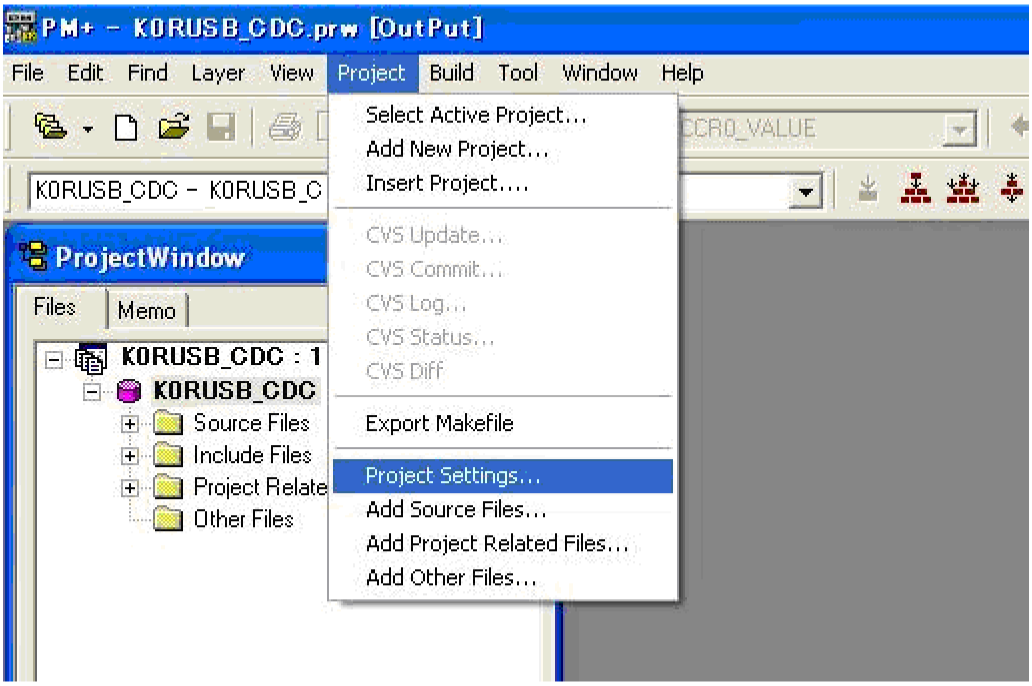
<2> In the **Open Workspace** dialog box, specify the workspace file in the NEC_project folder, which is the sample driver installation directory.



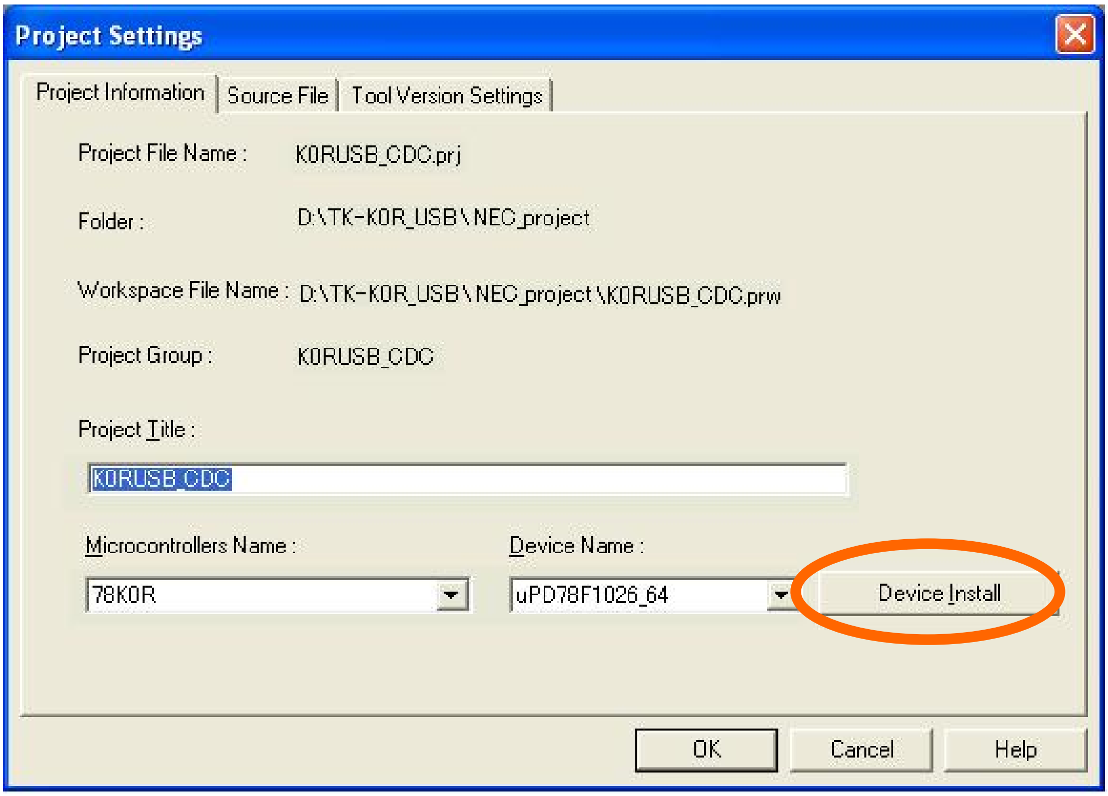
Installing a device file

The procedure for using a device file for the 78K0R/Kx3-L is described below.

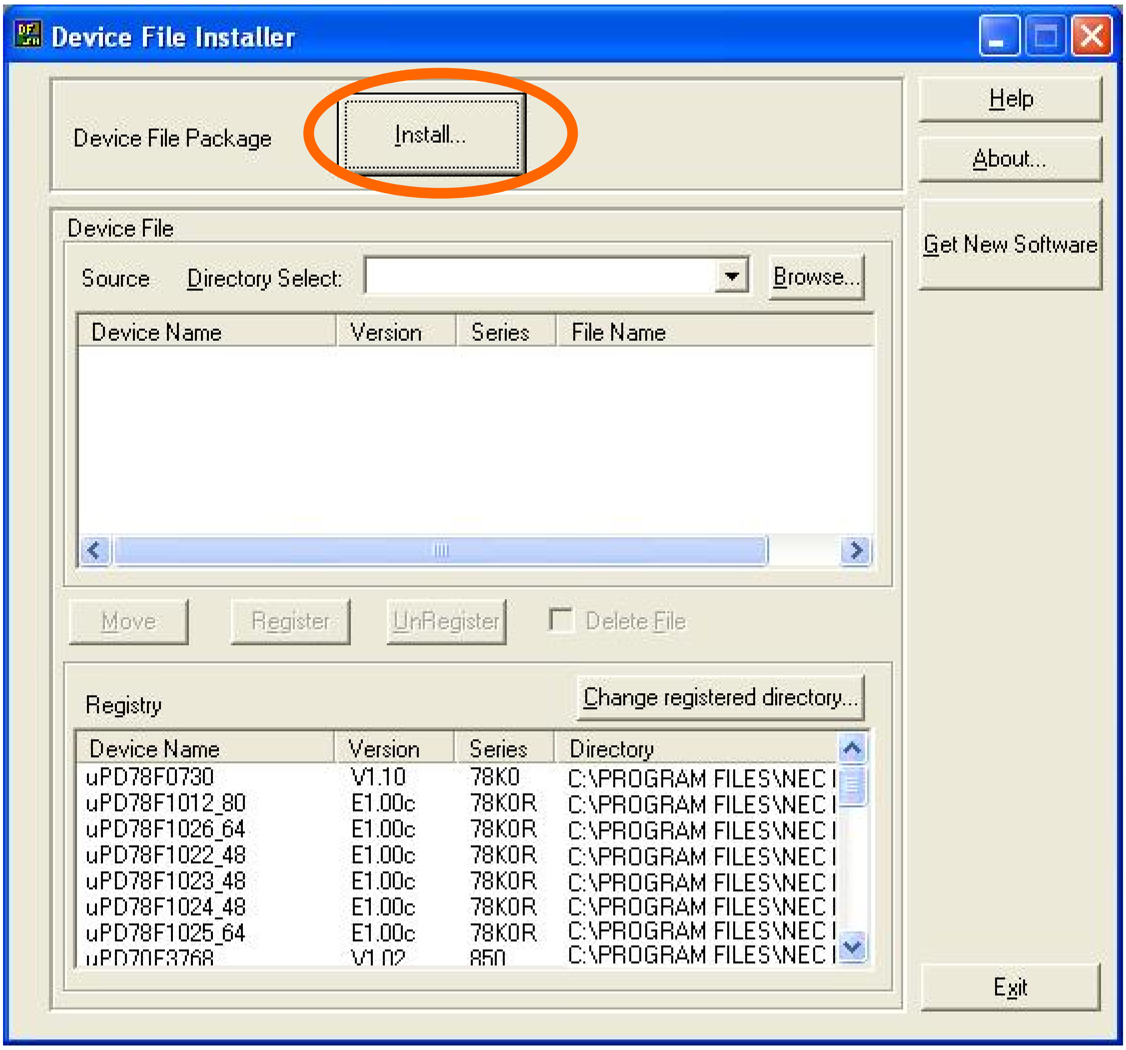
<1> Select **Project Settings** in the PM+ **Project** menu.



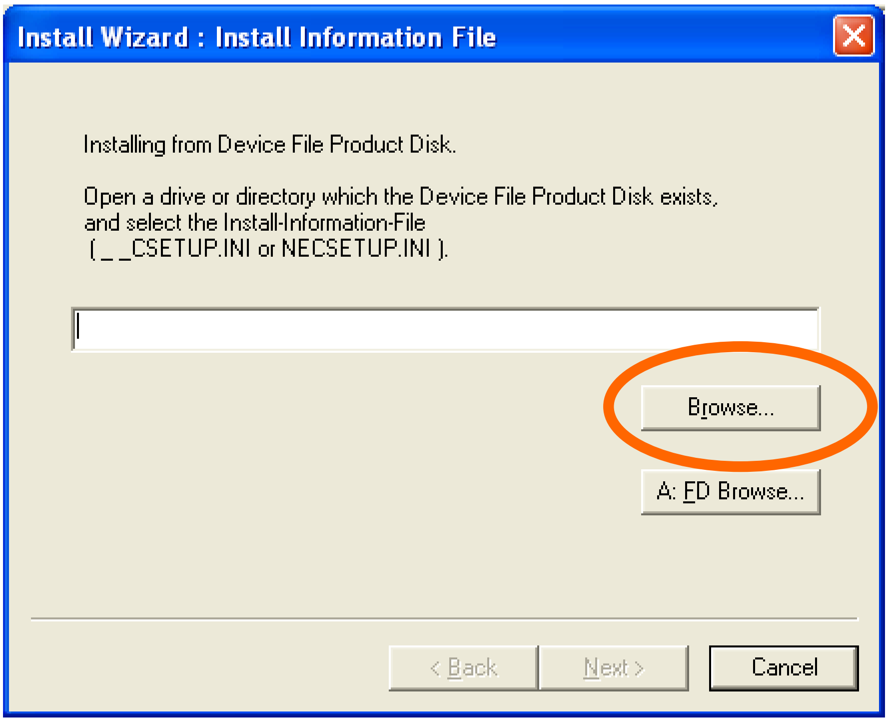
<2> In the **Project Settings** dialog box, click the **Device Install** button on the **Project Information** tab to start the Device File Installer.



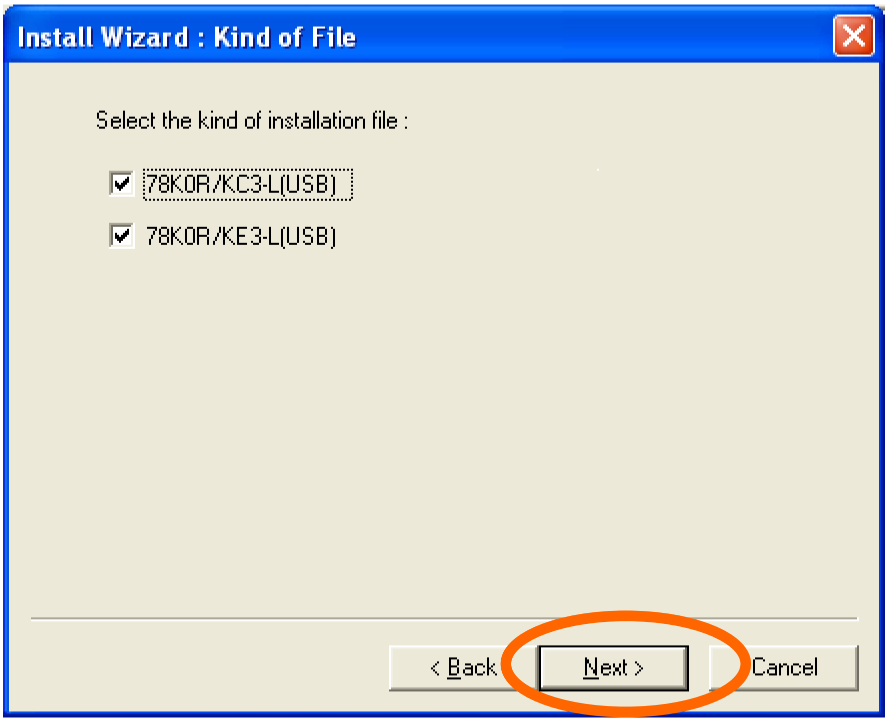
<3> In the **Device File Installer** dialog box, click the **Install** button to start the installation wizard.



<4> In the **Install Information File** dialog box, click the **Browse** button.

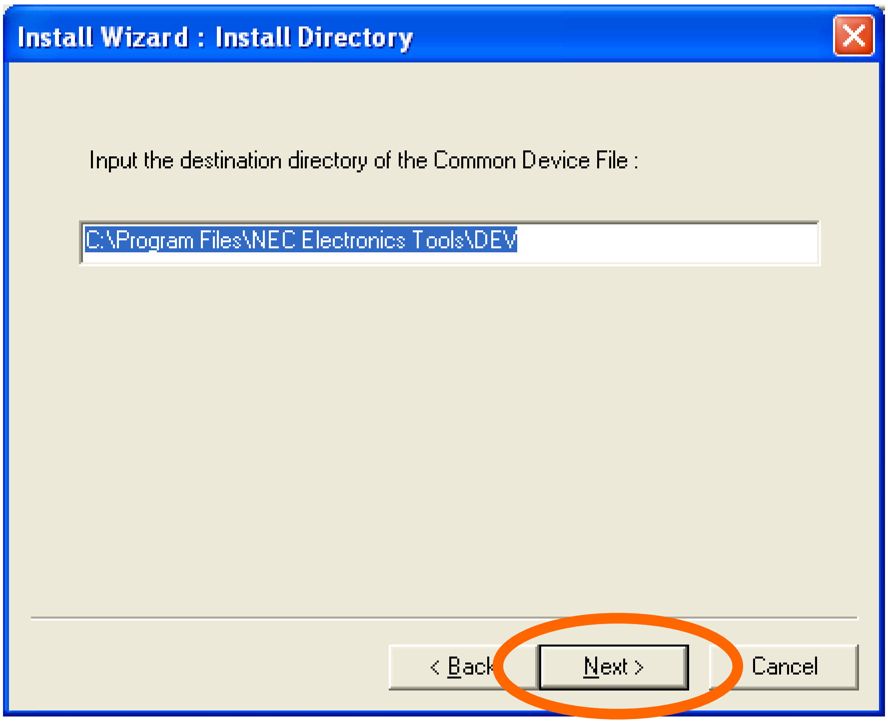


<5> In the **Open** dialog box, open the directory in which the device file was stored, select "NECSETUP.INI", file and then click the **Open** button.
<6> In the message about usage permission, click the **Next** button.
<7> In the **File type selection** dialog box, click of **Next** button after selecting relevant device files.

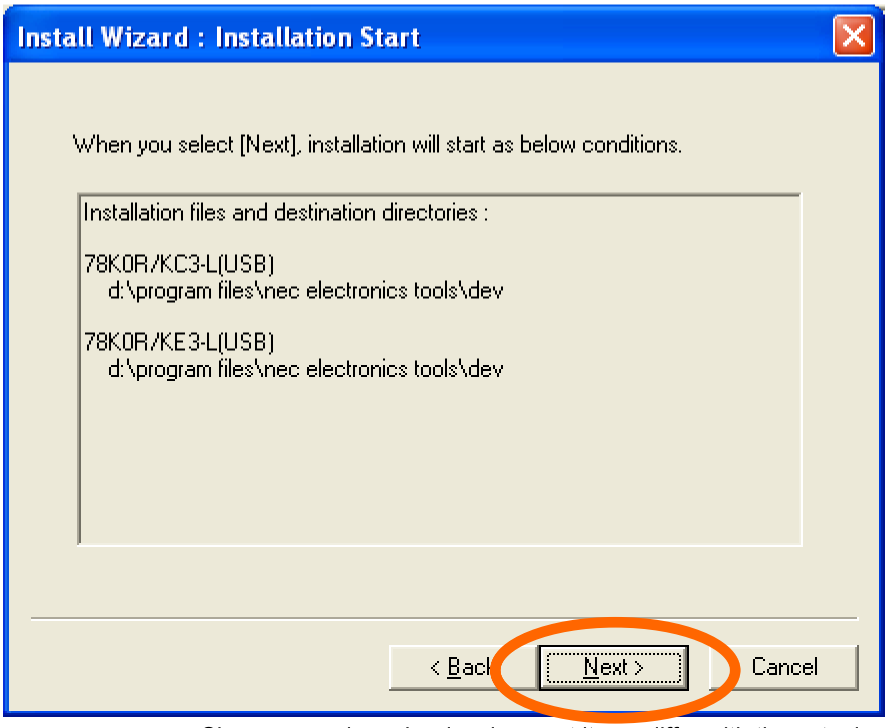


※ Since screen is under development it can differ with the actuals

<8> 「In the **Install Directory** dialog box, confirm that a path is displayed, and then click the **Next** button.



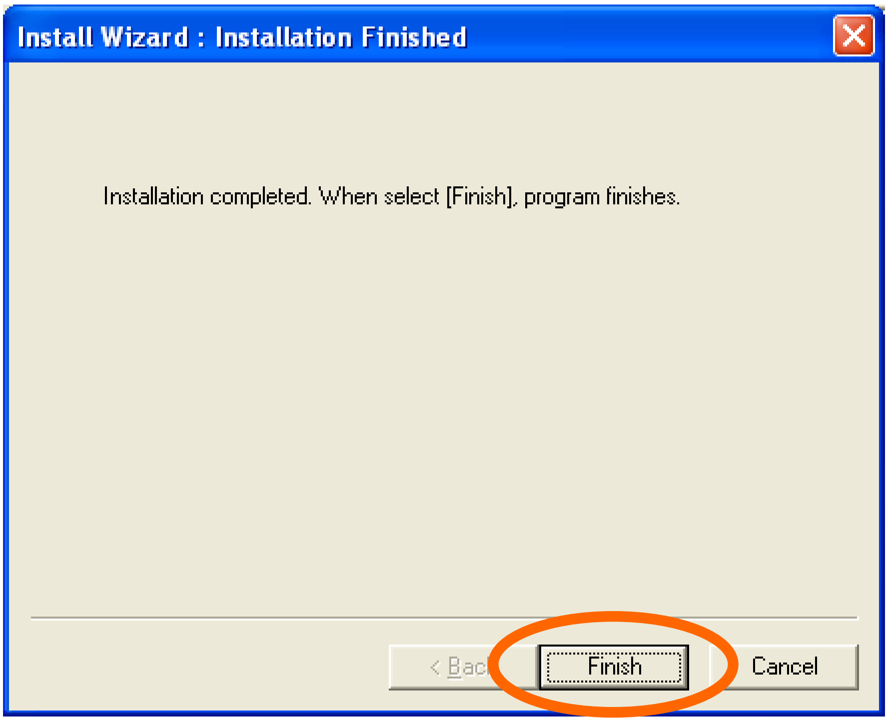
<9> In the **Installation Start** dialog box, click the **Next** button.



※ Since screen is under development it can differ with the actuals.

<10> The device file is installed to the project. This might take a while depending on the environment.

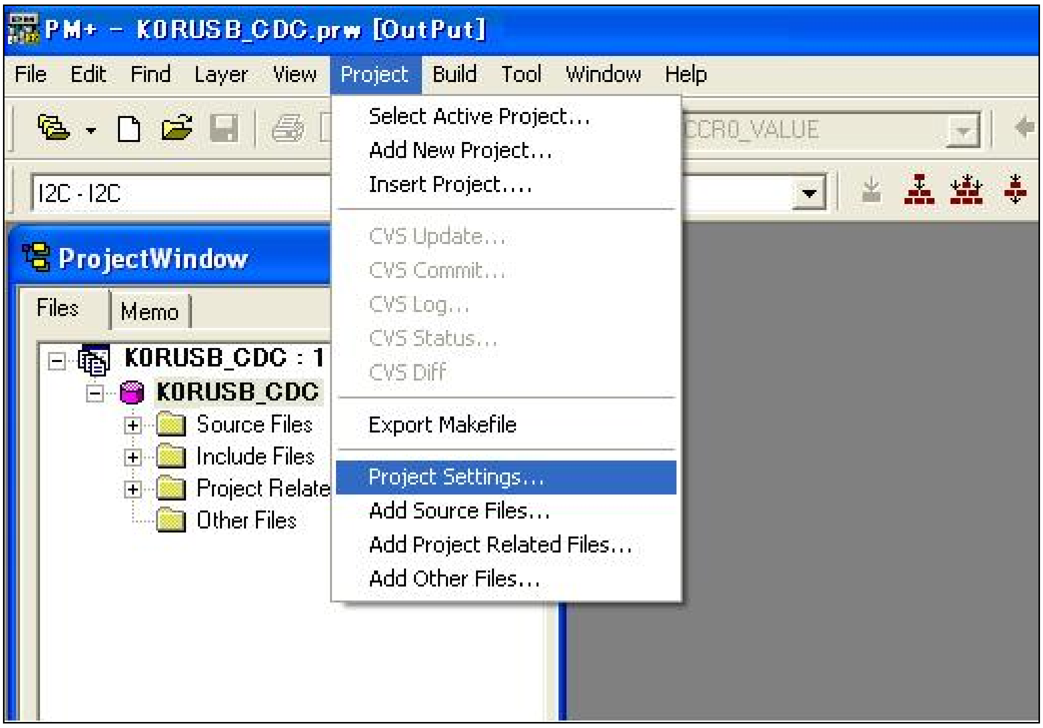
<11> In the **Installation Finished** dialog box, click the **Finish** button.



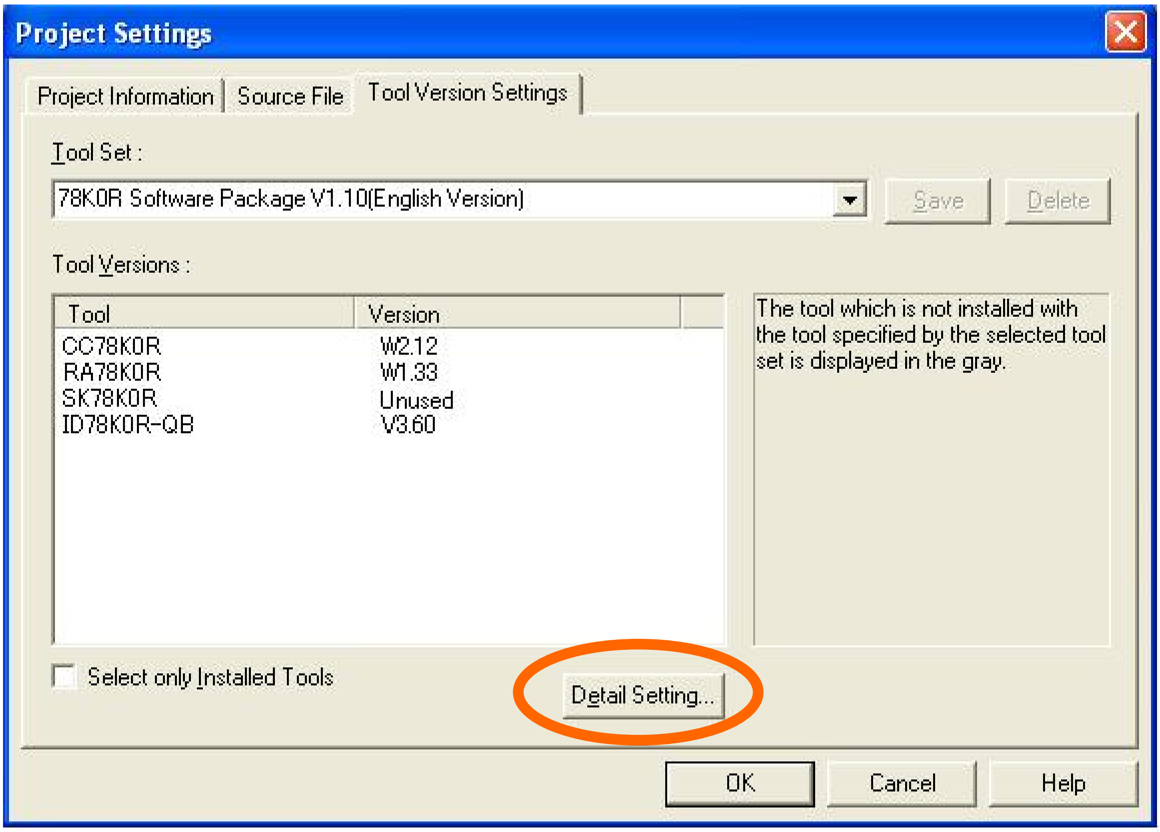
Setting up the building tool

The procedure for using the CC78K0R、RA78K0R as the building tool and ID78K0R-QB as the debugging tool is described below.

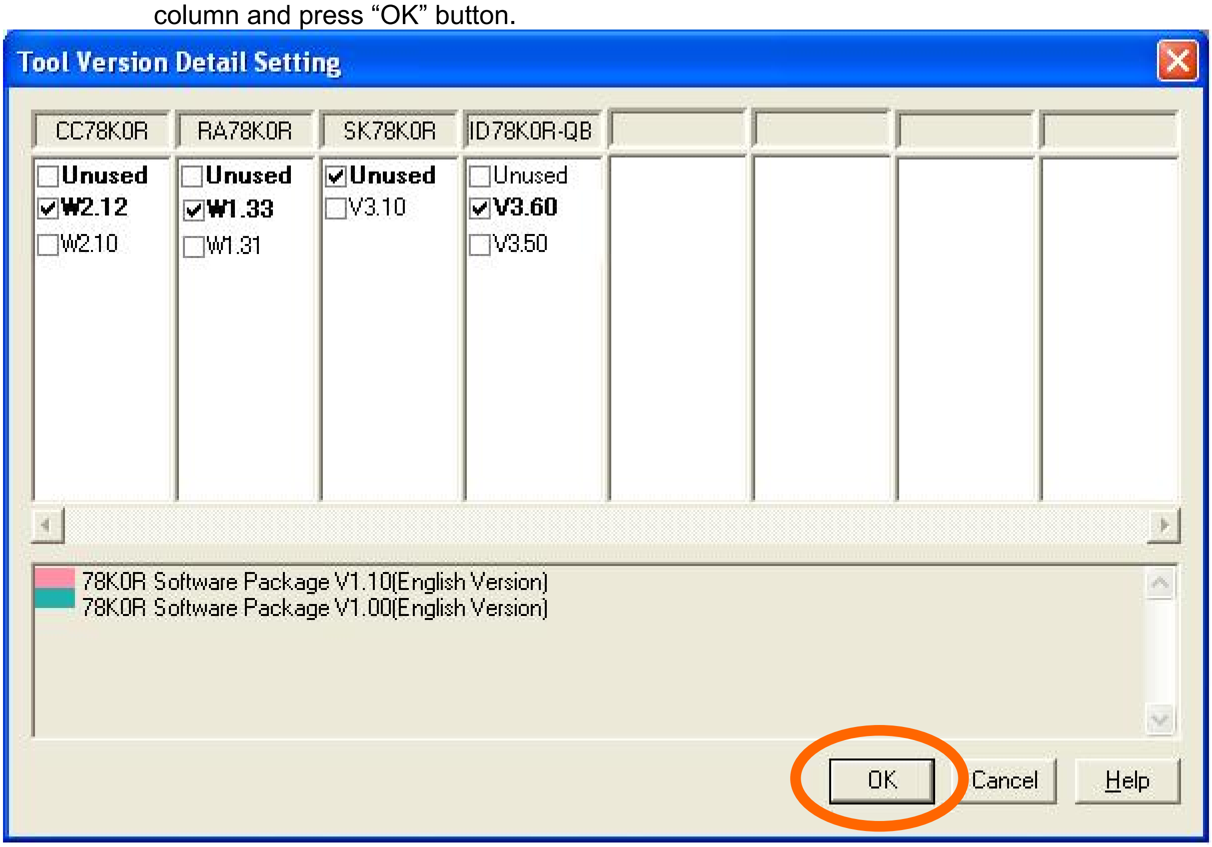
<1> Select **Project Settings** in the PM+ **Project** menu.



<2> In the **Project Settings** dialog box, click the **Detail Setting** button on the **Tool Version Settings** tab.



<3> In the **Tool Version Detail Setting** dialog box, select the compiler version to use in the "CC78K0R" "RA78K0R" columns and the debugger version to use in the "ID78K0R-QB" column and press "OK" button.



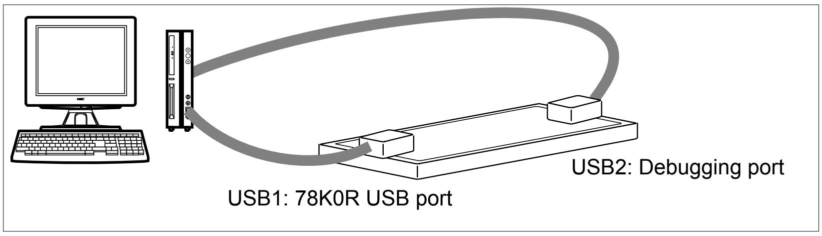
5. 2. 2 Setting up the target environment

Connect the target device to use for debugging.

(1) Connecting the target device

Connect the two USB ports on the TK-78K0R/KE3L+USB to the USB ports of the host by using USB cables.

Figure 5-2 Connecting the TK-78K0R/KE3L+USB



Remark For a drawing and details about the ports of the TK-78K0R/KE3L+USB, see **APPENDIX A STARTER KIT.**

Installing the host driver

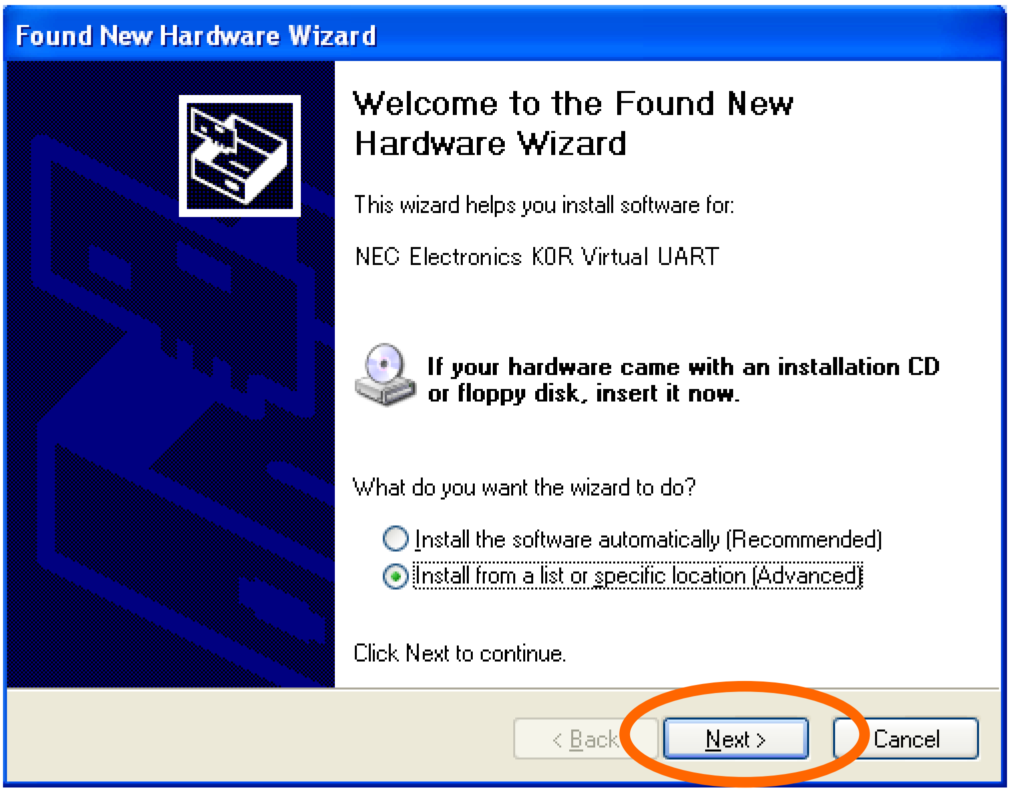
The procedure for using the virtual COM port host driver included with the sample driver is described below.

Remark One of the two USB ports on the 78K0R/KE3-L is a debugging port that requires a separate host driver. For details about the files to use and how to obtain them, contact NEC Electronics.

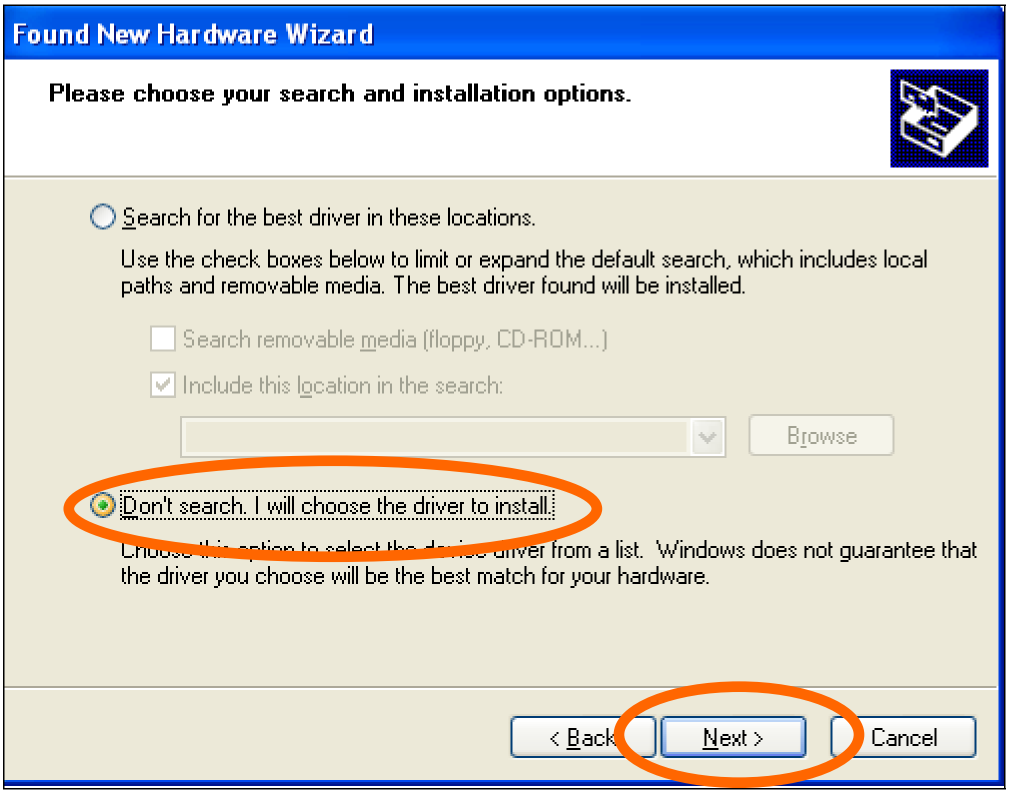
<1> When the connections of the TK-78K0R/KE3L+USB are recognized by the host, the “Found New Hardware “message is displayed, and then the Found New Hardware Wizard starts.

<2> 「On the first page of the **Found New Hardware Wizard** dialog box, select **No, not this time**, and then click the **Next** button.

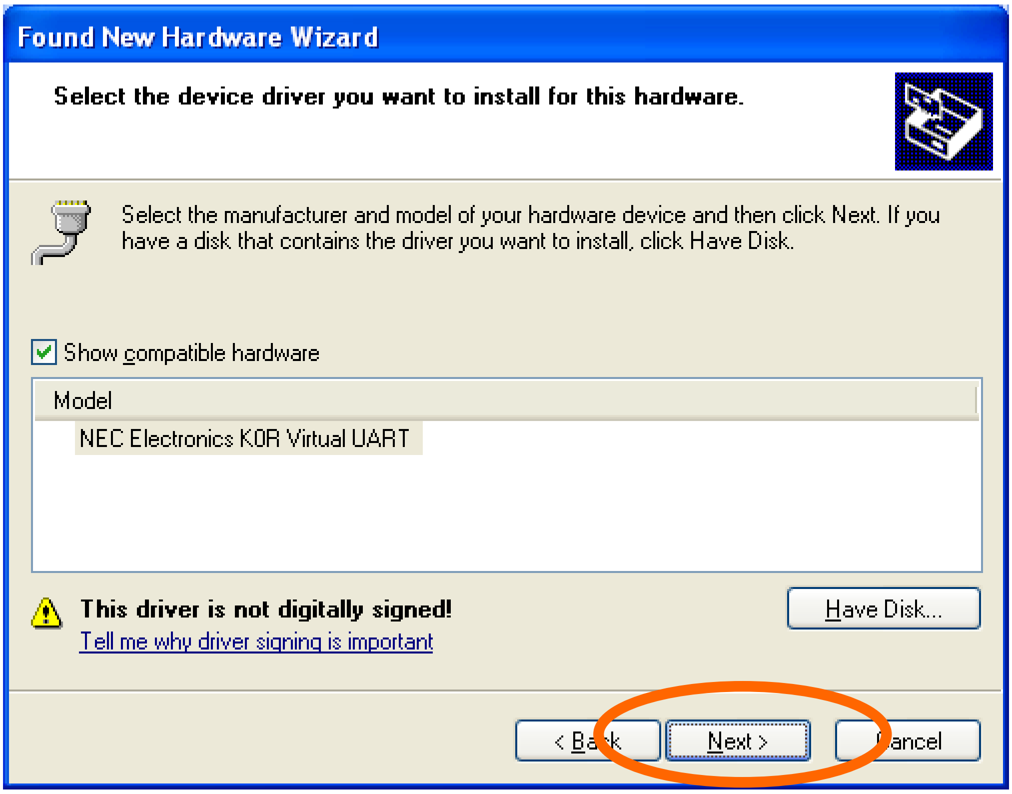
<3> On the next page, select **Install from a list or specific location (Advanced)** and then click the **Next** button.



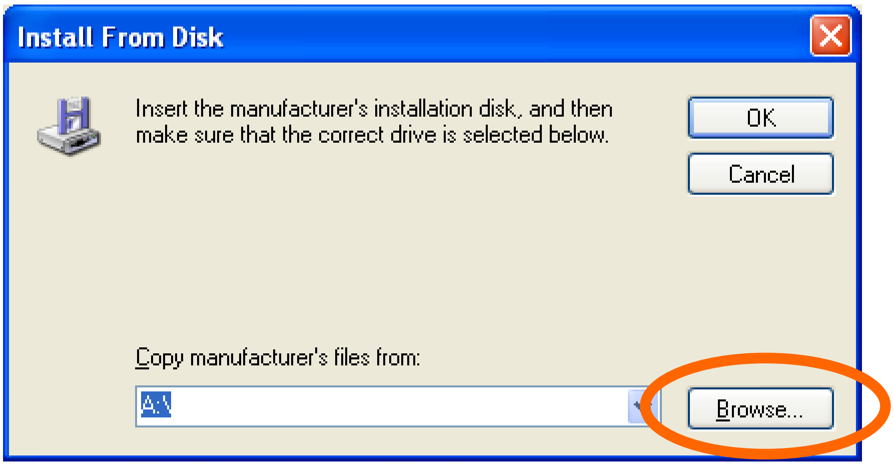
<4> On the next page, select **Don’t search. I will choose the driver to install** and then click the **Next** button.



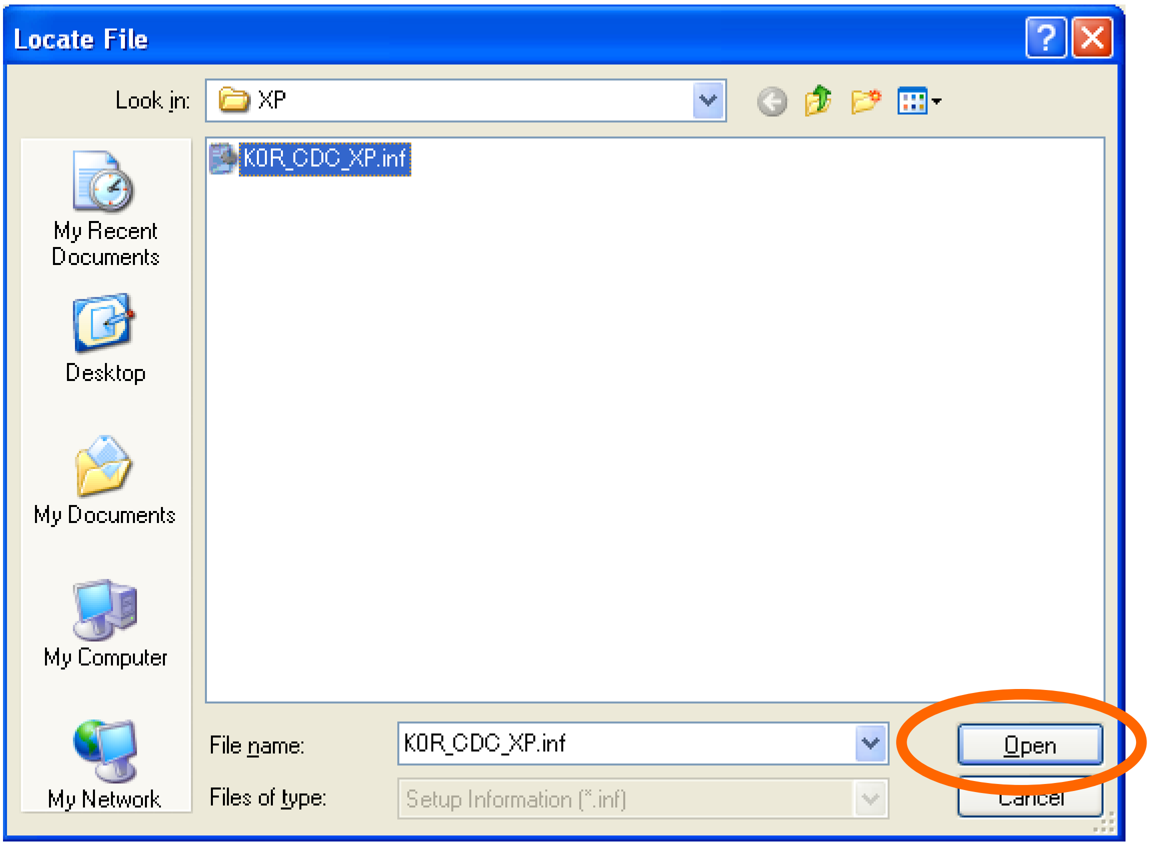
<5> On the next page, click the **Have Disk** button.



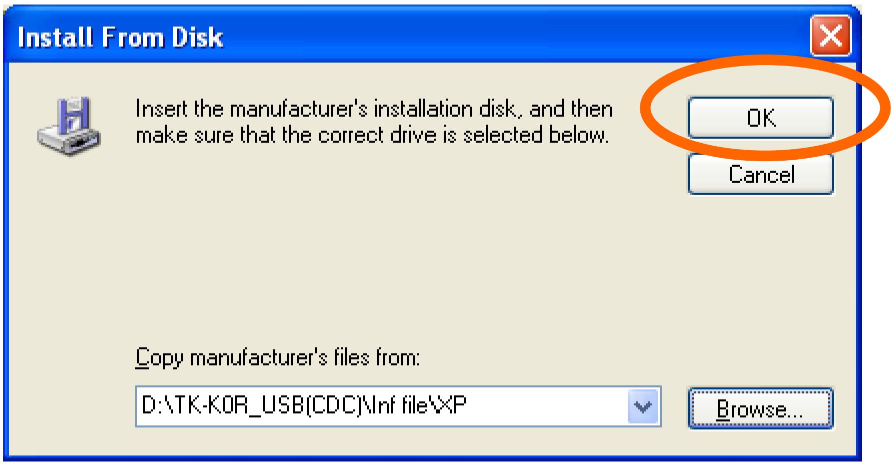
<6> In the **Install From Disk** dialog box, click the **Browse** button to display the **inf file** folder in the directory in which the sample driver was stored.



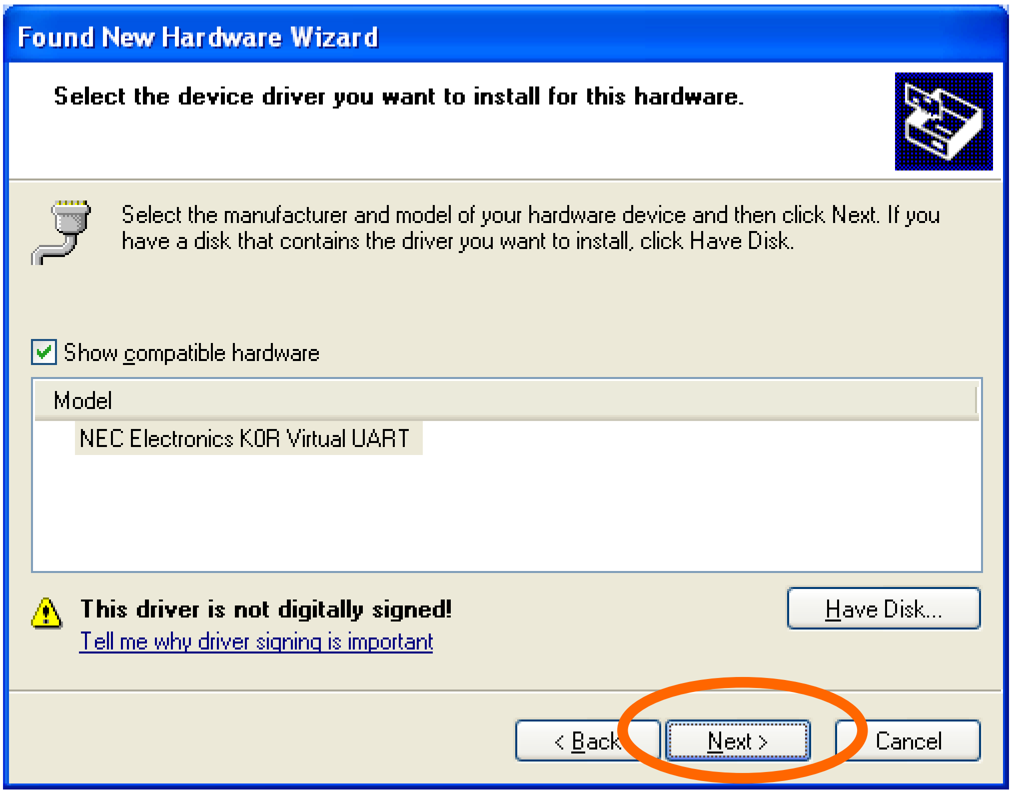
<7> Select the inf file in the **XP** folder according to the OS used on the host, and then click the **Open** button



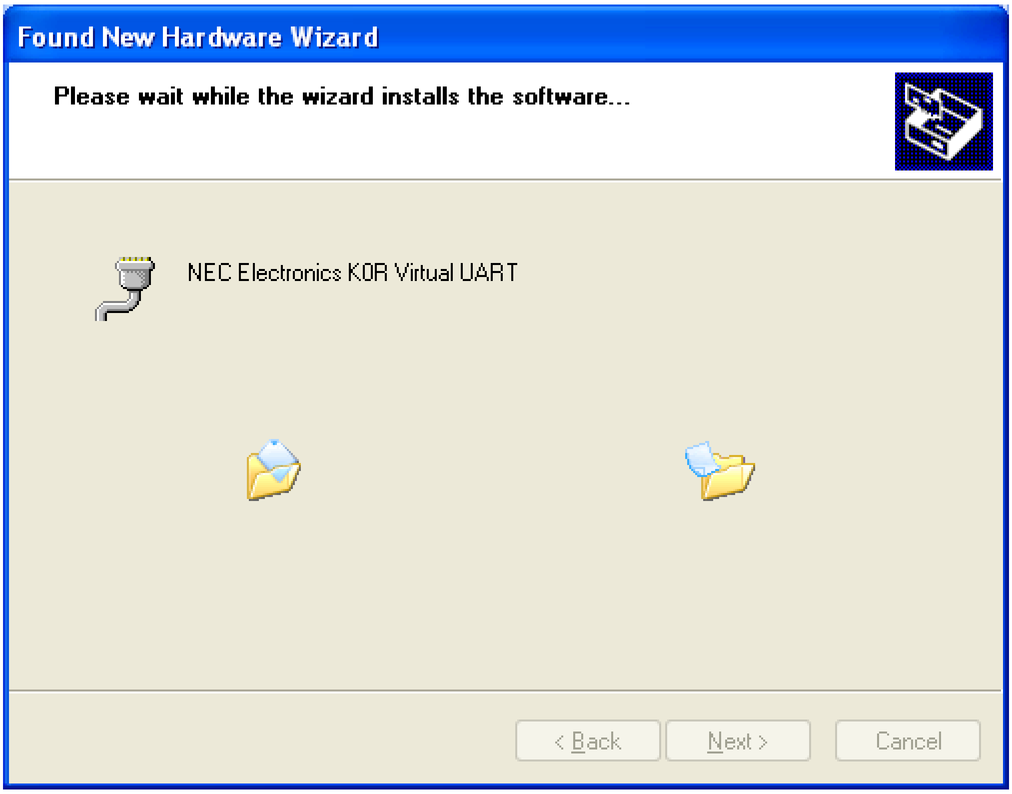
<8> In the **Install From Disk** dialog box, confirm that the path under **Copy manufacturer's files from:** is correct, and then click the **OK** button.



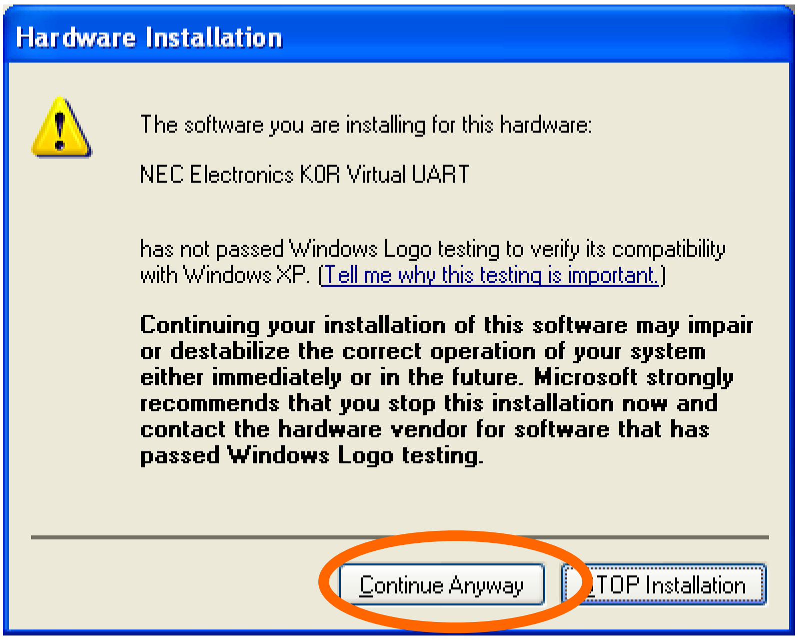
<9> In the **Found New Hardware Wizard** dialog box, select **NEC Electronics K0R Virtual UART**, and then click the **Next** button



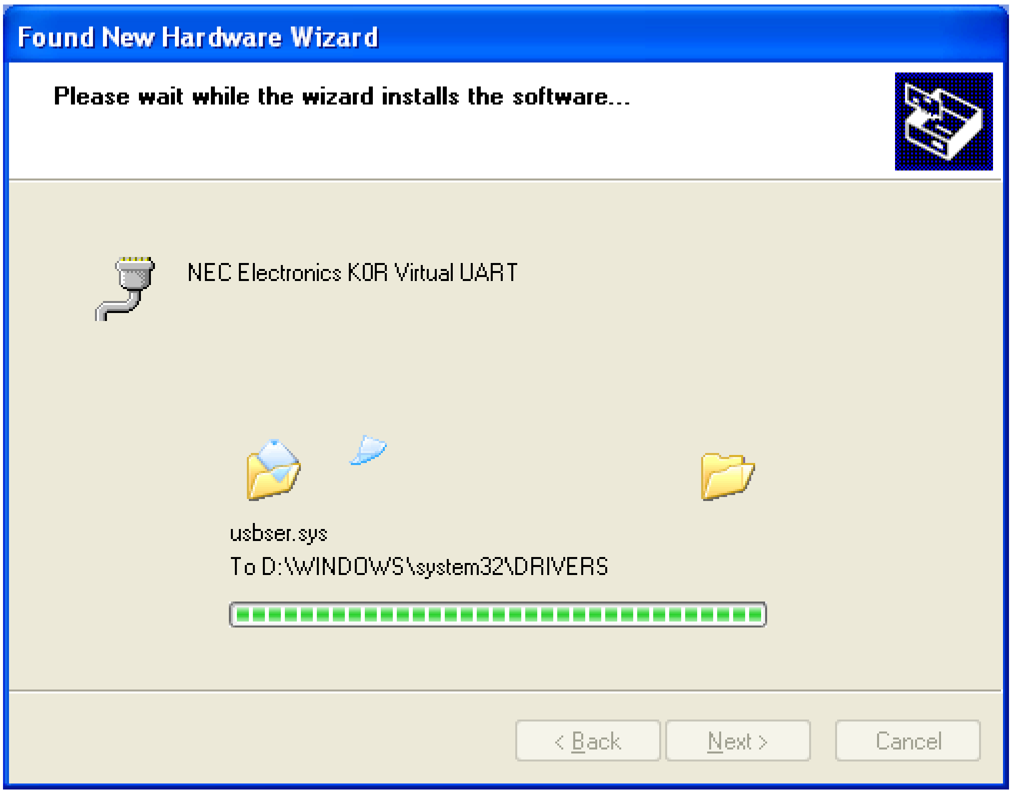
<10> The driver installation starts.



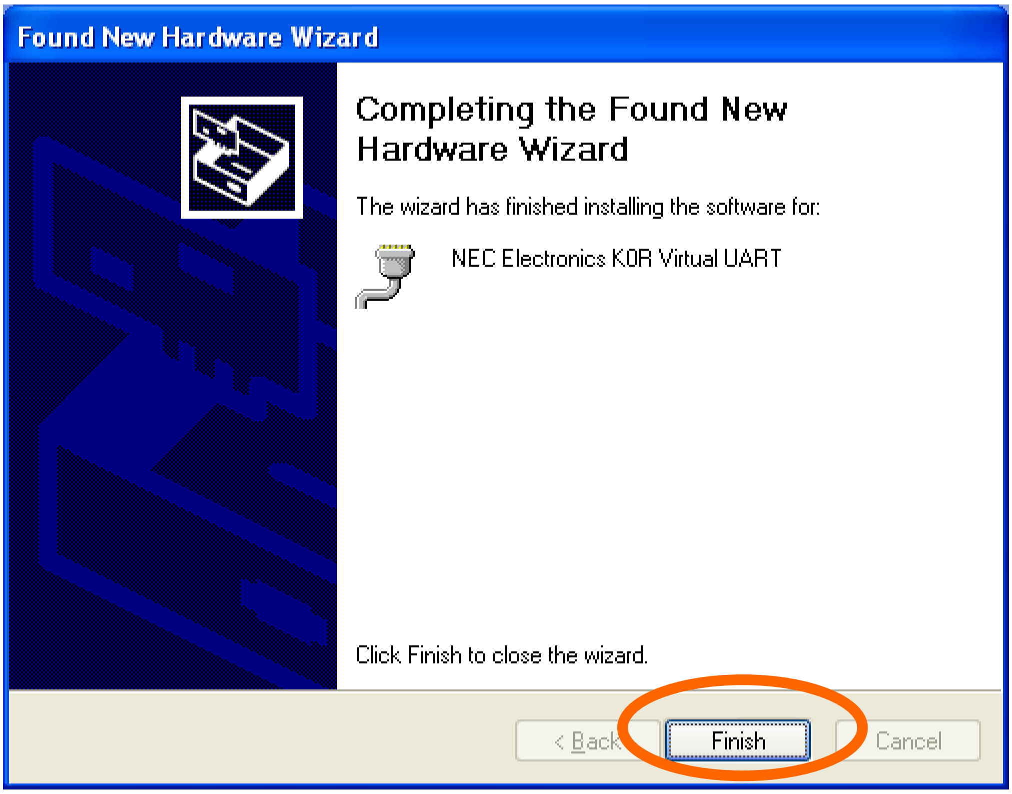
<11> In the **Hardware Installation** dialog box, click the **Continue Anyway** button.



<12> The driver is installed. This might take a while depending on the environment.

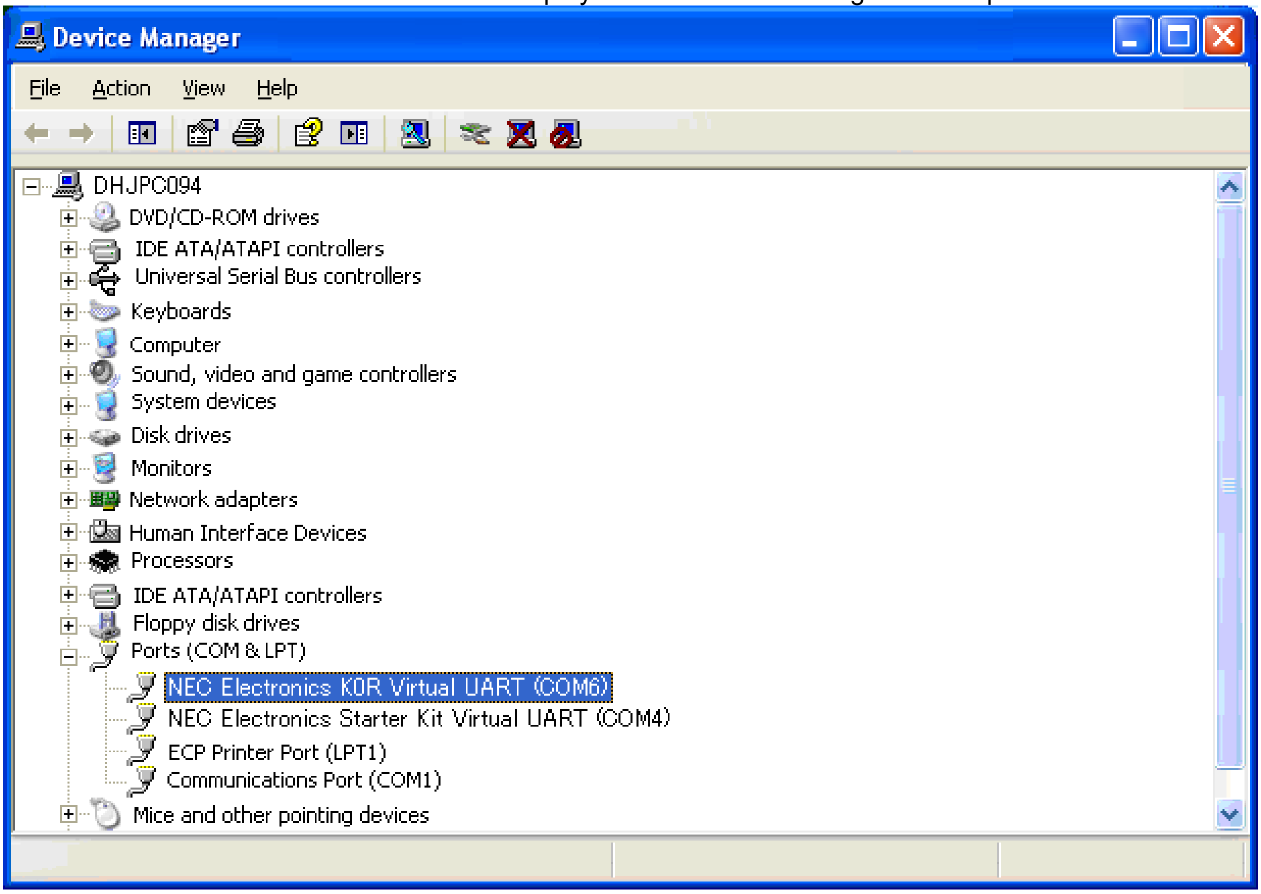


<13> On the next page, click the **Finish** button.



Checking the device assignment

Open the Windows **Device Manager** window. In the **Ports** category, make sure that **NEC Electronics K0R Virtual UART** is displayed and check the assigned COM port number



Remark Device names and port numbers can be changed. For details, see **6.2 Customizing the Sample Driver**.

5. 3 On-Chip Debugging

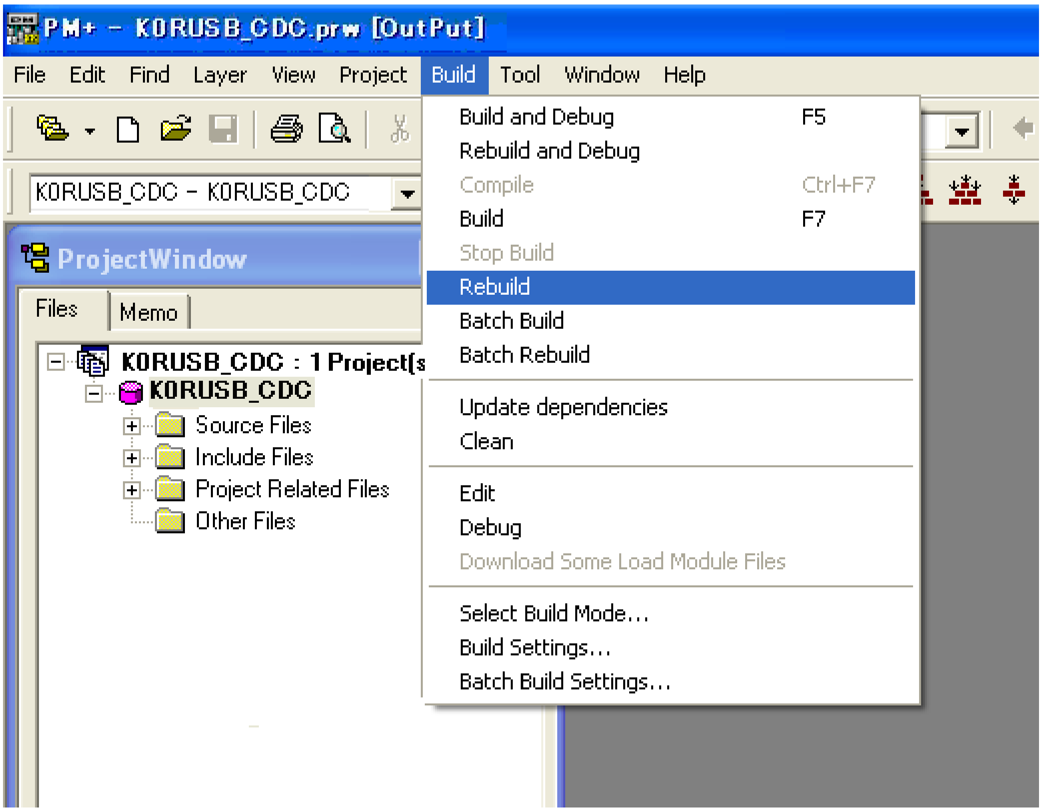
This section describes the procedure for debugging an application program that was developed using the workspace described in **5.2 Setting Up the Environment.**

For the 78K0R/Kx3-L, a program can be written to its internal flash memory and the program operation can be checked by directly executing the program by using a debugger (on-chip debugging).

5. 3. 1 Generating a load module

To write a program to the target device, use a C compiler to generate a load module by converting a file written in C or assembly language.

For PM+, generate a load module by selecting **Rebuild** in the **Build** menu.



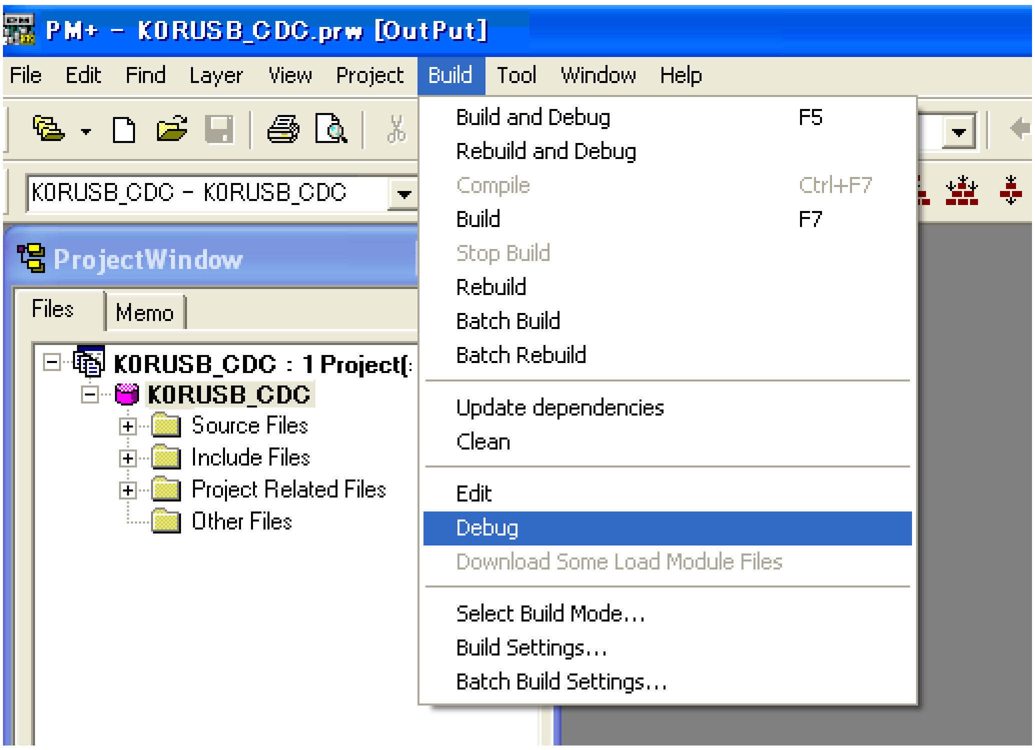
5. 3. 2 Loading and executing the load module

Execute the generated load module by writing (loading) it to the target.

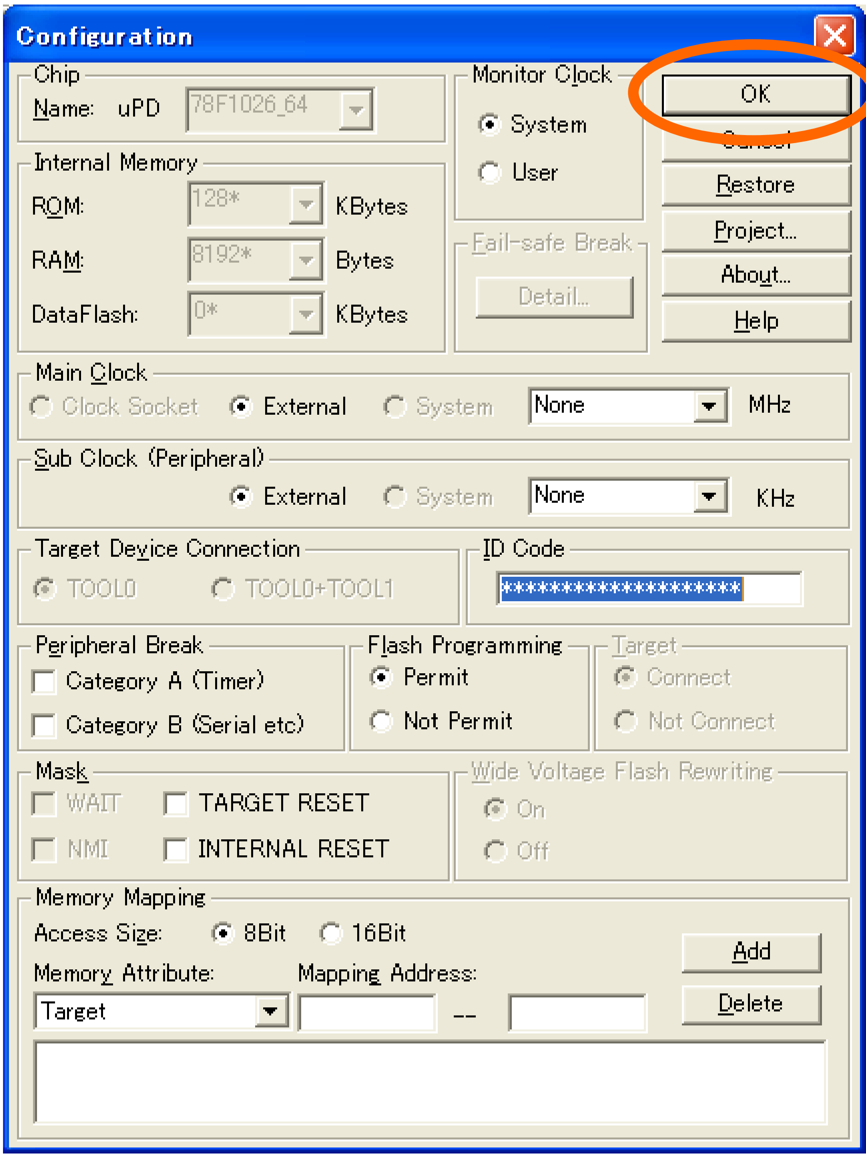
(2) Writing the load module

The procedure for writing the load module to the TK-78K0R/KE3L+USB by using PM+ is described below.

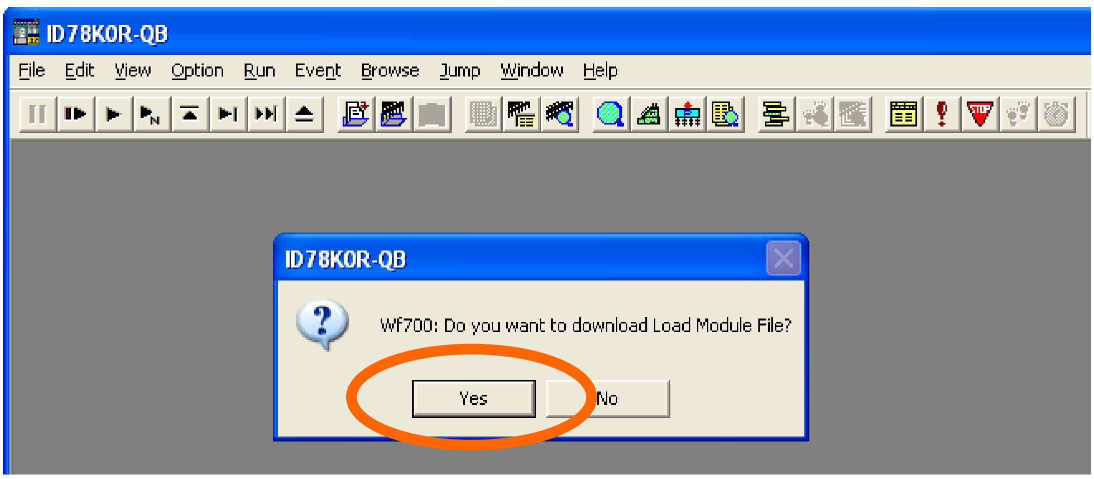
<1> Start the ID78K0R-QB by selecting **Debug** in the **Build** menu



<2> In the **Configuration** dialog box, click on “OK” button.

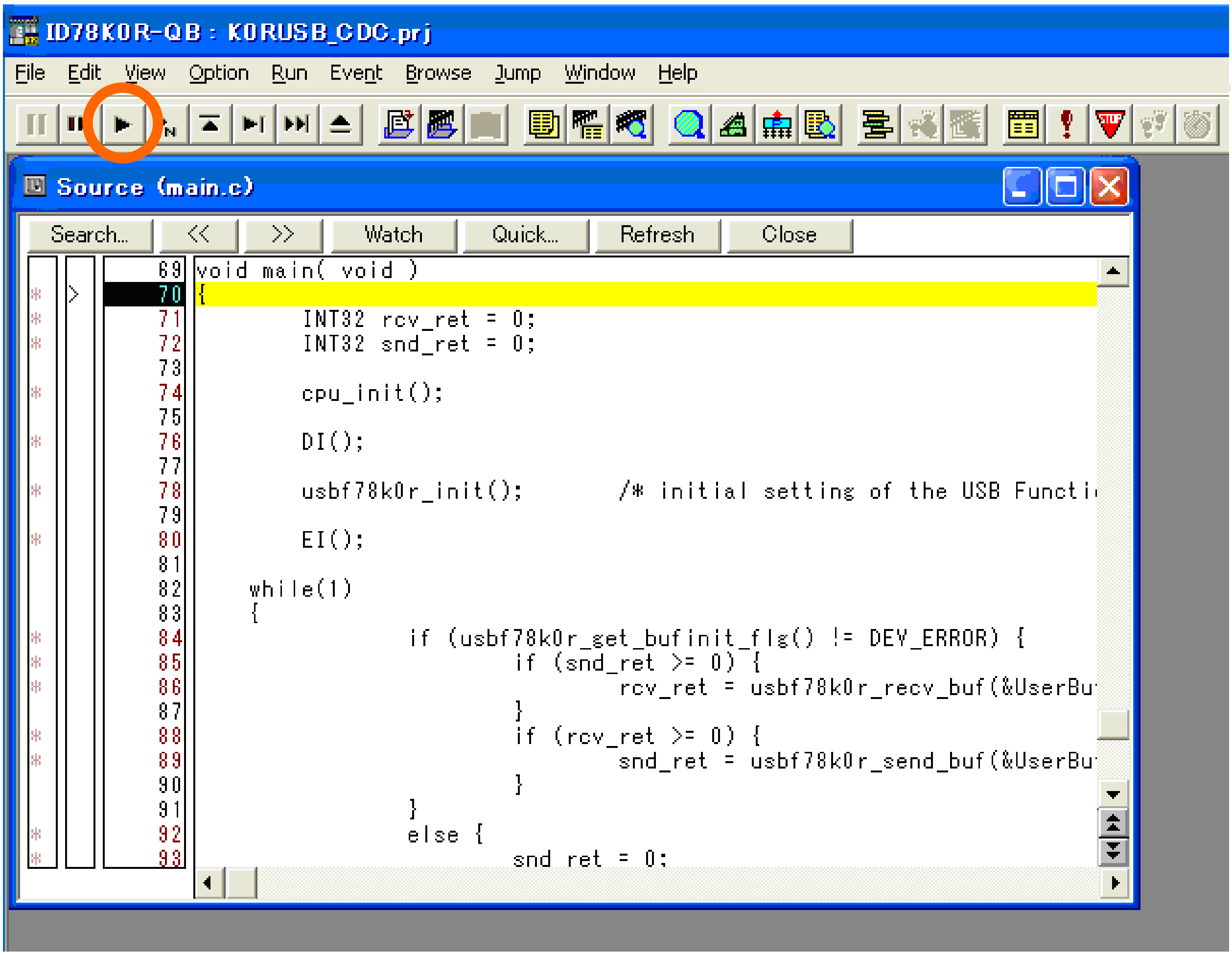


<3> If a project file included with the sample driver is used, the following dialog box is displayed. Click the **Yes** button to start writing the load module file.



Executing the program

Click the  button in the ID78K0R-QB window or select **Run Without Debugging** in the **Run** menu.

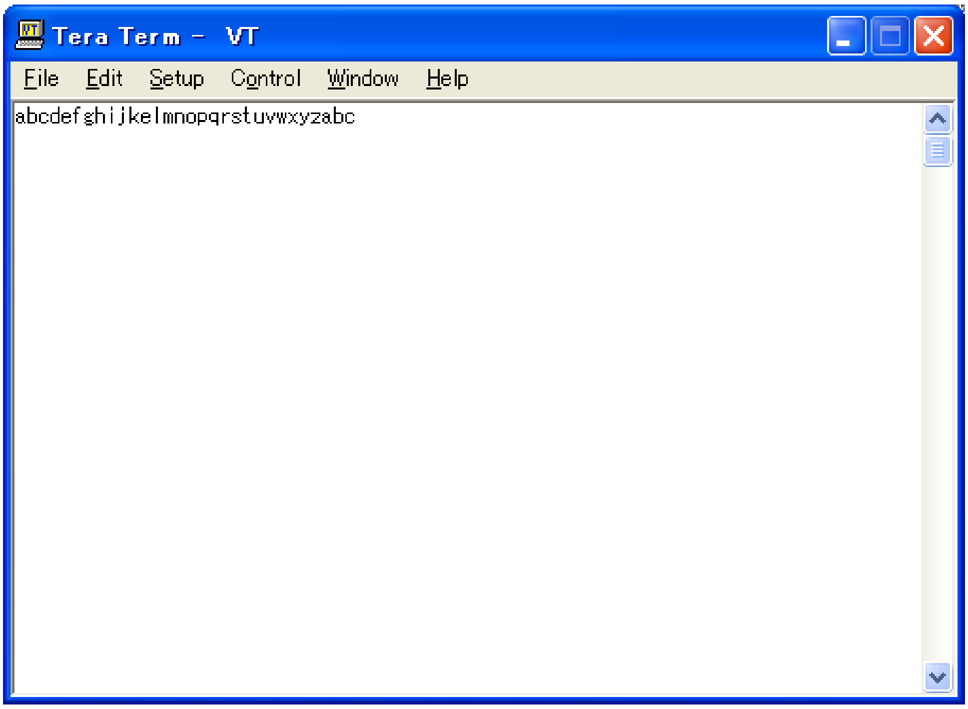


5. 4 Checking the Operation

If the target device that has loaded the sample driver is connected to the host via USB, the result of executing the sample application in the driver can be checked.

Start terminal software (such as Tera Term) on the host, enter the following characters, and then check how they are displayed.

Remark For details of sample application, see Chapter 4 **Sample application specifications.**



CHAPTER 6 USING THE SAMPLE DRIVER

This chapter describes information that you should know when using the USB Communication Device Class sample driver for the 78K0R/Kx3-L.

6. 1 Overview

The sample software can be used in the following two ways.

(1) Customizing the sample driver

Rewrite the following sections of the sample driver as required.

. The sample application section in “main.c”
. The values specified for the various registers in “usbf78k0r.h” file
. The descriptor information in “usbf78k0r_desc.h” file
. Device names and provider information included in the virtual COM port host driver (inf file)

Remark: For the list of files included in the sample driver, see **1.1.3 Files included in the sample driver**.

(2) Using functions

Call functions from within the application program as required. For details about the provided functions see **3.3 Function Specifications.**

6. 2 Customizing the Sample Driver

This section describes the sections to rewrite as required when using the sample driver.

6. 2. 1 Application section

The code in main.c file below includes a simple example of processing using the sample driver. The initialization before and after the processing and endpoint monitoring can be used by including the processing to actually use for the application in this section.

List 6-1 Sample Application Code

```
/*=========================================================
 Main function
 void main(void)

 Arguments:
        N/A
 Return values:
        N/A
 Overview:
        main routine.
=========================================================*/
void main(void)
{
        INT32 rcv_ret = 0;
        INT32 snd_ret = 0;

        cpu_init();

        DI();

        usbf78k0r_init();   /* initial setting of the USB Function */

        EI();

        while(1)
        {
                if (usbf78k0r_get_bufinit_flg() != DEV_ERROR) {
                        if (snd_ret >= 0) {
                                rcv_ret = usbf78k0r_recv_buf(&UserBuf[0], USERBUF_SIZE);
                        }
                        if (rcv_ret >= 0) {
                                snd_ret = usbf78k0r_send_buf(&UserBuf[0], rcv_ret);
                        }
                }
                else {
                        snd_ret = 0;
                        rcv_ret = 0;
                }
        }
}
```

6. 2. 2 Setting up the registers

The registers the sample driver uses (writes to) and the values specified for them are defined in "usbf78k0r.h" file. By rewriting the values in this file according to the actual use for the application, the operation of the target device can be specified by using the sample driver.

6. 2. 3 Descriptor information

The data the sample driver adds to the USBF during initialization processing (described in **3.1.3 Descriptor settings**) is defined in "usbf78k0r_desc.h" file. Information such as the attributes of the target device can be specified by using the sample driver by rewriting the values in this file according to the use in an actual application.

If the vendor ID and product ID of the device descriptor are rewritten, the vendor ID and product ID must also be rewritten in the host driver to install (the INF file) when connecting the target device. (For details, see **6.2.4 (3) Changing the vendor and product IDs**).

Any information can be specified for the string descriptor. The sample driver defines manufacturer and product information, so rewrite the information as required.

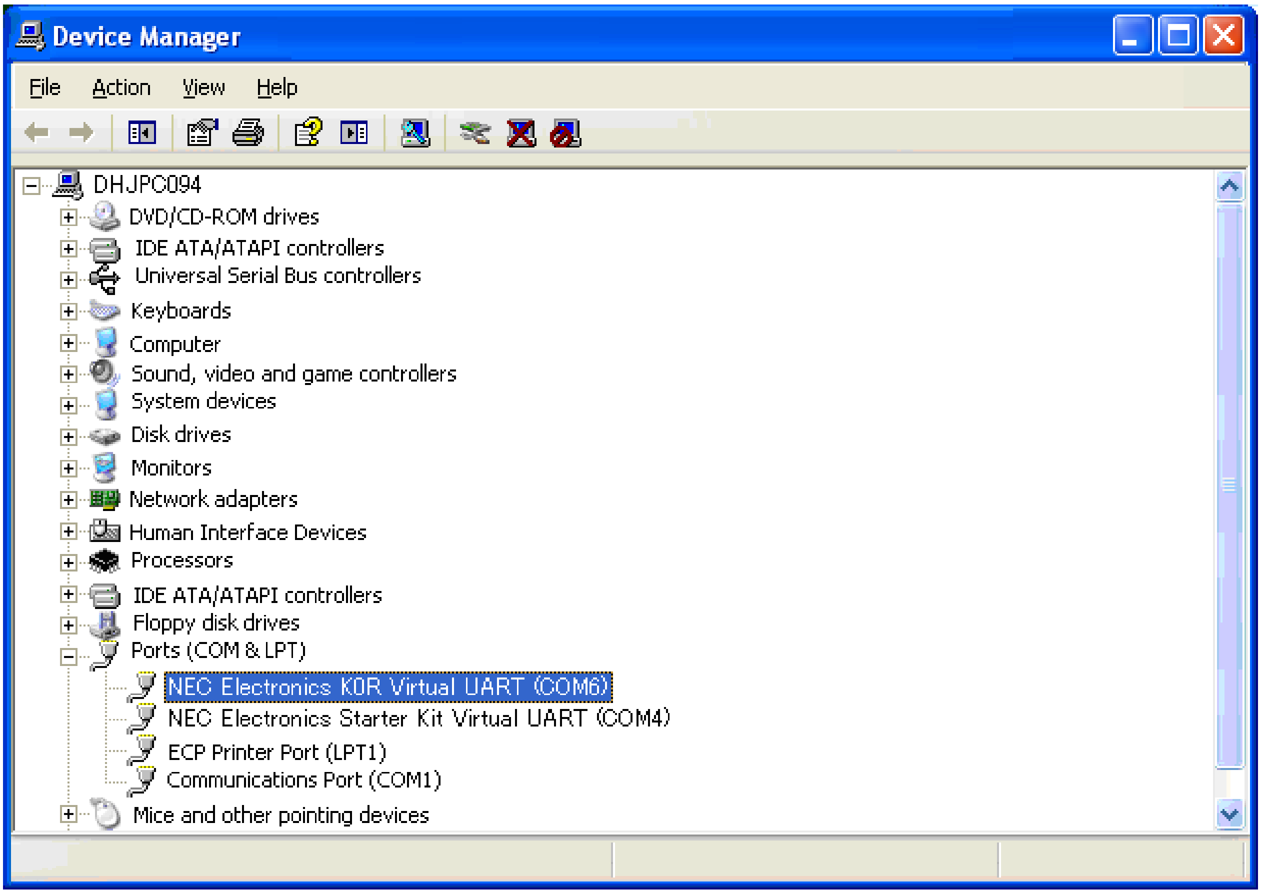
6. 2. 4 Setting up the virtual COM port host driver

The driver that was installed in **5.2.2 Preparing the environment** can be customized as follows.

Changing the COM port number

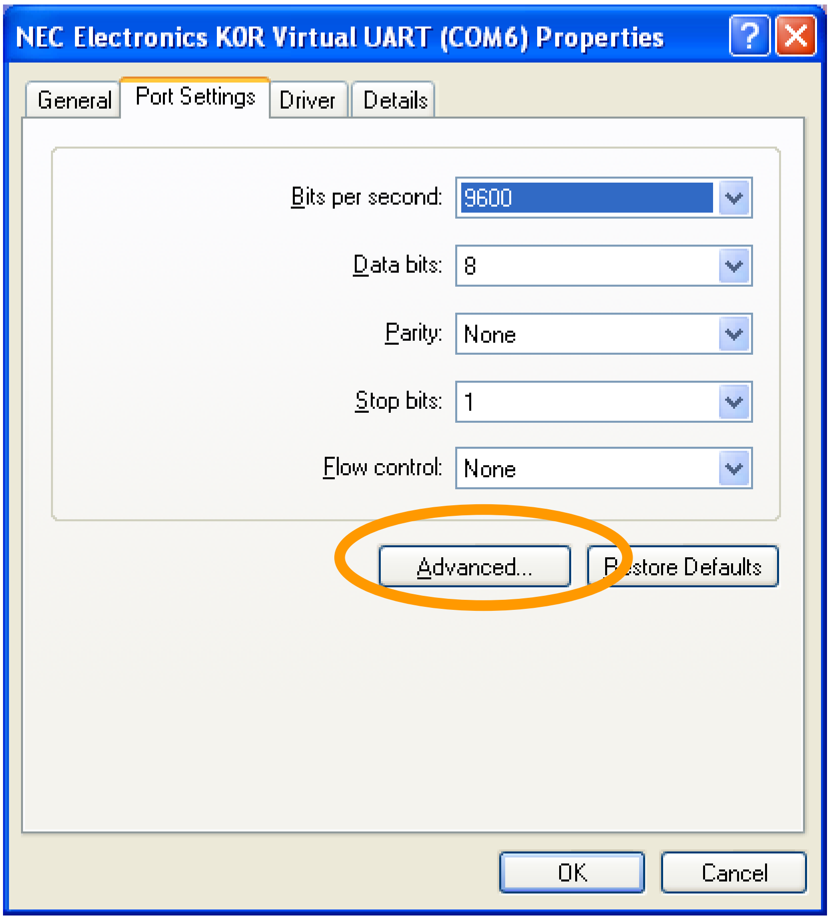
When the connection of a USB device is recognized by the host, the host automatically assigns the COM port number of the device, but the number can be changed to any number. To change the COM port number by using the host, perform the following procedure.

<1> Open the Device Manager Windows and display the “Port” tree in the device list display.

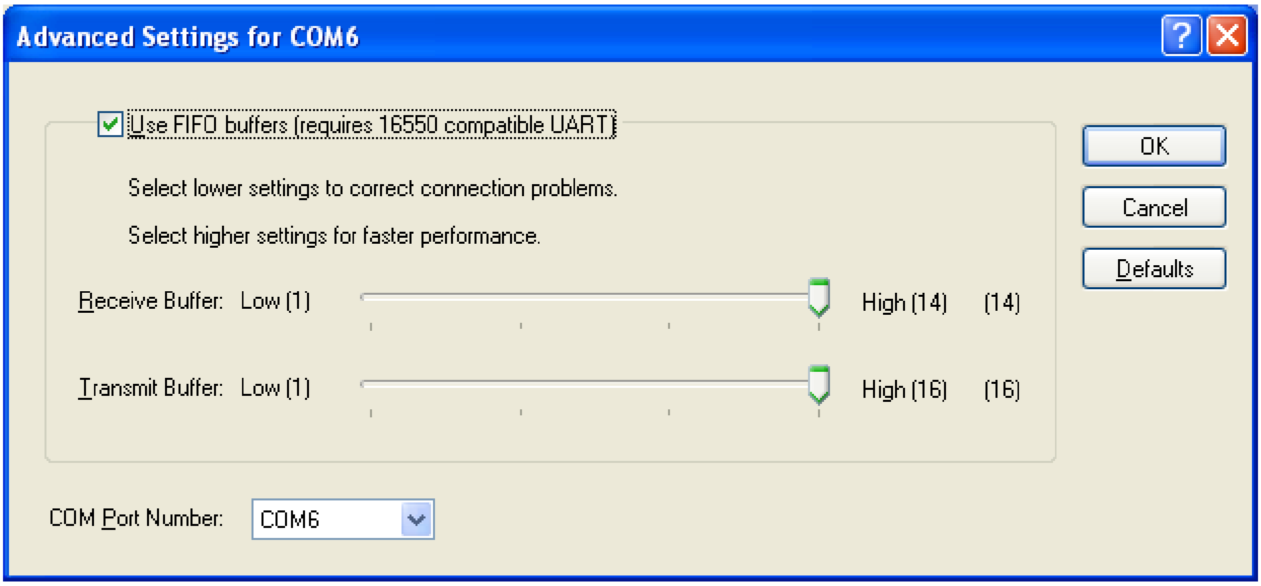


<2> Select "**NEC Electronics Jx3H Virtual UART (COMn)**" (where *n* is a number assigned by the host) to display its properties.

<3> Click the "**Advanced**" button on the "**Port Settings**" tab.



<4> In the "**Advanced Settings for COMn**" dialog box (where *n* is a number assigned by the host), select any port number from the "**COM Port Number**" drop-down list.



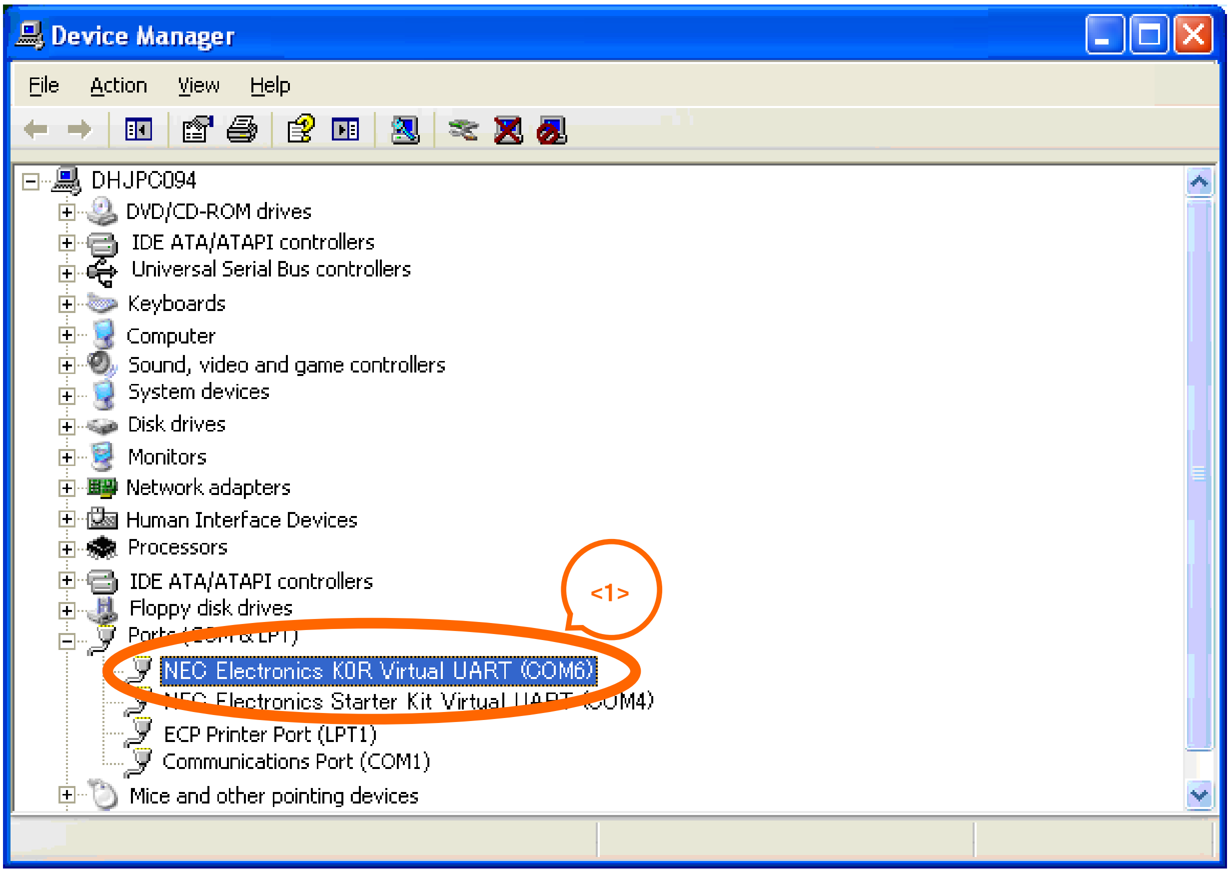
Remarks 1. Make sure not to select a port number that is used for a different device.

2. Immediately after applying this change, the new port number becomes valid but might not be reflected immediately in the Device Manager.

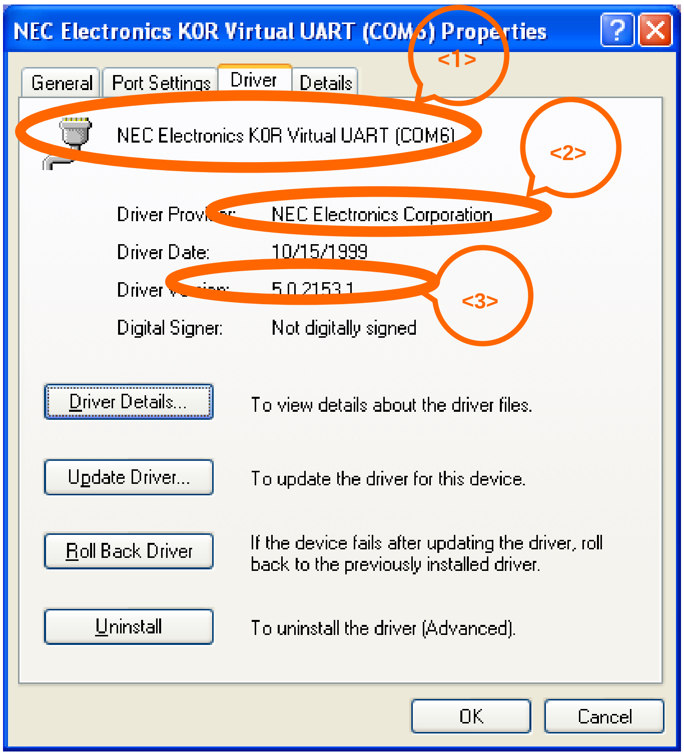
Changing properties

Some information, such as the attributes of the device used by the Windows Device Manager, can be changed. The information that can be changed is shown below.

(a) The device name (in the list of devices)



(b) The device name, manufacturer name, and version (in the device properties)



Because this information is displayed based on the information included in the host driver (the INF file), it can be changed by rewriting the INF file. The sections in the INF file, which correspond to the numbers in the example on the previous page, are shown below.

List 6-2INF file "K0R_CDC_XP.inf" code

```
1   ; .inf file (Win2000,XP):
2   [Version]
3   Signature="$Windows NT$"
4   Class=Ports
5   ClassGuid={4D36E978-E325-11CE-BFC1-08002BE10318}
6
7   Provider=%NEC%
8   LayoutFile=layout.inf
9   DriverVer=10/15/1999,5.0.2153.1                         <3>
10
11  [Manufacturer]
12  %NEC%=NEC
13
14  [NEC]
15  %NEC78K0RKx3L%=Reader, USB¥VID_0409&PID_01D0
16
17  [Reader_Install.NTx86]
18  ;Windows2000
19
20  [DestinationDirs]
21  DefaultDestDir=12
22  Reader.NT.Copy=12
23
24  [Reader.NT]
25  CopyFiles=Reader.NT.Copy
26  AddReg=Reader.NT.AddReg
27
28  [Reader.NT.Copy]
29  usbser.sys
30
31  [Reader.NT.AddReg]
32  HKR,,DevLoader,,*ntkern
33  HKR,,NTMPDriver,,usbser.sys
34  HKR,,EnumPropPages32,,"MsPorts.dll,SerialPortPropPageProvider"
35
36  [Reader.NT.Services]
37  AddService = usbser, 0x00000002, Service_Inst
38
39  [Service_Inst]
40  DisplayName = %Serial.SvcDesc%
41  ServiceType = 1 ; SERVICE_KERNEL_DRIVER
42  StartType = 3 ; SERVICE_DEMAND_START
43  ErrorControl = 1 ; SERVICE_ERROR_NORMAL
44  ServiceBinary = %12%¥usbser.sys
45  LoadOrderGroup = Base
46
47  [Strings]
48  NEC = "NEC Electronics Corporation"                     <2>
49  NEC78K0RKx3L = "NEC Electronics K0R Virtual UART"     <1>
50  Serial.SvcDesc = "USB Serial emulation driver"
```

Changing the vendor and product IDs

If the vendor and product IDs in the device descriptor are changed, the same changes must be specified in the host driver (the INF file).

Include the vendor and product IDs in the INF file as shown on line 15 in List 6-2.

Vendor ID: Represented by four digits in hexadecimal format following “VID_”
Product ID: Represented by four digits in hexadecimal format following “PID_”

6. 3 Using Functions

The code for applications can be simplified and the code size can be reduced because frequently used and versatile types of processing are provided as defined functions. For details about each function, see

3.3 Function Specifications. The following sections of the sample application shown in List can be reused as application examples for various types of defined processing.

(1) Verifying FIFO state for user data

FIFO state notification function (usbf78k0r_get_bufinit_flg) for user data is called and FIFO initialization flag “usbf78k0r_bufinit_flg” for user data is monitored on line 27. This flag is uniquely defined by the sample driver and if FIFO is initialized in the Bus Reset process reported by sample driver INTUSB interrupt and Set Line Coding request process of class request, “1” is set.

“0” is set to clear the error state of transmission/reception process of user data at the FIFO initialization in the sample application.

(2) User data reception processing

For the sample driver, separate functions that define retrieval processing for the received data, one for acquiring the data length and another for copying the data, are provided.

Received data size can be verified before the reception process by calling the acquisition function (usbf78k0r_rdata_length) of reception data length at the reception process based on length of the actually received data. Reception process can also be called on the basis of buffer size when buffer size for user data is determined. However, take care that maximum data length for one time reception should be less than the data size that is received in 1 packet.

In the sample application, data received from used endpoint at the received data in the user data reception function (usbf78k0r_recv_buf) on the line 29 is read as a usage example when buffer size is determined.

(3) User data transmission processing

Used endpoint FIFO state is verified at the transmitted data in the user data transmission function (usbf78k0r_send_buf) on line 32 and if it is FIFO Empty, data is written. In case of FIFO Full, it is error end. When size of the data of the packet transmitted at the earlier and not the transmitted data is Max Packet Size, NULL packet is transmitted. Since this is characteristic of communication device class, NULL packet is transmitted to report that it is last data to host when last packet of data is Max Packet Size.

In the sample application, when process is terminated with the generation of error, reception process is stopped and transmission process is repeated until the normal termination of writing of transmission wait data to FIFO. Initialization of FIFO for user data is the only exception. Transmitted/received data and transmission wait data in FIFO are discarded when FIFO is initialized by the request from user or host.

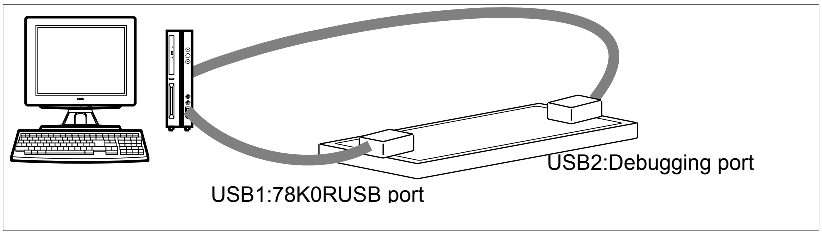
CHAPTER 7 STARTER KIT

This chapter describes the TK-78K0R/KE3L+USB starter kit for the 78K0R/Kx3-L, made by Tessera Technology, Inc.

7. 1 Overview

TK-78K0R/KE3L+USB is a kit to develop applications that use the 78K0R/KE3-L. The entire development sequence from creating a program to building, debugging, and checking operation can be performed simply by installing development tools and USB drivers and then connecting either board to the host. This kit uses a monitoring program that enables debugging without connecting an emulator (on-chip debugging).

Figure 7-1Connections of TK-78K0R/KE3L+USB



7. 1. 1 Features

TK-78K0R/KE3L + USB has the following features.

- A USB miniB connector for the internal USBF
- As small as a business card
- Efficient development by using the board with the integrated development environment (PM+)

7. 2 Specifications

The main specifications of the TK-78K0R/KE3L＋USB are as follows.

○CPU	μPD78F1026(78K0R/KE3-L)
○Operating frequency	20 MHz (USB:48 MHz)
○Interface	USB connector (miniB) x 2 MINICUBE2 connector Peripheral board connector x 2 (only the pad)
○Supported platform	Host: DOS/V computer that has a USB interface OS:Windows XP
○Operating voltage	5.0 V(internal operation at 3.3 V)
○Package dimensions	W89 x D52(mm)

[Memo]

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