V850E2/MN4

USB CDC (Communication Device Class) Driver

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Introduction

This application note describes the sample CDC (Communication Device Class) driver for the USB function controller that is incorporated in the V850E2/MN4 microcontroller.

The application note consists primarily of the following parts:

- Sampler driver specifications
- Environment for developing application programs that make use of the sample driver
- Reference information that is useful for using the sample driver

Target Device

RTE-V850E2/MN4-EB-S incorporating the V850E2/MN4 (µPD70F3512)

Contents

1. Introduction

1.1 Note

The sample program introduced in this application note is provided only for reference purposes. Renesas does not guarantee normal operation of the sample program under any circumstances.

When using the sample program, make extensive evaluations of the driver on a user's set.

1.2 Intended Audiences

This application note is intended for the users who have basic understanding of the capabilities of the V850E2/MN4 microcontroller and who are to develop application systems utilizing that microcontroller.

1.3 Objective

The objective of this application note is to help the users acquire an understanding of the specifications for the sample program for utilizing the USB function controller incorporated in the V850E2/MN4 microcontroller.

1.4 Organization

This application note is divided into the following topics:

- Overview of the USB standards
- Specifications for the sample driver
- Development environment (CubeSuite or Multi*[1] / IAR Embedded Workbench*[2])
- Application of the sample driver

Notes: 1. Multi is a registered trademark of Green Hills Software™, Inc.
2. IAR Embedded Workbench is a registered trademark of IAR Systems, Inc.

1.5 How to Read this Document

The readers of this document are assumed to have general knowledge about electronics, logic circuits, and microcontrollers.

- If you want to know the hardware capabilities and electrical characteristics of the V850E2/MN4 microcontroller
  → Refer to the separately available V850E2/MN4 Microcontroller User's Manual [Hardware].
- If you want to know the instruction set of the V850E2/MN4 microcontroller
  → Refer to the separately available V850E2M User's Manual [Architecture].

2. Overview

This application note describes the sample CDC (Communication Device Class) driver for the USB function controller incorporated in the V850E2/MN4 microcontroller. It is composed of the following topics:

- Specifications for the sample driver
- Environment for developing application programs that are to use the sample driver
- Reference information useful for making use of the sample driver

In this section, an overview of the sample driver and the description of the applicable microcontrollers are introduced.

2.1 Overview

2.1.1 Features of the USB Function Controller

The USB function controller of the V850E2/MN4 microcontroller, which is the control target of this sample driver, has the features listed below.

- Conforms to the USB (Universal Serial Bus Specification) 2.0.
- Operates as a full-speed (12 Mbps) device.
- Endpoints are configured as summarized in the table below.

Table 2.1 V850E2/MN4 Microcontroller's Endpoint Configuration

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

- Automatically responds to USB standard requests (except part of requests)
- Bus-powered or self-powered mode selectable
- Internal or external clock selectable *[1]

  Internal clock: External 9.6 MHz × 20 (internally) ÷ 4 (48 MHz)
  or External 7.2 MHz × 20 (internally) ÷ 3 (48 MHz)

  External clock: Input to the USBCLK pin (fUSB = 48 MHz)

Note: 1. The internal clock is selected for the sample driver.

2.1.2 Features of the Sample Driver

The CDC (Communication Device Class) sample driver for the V850E2/MN4 microcontroller has the features listed below. For details about the features and operations of the sample driver, see section 4, Sample Driver Specifications.

- Conforms to the USB Communication Device Class Version 1.1 Abstract Control Model
- Operates as a virtual COM device
- Occupies memory areas of the following sizes (excluding that of the vector table):
  ROM: Approx. 4.6 Kbytes
  RAM: Approx. 0.8 Kbytes

2.1.3 Sample Driver Configuration

The sample driver is available in three versions, i.e., the CubeSuite version, the Multi version, and the IAR Embedded Workbench. Use the correct version of the sample driver according to your development environment.

Each version of the sample driver is made up of the files that are described below.

(1) CubeSuite Version

The CubeSuite version of the sample driver comprises files that are summarized below.

Table 2.2 CubeSuite Version Sample Driver File Configuration

Folder	File	Outline
src	main.c	Main routine, initialization, sample application
	usbf850.c	USB initialization, endpoint control, bulk transfer, and control transfer
	usbf850_communication.c	CDC-specific processing
	cstart.asm	Bootstrap
include	main.h	main.c function prototype declarations
	usbf850.h	usbf850.c function prototype declarations
	usbf850_communication.h	usbf850_communication.c function prototype declarations
	usbf850_desc.h	Descriptor definitions
	usbf850_errno.h	Error code definitions
	usbf850_types.h	User type declarations
	reg_v850e2mn4.h	USB function register definitions
Inf	XXX_CDC_VISTA.inf	Windows® Vista® .inf file The names of the microcontrollers are inserted in the sections marked "****": MN4
	XXX_CDC_WIN7.inf	Windows 7® .inf file The names of the microcontrollers are inserted in the sections marked "****": MN4
	XXX_CDC_XP.inf	Windows XP® .inf file The names of the microcontrollers are inserted in the sections marked "****": MN4

Remarks: The sample driver package comes also with a set of project-related files for the CubeSuite (Renesas Electronics' integrated development tool suit). For further information, see section 6.2.1, Setting up the Host Environment.

(2) Multi Version

The Multi version of the sample driver comprises files that are summarized below.

Table 2.3 Multi Version Sample Driver File Configuration

Folder	File	Outline
src	main.c	Main routine, initialization, sample application
	usbf850.c	USB initialization, endpoint control, bulk transfer, and control transfer
	usbf850_communication.c	CDC-specific processing
	initial.s	Bootstrap
	vector.s	Interrupt vector table declarations
include	main.h	main.c function prototype declarations
	usbf850.h	usbf850.c function prototype declarations
	usbf850_communication.h	usbf850_communication.c function prototype declarations
	usbf850_desc.h	Descriptor definitions
	usbf850_errno.h	Error code definitions
	usbf850_types.h	User type declarations
	reg_v850e2mn4.h	USB function register definitions
	df3512_800.h	V850E2/MN4 register definitions
Inf	XXX_CDC_VISTA.inf	Windows® Vista® .inf file The names of the microcontrollers are inserted in the sections marked "****": MN4
	XXX_CDC_WIN7.inf	Windows 7® .inf file The names of the microcontrollers are inserted in the sections marked "****": MN4
	XXX_CDC_XP.inf	Windows XP® .inf file The names of the microcontrollers are inserted in the sections marked "****": MN4

Remarks: The sample driver package comes also with a set of project-related files for the Multi (Green Hills Software™, Inc. integrated development tool suit). For further information, see section 6.4.1, Setting up the Host Environment.

(3) IAR Embedded Workbench Version

The IAR Embedded Workbench version of the sample driver comprises files that are summarized below.

Table 2.4 IAR Embedded Workbench Version Sample Driver File Configuration

Folder	File	Outline
src	main.c	Main routine, initialization, sample application
	usbf850.c	USB initialization, endpoint control, bulk transfer, and control transfer
	usbf850_communication.c	CDC-specific processing
include	main.h	main.c function prototype declarations
	usbf850.h	usbf850.c function prototype declarations
	usbf850_communication.h	usbf850_communication.c function prototype declarations
	usbf850_desc.h	Descriptor definitions
	usbf850_errno.h	Error code definitions
	usbf850_types.h	User type declarations
	reg_v850e2mn4.h	USB function register definitions
Inf	XXX_CDC_VISTA.inf	Windows® Vista® .inf file The names of the microcontrollers are inserted in the sections marked "****": MN4
	XXX_CDC_WIN7.inf	Windows 7® .inf file The names of the microcontrollers are inserted in the sections marked "****": MN4
	XXX_CDC_XP.inf	Windows XP® .inf file The names of the microcontrollers are inserted in the sections marked "****": MN4

Remarks: The sample driver package comes also with a set of project-related files for the IAR Embedded Workbench. For further information, see section 6.6.1, Setting up the Host Environment.

2.2 V850E2/MN4 Microcontroller

For details on the V850E2/MN4 microcontroller that is to be controlled by the sample driver, refer to the user's manual [hardware] of the individual products.

2.2.1 Applicable Products

The sample driver is applicable to the products that are listed below.

Table 2.5 List of Supported V850E2/MN4 Microcontroller Products

Model Name	Part Number	Internal Memory		Internal USB Function	Interrupt		UM
		Flash Memory	RAM		Internal Note 1	External Note 1	
V850E2/MN4	μPD70F3510	1 Mbytes	64 Kbytes + 64 Kbytes	Host and Function	180	29	V850E2/MN4 User's Manual [Hardware] (R01UH0011EJ)
	μPD70F3512	1 Mbytes	64 Kbytes + 64 Kbytes	Host and Function	190	29	
	μPD70F3514	1 Mbytes	64 Kbytes × 2 + 64 Kbytes	Host and Function	196	29	
	μPD70F3515	2 Mbytes	64 Kbytes × 2 + 64 Kbytes	Host and Function	196	29	

Note: 1. Includes nonmaskable interrupts

2.2.2 Features

The major features of the V850E2/MN4 are listed below.

- Internal memory
  RAM: Single core, 64 Kbytes; Dual core, 64 Kbytes × 2
  Flash memory: 1 Mbyte
- Flash cache memory
  Single core: 16 Kbytes (4-way associative)
  Dual core: 16 Kbytes (4-way associative) × 2
- External bus interface
  Equipped with 2 systems of memory controllers.
  Primary memory controller (SRAM/SDRAM connectable)
  Secondary memory controller (SRAM/SDRAM connectable)
- Serial interfaces
  Asynchronous serial interface UART: 6 channels
  Clock synchronous serial interface CSI: 6 channels
  Asynchronous serial interface UART (FIFO): 4 channels
  Clock synchronous serial interface CSI (FIFO): 4 channels
  I2C: 6 channels
  CAN: 2 channels (μPD70F3512, μPD70F3514, and μPD70F3515)
  USB function controller: 1 channel
  USB host controller: 1 channel
  Ethernet controller: 1 channel (μPD70F3512, μPD70F3514, and μPD70F3515)
- DMA controllers
  DMA controller: 16 channels
  DTS: 128 channels maximum

3. USB Overview

This section provides a brief description of the USB standard to which the sample driver conforms.

USB (Universal Serial Bus) is a standard for interfacing various peripheral devices with a host computer with a common connector. It provides an interface that is more flexible and easier to use than conventional interfaces. For example, it supports the hot-plug feature and allows a maximum of 127 devices to be connected together through the use of additional connection nodes called hubs. The ratio of the PCs having the USB interface installed to the entire PCs that are presently available is reaching almost 100%. It can safely be said that the USB interface has become the standard interface for connecting the PC and peripheral devices.

The USB standard is formulated and managed by the organization called the USB Implementers Forum (USB-IF). For details on the USB standard, visit the USB-IF's official web site (www.usb.org).

3.1 Transfer Modes

The USB standard defines four types of transfer modes (control, bulk, interrupt, and isochronous). The major features of the transfer modes are summarized in table 3.1.

Table 3.1 USB Transfer Modes

Item \ Transfer Mode		Control Transfer	Bulk Transfer	Interrupt Transfer	Isochronous Transfer
Feature		Transfer mode that is used to exchange information necessary for controlling peripheral devices.	Transfer mode that is used to handle a large amount of data nonperiodically.	Transfer mode that is used to transfer data periodically and has a narrow band width.	Transfer mode used in applications that are required of high realtime performance.
Allowable packet size	High speed (480 Mbps)	64 bytes	512 bytes	1 to 1024 bytes	1 to 1024 bytes
	Full speed (12 Mbps)	8, 16, 32, or 64 bytes	8, 16, 32, or 64 bytes	1 to 64 bytes	1 to 1023 bytes
	Low speed (1.5 Mbps)	8 bytes	—	1 to 8 bytes	—
Transfer priority		3	3	2	1

3.2 Endpoints

An endpoint is an item of information used by the host device to identify a specific communication counterpart. An endpoint is specified by a number from 0 to 15 and the direction (IN or OUT). An endpoint need be provided for each data communication channel that is to be used by a peripheral device and cannot be shared by two or more communication channels*[1]. For example, a device that has the capabilities to write and read to and from an SD card and to print out data need be provided with an endpoint for writing to an SD card, an endpoint for reading from an SD card, and an endpoint for sending data to a printer. Endpoint 0 is used for control transfer which must always be performed by every device.

In data communication, the host device specifies the destination within the USB device using the USB device address which identifies the device and an endpoint (number and direction).

A buffer memory is provided within every peripheral device as a physical circuit for endpoints. It also serves as a FIFO that absorbs the difference in communication speed between the USB and the communication counterpart (e.g., memory).

Note: 1. There is a method of switching channels exclusively using a mechanism called the alternate setting.

3.3 Classes

Peripheral devices (function devices) connected via the USB have various classes defined according to their functionality. Typical classes include the mass storage class (MSC), communication device class (CDC), and human interface device class (HID). For each class, standard specifications are defined in the form of protocols. A common host driver can be used provided that it conforms to those standard specifications.

The communication device class (CDC) is a class for communication equipment connected to a host computer. It is used for devices such as modems, FAX equipment, and network cards. Since RS-232C interfaces are no longer provided as standard equipment on personal computers, the CDC is often used for devices that implement USB serial conversion when performing UART communication with a PC. Note that there are several models defined depending on the mounted equipment. Of these, this sample driver uses the Abstract Control Model.

3.4 Requests

According to the USB specification, communication is initiated by the host device issuing a command called a request to all function devices. The request contains data such as the direction and type of processing and the address of the target function device. Each function device decodes the request, determines whether the request is directed to itself, and responds to the request only when it is directed to the device.

3.4.1 Types

There are three types of requests, namely, the standard requests, class requests, and vendor requests.

See section 4.1.2, Requests Handling, for the requests that the sample driver support.

(1) Standard Requests

Standard requests are used in common by all USB compatible devices. A request is a standard request when both bits 6 and 5 of the bmRequestType field of the request are set to 0. Refer to the USB specification (Universal Serial Bus Specification Rev. 2.0) for the processing that is to be performed for the standard requests.

Table 3.2 List of Standard Requests

Request Name	Target Descriptor	Outline
GET_STATUS	Device	Read power (self or bus) and remote wakeup settings.
	Endpoint	Read Halt status.
CLEAR_FEATURE	Device	Clear remote wakeup.
	Endpoint	Cancel Halt (DATA PID = 0).
SET_FEATURE	Device	Set up remote wakeup or test mode.
	Endpoint	Set Halt
GET_DESCRIPTOR	Device, configuration, string	Read target descriptor
SET_DESCRIPTOR	Device, configuration, string	Set target descriptor (optional)
GET_CONFIGURATION	Device	Read current configuration value.
SET_CONFIGURATION	Device	Set configuration value.
GET_INTERFACE	Interface	Read alternate value out of the current settings of the target interface.
SET_INTERFACE	Interface	Set alternate value of the target interface.
SET_ADDRESS	Device	Set USB address.
SYNCH_FRAME	Endpoint	Read frame-synchronous data.

(2) Class Requests

Class requests are unique to the device class. Response processing for class requests corresponding to the CDC abstract control model is implemented in the sample driver. The sample driver can respond to the following requests.

- Send Encapsulated Command
  This request is used to issue commands in the communication class interface control protocol format.
- Get Encapsulated Command
  This request requests a response in the communication class interface control protocol format.
- Set Line Coding
  This request specifies the communications format for the serial communication.
- Get Line Coding
  This request is used to acquire the current communication format setting at the device.
- Set Control Line State
  This request is used for the RS-232/V.24 format control signals.

(3) Vendor Requests

The vendor requests are defined uniquely by the individual vendors. A vendor who is to use a vendor request needs to provide a host driver that handles that request. A request is a vendor request when bit 6 of the bmRequestType field is set to 1 and bit 5 to 0.

3.4.2 Format

A USB request is 8 bytes long and consists of the fields that are listed in the table below.

Table 3.3 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	Arbitrary value used in the request
3		Upper	
4	wIndex	Lower	Index or offset used in the request
5		Upper	
6	wLength	Lower	Number of bytes to transfer in data stage (data length)
7		Upper	

3.5 Descriptors

In the USB specification, a set of information that is specific to a function device and is encoded in a predetermined format is called a descriptor. Each function device sends its descriptor in response to a request from the host device.

3.5.1 Types

The following five types of descriptors are defined:

- Device descriptor
  This descriptor is present in all types of devices. It contains basic information such as the version of the supported USB specification, device class, protocol, maximum packet length available for transfer to Endpoint0, vendor ID, and product ID.
  The descriptor must be sent in response to a GET_DESCRIPTOR_Device request.

- Configuration descriptor
  Every device has one or more configuration descriptors. It contains such information as device attributes (power supplying method) and power consumption. The descriptor must be sent in response to a GET_DESCRIPTOR_Configuration request.

- Interface descriptor
  This descriptor is necessary for each interface. It contains an interface ID, interface class, and the number of endpoints that are supported. The descriptor must be sent in response to a GET_DESCRIPTOR_Configuration request.

- Endpoint descriptor
  This descriptor is necessary for each endpoint that is specified in the interface descriptor. It defines the transfer type (direction of transfer), maximum packet length available for transfer to the endpoint, and transfer interval. Endpoint0, however, does not have this descriptor.
  The descriptor must be sent in response to a GET_DESCRIPTOR_Configuration request.

- String descriptor
  This descriptor contains an arbitrary string. The descriptor must be sent in response to a GET_DESCRIPTOR_String request.

3.5.2 Formats

The size and field structure of descriptors varies depending on the descriptor type as summarized in the tables below. The data in each field is arranged in little endian format.

Table 3.4 Device Descriptor Format

Field	Size (Bytes)	Description
bLength	1	Size of the descriptor
bDescriptorType	1	Type of the descriptor
bcdUSB	2	Release number of the USB specification
bDeviceClass	1	Class code
bDeviceSubClass	1	Subclass code
bDeviceProtocol	1	Protocol code
bMaxPacketSize0	1	Maximum packet size of Endpoint0
idVendor	2	Vendor ID
idProduct	2	Product ID
bcdDevice	2	Device release number
iManufacturer	1	Index of the string descriptor describing the manufacturer
iProduct	1	Index of the string descriptor describing the product
iSerialNumber	1	Index of the string descriptor describing the device's serial number
bNumConfigurations	1	Number of configurations

Remarks: Vendor ID: Identification number that the vendor who is to develop a USB device acquires from USB-IF

Product ID: Identification number that the vendor assigns to each of its products after acquiring a vendor ID.

Table 3.5 Configuration Descriptor Format

Field	Size (Bytes)	Description
bLength	1	Size of the descriptor
bDescriptorType	1	Type of the descriptor
wTotalLength	2	Total number of bytes of the configuration, interface, and endpoint descriptors
bNumInterfaces	1	Number of interfaces supported by this configuration
bConfigurationValue	1	Identification number of this configuration
iConfiguration	1	Index of the string descriptor describing this configuration
bmAttributes	1	Characteristics of this configuration
bMaxPower	1	Maximum consumption current of this configuration (in 2 μA units)

Table 3.6 Interface Descriptor Format

Field	Size (Bytes)	Description
bLength	1	Size of the descriptor
bDescriptorType	1	Type of the descriptor
bInterfaceNumber	1	Identification number of this interface
bAlternateSetting	1	Presence or absence of alternate setting for this interface
bNumEndpoints	1	Number of endpoints used by this interface
bInterfaceClass	1	Class code
bInterfaceSubClass	1	Subclass code
bInterfaceProtocol	1	Protocol code
iInterface	1	Index of the string descriptor describing this interface

Table 3.7 Endpoint Descriptor Format

Field	Size (Bytes)	Description
bLength	1	Size of the descriptor
bDescriptorType	1	Type of the descriptor
bEndpointAddress	1	Transfer direction of this endpoint Address of this endpoint
bmAttributes	1	Transfer type of this endpoint
wMaxPacketSize	2	Maximum packet size available for transfer at this endpoint
bInterval	1	Interval for polling this endpoint

Table 3.8 String Descriptor Format

Field	Size (Bytes)	Description
bLength	1	Size of the descriptor
bDescriptorType	1	Type of the descriptor
bString	Arbitrary	Arbitrary data string

4. Sample Driver Specifications

This section contains a detailed description of the features and operations of the USB communication device class (CDC) sample driver for the V850E2/MN4 microcontroller. It also describes the specifications for the functions of the sample driver.

4.1 Overview

4.1.1 Features

The sample driver has the following processing implemented:

(1) Initialization

The initialization routine manipulates and sets up various registers to make the USB function controller ready for use. The register settings are broadly divided into those for the V850E2/MN4's CPU registers and those for the registers of the USB function controller. For details, see section 4.2.1, CPU Initialization Processing, and section 4.2.2, USB Function Controller Initialization Processing.

(2) Endpoint Processing

The state of the endpoints for data transfer in the USB function controller is reported by the INTUSFA0I1 interrupt. Broadly classified, there are two interrupts: the CPUDEC interrupt when a request to perform decoding is received in the sample driver for a control data transfer endpoint (Endpoint0), and the BKO1DT interrupt that indicates that data has been received normally for the bulk OUT data transfer (reception) endpoint (Endpoint2). The request response is made in the Endpoint0 processing. For details, see section 4.2.3, USBF Interrupt Processing (INTUSFA0I1).

(3) Sample Application

The sample application reads the data in the bulk OUT data transfer (reception) endpoint and writes that read data without modification to the bulk IN data transfer (transmission) endpoint. For details, see section 5, Sample Application Specifications.

4.1.2 Request Handling

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

(1) Standard Requests

The sample driver performs the following response processing for requests that the V850E2/MN4 does not automatically respond:

(a) GET_DESCRIPTOR_string

This request is used by the host to get the string descriptor of a function device.

Upon receipt of this request, the sample driver performs the processing of sending the requested string descriptor (control read transfer).

(b) SET_DESCRIPTOR

This request is used by the host to set the descriptor of a function device.

Upon receipt of this request, the sample driver returns a STALL response.

(2) Class Requests

The sample driver performs the following response processing for class requests of the bulk-only transport protocol for the USB communication device class (CDC):

(a) SendEncapsulatedCommand

This request is used to issue commands in the CDC interface control protocol format.

When this request is received, the sample driver acquires the data associated with the request and performs the transmit processing (bulk IN transfer).

(b) GetEncapsulatedResponse

This request is used to request a response in the CDC interface control protocol format.

Currently, the sample drive does not support this request.

(c) SetLineCoding

This request is used to specify the communication format for the serial communication.

When this request is received, the sample driver acquires the data associated with the request, sets the communication rate and other parameters and performs NULL packet transmission processing (control read transfer).

(d) GetLineCoding

This request is used to acquire communication format setting for the serial communication.

When this request is received, the sample driver reads the communication rate and other settings and transmission processing (control read transfer).

(e) SetControlLineState

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

When this request is received, the sample driver performs NULL packet transmission processing (control read transfer).

4.1.3 Descriptor Settings

The descriptor settings that the sample driver makes are summarized in the tables below. The settings of the individual descriptors are defined in the header file named “usbf850_desc.h.”

(1) Device Descriptor

This descriptor is sent in response to a GET_DESCRIPTOR_device request.

Since the hardware automatically responds to the GET_DESCRIPTOR_device request, the settings are stored in the USFA0DDn registers (n = 0 to 17) when the USB function controller is initialized.

Table 4.1 Device Descriptor Settings

Field	Size (Bytes)	Value	Description
bLength	1	0x12	Size of the descriptor: 18 bytes
bDescriptorType	1	0x01	Type of the descriptor: 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 used
bMaxPacketSize0	1	0x40	Maximum packet size of Endpoint0: 64
idVendor	2	0x045B	Vendor ID: Renesas Electronics
idProduct	2	0x0200	Product ID: V850E2/MN4
bcdDevice	2	0x0001	Device release number: First version
iManufacturer	1	0x01	Index of string descriptor describing the manufacturer: 1
iProduct	1	0x02	Index of string descriptor describing the product: 2
iSerialNumber	1	0x03	Index of string descriptor describing the serial number of the device: 3
bNumConfigurations	1	0x01	Number of configurations: 1

(2) Configuration Descriptor

This descriptor is sent in response to a GET_DESCRIPTOR_configuration request.

Since the hardware automatically responds to the GET_DESCRIPTOR_configuration request, the settings are stored in the USFA0CIEn registers (n = 0 to 255) when the USB function controller is initialized.

Table 4.2 Configuration Descriptor Settings

Field	Size (Bytes)	Value	Description
bLength	1	0x09	Size of the descriptor: 9 bytes
bDescriptorType	1	0x02	Type of the descriptor: Configuration
wTotalLength	2	0x0030	Total number of bytes of the configuration, interface, and endpoint descriptors: 48 bytes
bNumInterfaces	1	0x02	Number of interfaces supported by this configuration: 2
bConfigurationValue	1	0x01	Identification number of this configuration: 1
iConfiguration	1	0x00	Index of the string descriptor describing this configuration: 0
bmAttributes	1	0x80	Characteristics of this configuration: Bus powered, no remote wakeup
bMaxPower	1	0x1B	Maximum consumption current of this configuration: 54 mA

(3) Interface Descriptor

This descriptor is sent in response to a GET_DESCRIPTOR_configuration request.

Since the hardware automatically responds to the GET_DESCRIPTOR_configuration request, the settings are stored in the USFA0CIEn registers (n = 0 to 255) when the USB function controller is initialized.

Since the sample driver uses two endpoints, two endpoint descriptors are set up.

Table 4.3 Interface 0 Interface Descriptor Settings

Field	Size (Bytes)	Value	Description
bLength	1	0x09	Size of the descriptor: 9 bytes
bDescriptorType	1	0x04	Type of the descriptor: Interface
bInterfaceNumber	1	0x00	Identification number of this interface: 0
bAlternateSetting	1	0x00	Presence or absence of alternate setting for this interface: Absence
bNumEndpoints	1	0x01	Number of endpoints used by this interface: 1
bInterfaceClass	1	0x02	Class code: Communication interface class
bInterfaceSubClass	1	0x02	Subclass code: Abstract Control Model
bInterfaceProtocol	1	0x00	Protocol code: No unique protocol used
iInterface	1	0x00	Index of the string descriptor describing this interface: 0

Table 4.4 Interface 1 Interface Descriptor Settings

Field	Size (Bytes)	Value	Description
bLength	1	0x09	Size of the descriptor: 9 bytes
bDescriptorType	1	0x04	Type of the descriptor: Interface
bInterfaceNumber	1	0x01	Identification number of this interface: 1
bAlternateSetting	1	0x00	Presence or absence of alternate setting for this interface: Absence
bNumEndpoints	1	0x02	Number of endpoints used by this interface: 2
bInterfaceClass	1	0x0A	Class code: Communication interface class
bInterfaceSubClass	1	0x00	Subclass code: Abstract Control Model
bInterfaceProtocol	1	0x00	Protocol code: No unique protocol used
iInterface	1	0x00	Index of the string descriptor describing this interface: 0

(4) Endpoint Descriptor

This descriptor is sent in response to a GET_DESCRIPTOR_configuration request.

Since the hardware automatically responds to the GET_DESCRIPTOR_configuration request, the settings are stored in the USFA0CIEn registers (n = 0 to 255) when the USB function controller is initialized.

Since the sample driver uses three endpoints, three endpoint descriptors are set up.

Table 4.5 Endpoint1 (Bulk IN) Endpoint Descriptor Settings

Field	Size (Bytes)	Value	Description
bLength	1	0x07	Size of the descriptor: 7 bytes
bDescriptorType	1	0x05	Type of the descriptor: Endpoint
bEndpointAddress	1	0x81	Transfer direction of this endpoint: IN Address of this endpoint: 1
bmAttributes	1	0x02	Transfer type of this endpoint: Bulk
wMaxPacketSize	2	0x0040	Maximum packet size available for transfer to this endpoint: 64 bytes
bInterval	1	0x00	Interval for polling this endpoint: 0 ms

Table 4.6 Endpoint2 (Bulk OUT) Endpoint Descriptor Settings

Field	Size (Bytes)	Value	Description
bLength	1	0x07	Size of the descriptor: 7 bytes
bDescriptorType	1	0x05	Type of the descriptor: Endpoint
bEndpointAddress	1	0x02	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 available for transfer to this endpoint: 64 bytes
bInterval	1	0x00	Interval for polling this endpoint: 0 ms

Table 4.7 Endpoint7 (Interrupt IN) Endpoint Descriptor Settings

Field	Size (Bytes)	Value	Description
bLength	1	0x07	Size of the descriptor: 7 bytes
bDescriptorType	1	0x05	Type of the descriptor: 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 available for transfer to this endpoint: 8 bytes
bInterval	1	0x0A	Interval for polling this endpoint: 10 ms

(5) String Descriptor

This descriptor is sent in response to a GET_DESCRIPTOR_string request.

When the sample driver receives a GET_DESCRIPTOR_string request, it fetches the string descriptor settings from the header file named “usbf850_desc.h” and stores them in the USFA0E0W registers of the USB function controller.

Table 4.8 String Descriptor Settings

(a) String 0

Field	Size (Bytes)	Value	Description
bLength	1	0x04	Size of the descriptor: 4 bytes
bDescriptorType	1	0x03	Type of the descriptor: String
bString	2	0x09, 0x04	Language code: English (U.S.)

(b) String 1

Field	Size (Bytes)	Value	Description
bLength *1	1	0x30	Size of the descriptor: 42 bytes
bDescriptorType	1	0x03	Type of the descriptor: String
bString *2	46	—	Vendor: Renesas Electronics Co.

Notes: 1. The value varies with the size of the bString field.
2. The size and value are not fixed because this area can be set up arbitrarily by the vendor.

(c) String 2

Field	Size (Bytes)	Value	Description
bLength *1	1	0x0E	Size of the descriptor: 14 bytes
bDescriptorType	1	0x03	Type of the descriptor: String
bString *2	12	—	Product type: CDCDrv (CDC driver)

Notes: 1. The value varies with the size of the bString field.
2. The size and value are not fixed because this area can be set up arbitrarily by the vendor.

(d) String 3

Field	Size (Bytes)	Value	Description
bLength *1	1	0x16	Size of the descriptor: 24 bytes
bDescriptorType	1	0x03	Type of the descriptor: String
bString *2	22	—	Serial number: V850E2/MN4: 020002020010

Notes: 1. The value varies with the size of the bString field.
2. The size and value are not fixed because this area can be set up arbitrarily by the vendor.

4.2 Operations

When the sample driver is started, it performs the sequence of processes that are illustrated in the figure below. This section describes the individual processes.

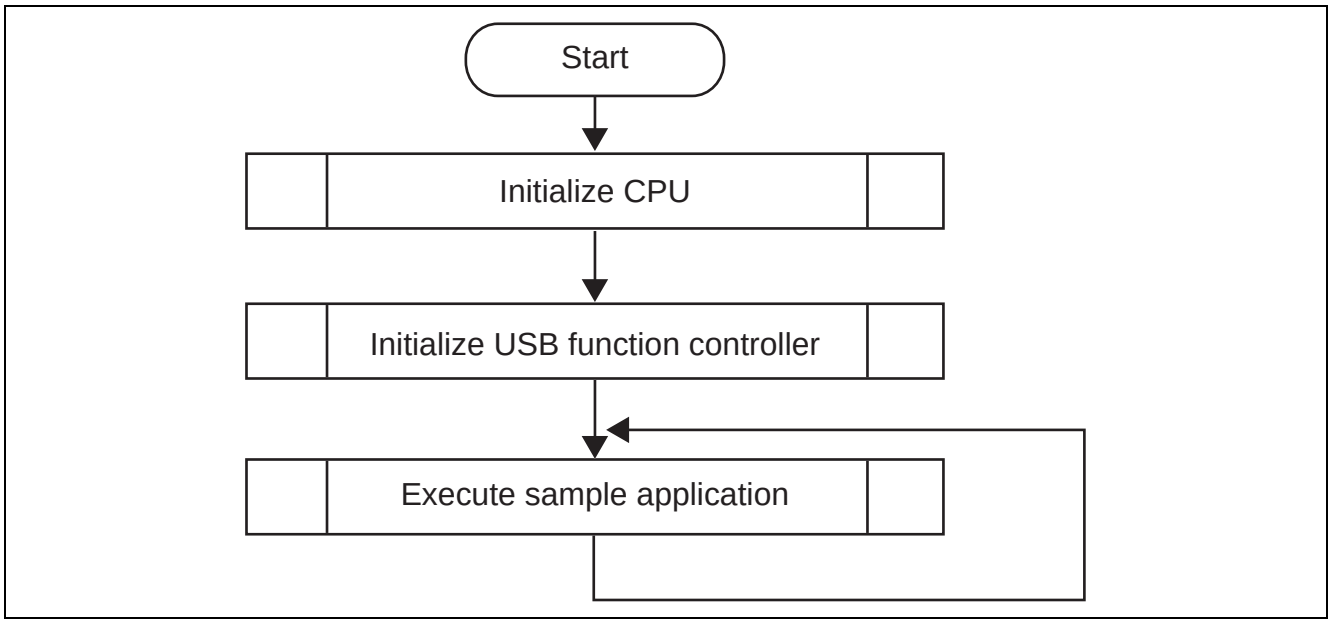


Figure 4.1 Sample Driver Processing Flow

4.2.1 CPU Initialization Processing

The CPU initialization processing routine sets up the parameters that are necessary for using the USB function controller.

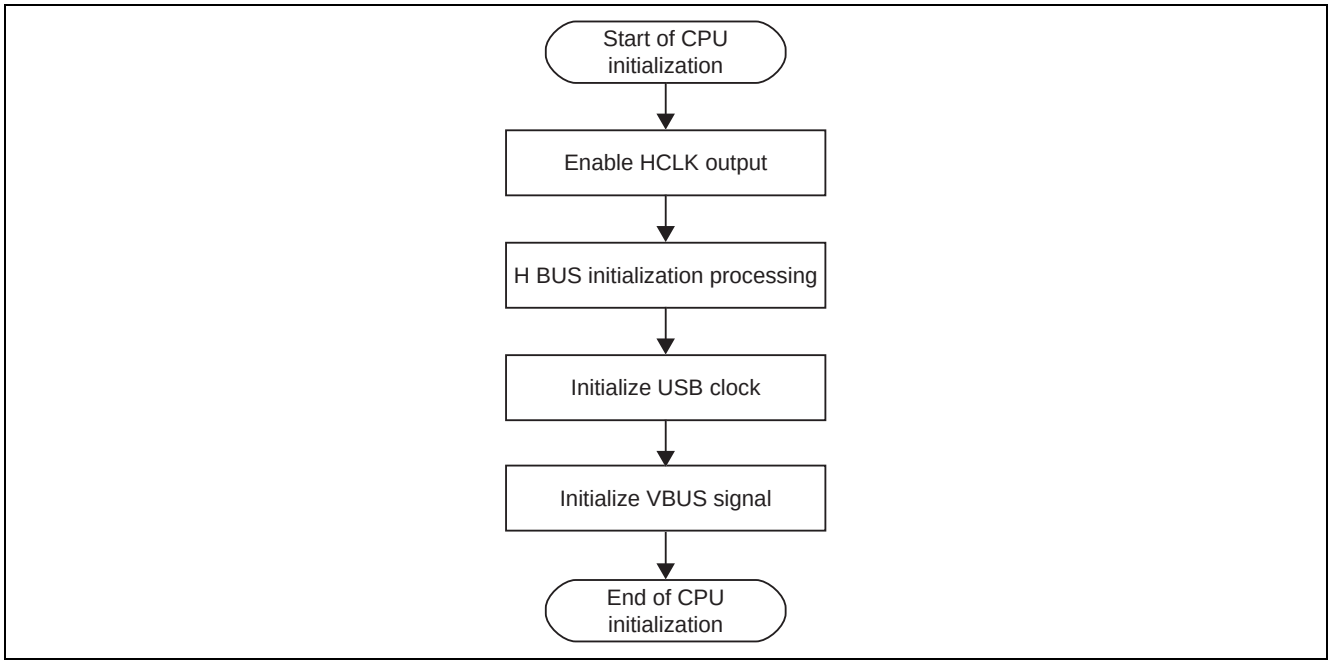


Figure 4.2 CPU Initialization Processing Flow

(1) Enabling HCLK Output

This process makes settings to enable the HCLK output so that the USBF connected to the H bus becomes enabled. Since the SFRCTL2 register used for this setup is a specific write register, a specific write sequence is followed for the setup.

(2) H Bus Initialization

This process initializes the H-bus. The routine initializes the H bus according to the specified directions. See the V850E2/MN4 Microcontroller User's Manual [Hardware (R01UH0011EJ)].

(3) Initializing USB Clock

This process sets up the multiplexed pin P13 to which UCLK is connected. This sample driver uses UCLK as the USB clock input to the USB.

(4) Initializing VBUS Signal

This process initializes the VBUS signal.

4.2.2 USB Function Controller Initialization Processing

The USB function controller initialization processing routine sets up the parameters necessary for starting the use of the USB function controller.

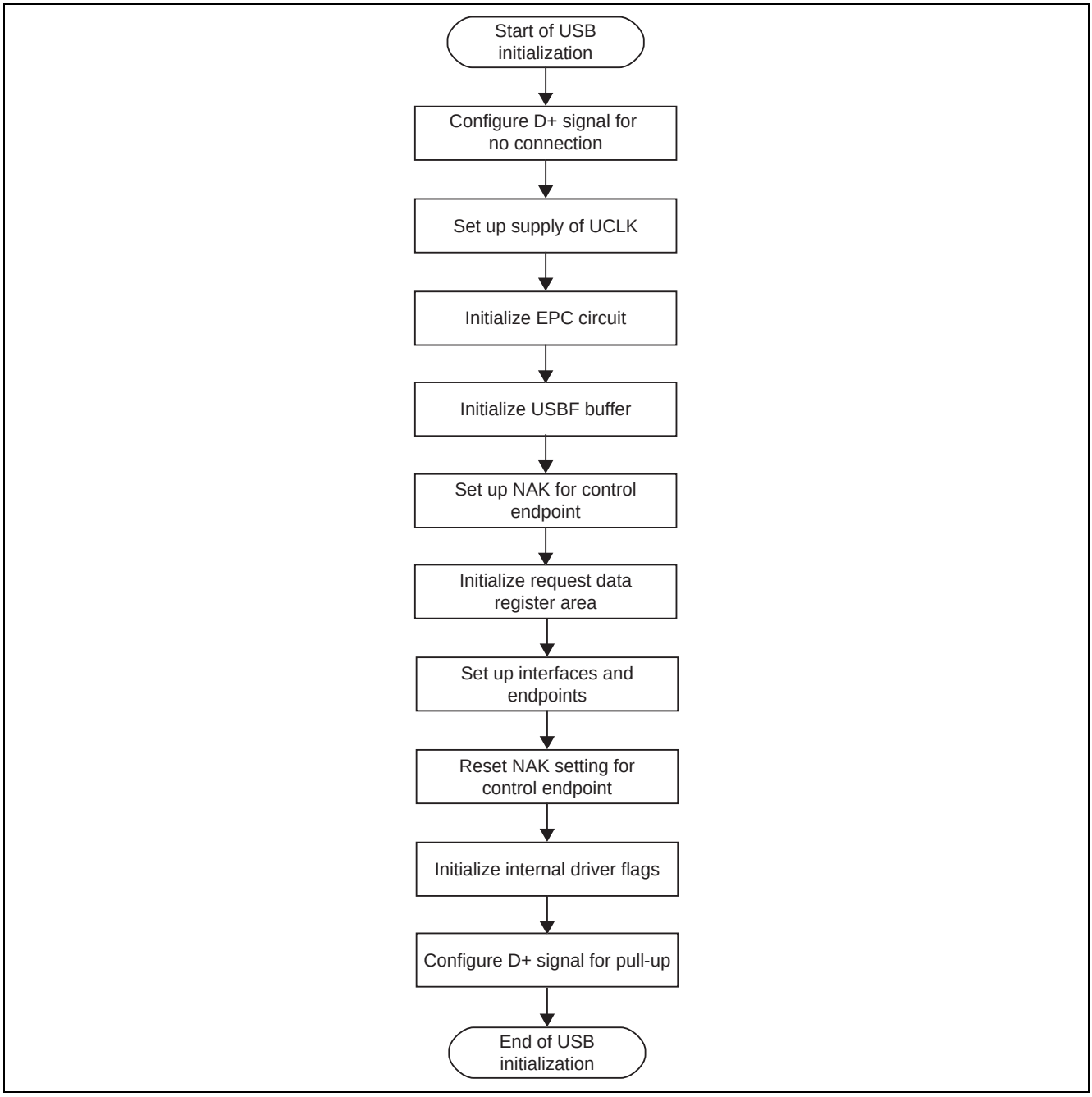


Figure 4.3 USB Function Controller Initialization Processing Flow

(1) Configuring the D+ signal as Pull Down

Loads the CPU's P4.10 with "0." This sets the D+ signal low, disabling the host side to detect any device connection.

(2) Setting up for the Supply of UCLK

Loads the SFRCTL3 register with "0x48" to enable the clock to be supplied to the USB function.

(3) Initializing the EPC Circuit

Loads the USFA0EPCCTL register with “0x00000000” to cancel the EPC reset signal.

(4) Initializing the USB Function Buffer

Loads the USFBC register with “0x00000003” to enable the USBF buffer and floating provisions.

(5) Setting up NAK for Control Endpoint

Sets the EP0NKA bit of the USFA0E0NA register to 1. This setting causes the hardware to respond with NAK against all requests including automatically responded requests.

This bit is used by the software until the registration of data to be used in automatically responded requests is completed, so that the hardware will not return unintended data in response to an automatically responded request.

(6) Initializing the Request Data Register Area

Loads relevant registers with descriptor data that is to be used to automatically respond to GET_DESCRIPTOR requests.

The following registers are accessed during this processing:

(a) The USFA0DSTL register is loaded with “0x01.” This setting disables the remote wakeup function and the USB function controller operates as a self-powered device.
(b) The USFA0EnSL registers (n = 0 to 2) are loaded with “0x00.” These settings indicate that the Endpoint n are running normally.
(c) The USFA0DSCL register is loaded with the total length (in bytes) of the data in the necessary descriptors. This setting determines the range of the USFA0CIEn registers (n = 0 to 255) to be used.
(d) The USFA0DDn registers (n = 0 to 7) are loaded with the data for the device descriptor.
(e) The USFA0CIEn registers (n = 0 to 255) are loaded with the data for the configuration, interface, and endpoint descriptors.
(f) The USFA0MODC register is loaded with “0x00.” This setting enables GET_DESCRIPTOR_configuration requests to be automatically responded.

(7) Setting up the Interfaces and Endpoints

Loads relevant registers with the number of interfaces to support, alternate setting status, and the relationship between the interfaces and endpoints.

The following registers are accessed during this processing:

(a) The USFA0AIFN register is loaded with “0x80.” This setting enables up to two interfaces.
(b) The USFA0AAS register is loaded with “0x00.” This setting disables the alternate setting.
(c) The USFA0E1IM register is loaded with “0x40.” This setting causes Endpoint1 to be linked to Interface1.
(d) The USFA0E2IM register is loaded with “0x40.” This setting causes Endopoint2 to be linked to Interface1.
(e) The USFA0E7IM register is loaded with “0x20.” This setting causes Endopoint7 to be linked to Interface0.

(8) Resetting NAK Setting for Control Endpoint

Sets the EP0NKA bit of the USFA0E0NA register to 0. This setting enables the resumption of responses to all requests including automatically responded requests.

(9) Setting up the Interrupt Mask Register

Sets the mask bits associated with the interrupt sources of the USB function controller.

The following registers are accessed during this processing:

(a) The USFA0ICn registers (n = 0 to 4) are loaded with “0x00. This setting causes all interrupt sources to be cleared.
(b) The USFA0FIC0 register is loaded with “0xF7” and the USFA0FIC1 register with “0x0F.” These settings cause all FIFOs available for data transfer to be cleared.
(c) The USFA0IM0 register is loaded with “0x1B.” This setting masks all interrupt sources defined in the USFA0IS0 register, except those for the BUSRST, RSUSPD, and SETRQ interrupts.
(d) The USFA0IM1 register is loaded with “0x7E.” This setting masks all interrupt sources defined in the USFA0IS1 register, except that for the CPUDEC interrupt.
(e) The USFA0IM2 register is loaded with “0xF1.” This setting masks all interrupt sources defined in the USFA0IS2 register.
(f) The USFA0IM3 register is loaded with “0xFE.” This setting masks all interrupt sources defined in the USFA0IS3 register, except that for the BKO1DT interrupt.
(g) The USFA0IM4 register is loaded with “0x20.” This setting masks all interrupt sources defined in the USFA0IS4 register.
(i) The USFA0EPCINTE register is loaded with “0x0003” to enable the interrupts for which the EPC_INT0BEN and EPC_INT1BEN bits are set.
(j) The ICUSFA0I1 is loaded with “0” and the ICUSFA0I2 with “0” to enable INTUSFA0I1 and INTUSFA0I2, respectively.

(10) Initializing the Internal Driver Flags

Initializes the flags (usbf850_busrst_flg, usbf850_rsuspd_flg, and usbf850_rdata_flg) that are to be used within the driver.

(11) Setting up the D+ signal as pull-up

Loads the CPU’s P4 register with “0x0400.” This setting causes a “1” to be output from P4_10, which generates a high-level output from the D+ signal pin, notifying the host that a device has been connected. The sample driver assumes the wiring configuration shown in figure 4.4.

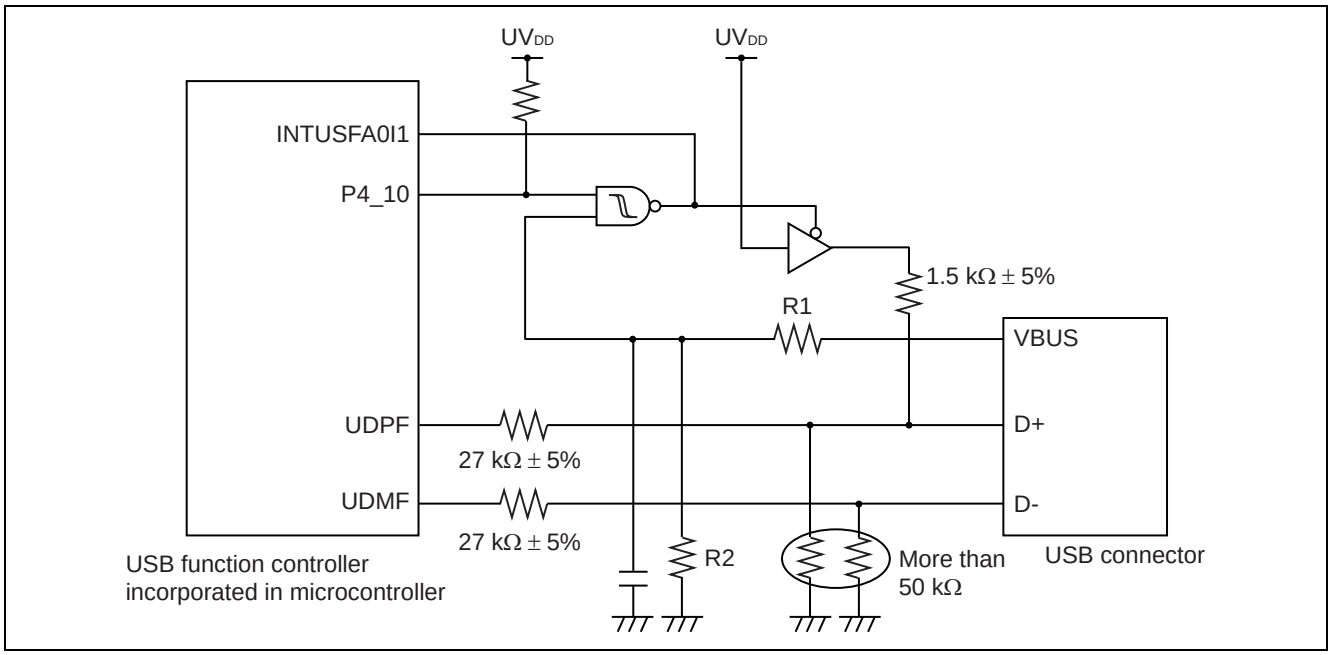


Figure 4.4 USB Function Controller Configuration Example

4.2.3 USBF Interrupt Processing (INTUSFA0I1)

Of the interrupt requests (INTUSFA0I1) from the USB function controller, only those for which the interrupt mask has been cleared at initialization are reported. Therefore applications must clear the interrupt masks at initialization for all required interrupts. For all reported interrupts, the corresponding required processing will be performed.

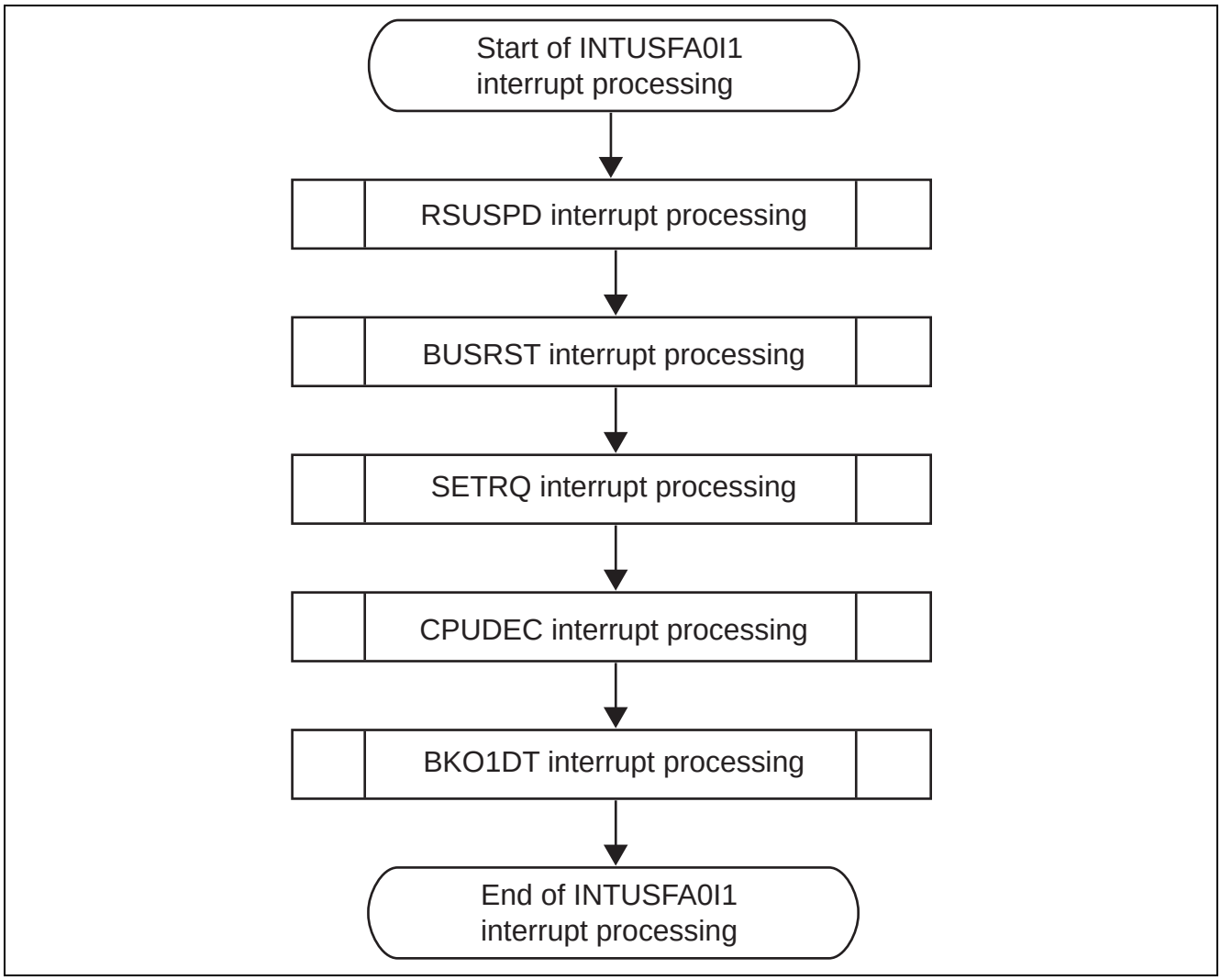


Figure 4.5 INTUSFA0I1 Interrupt Handler Processing Flow

(1) RSUSPD Interrupt Processing

If the RSUSPD bit in the USFA0IS0 register is 1, the RSUSPDC bit in the USFA0IC0 register will be cleared to 0. Next, if the RSUM bit in the USFA0EPS1 register is 1, the flag that indicates the suspend state (usbf850_rsuspd_flg) will be updated (a suspend will occur).

(2) BUSRST Interrupt Processing

If the BUSRST bit in the USFA0IS0 register is 1, the BUSRSTC bit in the USFA0IC0 register will be cleared to 0. Next, the flag that indicates that a bus reset has occurred (usbf850_busrst_flg) is updated (a bus reset occurred), the function usbf850_buff_init() is called and the buffer is initialized.

(3) SETRQ Interrupt Processing

If the SETRQ bit in the USFA0IS0 register is 1, the SETRQC bit in the USFA0IC0 register will be cleared to 0. Next, if both the SETCON bit in the USFA0SET register and the CONF bit in the USFA0MODS register are 1, the flag that indicates that set configuration request was processed (usbf850_busrst_flg) is cleared.

(4) CPUDEC Interrupt Processing

If the CPUDEC bit in the USFA0IS0 register is 1, the CPUDECC bit in the USFA0IC0 register will be cleared to 0. Next, the USFA0E0ST register is read 8 times and the request data is acquired and decoded. If the request is a standard request, the function usbf850_standardreq() is called and if it is a class request, the function usbf850_classreq() is called.

(5) BKO1DT Interrupt Processing

If the BKODT bit in the USFA0IS3 register is 1, the BKODTC bit in the USFA0IC3 register will be cleared to 0. Next, the flag that indicates that data has been received (usbf850_rdata_flg) is updated. This interrupt occurs if there is valid data stored in the receive FIFO.

4.3 Function Specifications

This section describes the functions that are implemented in the sample driver.

4.3.1 List of Functions

Table 4.9 shows a list of functions that are implemented in the source files for the sample driver.

Table 4.9 Sample Driver Functions

Source File	Function Name	Description
main.c	main	Main routine
	cpu_init	Initializes the CPU.
	SetProtectReg	Processes access to a write-protected register.
usbf850.c	usbf850_init	Initializes the USB function controller.
	usbf850_intusbf0	Monitors Endpoint0 and controls responses to requests.
	usbf850_intusbf1	Processes resume interrupts.
	usbf850_data_send	Sends USB data.
	usbf850_data_receive	Receives USB data.
	usbf850_rdata_length	Gets USB receive data length.
	usbf850_send_EP0	Sends at Endpoint0.
	usbf850_receive_EP0	Receives at Endpoint0.
	usbf850_send_null	Sends Null packets to Bulk/ Interrupt In Endpoint.
	usbf850_sendnullEP0	Sends out NULL packet for Endpoint0.
	usbf850_sendstallEP0	Returns STALL for Endpoint0.
	usbf850_ep_status	Notifies FIFO state of Bulk/ Interrupt In Endpoint.
	usbf850_fifo_clear	Clears FIFOs for endpoints other than Endpoint0.
	usbf850_standardreq	Processes a standard request.
	usbf850_getdesc	Processes a GET_DESCRIPTOR request.
usbf850_communication.c	usbf850_classreq	Processes a CDC class request.
	usbf850_send_encapsulated_command	Processes a Send Encapsulated Command request.
	usbf850_get_encapsulated_response	Processes a Get Encapsulated Command request.
	usbf850_set_line_coding	Processes a Set Line Coding request.
	usbf850_get_line_coding	Processes a Get Line Coding request.
	usbf850_set_control_line_state	Processes a Set Control Line State request.
	usbf850_buff_init	FIFO clear processing for the endpoint used for CDC data transmission
	usbf850_get_bufinit_flg	Execution state notification processing for FIFO initialization
	usbf850_send_buf	CDC data send processing
	usbf850_recv_buf	CDC class request processing function registration

4.3.2 Correlation among the Sample Driver Functions

There are some sample driver functions that call another function during their execution. This function call relationships are shown below.

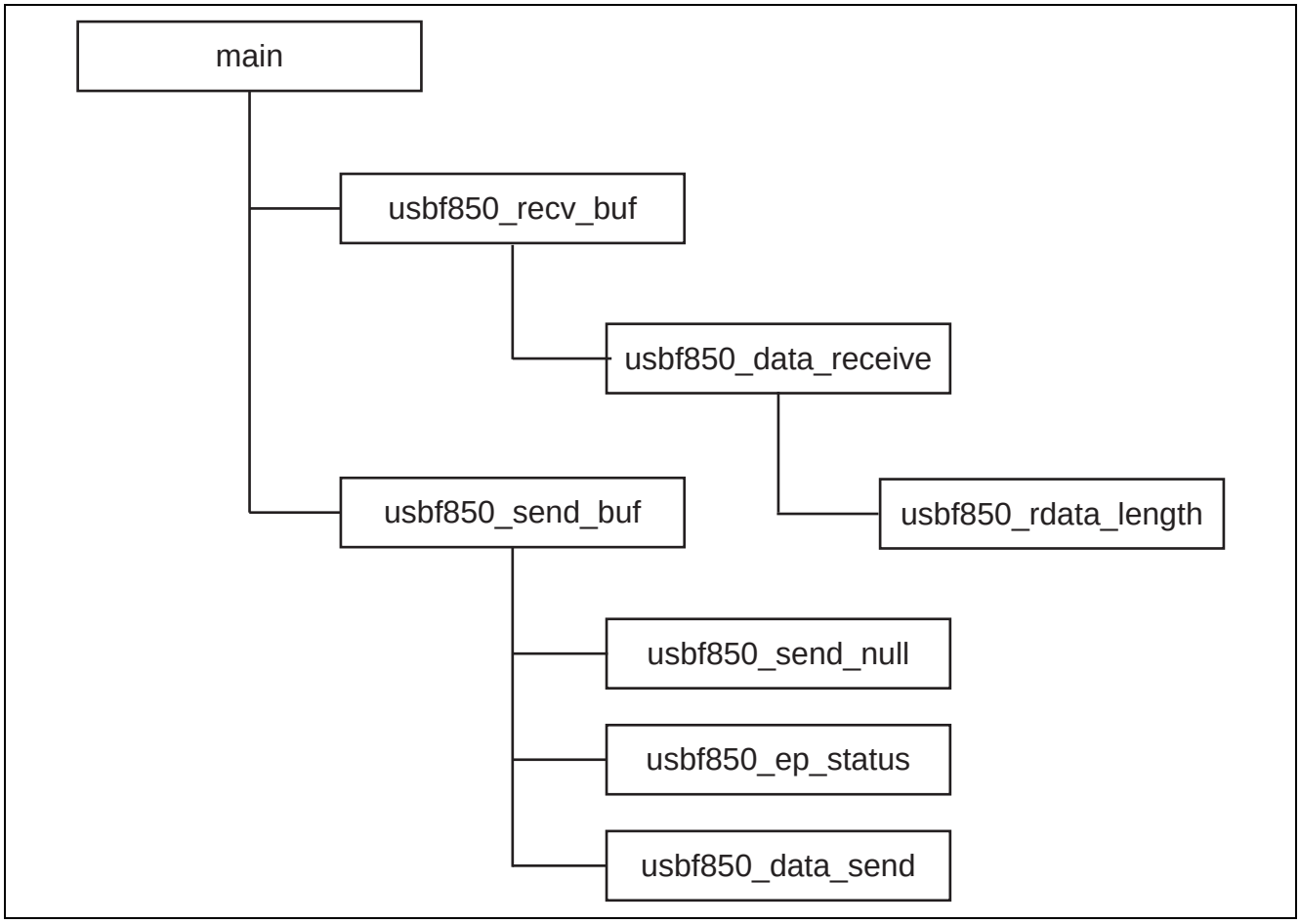


Figure 4.6 Function Calls within main Processing

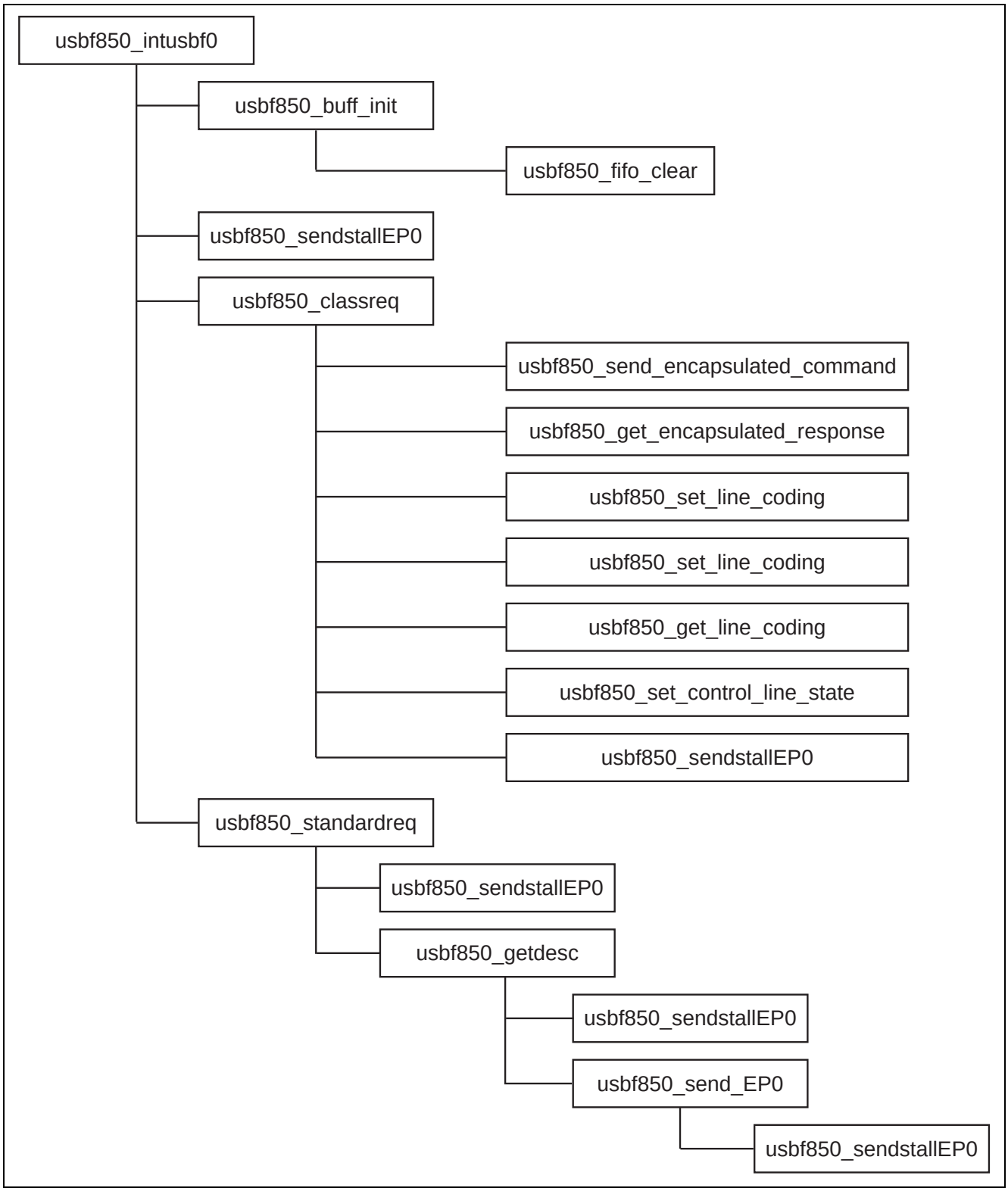


Figure 4.7 Function Calls in USB Function Control Processing

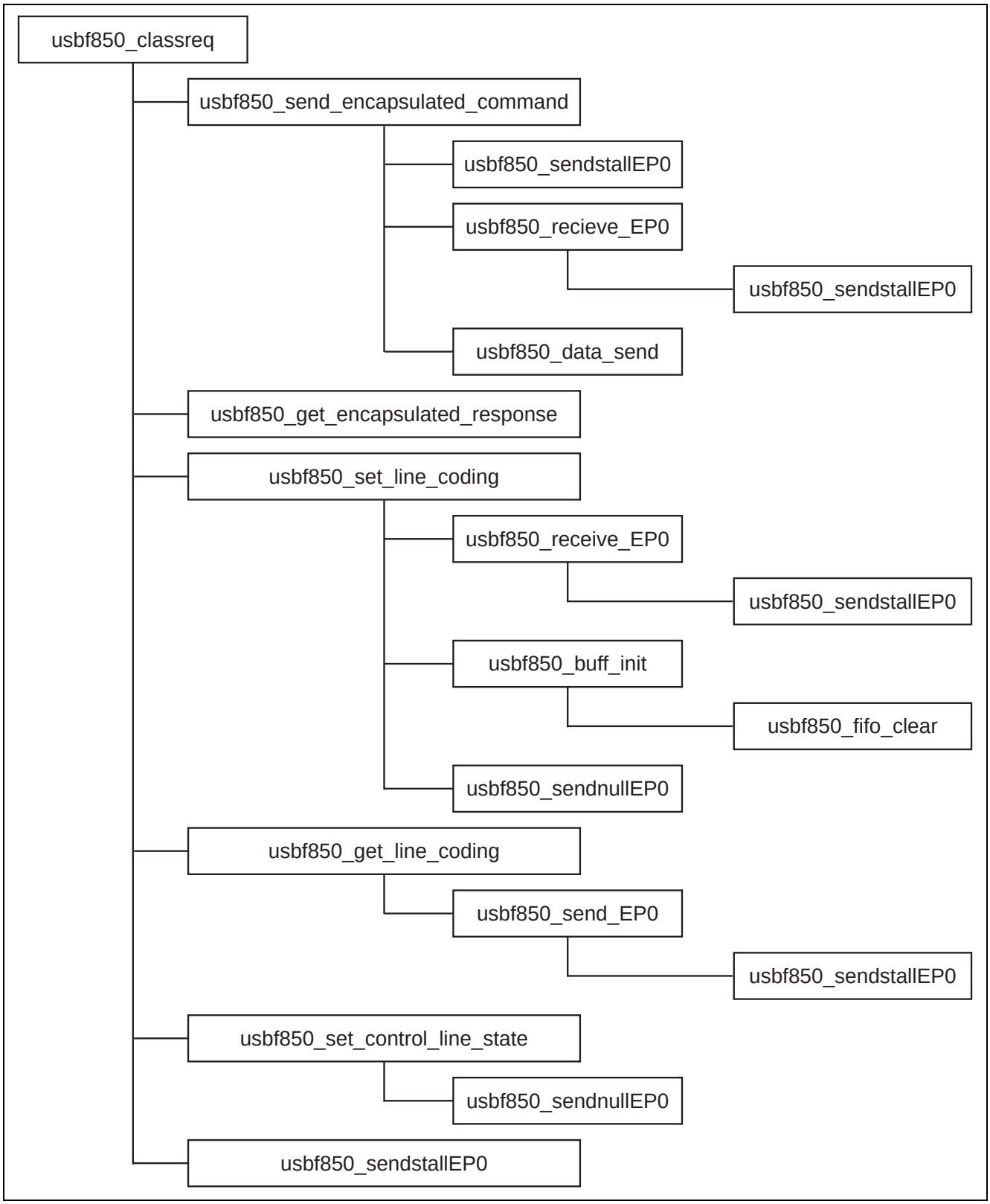


Figure 4.8 Function Calls in USB Communication Class Processing (1/2)

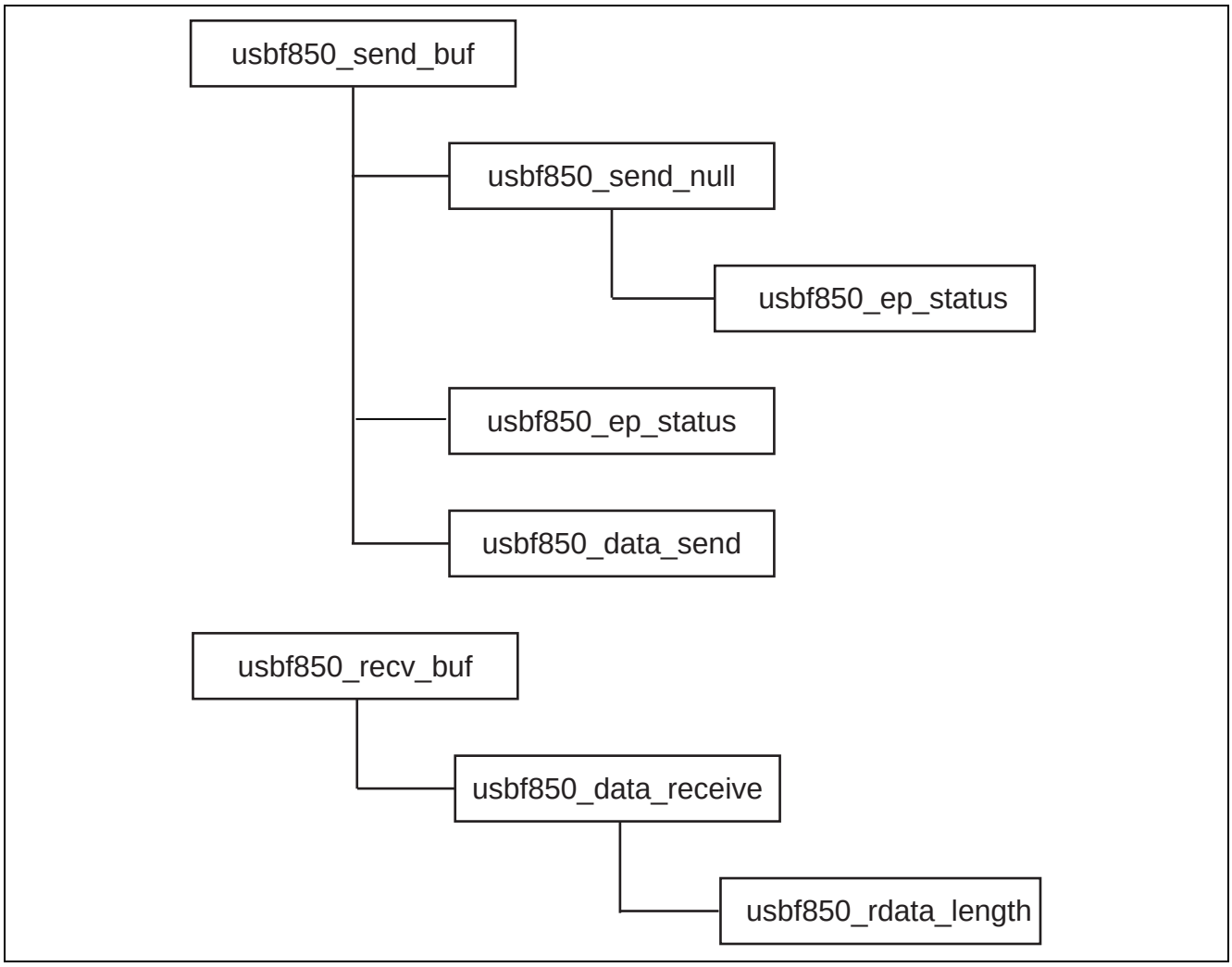


Figure 4.9 Function Calls in USB Communication Class Processing (2/2)

4.3.3 Function Descriptions

This section contains a description of the functions that are implemented in the sample driver.

(1) Functional Description Format

The functional descriptions are given in the format shown below.

Function Name

[Synopsis]

Gives a synopsis of the function.

[C language format]

Shows the format in C language

[Parameters]

Describes the parameters (arguments).

Parameter	Description
Parameter type, name	Parameter outline

[Return Value]

Describes the return value.

Symbol	Description
Type of return value, name	Return value outline

[Function]

Explains the function.

(2) Main Routine Functions

main

[Synopsis]

Perform main processing.

[C language format]

void main(void)

[Parameters]

None

[Return Value]

None

[Function]

This function is called first when the sample driver is started.

The function initializes first the CPU and then the USB function controller. Next, it performs the sample application processing and monitors the flag (usbf850_rsuspd_flg) that indicates that a suspend has occurred. If a suspend has occurred, it performs suspend and resume processing at that point.

cpu_init

[Synopsis]

Initialize CPU.

[C language format]

void cpu_init(void)

[Parameters]

None

[Return Value]

None

[Function]

This function is called during initialization processing.

It initializes the H bus and sets up the USB clock and other parameters that are necessary to use the USB function controller.

SetProtectReg

[Synopsis]

Access write-protected register.

[C language format]

void SetProtectReg(volatile UINT32 *dest_reg, UINT32 wr_dt, volatile UINT8 *prot_reg)

[Parameters]

Parameter	Description
volatile UINT32 *dest_reg	Protected register address
UINT32 wr_dt	Write value
volatile UINT8 *prot_reg	Protect command register address

[Return Value]

None

[Function]

This function writes a value into the given write-protected register.

(3) USB Function Controller Processing Functions

usbf850_init

[Synopsis]

Initialize USB function controller.

[C language format]

void usbf850_init(void)

[Parameters]

None

[Return Value]

None

[Function]

This function is called during initialization processing.

It allocates and sets up the data area, and sets interrupt request masks and other parameter items that are necessary to use the USB function controller.

usbf850_intusbf0

[Synopsis]

Endpoint0 monitor processing

Endpoint2 monitor processing

[C language format]

void usbf850_intusbf0(void)

[Parameters]

None

[Return Value]

None

[Function]

This function is an interrupt service routine that is called by the INTUSFA0I1 interrupt.

For USB function controller interrupts that are not masked, it verifies the details of the interrupt and processes the interrupt that occurred.

usbf850_intusbf1

[Synopsis]

Resume interrupt processing

[C language format]

void usbf850_intusbf1(void)

[Parameters]

None

[Return Value]

None

[Function]

This function is an interrupt service routine that is called by the INTUSFA0I2 interrupt. It clears the flag that indicates the suspend state and updates the resume flag.

usbf850_data_send

[Synopsis]

USB data transmit processing for bulk/interrupt in endpoints

[C language format]

INT32 usbf850_data_send(UINT8 *data, INT32 len, INT8 ep)

[Parameters]

Parameter	Description
UINT8 *data	Pointer to transmit data buffer
INT32 len	Transmit data length
INT8 ep	Endpoint number of the endpoint to be used for data transmission

[Return Value]

Symbol	Description
len (>=0)	Size of the data that was transmitted normally.
DEV_ERROR	Abnormal termination

[Function]

This function transfers data from the transmit data buffer to the FIFO for the specified endpoint, one byte at a time.

usbf850_data_receive

[Synopsis]

Receive USB data.

[C language format]

INT32 usbf850_data_receive(UINT8 *data, INT32 len, INT8 ep)

[Parameters]

Parameter	Description
UINT8 *data	Pointer to receive data buffer
INT32 len	Receive data length
INT8 ep	Endpoint number of the endpoint to be used for data reception

[Return Value]

Symbol	Description
len (>=0)	Size of the data that was transmitted normally.
DEV_ERROR	Abnormal termination

[Function]

This function reads data from the FIFO for the specified endpoint into the receive data buffer, one byte at a time.

usbf850_rdata_length

[Synopsis]

Get USB receive data length.

[C language format]

void usbf850_rdata_length(INT32 *len , INT8 ep)

[Parameters]

Parameter	Description
INT32* len	Pointer to the address storing the receive data length
INT8 ep	Endpoint number of the data receiving endpoint

[Return Value]

None

[Function]

This function reads the receive data length of the specified endpoint.

usbf850_send_EP0

[Synopsis]

Send USB data for Endpoint0.

[C language format]

INT32 usbf850_send_EP0(UINT8* data, INT32 len)

[Parameters]

Parameter	Description
UINT8* data	Pointer to transmit data buffer
INT32 len	Transmit data size

[Return Value]

Symbol	Description
DEV_OK	Normal termination
DEV_ERROR	Abnormal termination

[Function]

This function transfers data from the transmit data buffer to the transmit FIFO for Endpoint0, one byte at a time.

usbf850_receive_EP0

[Synopsis]

Receive USB data for Endpoint0.

[C language format]

INT32 usbf850_receive_EP0(UINT8* data, INT32 len)

[Parameters]

Parameter	Description
UINT8* data	Pointer to receive data buffer
INT32 len	Receive data size

[Return Value]

Symbol	Description
DEV_OK	Normal termination
DEV_ERROR	Abnormal termination

[Function]

This function reads data from the receive FIFO for Endpoint0 into the receive data buffer, one byte at a time.

usbf850_send_null

[Synopsis]

Send Null packet for Bulk/Interrupt In Endpoint.

[C language format]

INT32 usbf850_send_null(INT8 ep)

[Parameters]

Parameter	Description
INT8 ep	Endpoint number of the data transmitting endpoint

[Return Value]

Symbol	Description
DEV_OK	Normal termination
DEV_ERROR	Abnormal termination

[Function]

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

usbf850_sendnullEP0

[Synopsis]

Send NULL packet for Endpoint0.

[C language format]

void usbf850_sendnullEP0(void)

[Parameters]

None

[Return Value]

None

[Function]

This function sends a Null packet from the USB function controller by clearing the FIFO for Endpoint0 and setting the bit that specifies the end of data to 1.

usbf850_sendstallEP0

[Synopsis]

Send STALL response for Endpoint0.

[C language format]

void usbf850_sendstallEP0(void)

[Parameters]

None

[Return Value]

None

[Function]

This function causes the USB function controller to return a STALL response by setting the bit that indicates the use of a STALL handshake to 1.

usbf850_ep_status

[Synopsis]

Notify state of FIFO for Bulk/ Interrupt In Endpoint.

[C language format]

INT32 usbf850_ep_status(INT8 ep)

[Parameters]

Parameter	Description
INT8 ep	Endpoint number of the data transmitting endpoint

[Return Value]

Symbol	Description
DEV_OK	Normal termination
DEV_RESET	Bus Reset processing in progress
DEV_ERROR	Abnormal termination

[Function]

This function notifies the state of the FIFO for the specified Endpoint (for transmission).

usbf850_fifo_clear

[Synopsis]

Clear FIFO for Bulk/ Interrupt Endpoint.

[C language format]

void usbf850_fifo_clear(INT8 in_ep, INT8 out_ep)

[Parameters]

Parameter	Description
INT8 in_ep	Data transmitting Endpoint
INT8 out_ep	Data receiving Endpoint

[Return Value]

None

[Function]

This function clears the FIFO for the specified Endpoint (Bulk/Interrupt) and the data receive flag (usbf850_rdata_flg).

usbf850_standardreq

[Synopsis]

Process standard request not automatically responded by USB function controller.

[C language format]

void usbf850_standardreq(USB_SETUP *req_data)

[Parameters]

Parameter	Description
USB_SETUP *req_data	Pointer to the address storing the receive data length

[Return Value]

None

[Function]

Function that is called for the CPUDEC interrupt factor for INTUSFA0I1 interrupt processing.

It calls the GET_DESCRIPTOR request processing function (usbf850_getdesc) if the decoded request is GET_DESCRIPTOR. For the other requests, the function calls the STALL response processing function for Endpoint0 (usbf850_sendstallEP0).

usbf850_getdesc

[Synopsis]

Process GET_DESCRIPTOR request.

[C language format]

void usbf850_getdesc(USB_SETUP *req_data)

[Parameters]

Parameter	Description
USB_SETUP *req_data	Pointer to the address storing the receive data length

[Return Value]

None

[Function]

This function is called to process standard requests that are not automatically responded by the USB function controller.

If the decoded request asks for a string descriptor, the function calls the USB data transmit processing function (usbf850_data_send) to send a string descriptor from Endpoint0. If a descriptor other than the string descriptor is requested, the function calls the STALL response processing function for Endpoint0 (usbf850_sendstallEP0).

(4) USB Communication Class Processing Functions

usbf850_classreq

[Synopsis]

Process CDC class request.

[C language format]

void usbf850_classreq(USB_SETUP *req_data)

[Parameters]

Parameter	Description
USB_SETUP *req_data	Pointer to area storing the request data

[Return Value]

None

[Function]

This function is called for the CPUDEC interrupt source during INTUSFA0I1 interrupt processing. If the decoded request is the one that is specific to the communication device class, the function calls the corresponding request processing function. In the other cases, the function sends a STALL to Endpoint0.

usbf850_send_encapsulated_command

[Synopsis]

Send Encapsulated Command request processing

[C language format]

void usbf850_send_encapsulated_command(USB_SETUP *req_data)

[Parameters]

Parameter	Description
USB_SETUP *req_data	Pointer to area storing the request data

[Return Value]

None

[Function]

This function calls the data reception processing function (usbf850_data_receive()) to acquire the data received by Endpoint0 and calls the data transmission processing function (usbf850_data_send()) to send that data by bulk in transmission (send) from Endpoint2.

usbf850_set_line_coding

[Synopsis]

Set Line Coding request processing

[C language format]

void usbf850_set_line_coding(USB_SETUP *req_data)

[Parameters]

Parameter	Description
USB_SETUP *req_data	Pointer to area storing the request data

[Return Value]

None

[Function]

This function calls the data reception processing function (usbf850_data_receive()) to acquire the data received by Endpoint0 and writes that data to a UART_MODE_INFO structure. Also, based on this value, it sets the transfer speed, data length, and other aspects of the UART mode and then calls the Endpoint0 null packet transmit processing function (usbf850_sendnullEP0()).

usbf850_get_line_coding

[Synopsis]

Get Line Coding request processing

[C language format]

void usbf850_get_line_coding(USB_SETUP *req_data)

[Parameters]

Parameter	Description
USB_SETUP *req_data	Pointer to area storing the request data

[Return Value]

None

[Function]

This function calls the data transmission processing function (usbf850_data_send()) to send the value of the UART_MODE_INFO structure from Endpoint0.

usbf850_set_control_line_state

[Synopsis]

Set Control Line State request processing

[C language format]

void usbf850_set_control_line_state(USB_SETUP *req_data)

[Parameters]

Parameter	Description
USB_SETUP *req_data	Pointer to area storing the request data

[Return Value]

None

[Function]

This function calls the Endpoint0 null packet transmit processing function (usbf850_sendnullEP0()).

5. Sample Application Specifications

This section describes the sample application that is included in the sample driver.

5.1 Overview

This sample application is provided as a simple example of use of the USB communication device class driver and is embedded in the main routine of the sample driver.

This sample application performs the sequence of processing required to read data received by the USB function controller and transmit that read data. It uses various functions provided by the sample driver to perform this sequence of processing.

5.2 Operation

The sample application performs the flow of operation shown below.

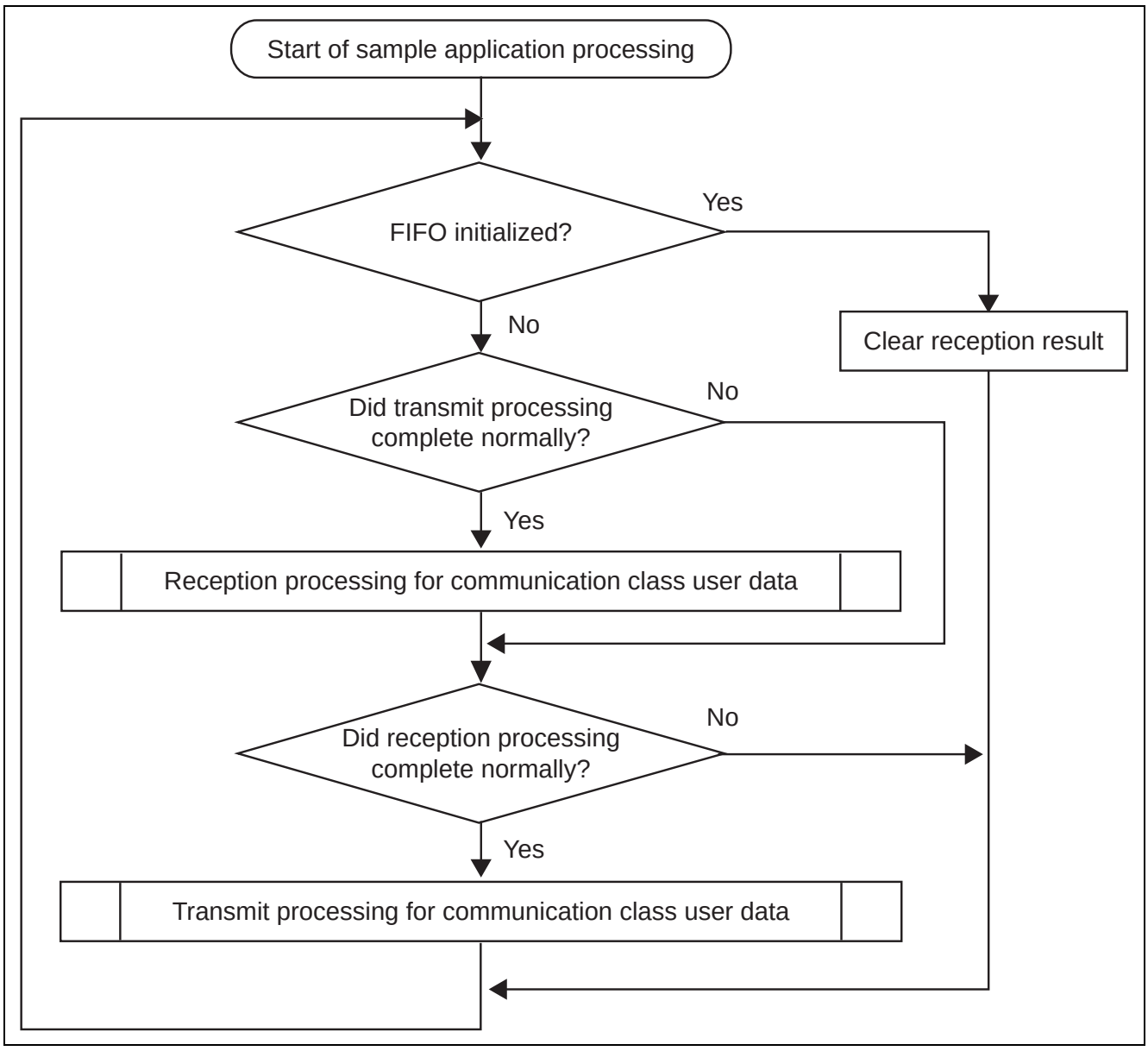


Figure 5.1 Sample Application Processing Flowchart

(1) User Data FIFO Initialization Verification

The sample application calls user data FIFO status notification function (usbf850_get_bufinit_flg()). If the FIFO is in the normal state it proceeds to transmit processing result verification, and if the FIFO is in the initialized state it clears the transmission result (clears the CDC user data transmit result to 0).

(2) CDC User Data Transmit Result Verification

If the CDC user data transmit result is normal completion (or initial state), the sample application performs CDC user data reception processing, and if it is in an abnormal termination state, it verifies the result of reception processing.

(3) CDC User Data Reception Processing

The sample application specifies the size of the buffer used to store the receive data and calls the CDC user data reception processing function (usbf850_recv_buf()).

(4) CDC User Data Reception Processing Result Verification

If the CDC user data receive result is normal completion (or initial state), the sample application performs CDC user data transmission processing, and if it is in an abnormal termination state, it performs user data FIFO initialization verification processing.

(5) CDC User Data Transmission Processing

The sample application specifies the address of the buffer that holds the data to transmit and the size of the data to transmit and calls the CDC user data transmission processing function (usbf850_send_buf()).

5.3 Function Usage

In the source file main.c, which includes the sample application, use of the sample driver functions is coded as shown below. For detailed information on these functions, see section 4.3, Function Specifications.

```
1  #pragma ioreg                                                              ┐
2                                                                             │
3  #include "usbf850_types.h"                                                 │
4  #include "main.h"                                                         │
5  #include "usbf850_errno.h"                                                │
6  #include "usbf850.h"                                                      │
7  #include "usbf850_communication.h"                                        │
8  #include "reg_v850e2mn4.h"                                                ├···(1)
9      :                                                                      │
10  omitted                                                                   │
11     :                                                                      │
12 #define USERBUF_SIZE    (64)            /* user buffer size */            │
13 static UINT8   UserBuf[USERBUF_SIZE];   /* user buffer          */        │
14 extern UINT8   usbf850_rsuspd_flg;      /* resume/suspend flag  */        ┘
       :
15  omitted
       :
16 void main(void)
17 {
18   INT32 rcv_ret = 0;
19   INT32 snd_ret = 0;
20
21   cpu_init();                                                              ···(2)
22
23   usbf850_init();        /* initial setting of the USB Function */         ···(3)
24
25   __EI();
26
27   while (1)
28   {
29      if (usbf850_get_bufinit_flg() != DEV_ERROR)                           ···(4)
30      {
31         if (snd_ret >= 0)
32         {
33            rcv_ret = usbf850_recv_buf(&UserBuf[0], USERBUF_SIZE);          ···(5)
34         }
35         if (rcv_ret >= 0)
36         {
37            snd_ret = usbf850_send_buf(&UserBuf[0], rcv_ret);               ···(6)
38         }
39      }
40      else
41      {
42         snd_ret = 0;
43         rcv_ret = 0;                                                       ···(7)
44       }
45
46       if (usbf850_rsuspd_flg == SUSPEND)                                   ···(8)
47       {
48
49         __DI();
50
51         __halt();
52
53         usbf850_rsuspd_flg = RESUME;
54
55         __EI();
56       }
57   }
58 }
```

Figure 5.2 Sample Application Code (partial)

(1) Definitions and Declarations

The two header files usbf850.h and usbf850_communication.h are included so that the sample driver functions can be used. Also, a user buffer with a size adequate for processing one packet of data is provided for user data (the maximum packet size for bulk endpoints in USB full speed is 64 bytes).

(2) CPU Initialization

The CPU initialization function (cpu_init()) is called.

(3) USB Function Controller Initialization

The USB function controller initialization function (usbf850_init()) is called.

(4) User Data FIFO State Verification

The FIFO state is verified by calling the user data FIFO state reporting function (usbf850_get_bufinit_flg()).

(5) User Data Reception Processing

The CDC user data reception processing function (usbf850_recv_buf()) is called and the result saved.

(6) User Data Transmission Processing

The CDC user data transmission processing function (usbf850_send_buf()) is called and the result saved.

(7) Clearing the Transmit/Receive Results

The transmit and receive results saved in (5) and (6) are cleared to zero when the user data FIFO is initialized.

(8) Suspend and Resume Processing

The flag (usbf850_rsuspd_flg) that indicates that a suspend has occurred is monitored. If a suspend has occurred, the __halt() function is called to transition to the HALT state. A resume is performed in response to an external interrupt, and the flag (usbf850_rsuspd_flg) that indicates that a suspend has occurred is set to the RESUME state and operation restarts.

6. Development Environment

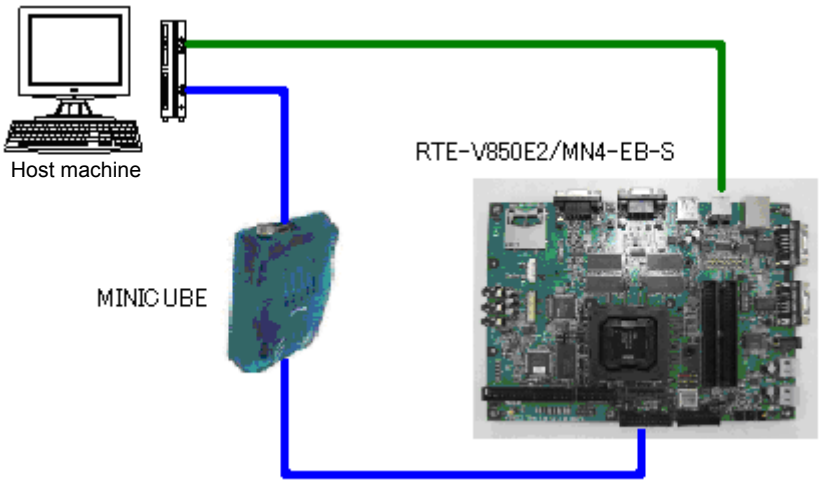
This section gives an example of constructing an environment for developing application programs using the USB communication device class sample driver for the V850E2/MN4 and the procedures for debugging them in that environment.

6.1 Development Environment

This section introduces a sample development configuration of hardware and software tool products.

6.1.1 System Configuration

The system configuration in which the sample driver is to be used is shown in figure 6.1.



Remarks: See section 8, Outline of the Starter Kit, for the physical appearance and port configuration of the RTE-V850E2/MN4-EB-S.

Figure 6.1 System Configuration of the Development Environment

6.1.2 Program Development

The hardware and software that are summarized below are required to develop a system using the sample driver.

Table 6.1 Example of Program Development Environment Configuration

Component Products		Product Example	Remarks
Hardware	Host machine	—	PC/AT™ compatible (OS: Windows XP or Windows Vista®)
Software	Integrated development tool	CubeSuite	V1.40
		Multi	V5.1.7D
		IAR Embedded Workbench	V3.71
	Compiler	CX850	V1.00
		CCV850	V5.1.7D
		ICCV850	V3.71.2

6.1.3 Debugging

The hardware and software that are summarized below are required to debug a system using the sample driver.

Table 6.2 Example of Debugging Environment Configuration

Component Products		Product Example	Remarks
Hardware	Host machine	—	PC/AT compatible (OS: Windows XP or Windows Vista®)
	Target	RTE-V850E2/MN4-EB-S	Manufactured by MIDAS LAB
	USB cable	—	Connection between B receptacle to A receptacle
Software	Integrated development tool/debugger	CubeSuite	V1.40
		Multi	V5.1.7D
		IAR Embedded Workbench	V3.71
File	Device file	DF703512	For V850E2/MN4 (separately available for CubeSuite, Multi, and IAR Embedded Workbench)
	Host driver for debugging port	—	Note1
	Project-related file	—	Note2

Notes: 1. Contact Renesas for product and ordering information.
2. The sample driver package comes with sample files that are built with CubeSuite, Multi, and IAR Embedded Workbench.

6.2 Setting up a CubeSuite Environment

This section explains the preparatory steps that are required to develop or debug using CubeSuite which is introduced in section 6.1, Development Environment. See section 6.4, Setting up a Multi Environment, when using Multi for program development and debugging. See section 6.6, Setting up IAR Embedded Workbench Environment, when using IAR Workbench for program development and debugging.

6.2.1 Setting up the Host Environment

You create a dedicated workspace on the host machine.

(1) Installing the CubeSuite Integrated Development Tools

Install CubeSuite. Refer to the CubeSuite user's manual for details.

(2) Expanding Driver and Other Files

Store a set of distribution sample driver files in an arbitrary directory without modifying their folder structure.

Store the host driver for the debugging port in an arbitrary directory.

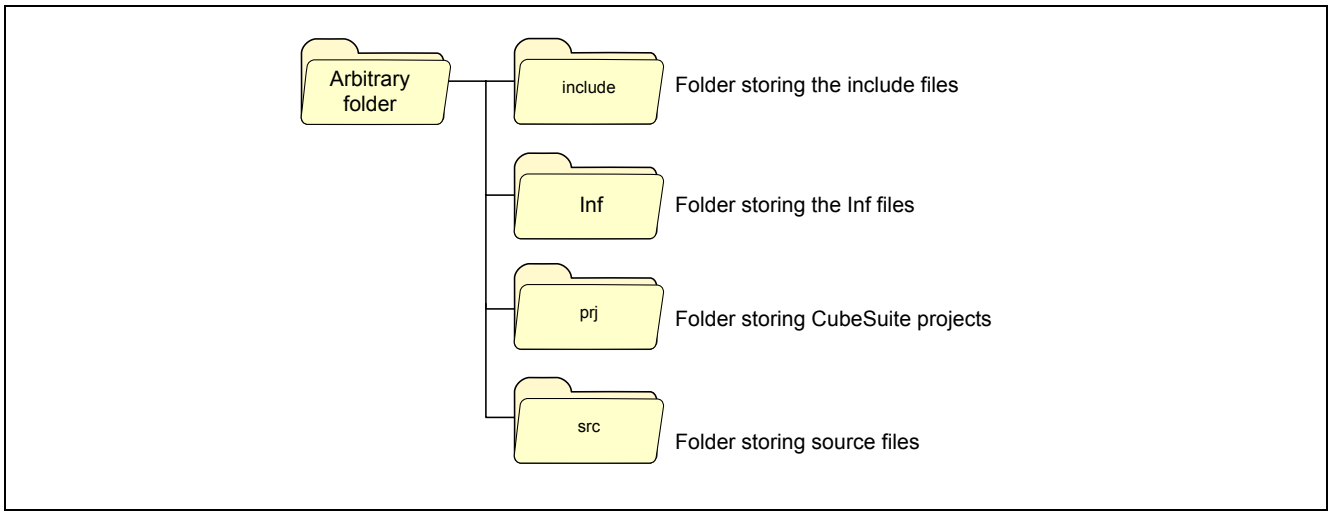


Figure 6.2 Folder Configuration for the Sample Driver (CubeSuite Version)

(3) Installing Device Files

Copy the V850E2/MN4 device files for CubeSuite in the folder where CubeSuite is installed.

Example: D:\Renesas Electronics CubeSuite\CubeSuite\Device_Custom

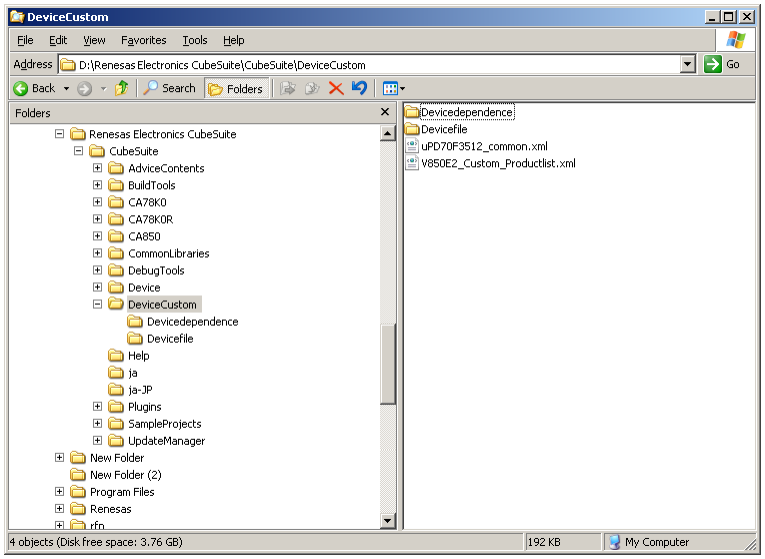


Figure 6.3 Example of Destination Folder for Storing the Device Files

(4) Setting up a Workspace

Follow the procedure given below when using the project-related files that come with the sample driver package.

<1> Start CubeSuite and choose “Open” from the “File” menu.

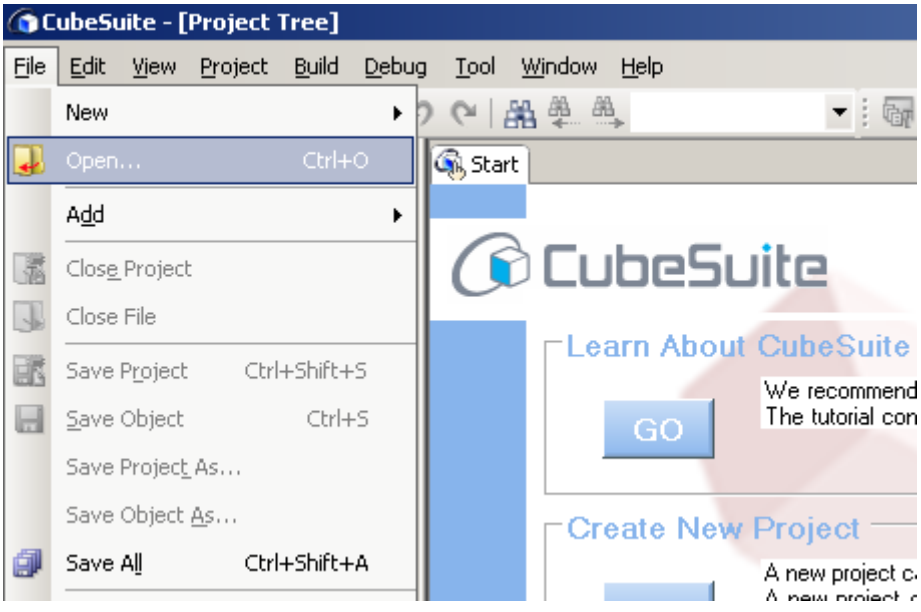


Figure 6.4 Choosing a CubeSuite Menu Item

<2> The “Open” dialog box will appear. Select the project file for CubeSuite which is located in the “prj” folder in the directory in which the sample driver is installed.

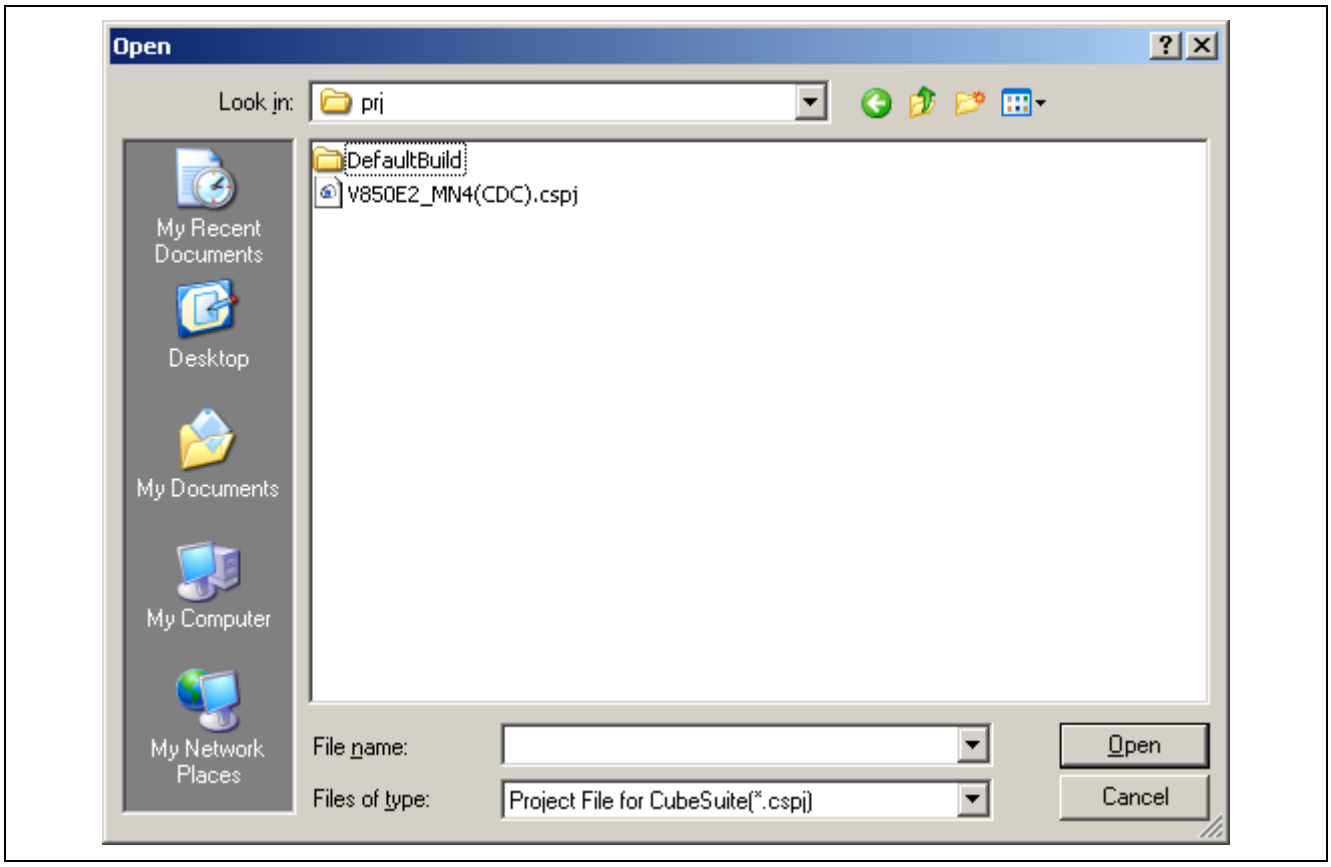


Figure 6.5 Selecting the CubeSuite Project File

(5) Setting up the Build Tool

Follow the procedure given below to select the version of CX850 which is to be used as the build tool and to designate V850E2M MINICUBE as the debugging tool.

<1> Select “CX (Build Tool)” from the “Project Tree” for CubeSuite to display its properties.

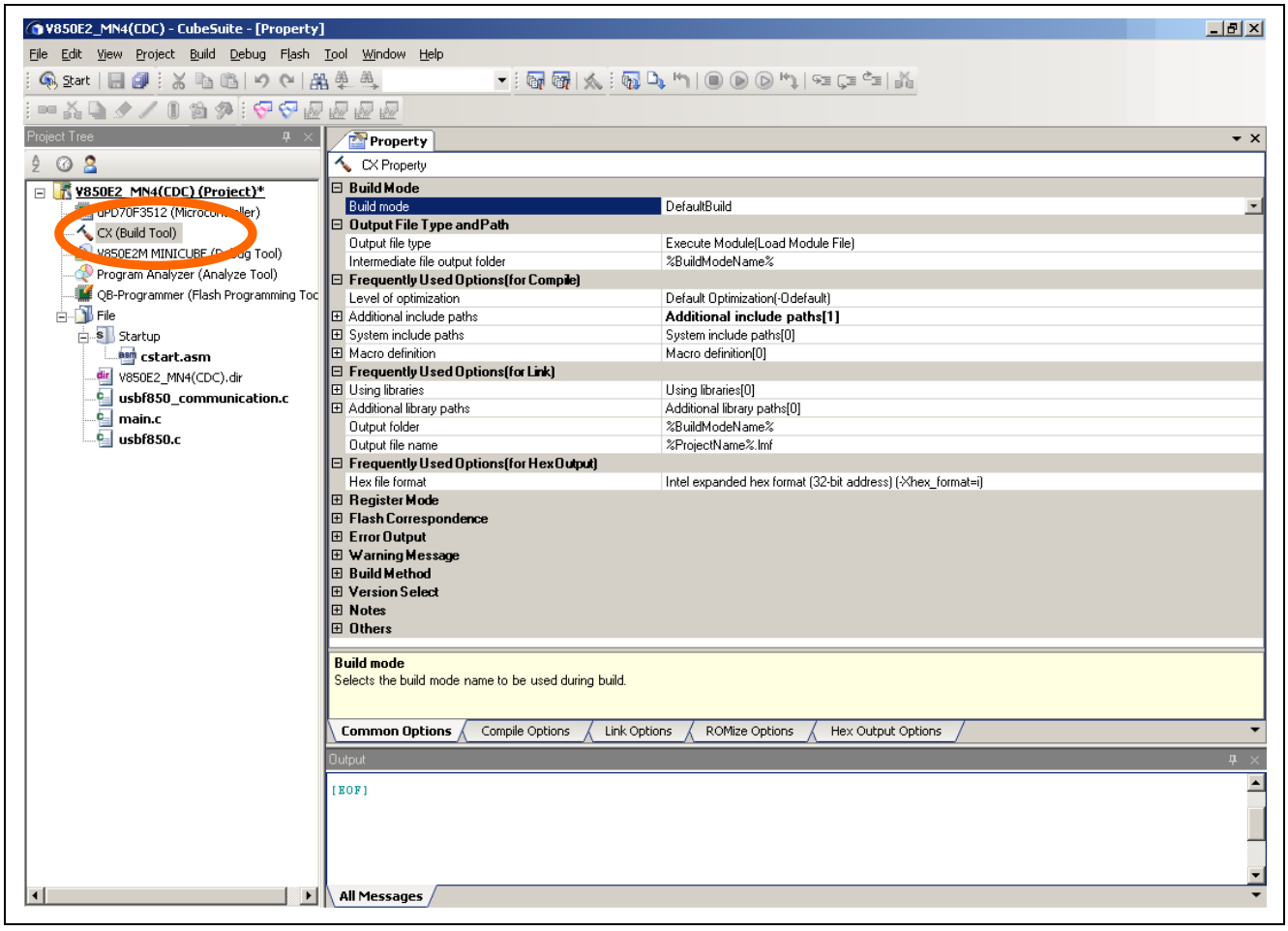


Figure 6.6 Selecting the Build Tool

<2> Select the “Version Select” properties item and sets the “Using compiler package version” entry to “Always latest version which was installed.”

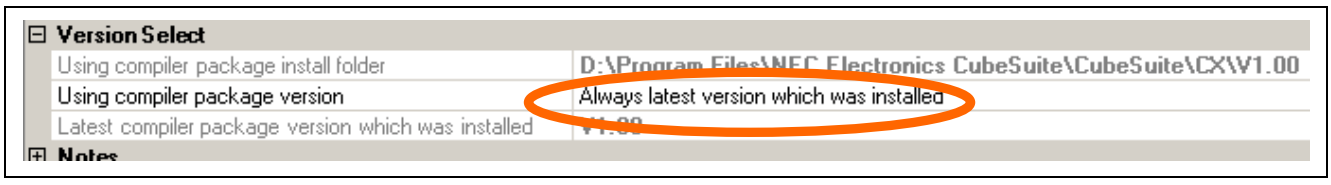


Figure 6.7 Setting up the Compiler Package

<3> Select “V850E2M MINICUBE (Debug Tool)” from the project tree and select “Using Debug Tool” → ”V850E2M MINICUBE” from the right-click menu.

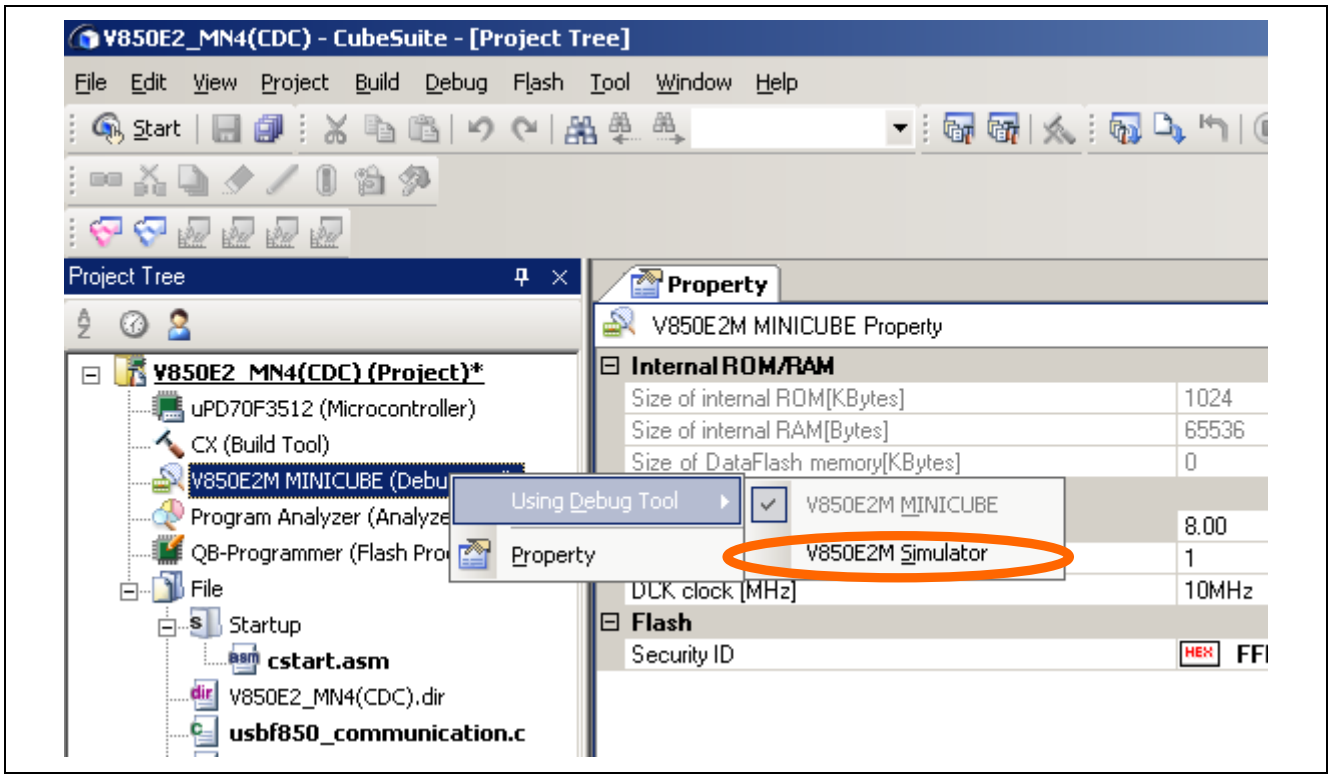


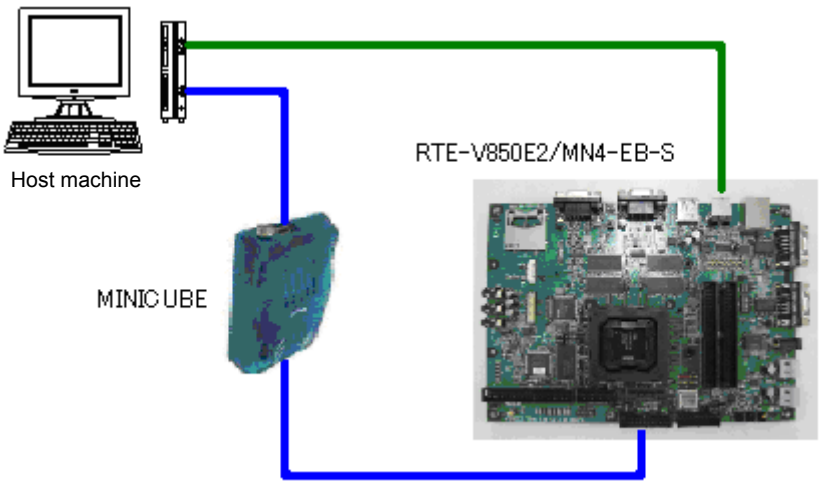
Figure 6.8 Selecting the Debugging Tool

6.2.2 Setting up the Target Environment

You connect the target device to be used for debugging to the host machine. The procedure is common to CubeSuite, Multi, and IAR Embedded Workbench.

(1) Connecting to the Debugging Port

Connect between the RTE-V850E2/MN4-EB-S and the host machine. Connect the RTE-V850E2/MN4-EB-S and the host machine via the MINICUBE for debugging. In addition, connect between the USB B type receptacle of the RTE-V850E2/MN4-EB-S and the USB receptacle of the host machine for the CDC.



Remarks: See section 8, Outline of the Starter Kit, for the physical appearance and port configuration of the RTE-V850E2/MN4-EB-S.

Figure 6.9 Connecting the RTE-V850E2/MN4-EB-S

(2) Host Driver Installation

This section presents the procedure for using the virtual COM port host driver included with this sample driver.

<1> When connection of the RTE-V850E2/MN4-EB-S is recognized by the host machine, it displays the “New hardware detected” message and starts the “Found New Hardware Wizard”.

<2> The “Found New Hardware Wizard” dialog opens. Select, “No, not this time” and click “Next”.

Figure 6.10 Add New Hardware Wizard (1)

<3> The next screen will be displayed. Select “Install from a list or specific location (Advanced)” and click “Next”.

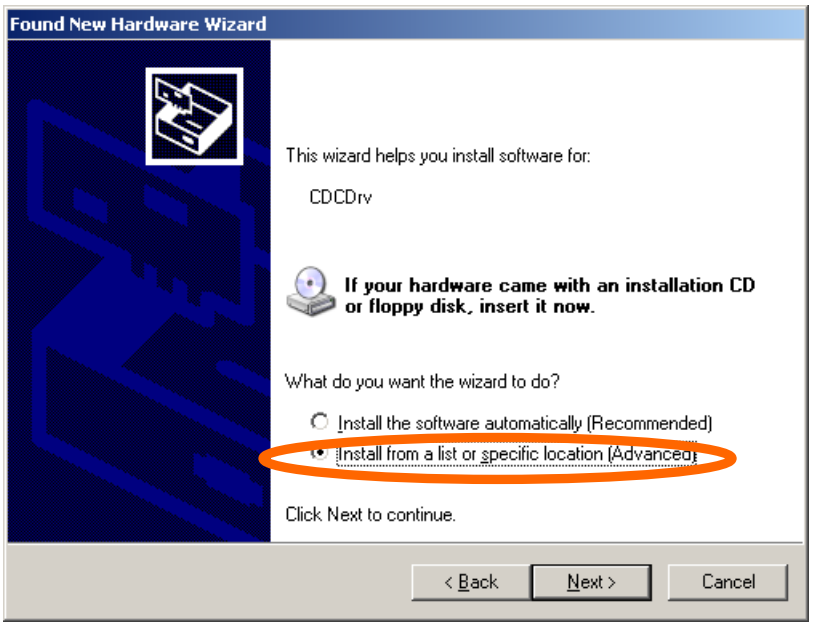


Figure 6.11 Add New Hardware Wizard (2)

<4> The next screen will be displayed. Select “Don’t search. I will choose the driver to install.” and click “Next”.

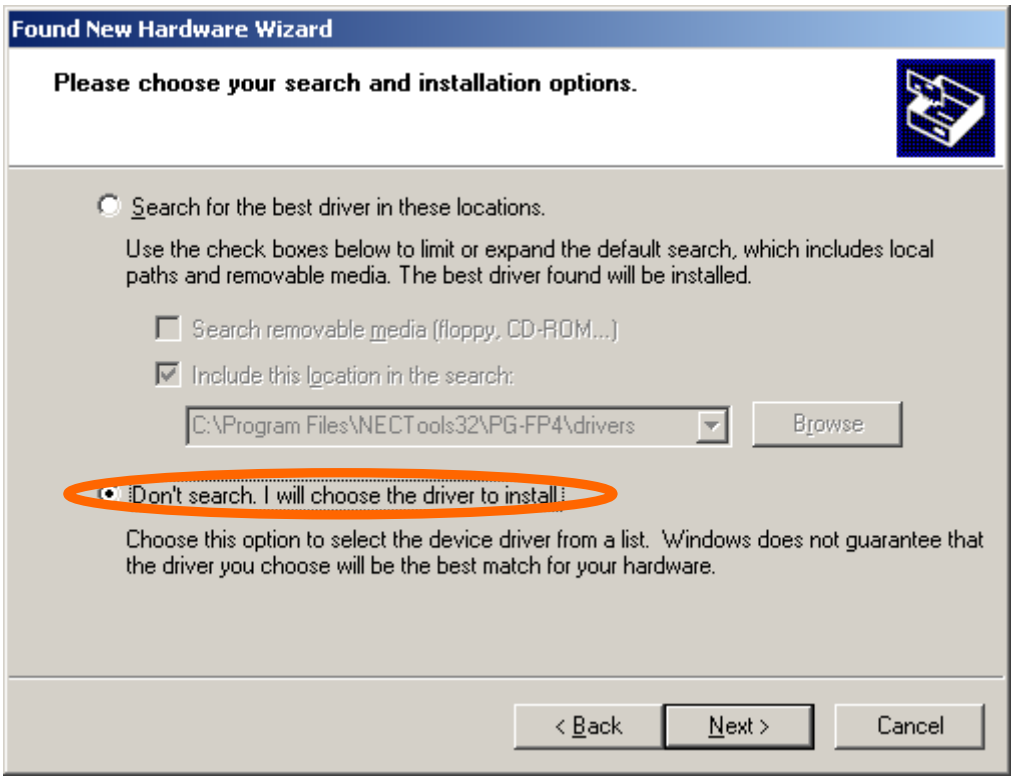


Figure 6.12 Add New Hardware Wizard (3)

<5> The next screen will be displayed. Click “Have Disk”.

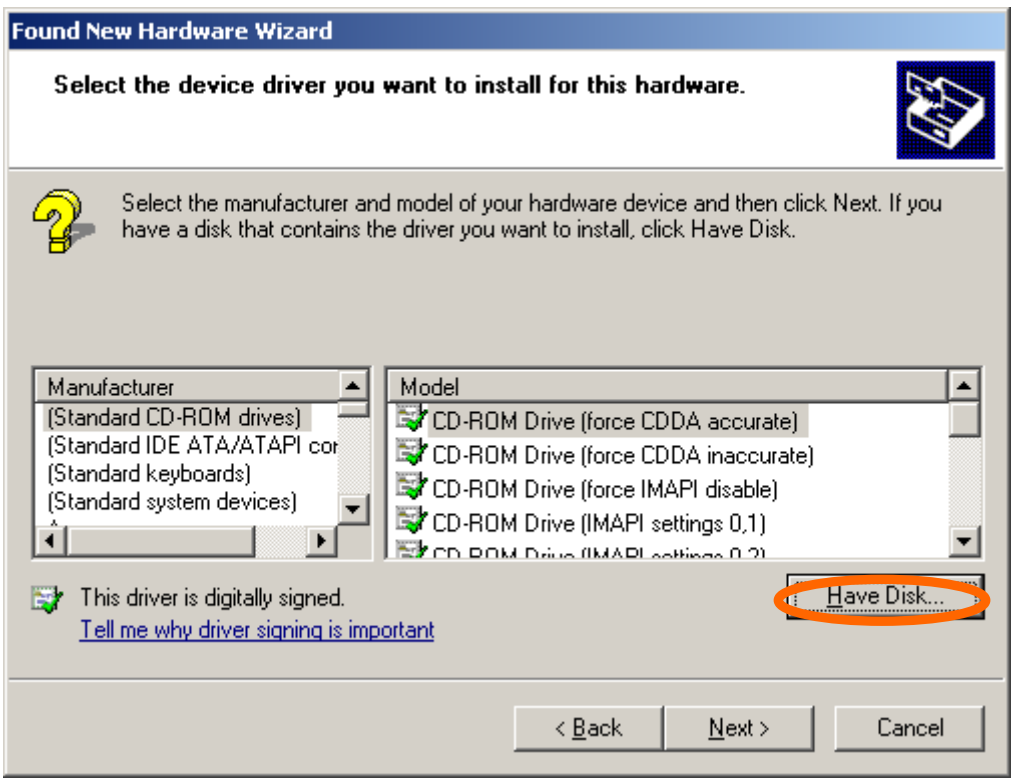


Figure 6.13 Add New Hardware Wizard (4)

<6> The “Install From Disk” dialog will open. Click “Browse...” to display the inf file folder in the directory that holds the sample driver.

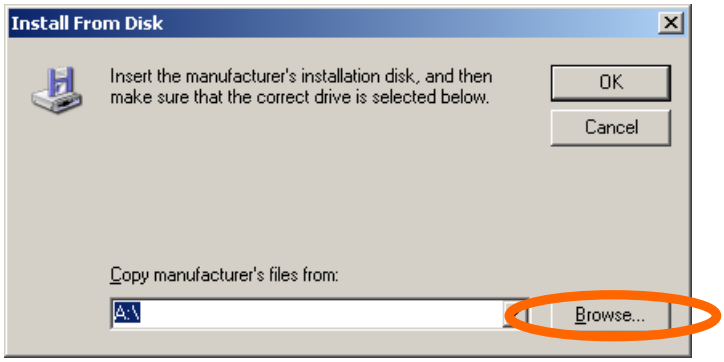


Figure 6.14 Browsing for .inf Files

<7> Select the .inf file in the folder (XP, Vista, or Win7) that matches the OS used on the host system and click Open.

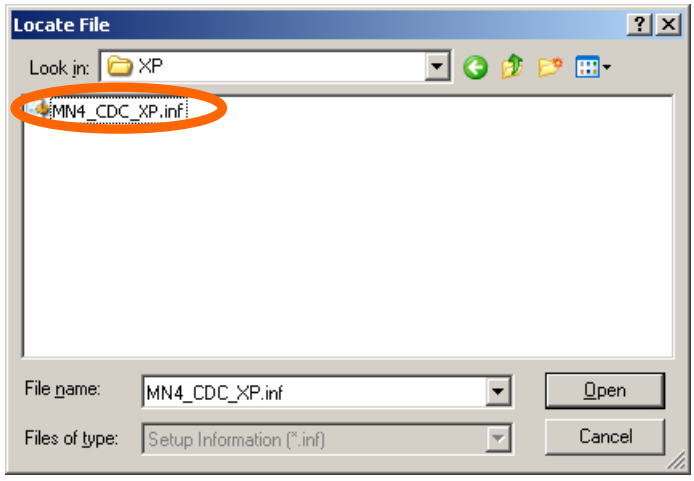


Figure 6.15 Selecting a .inf File

<8> The system will return to the “Install From Disk” dialog. Verify that the file shown in the “Copy manufacturer’s files from:” field is correct and click “OK”.

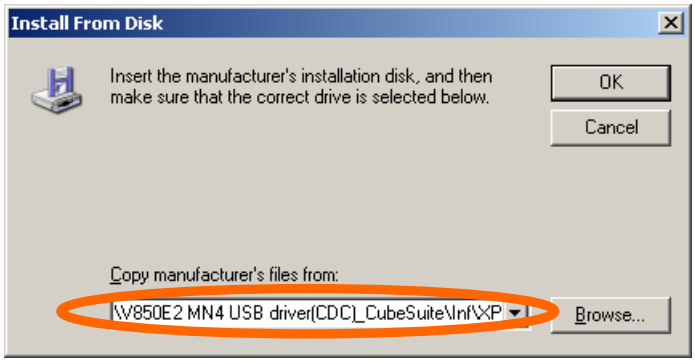


Figure 6.16 Installing the .inf File

<9> The system will return to the “Found New Hardware Wizard”. Select “Renesas Electronics V850E2/MN4 Virtual UART” and click “Next”.

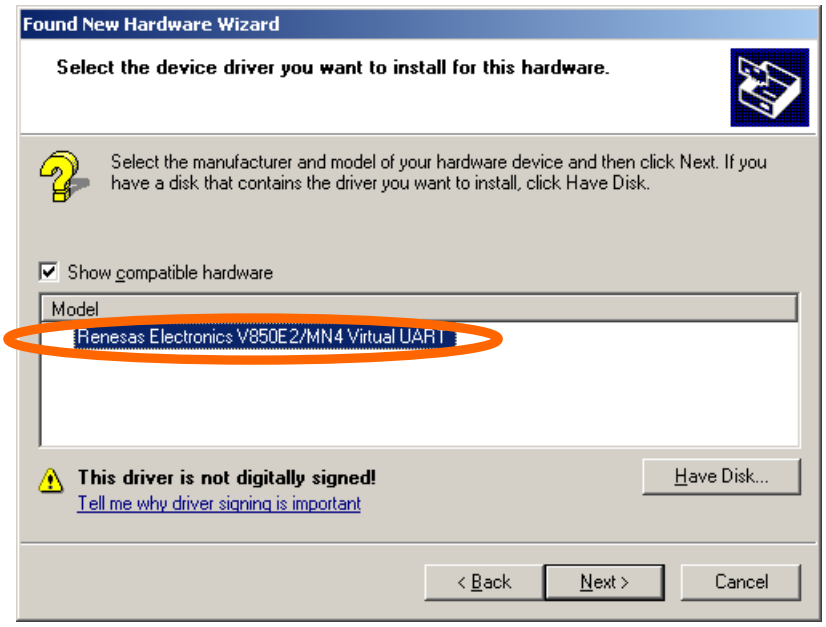


Figure 6.17 Selecting the Device Driver to Install

<10> The driver installation process will start.

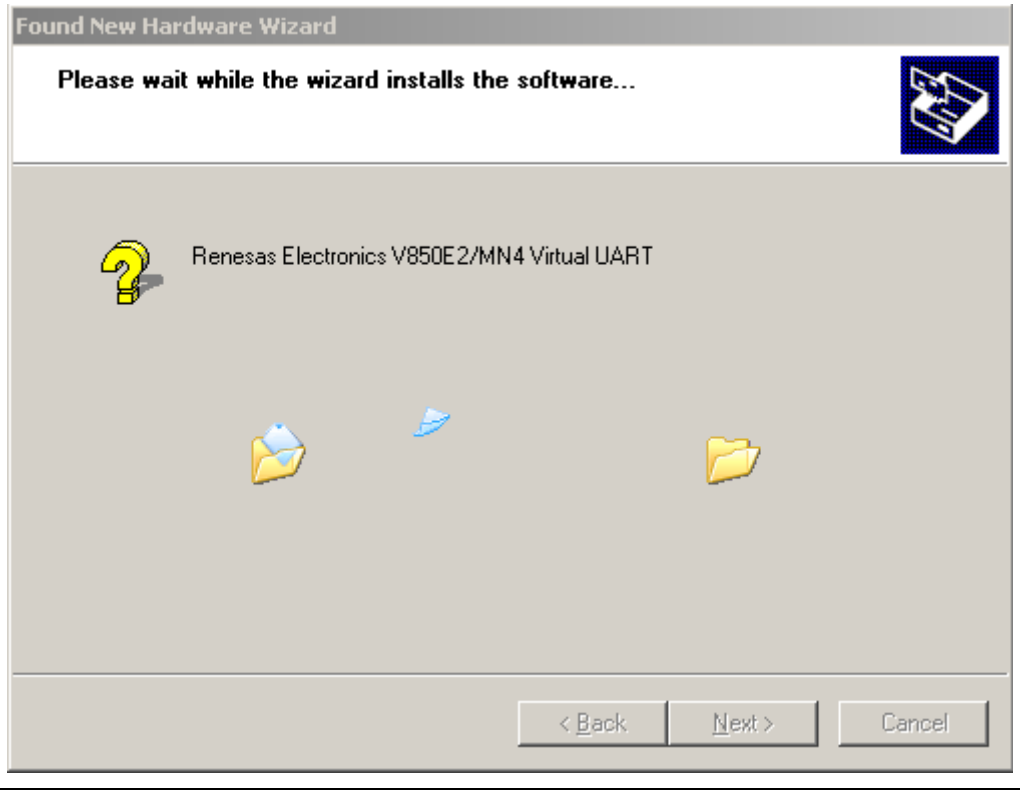


Figure 6.18 Driver Installation in Progress (1)

<11> The “Hardware Installation” dialog will be displayed. Click “Continue Anyway”.

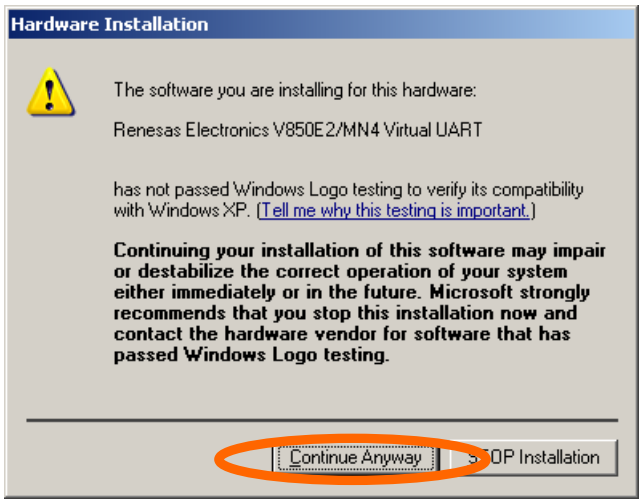


Figure 6.19 Driver Compatibility Verification Dialog

<12> The driver will be installed. Depending on the computer environment, some amount of time may be required.

<13> Click “Finish” after installation is completed.

(3) Verify Device Allocation

Open the Windows “Device Manager”. Expand the “Ports” tree in the device listing and verify both that the “Renesas Electronics V850E2/MN4 Virtual UART” is displayed and the allocated COM port number.

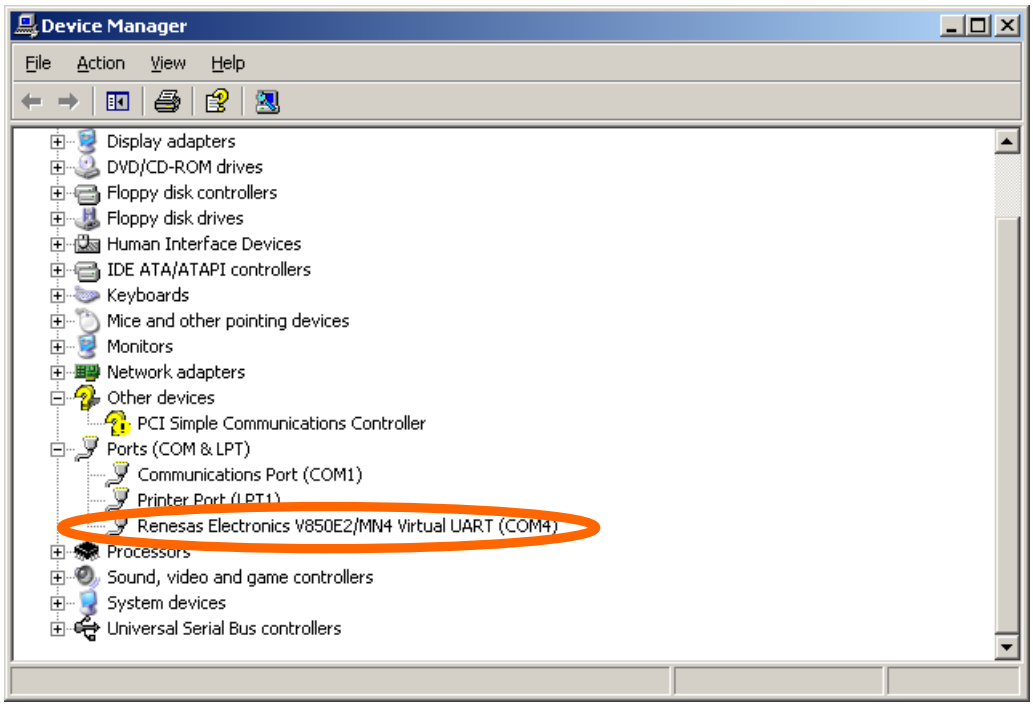


Figure 6.20 COM Port Verification

Note: Device and port numbers can be changed to arbitrary values. For details, see section 7.2, Customization.

6.3 Debugging in the CubeSuite Environment

This section explains the procedure to debug an application program that is developed in the workspace introduced in section 6.2, Setting up the CubeSuite Environment.

6.3.1 Generating a Load Module

To write a program into the target device, it is necessary to compile its source file that is coded in C or assembly language into a load module.

In CubeSuite, a load module is generated by choosing “Build Project” from the “Build” menu.

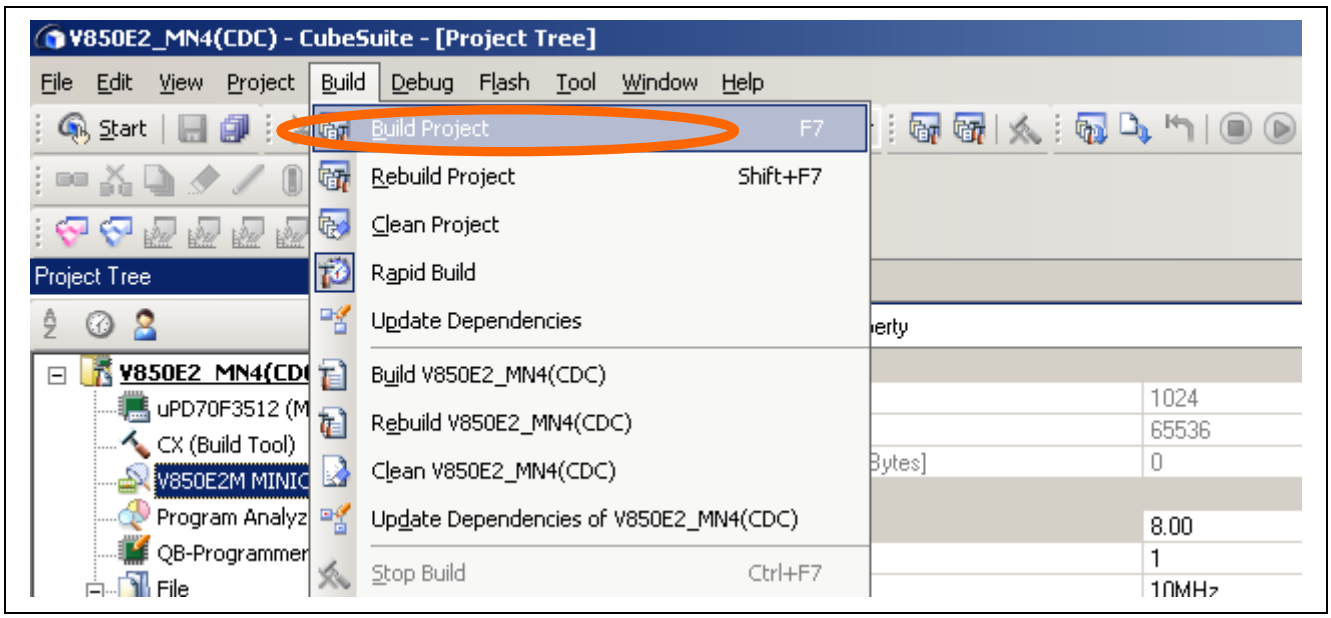


Figure 6.21 Selecting a Build Project

6.3.2 Loading and Executing

You write (load) the generated load module into the target for execution.

(1) Writing a Load Module

Shown below is the procedure to write a load module into the RTE-V850E2/MN4-EB-S via CubeSuite.

<1> Choose “Download” from the “Debug” menu and start the debugger.

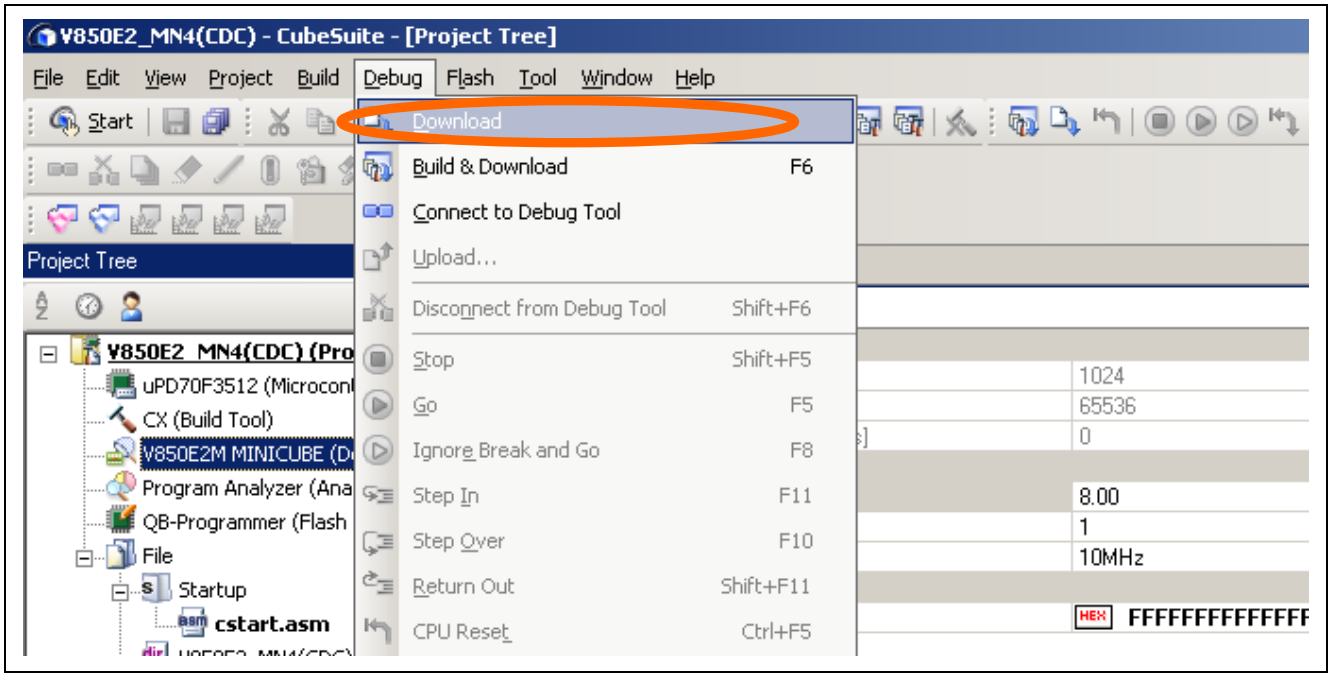


Figure 6.22 Starting the Debugger

<2> The downloading of the load module is started via the debugging tool.

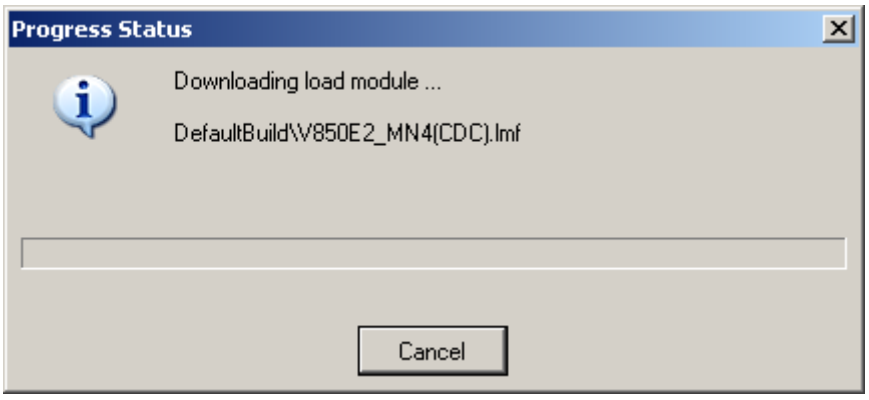


Figure 6.23 Executing the Download

(2) Running the Program

Press the CubeSuite's button or choose "Go" from the "Debug" menu.

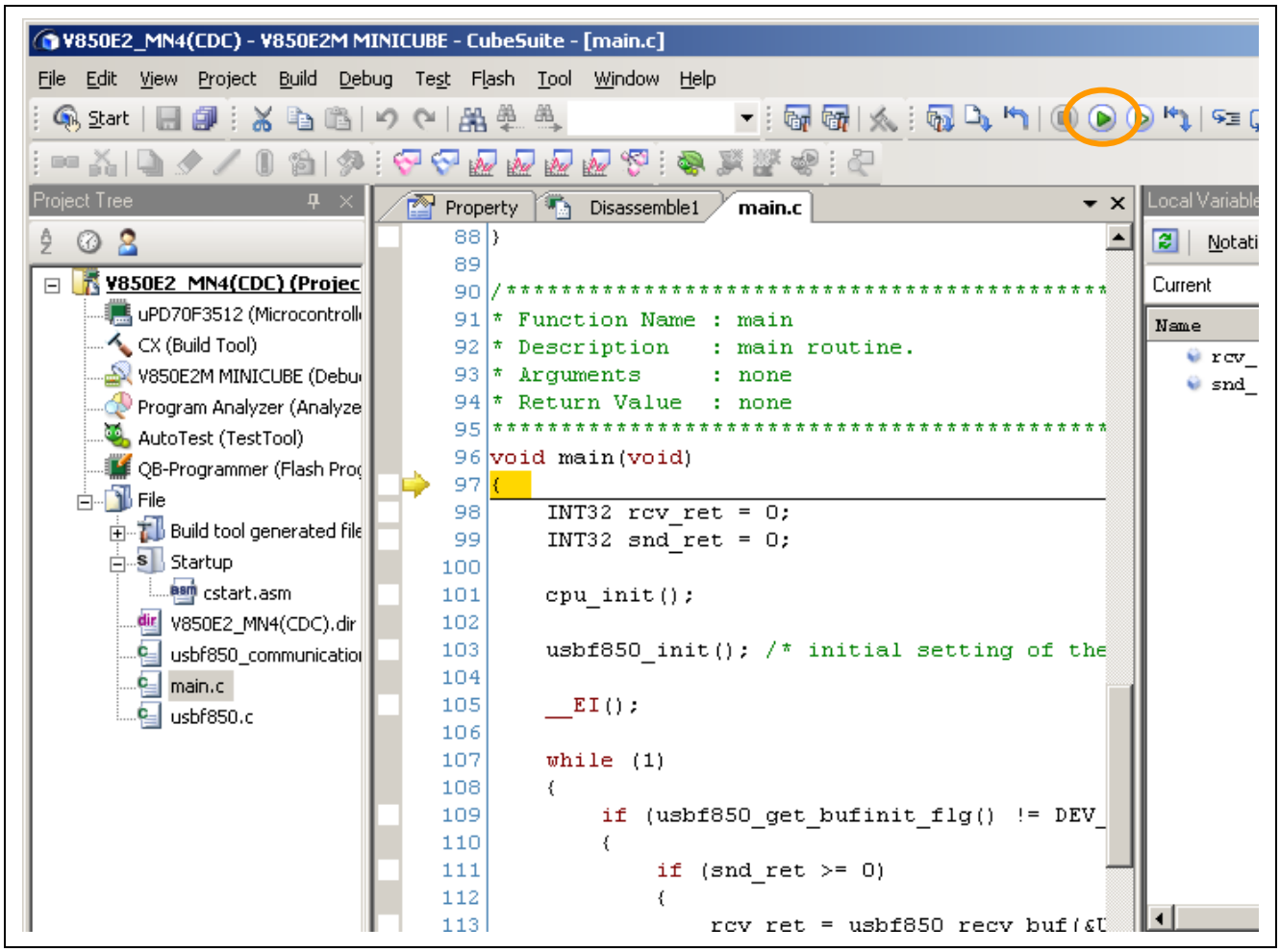


Figure 6.24 Running the Program

6.4 Setting up a Multi Environment

This section explains the preparatory steps that are required to develop or debug using Multi which is introduced in section 6.1, Development Environment.

6.4.1 Setting up the Host Environment

You create a dedicated workspace on the host machine.

(1) Installing the Multi Integrated Development Tools

Install Multi. Refer to the GHS user's manual for details.

(2) Expanding Driver and Other Files

Store a set of distribution sample driver files in an arbitrary directory without modifying their folder structure.

Store the host driver for the debugging port in an arbitrary directory.

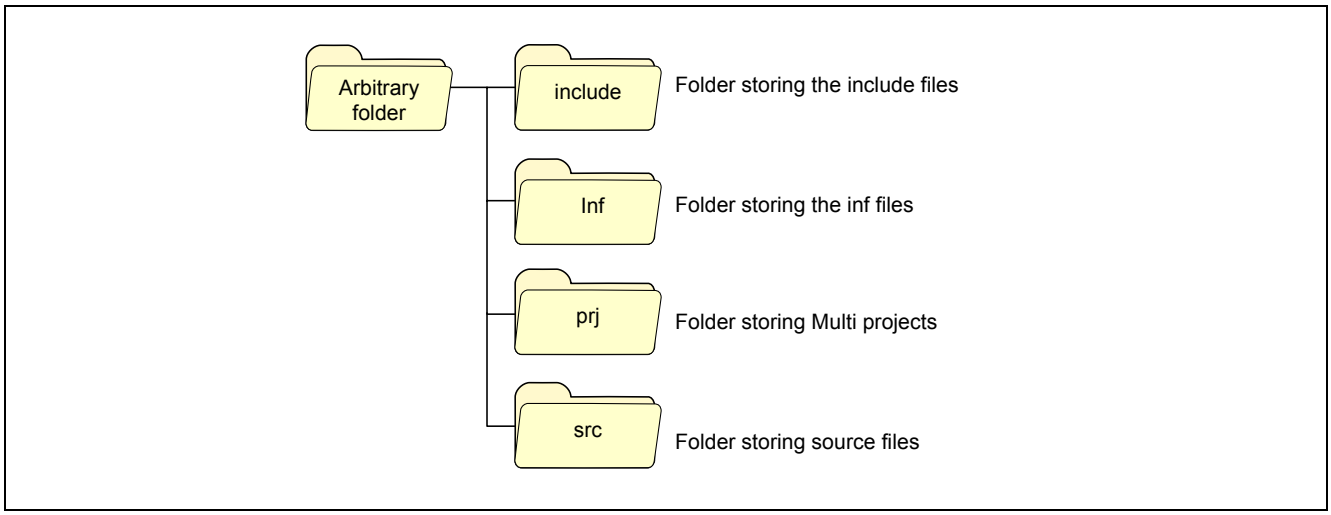


Figure 6.25 Folder Configuration for the Sample Driver (Multi Version)

(3) Installing Device Files

Copy the V850E2/MN4 device files for Multi in the folder where Multi is installed.

Example: C:\Green\V800.V517D\devicefile

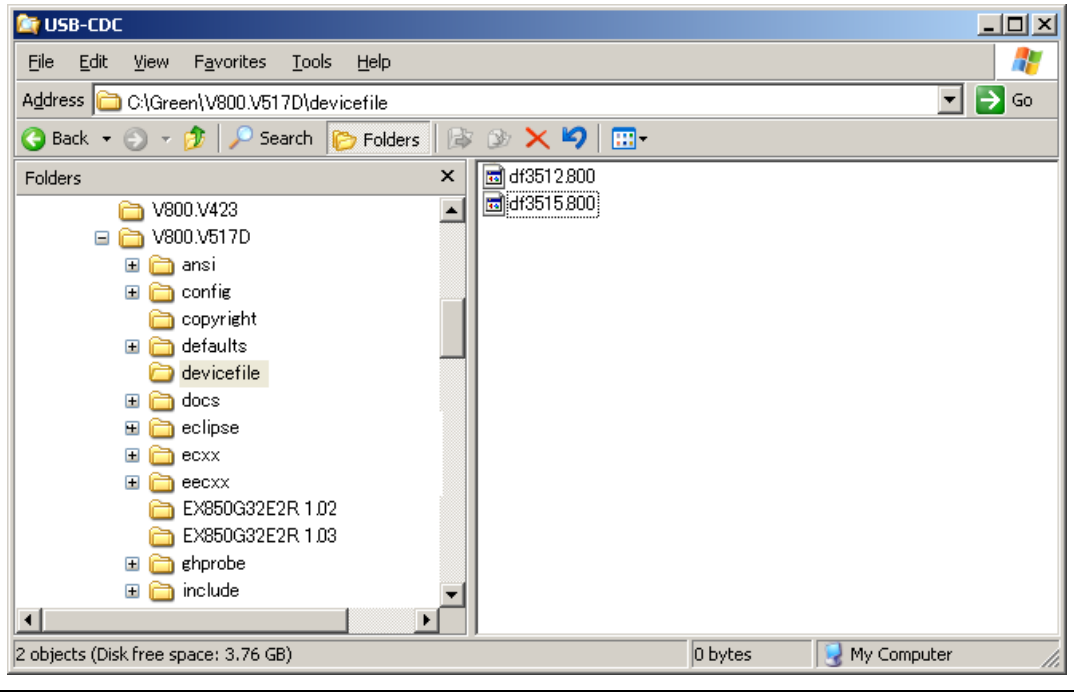


Figure 6.26 Example of Destination Folder for Storing the Device Files

(4) Starting Multi

Select and start Multi Project File in “V850E2_MN4(CDC)_GHS.gpj” which is included in the sample driver package from the Explorer.

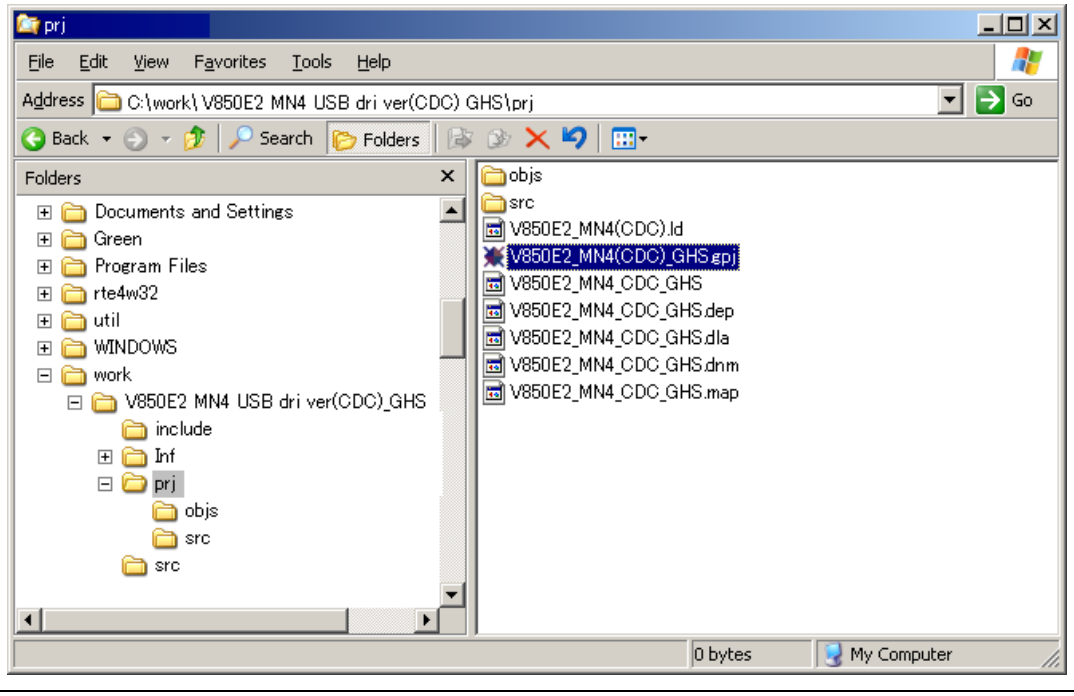


Figure 6.27 Selecting the Multi Project File

(5) Setting up the Debugging Tool

Given below is the procedure to use MINICUBE as the debugging tool.

<1> Choose “Connect” from the Multi’s “Connect” menu to open the Connection Chooser.

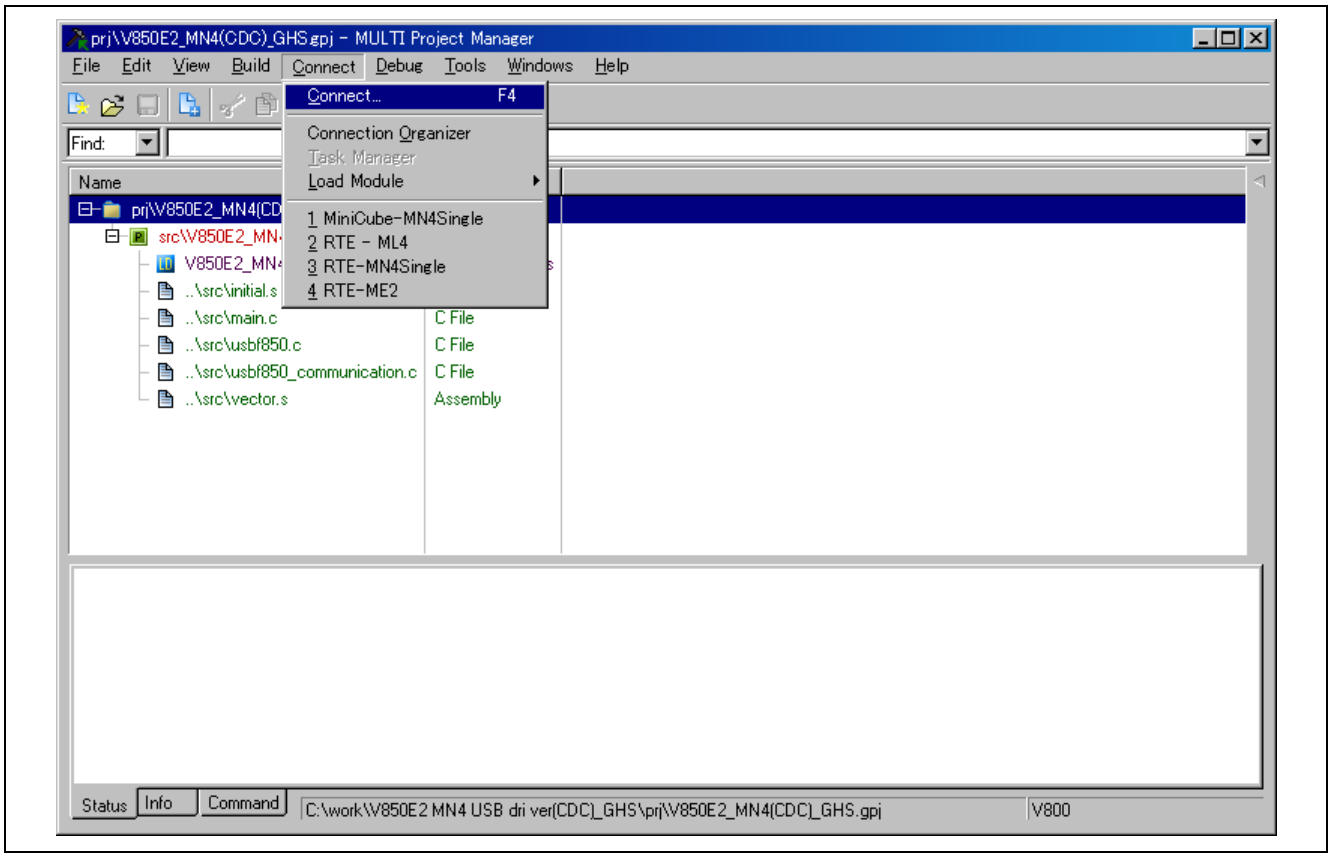


Figure 6.28 Starting the Connection Chooser

<2> Select the “Create New Connection Method” icon from the “Connection Chooser” dialog box.

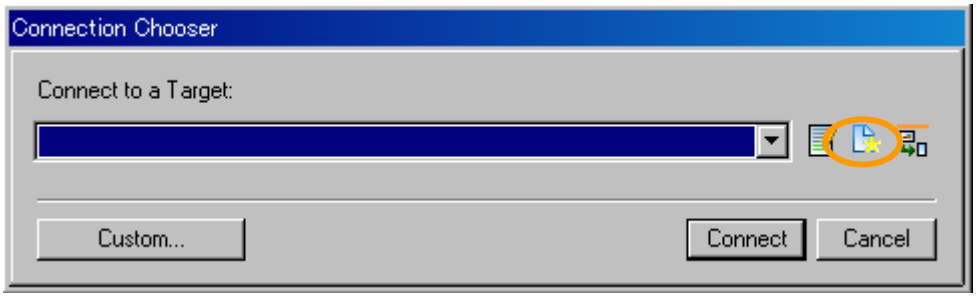


Figure 6.29 Selecting the Create a new Connection Method

<3> In the “Create New Connection Method” dialog box, enter an arbitrary name in the Name textbox and select “Custom” in the Type combo box, then click the “Create…” button to create MINICUBE connection settings. In the example shown here, the name is set to “MINICUBE” in the Name textbox.

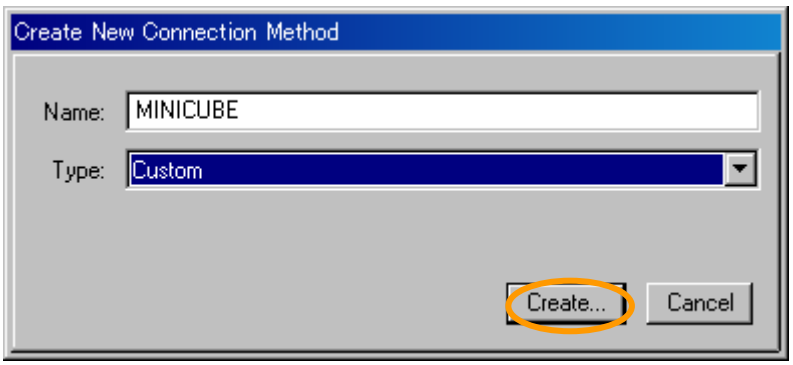


Figure 6.30 Creating the Create New Connection Method

<4> Connection Editor will then start. Fill the “Server” and “Arguments” fields as shown below and click the OK button.

Server: 850eserv2

Arguments: -minicube -e2 -ip=c:\green\v800.V517d\devicefile -df=df3512.800 -id ffffffffffffffffffffffff Note1

Note: 1. 24 occurrences of “f”

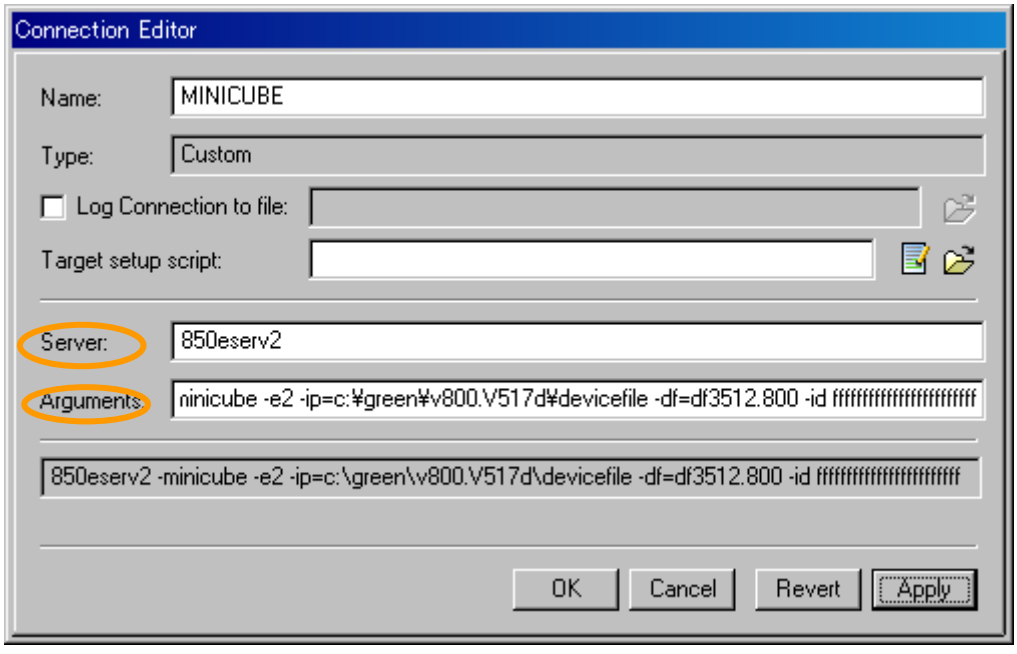


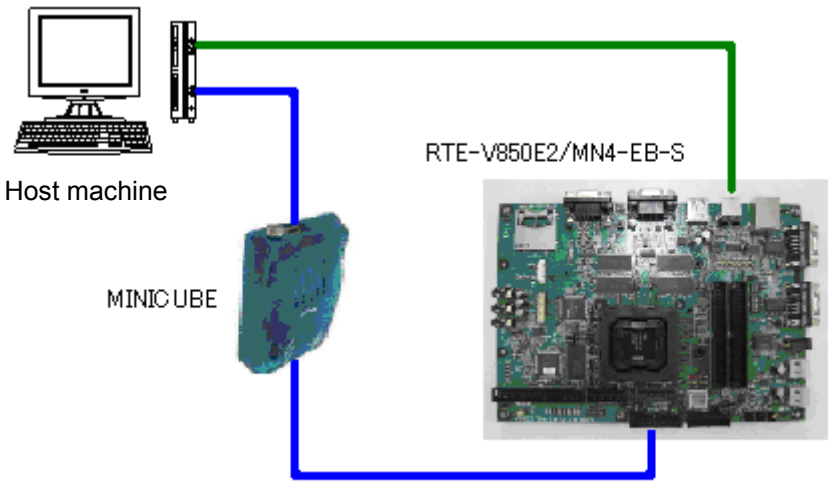
Figure 6.31 Configuring Connection Editor

6.4.2 Setting up the Target Environment

You connect the target device to be used for debugging to the host machine. The procedure is common to CubeSuite, Multi, and IAR Embedded Workbench.

(1) Connecting to the Debugging Port

Connect between the RTE-V850E2/MN4-EB-S and the host machine. Connect the RTE-V850E2/MN4-EB-S and the host machine via the MINICUBE for debugging. In addition, connect between the USB B type receptacle of the RTE-V850E2/MN4-EB-S and the USB receptacle of the host machine for the CDC.



Remarks: See section 8, Outline of the Starter Kit, for the physical appearance and port configuration of the RTE-V850E2/MN4-EB-S.

Figure 6.32 Connecting the RTE-V850E2/MN4-EB-S

(2) Host Driver Installation

This section presents the procedure for using the virtual COM port host driver included with this sample driver.

<1> When connection of the RTE-V850E2/MN4-EB-S is recognized by the host machine, it displays the “New hardware detected” message and starts the “Found New Hardware Wizard”.

<2> The “Found New Hardware Wizard” dialog opens. Select, “No, not this time” and click “Next”.

Figure 6.33 Add New Hardware Wizard (1)

<3> The next screen will be displayed. Select “Install from a list or specific location (Advanced)” and click “Next”.

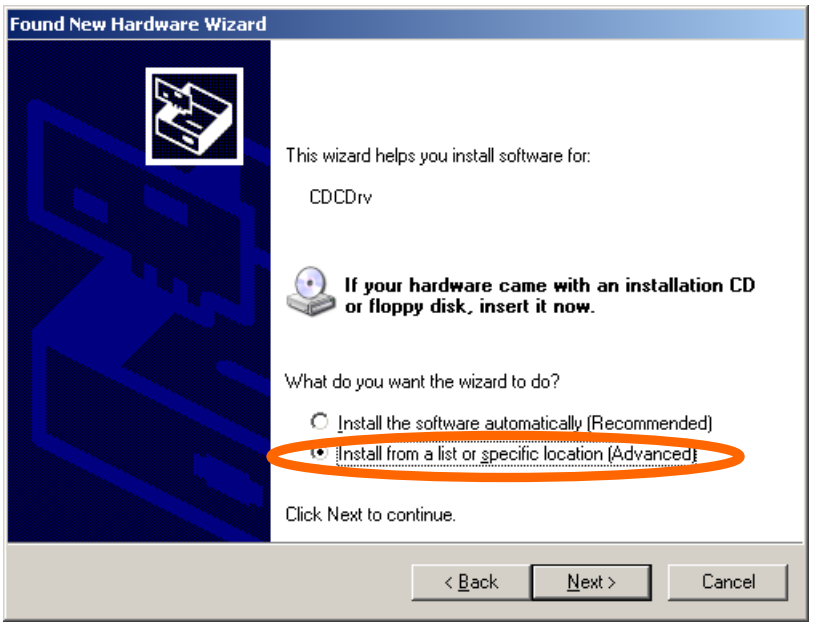


Figure 6.34 Add New Hardware Wizard (2)

<4> The next screen will be displayed. Select “Don’t search. I will choose the driver to install.” and click “Next”.

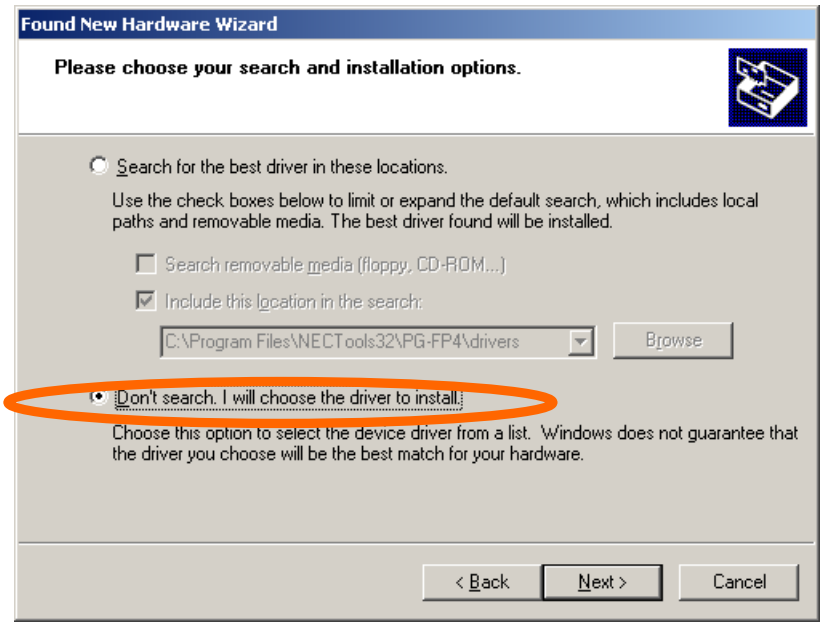


Figure 6.35 Add New Hardware Wizard (3)

<5> The next screen will be displayed. Click “Have Disk”.

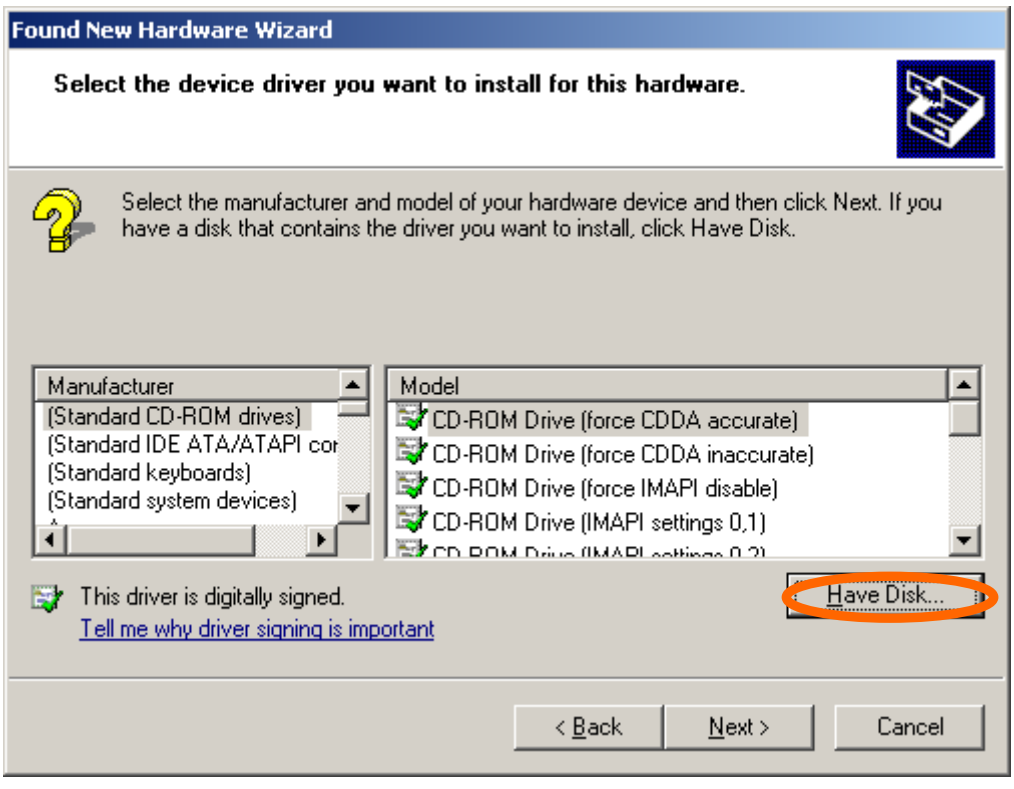


Figure 6.36 Add New Hardware Wizard (4)

<6> The “Install From Disk” dialog will open. Click “Browse...” to display the inf file folder in the directory that holds the sample driver.

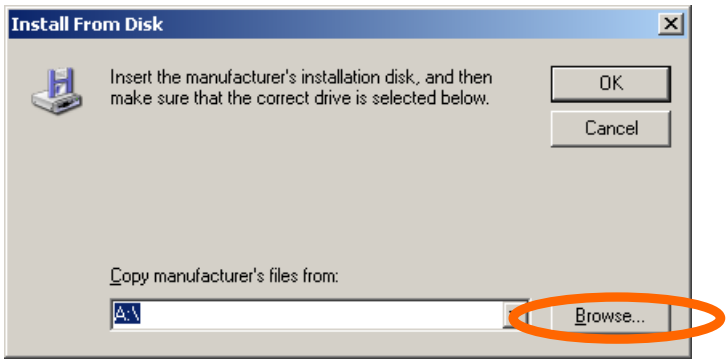


Figure 6.37 Browsing for .inf Files

<7> Select the .inf file in the folder (XP, Vista, or Win7) that matches the OS used on the host system and click “Open”.

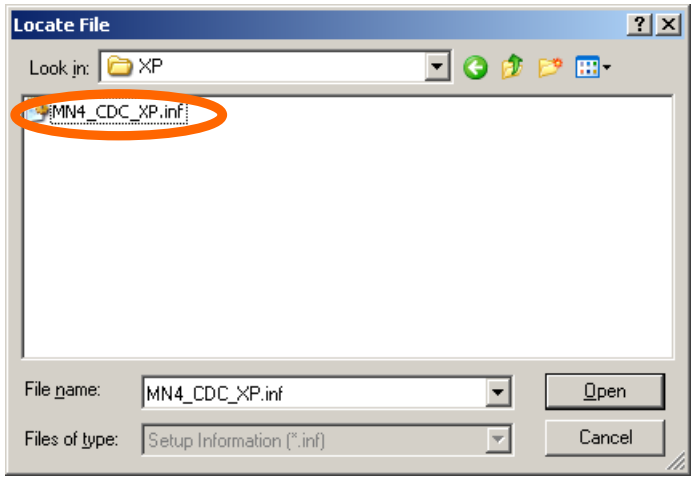


Figure 6.38 Selecting a .inf File

<8> The system will return to the “Install From Disk” dialog. Verify that the file shown in the “Copy manufacturer’s files from:” field is correct and click “OK”.

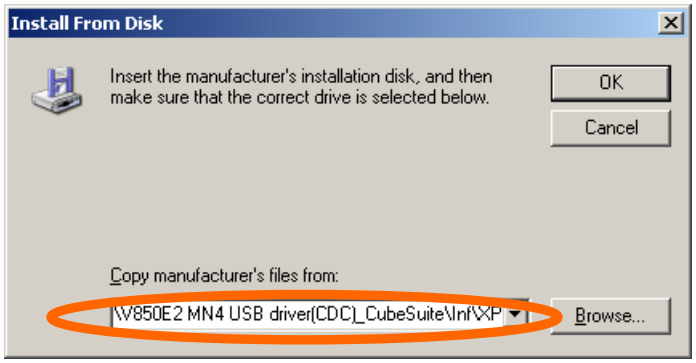


Figure 6.39 Installing the .inf File

<9> The system will return to the “Found New Hardware Wizard”. Select “Renesas Electronics V850E2/MN4 Virtual UART” and click “Next”.

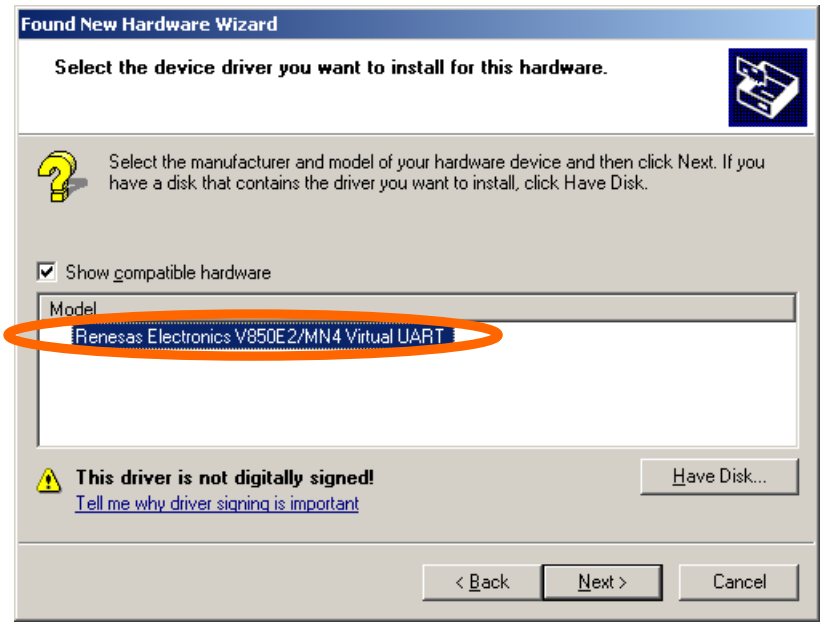


Figure 6.40 Selecting the Device Driver to Install

<10> The driver installation process will start.

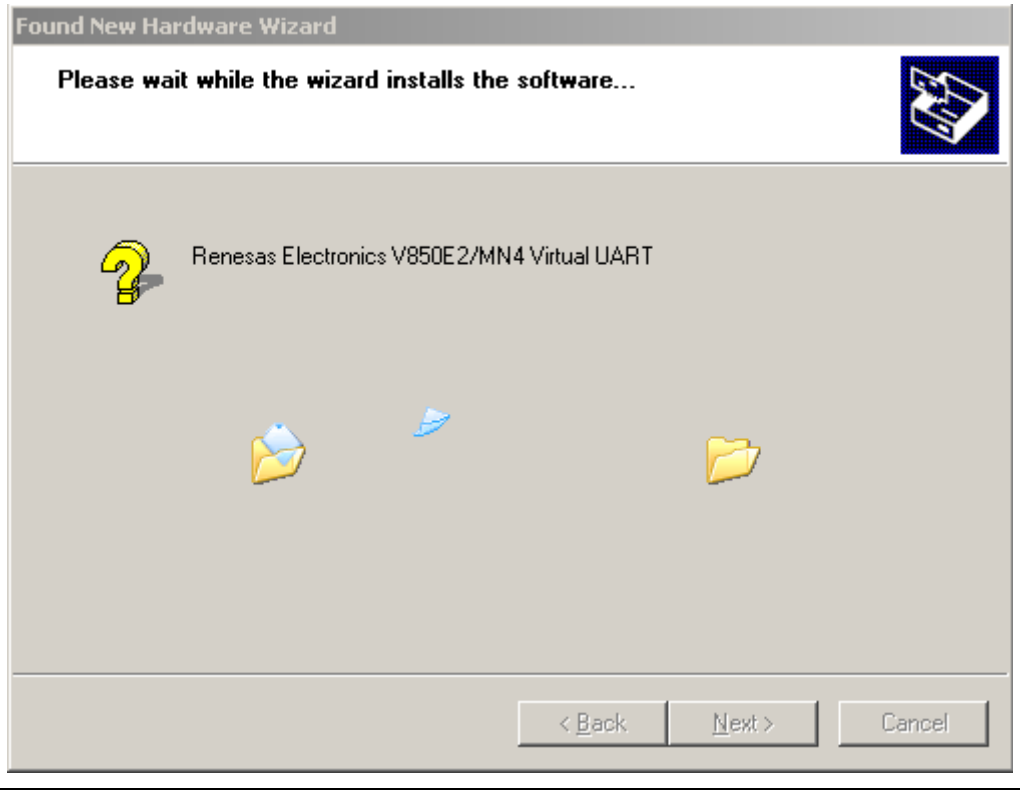


Figure 6.41 Driver Installation in Progress (1)

<11> The Install Hardware dialog will be displayed. Click Continue.

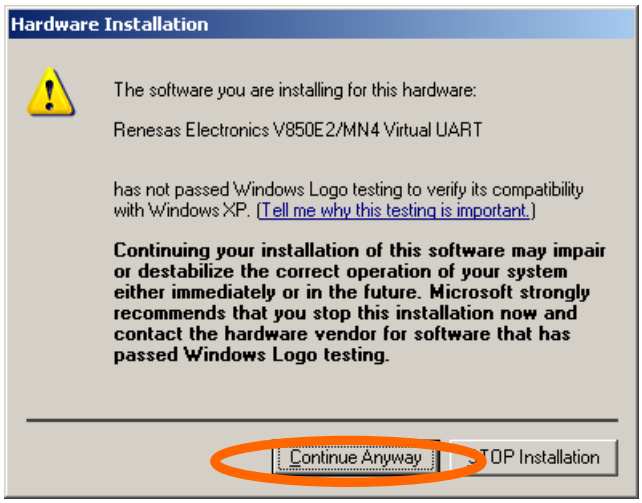


Figure 6.42 Driver Compatibility Verification Dialog

<12> The driver will be installed. Depending on the computer environment, some amount of time may be required.

<13> Click “Finish” after installation is completed.

(3) Verify Device Allocation

Open the Windows “Device Manager”. Expand the “Ports” tree in the device listing and verify both that the “Renesas Electronics V850E2/MN4 Virtual UART” is displayed and the allocated COM port number.

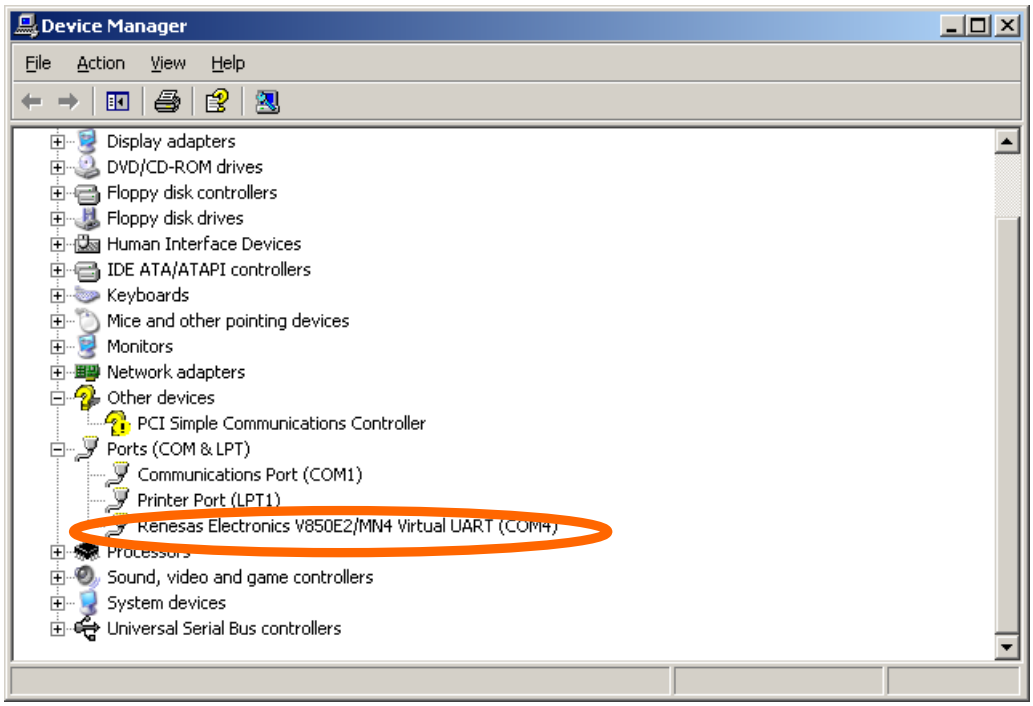


Figure 6.43 COM Port Verification

Note: Device and port numbers can be changed to arbitrary values. For details, see section 7.2, Customization.

6.5 Debugging in the Multi Environment

This section explains the procedure to debug an application program that is developed in the workspace that is introduced in section 6.4, Setting up the Multi Environment.

6.5.1 Generating a Load Module

To write a program into the target device, it is necessary to compile its source file that is coded in C or assembly language into a load module.

In Multi, a load module is generated by choosing “Build Top Project V850E2_MN4(CDC)_GHS.gpj” from the “Build” menu.

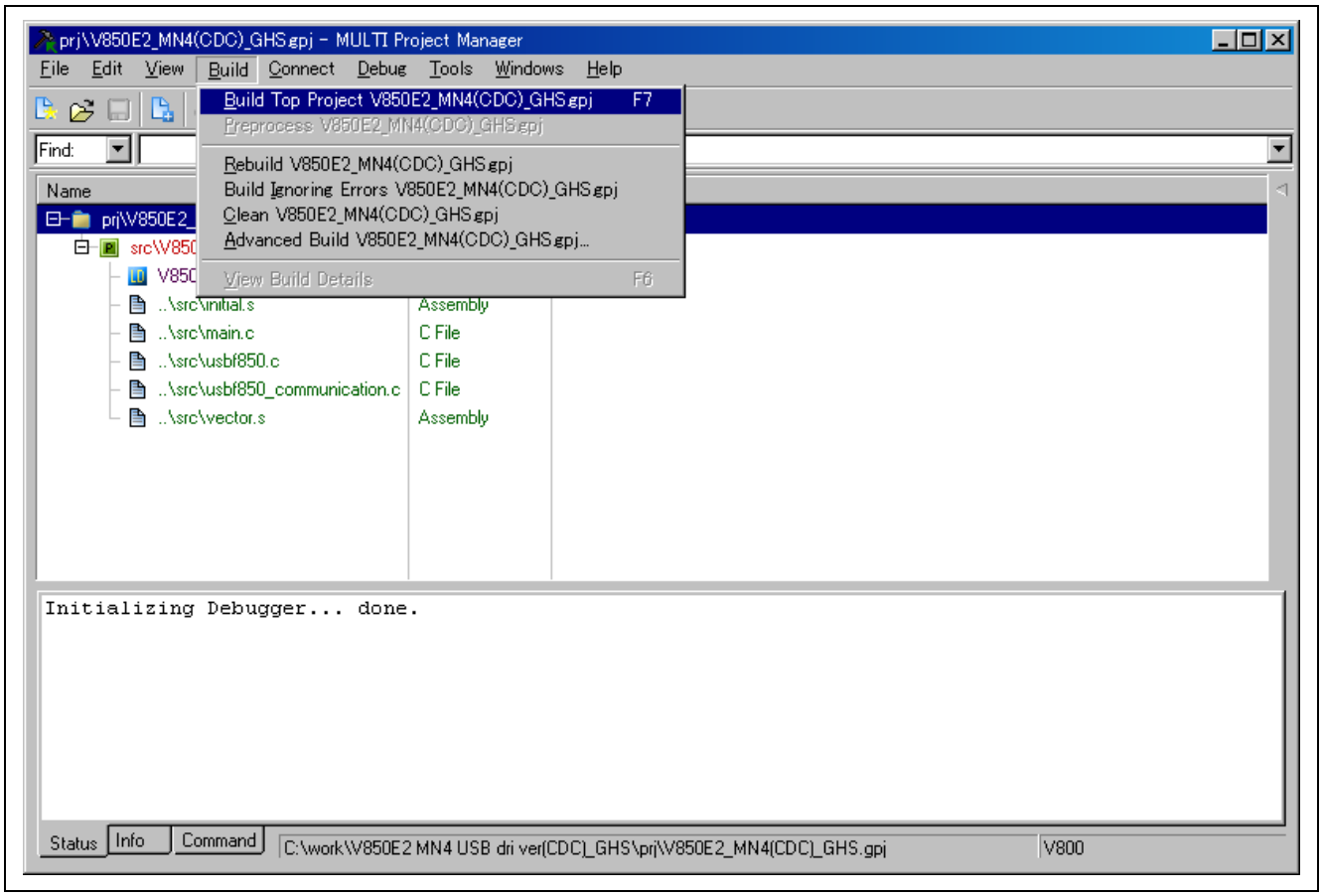


Figure 6.44 Choosing Build

6.5.2 Loading and Executing

You write (load) the generated load module into the target for execution.

(1) Programming the Load Module

Shown below is the procedure to program a load module into the RTE-V850E2/MN4-EB-S via Multi.

<1> Choose “Connect” from the Multi’s “Connect” menu to open the Connection Chooser.

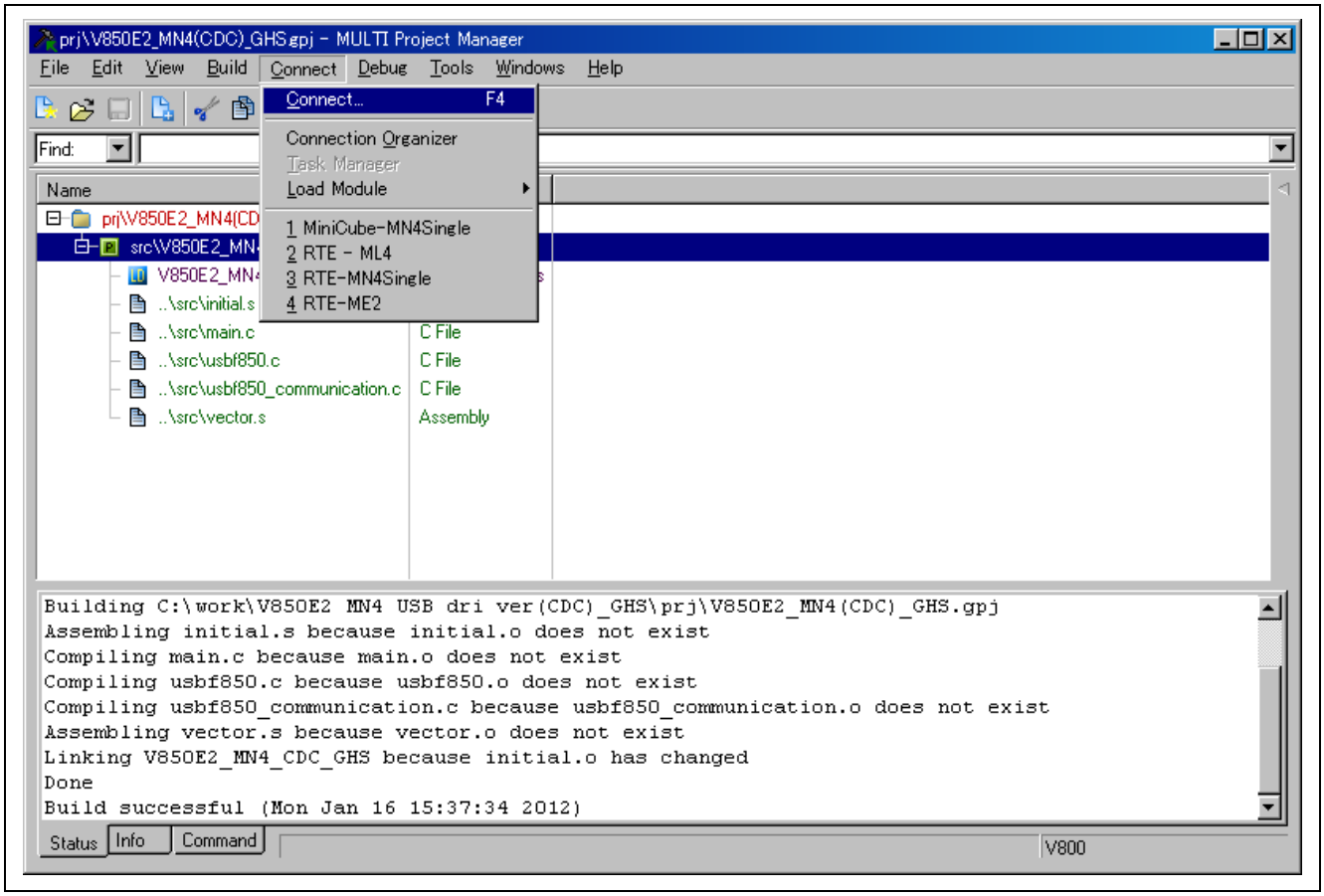


Figure 6.45 Starting the Connection Chooser

<2> From the Connection Chooser, select the MINICUBE connection settings you created according to the procedure explained in section 6.4.1, Setting up the Host Environment, and click the “Connect” button.

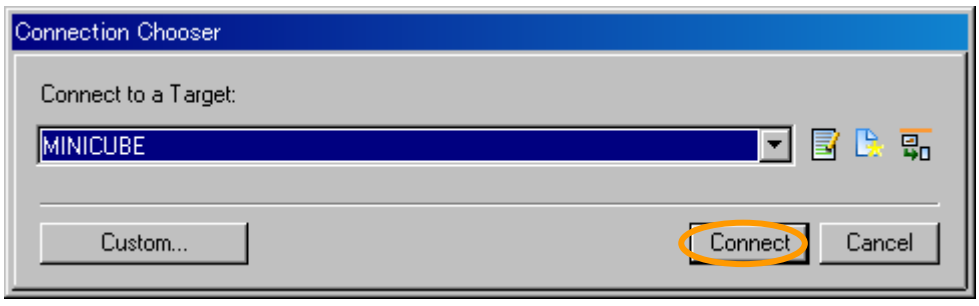


Figure 6.46 Selecting the MINICUBE Connection Settings

<3> MULTI Debugger will then start. Choose “Debug Program” from the “File” menu and download the load module.

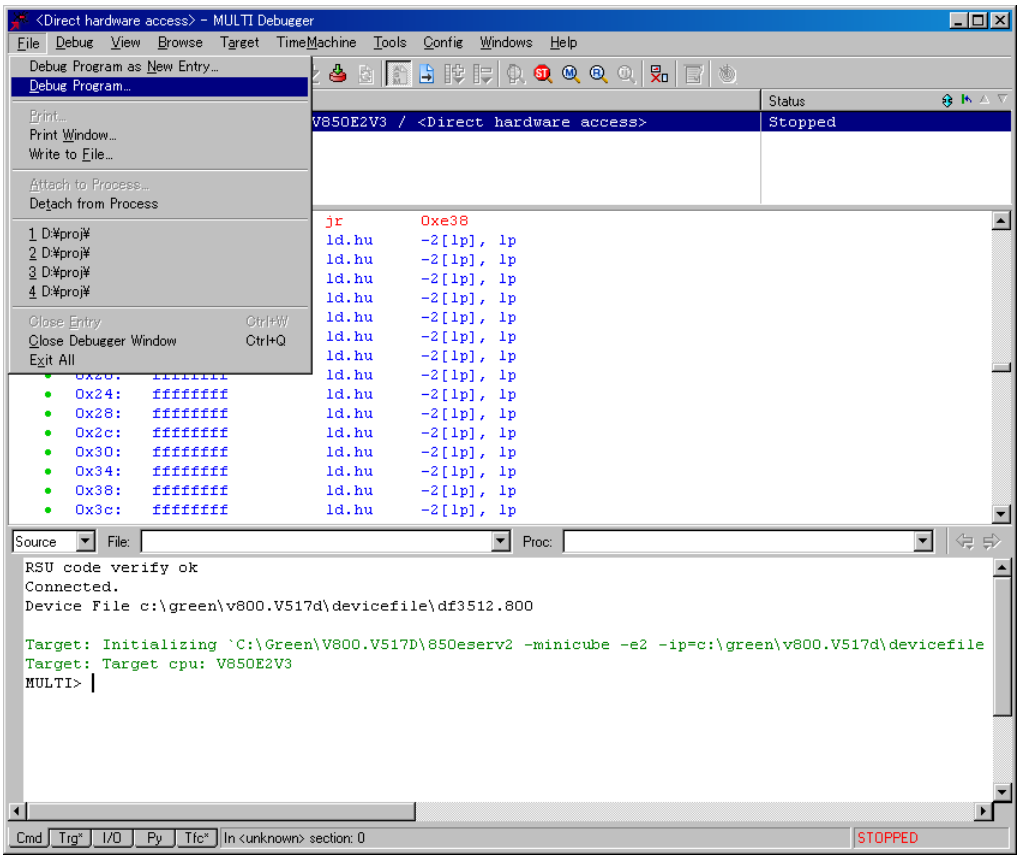


Figure 6.47 Choosing a MULTI Debugger Menu

The load module is generated in the “prj” folder under the name of “V850E2_MN4_CDC_GHS”. Select it and click the “Open” button.

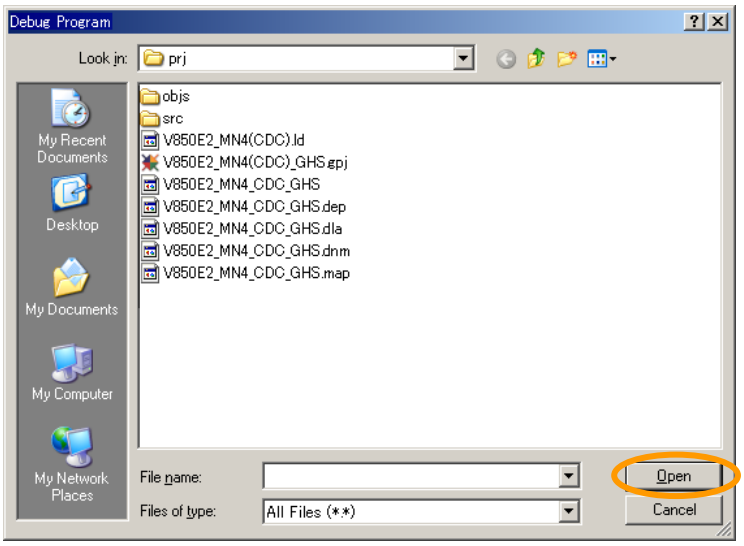


Figure 6.48 Selecting the Load Module

(2) Running the Program

Press the MULTI Debugger's  button or choose "Go on Selected Items" from the "Debug" menu.

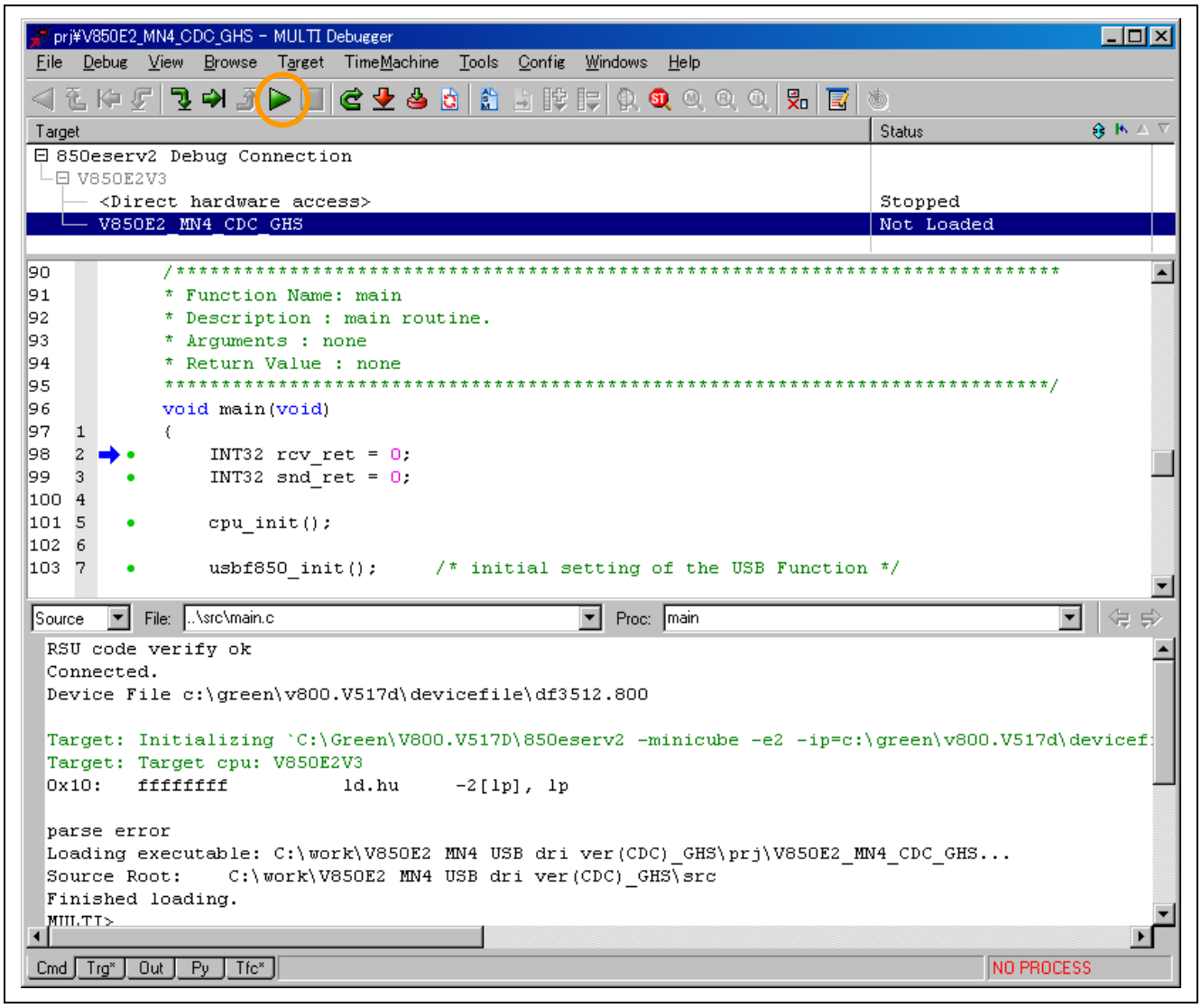


Figure 6.49 Running the Program

6.6 Setting up an IAR Embedded Workbench

This section explains the preparatory steps that are required to develop or debug using IAR Embedded Workbench which is introduced in section 6.1, Development Environment.

6.6.1 Setting up the Host Environment

You create a dedicated workspace on the host machine.

(1) Installing the IAR Embedded Workbench Integrated Development Tools

Install IAR Embedded Workbench. Refer to the IAR Embedded Workbench user's manual for details.

(2) Expanding Driver and Other Files

Store a set of distribution sample driver files in an arbitrary directory without modifying their folder structure.

Store the host driver for the debugging port in an arbitrary directory.

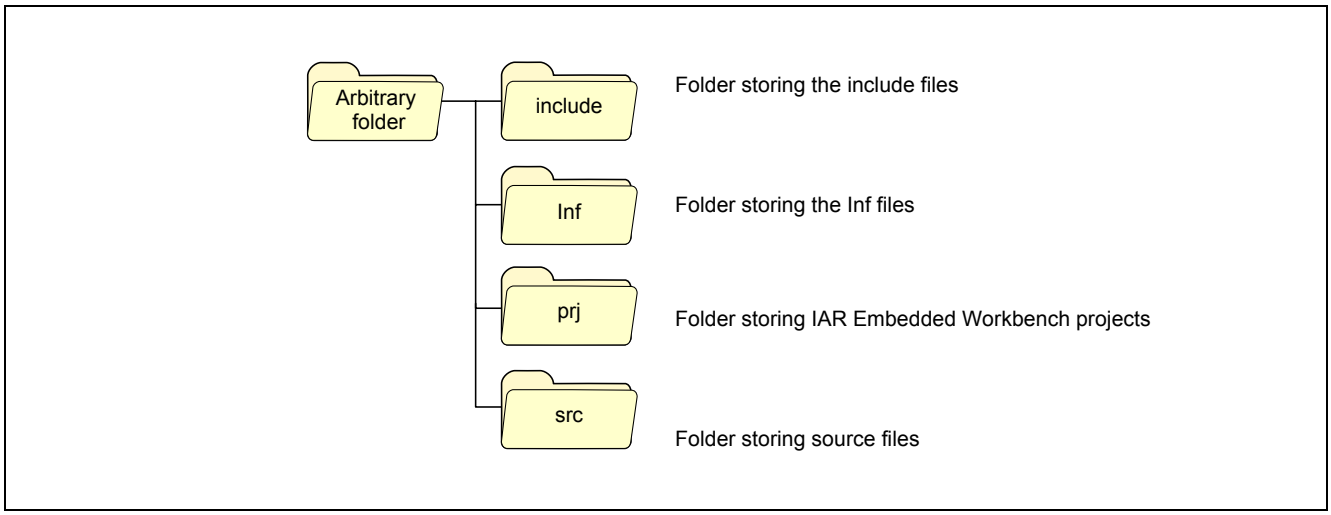


Figure 6.50 Folder Configuration for the Sample Driver (IAR Embedded Workbench Version)

(3) Installing Device Files

Copy the V850E2/MN4 device files for IAR Embedded Workbench in the folder where IAR Embedded Workbench is installed.

Example: C:\Program Files\IAR Systems\Embedded Workbench 6.0 for V850 Kickstart\v850\inc

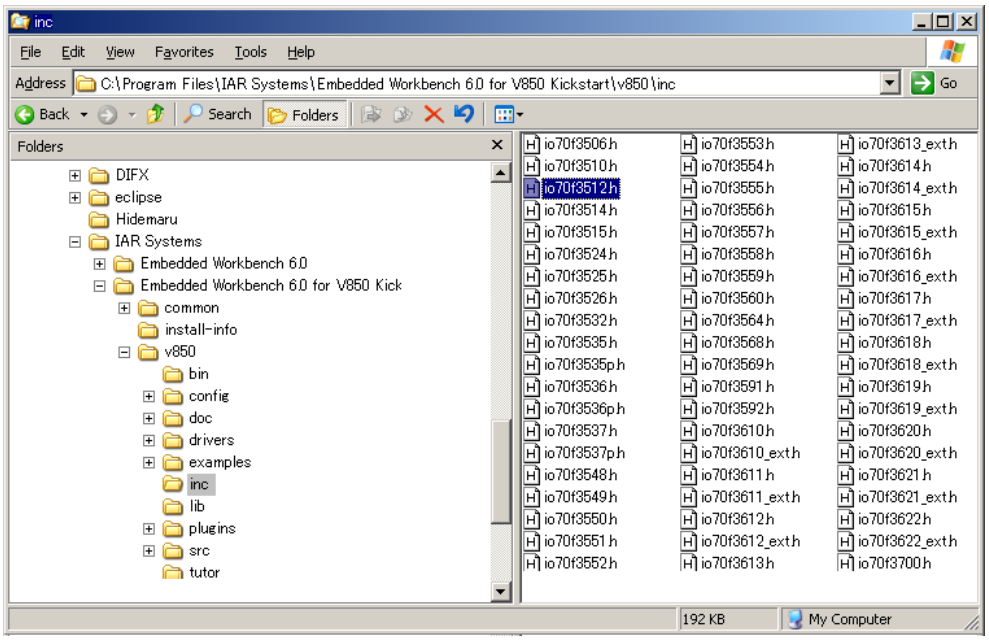


Figure 6.51 Example of Destination Folder for Storing the Device Files

(4) Starting the IAR Embedded Workbench

Select the “V850E2_MN4(CDC)_IAR.eww” IAR IDE Workspace from Window Explorer and start the IAR Embedded Workbench.

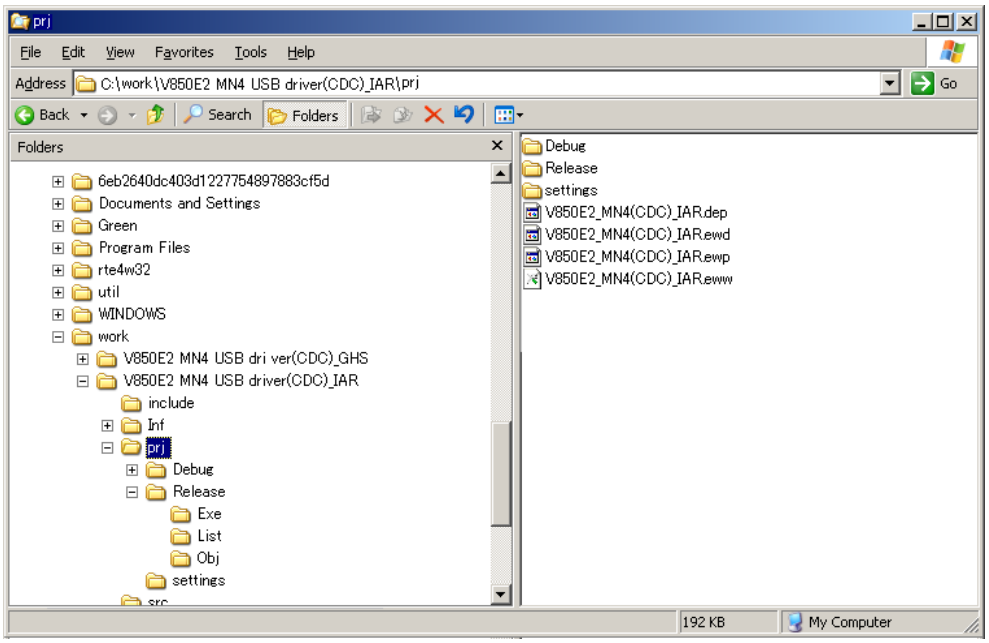


Figure 6.52 Selecting the IAR Embedded Workbench

(5) Debugging Tool Settings

This section presents the procedure when MINICUBE is used as a debugging tool.

<1> Move the mouse pointer to the “V850E2_MN4(CDC)_IAR-Release” (or “Debug”), right click, and select “Options”. The Options dialog will be displayed.

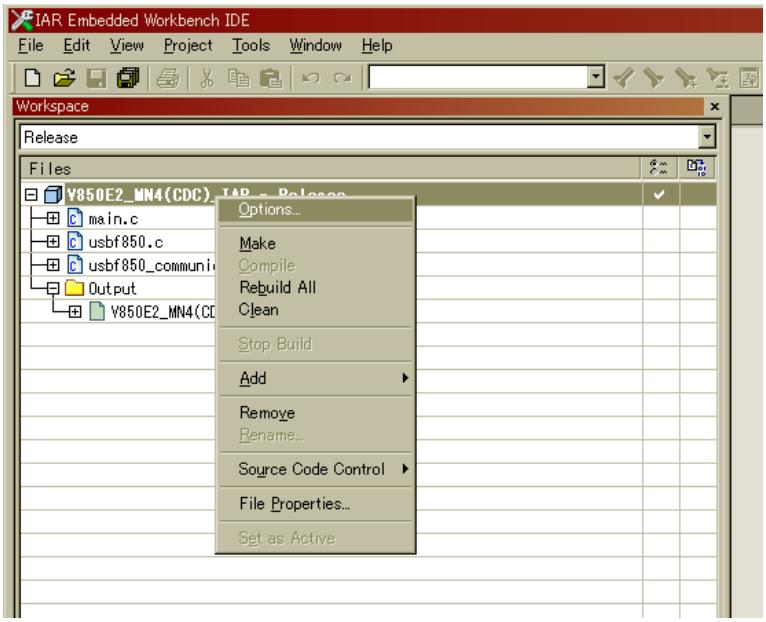


Figure 6.53 Option Selection

<2> In the “Options for node “V850E2_MN4(CDC)_IAR”” dialog, select “Debugger” in the “Category” area.

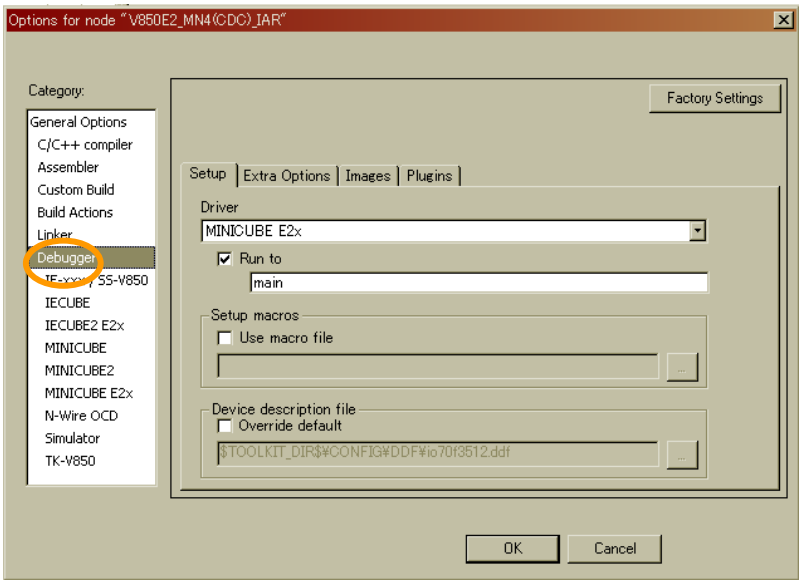


Figure 6.54 Debugger Selection

<3> Select “MINICUBE E2x” in the “Driver” item in the “Setup” tab and click “OK”.

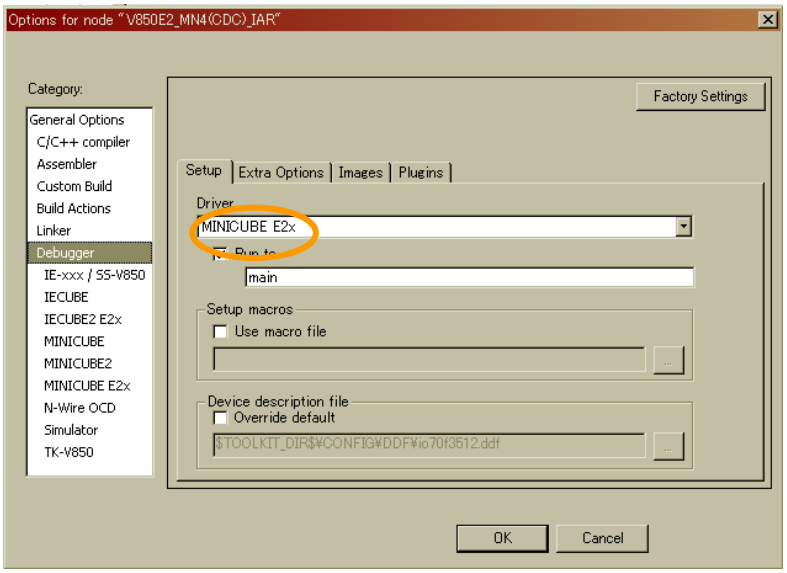


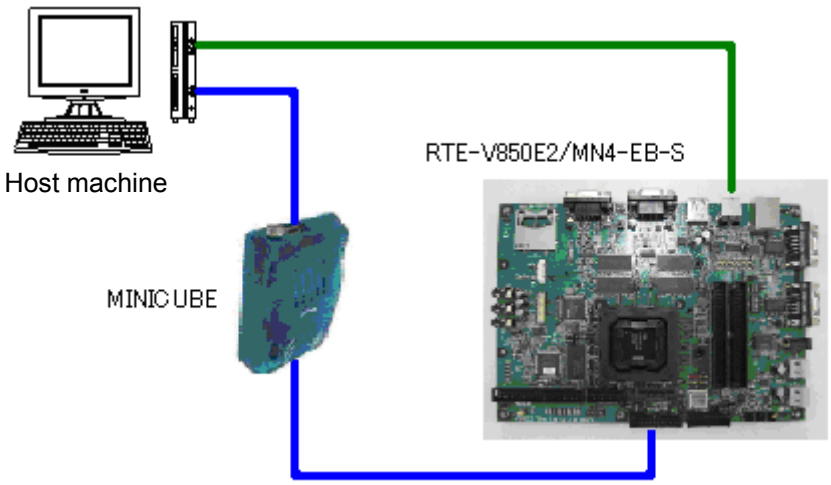
Figure 6.55 Debugger Selection

6.6.2 Setting up the Target Environment

You connect the target device to be used for debugging to the host machine. The procedure is common to CubeSuite, Multi, and IAR Embedded Workbench.

(1) Connecting to the Debugging Port

Connect between the RTE-V850E2/MN4-EB-S and the host machine. Connect the RTE-V850E2/MN4-EB-S and the host machine via the MINICUBE for debugging. In addition, connect between the USB B type receptacle of the RTE-V850E2/MN4-EB-S and the USB receptacle of the host machine for the CDC.



Remarks: See section 8, Outline of the Starter Kit, for the physical appearance and port configuration of the RTE-V850E2/MN4-EB-S.

Figure 6.56 Connecting the RTE-V850E2/MN4-EB-S

(2) Host Driver Installation

This section presents the procedure for using the virtual COM port host driver included with this sample driver.

<1> When connection of the RTE-V850E2/MN4-EB-S is recognized by the host machine, it displays the “New hardware detected” message and starts the “Found New Hardware Wizard”.

<2> The “Found New Hardware Wizard” dialog opens. Select, “No, not this time” and click “Next”.

Figure 6.57 Add New Hardware Wizard (1)

<3> The next screen will be displayed. Select “Install from a list or specific location (Advanced)” and click “Next”.

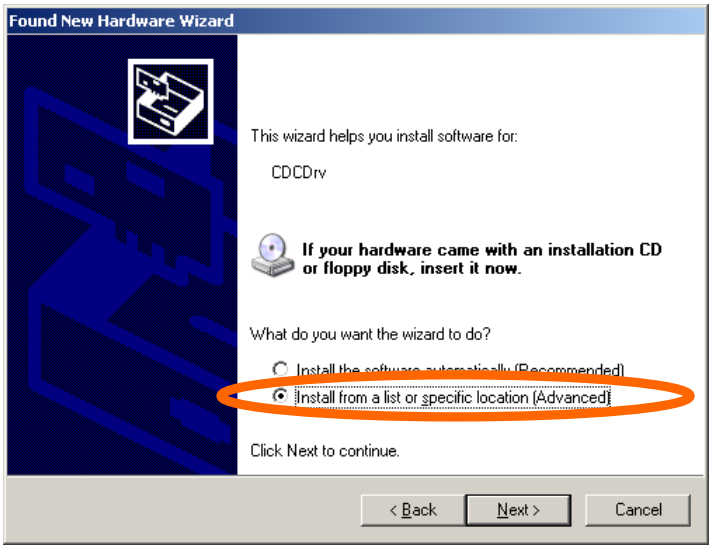


Figure 6.58 Add New Hardware Wizard (2)

<4> The next screen will be displayed. Select “Don’t search. I will choose the driver to install.” and click “Next”.

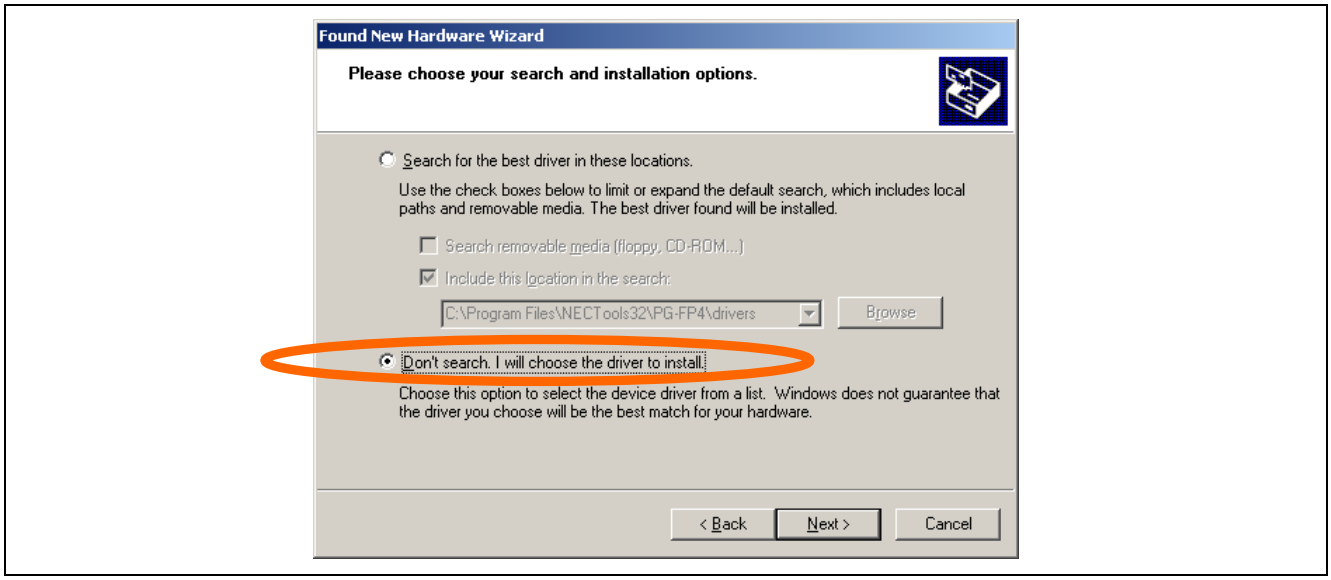


Figure 6.59 Add New Hardware Wizard (3)

<5> The next screen will be displayed. Click “Have Disk”.

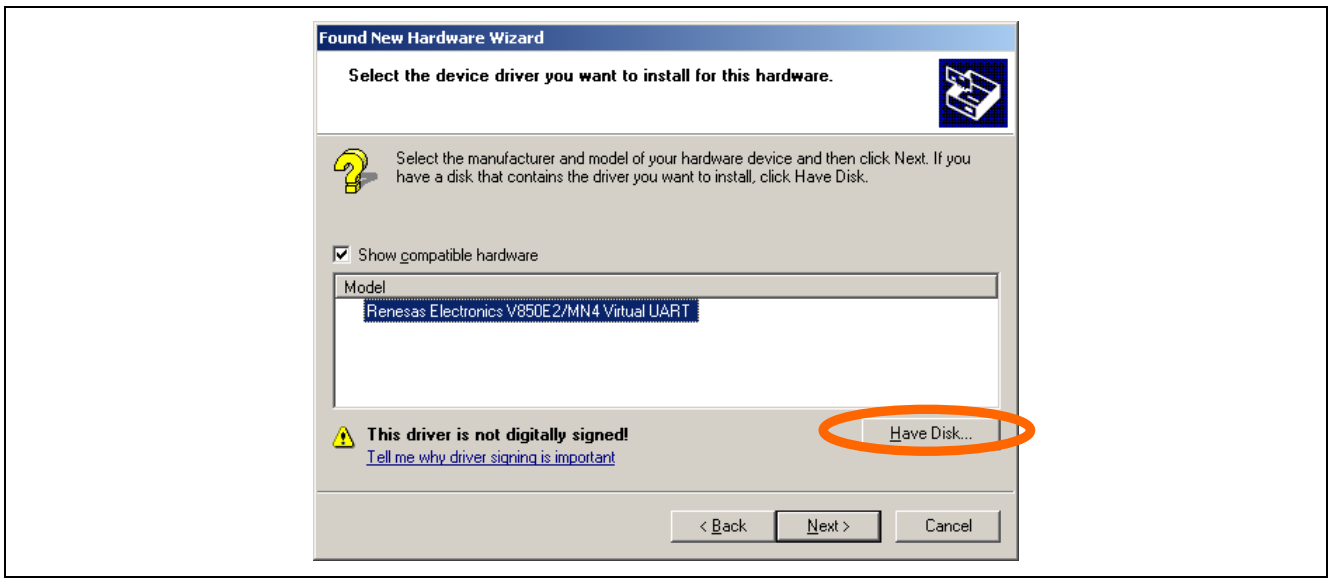


Figure 6.60 Add New Hardware Wizard (4)

<6> The “Install From Disk” dialog will open. Click “Browse...” to display the inf file folder in the directory that holds the sample driver.

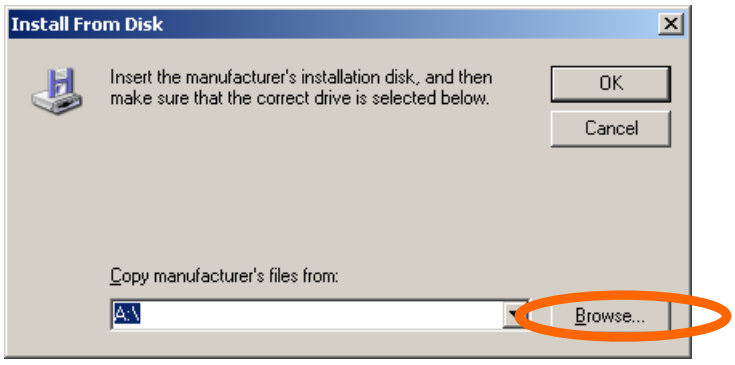


Figure 6.61 Browsing for .inf Files

<7> Select the .inf file in the folder (XP, Vista, or Win7) that matches the OS used on the host system and click “Open”.

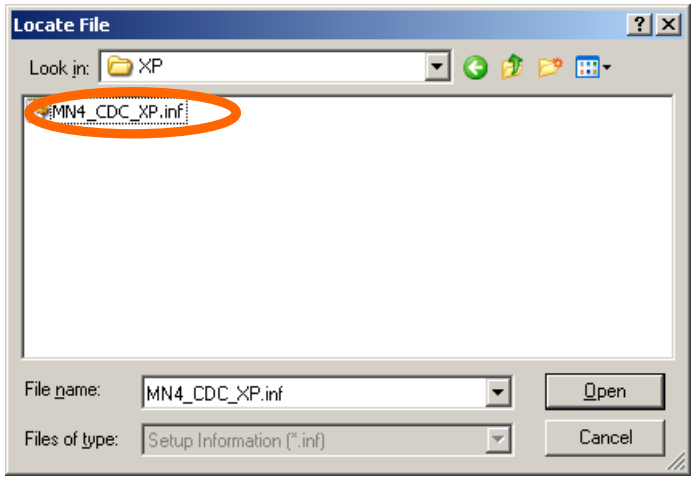


Figure 6.62 Selecting a .inf File

<8> The system will return to the “Install From Disk” dialog. Verify that the file shown in the “Copy manufacturer’s files from:” field is correct and click “OK”.

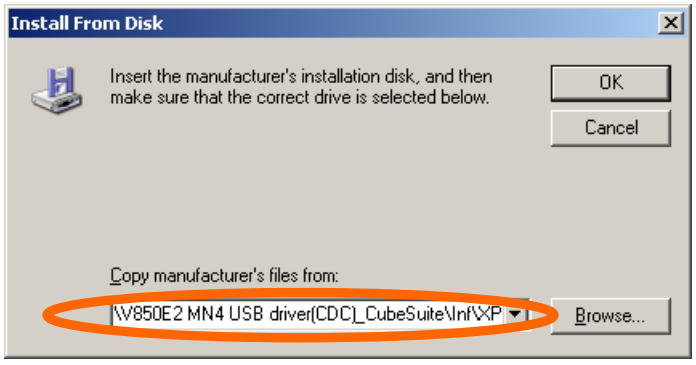


Figure 6.63 Installing the .inf File

<9> The system will return to the “Found New Hardware Wizard”. Select “Renesas Electronics V850E2/MN4 Virtual UART” and click “Next”.

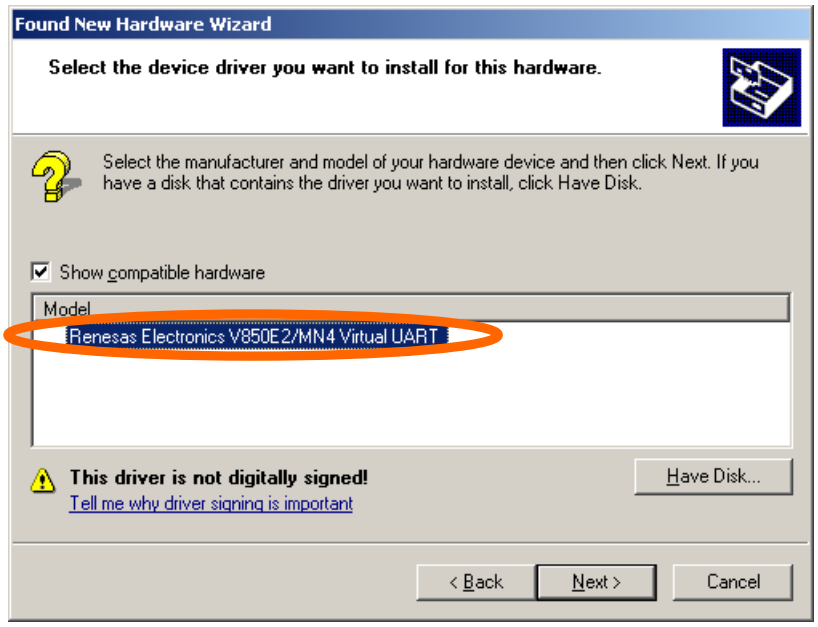


Figure 6.64 Selecting the Device Driver to Install

<10> The driver installation process will start.

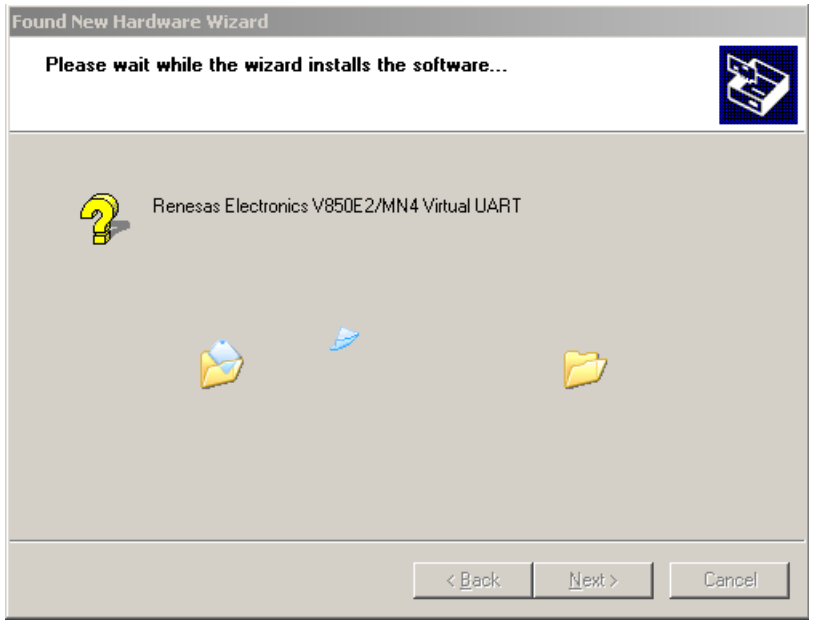


Figure 6.65 Driver Installation in Progress (1)

<11> The “Hardware Installation” dialog will be displayed. Click “Continue Anyway”.

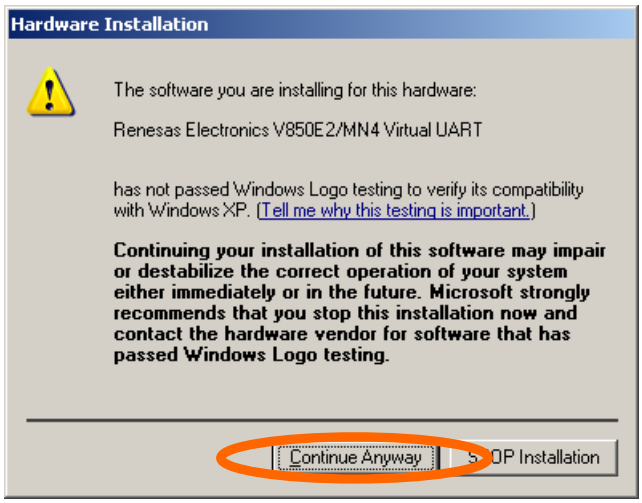


Figure 6.66 Driver Compatibility Verification Dialog

<12> The driver will be installed. Depending on the computer environment, some amount of time may be required.

<13> Click “Finish” after installation is completed.

(3) Verify Device Allocation

Open the Windows “Device Manager”. Expand the “Ports” tree in the device listing and verify both that the “Renesas Electronics V850E2/MN4 Virtual UART” is displayed and the allocated COM port number.

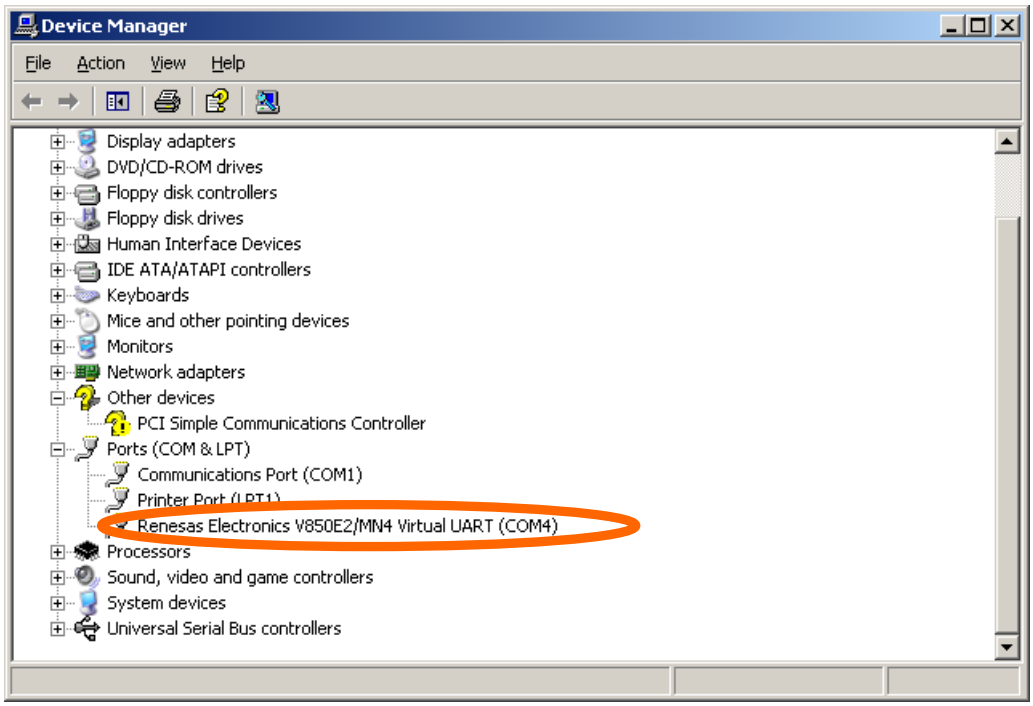


Figure 6.67 COM Port Verification

Note: Device and port numbers can be changed to arbitrary values. For details, see section 7.2, Customization.

6.7 Debugging in the IAR Embedded Workbench Environment

This section explains the procedure to debug an application program that is developed in the workspace introduced in section 6.6, Setting up the IAR Embedded Workbench Environment.

6.7.1 Generating a Load Module

To write a program into the target device, it is necessary to compile its source file that is coded in C or assembly language into a load module.

In IAR Embedded Workbench, a load module is generated by choosing “Rebuild All” from the “Project” menu.

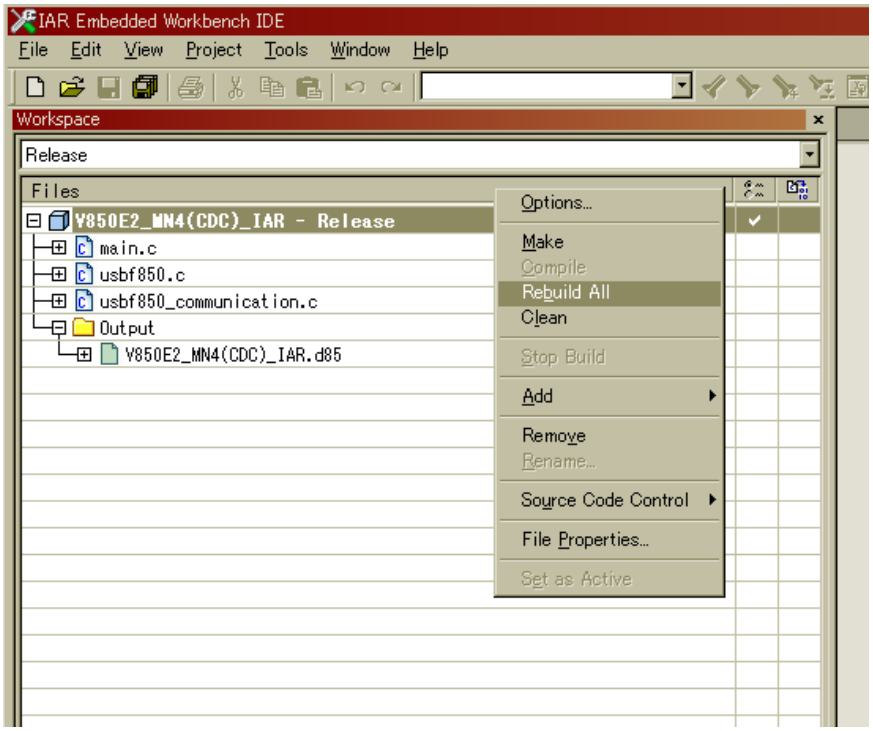


Figure 6.68 Selecting a Rebuild All

6.7.2 Loading and Executing

You write (load) the generated load module into the target for execution.

(1) Writing a Load Module

Shown below is the procedure to write a load module into the RTE-V850E2/MN4-EB-S via IAR Embedded Workbench.

<1> Select “Download and Debug” from the “Project” menu in the IAR Embedded Workbench.

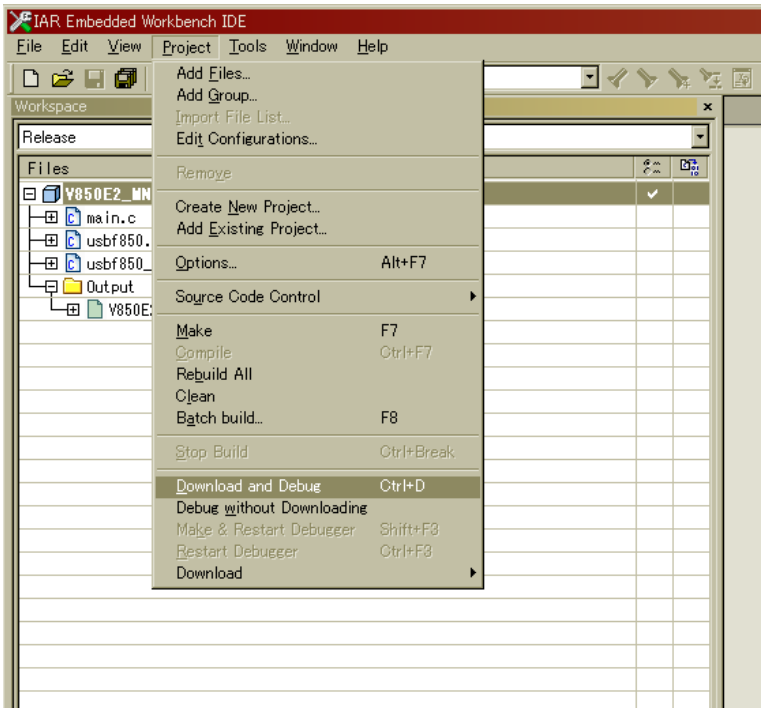


Figure 6.69 Starting the Debugger

<2> The downloading of the load module is started via the debugging tool.

(2) Running the Program

Press the IAR Embedded Workbench's  button or choose "Go" from the "Debug" menu.

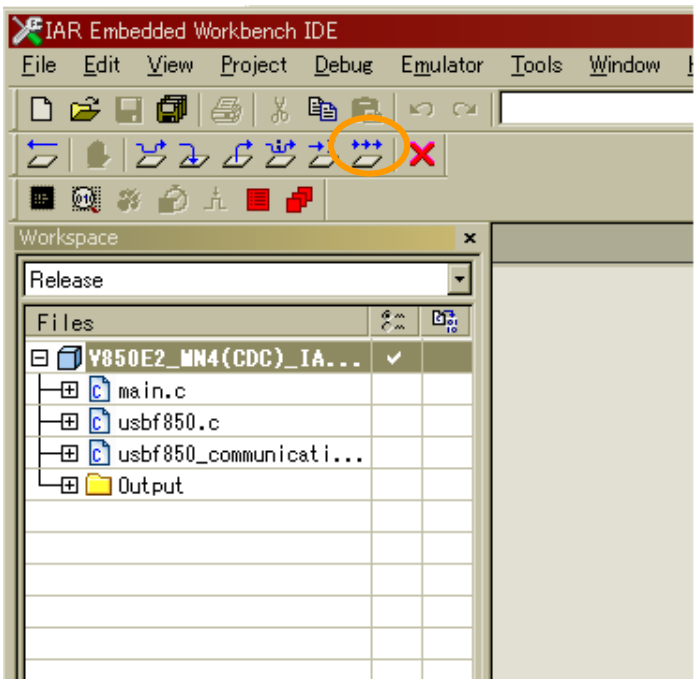


Figure 6.70 Running the Program

6.8 Operation Verification

The results of executing the sample application included in the driver can be verified if a target device with the sample driver loaded is connected to the host machine via USB.

First, run a terminal emulator (such as Tera Term) and verify that entered data is displayed.

Note: For details on the sample application, see section 5, Sample Application Specifications.

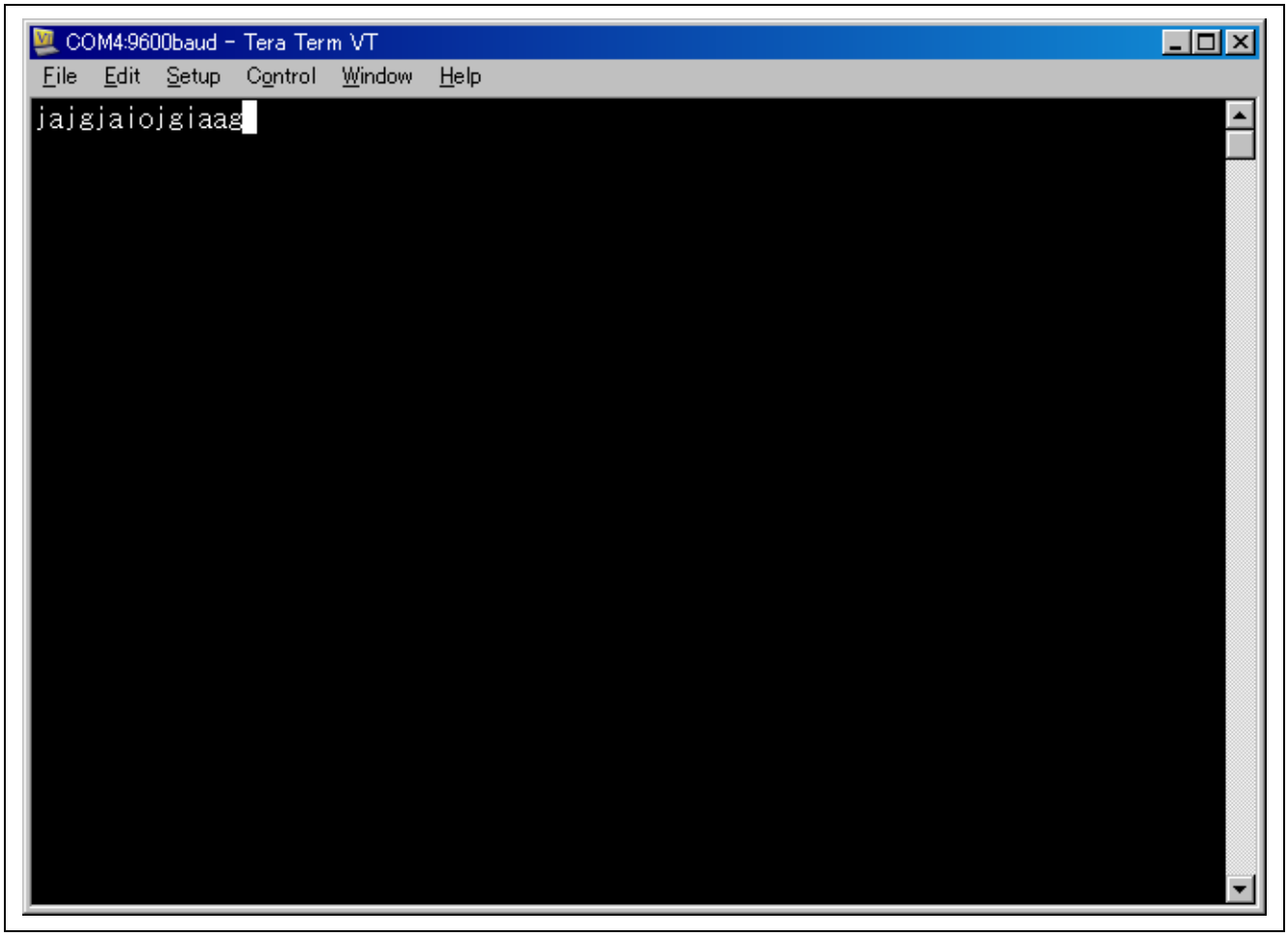


Figure 6.71 Terminal Input Character Echo Result

7. Using the Sample Driver

This section presents information that users need to know when using this USB communication device class sample driver for the V850E2/MN4 microcontroller.

7.1 Overview

Normally, the need to modify the following sections will arise when using the sample driver.

(1) Customization

Rewrite the following sections as needed.

- The sample application section in the file main.c
- The register setting values in the file usbf850.h
- The detailed content of the descriptors in the file usbf850_desc.h
- The device name and provider information in the virtual COM port host driver (.inf file)

Note: See section 2.1.3, Sample Driver Structure, for details on the sample driver file structure.

(2) Function Usage

The functions are called as required from application programs. See section 4.3, Function Specifications, for details on the implemented functions.

7.2 Customization

This section describes the sections you should rewrite when using the sample driver.

7.2.1 Application Section

The section indicated below in the file main.c codes some simple processing as an example of using the sample driver. Declare and code the processing actually required for the application in this section of the program. The initialization functions preceding this section and the data send/receive functions in the application can be used without modification. When using these, verify by checking section 4.3, Function Specifications, and section 7.3 Function Usage.

```
/*******************************************************************************
* Function Name : main
* Description   : main routine.
* Arguments     : none
* Return Value  : none
*******************************************************************************/
void main(void)
{
   INT32 rcv_ret = 0;
   INT32 snd_ret = 0;

   cpu_init();

   usbf850_init();        /* initial setting of the USB Function */

   __EI();

   while (1)
   {
      if (usbf850_get_bufinit_flg() != DEV_ERROR)
      {
         if (snd_ret >= 0)
         {
            rcv_ret = usbf850_recv_buf(&UserBuf[0], USERBUF_SIZE);
         }
         if (rcv_ret >= 0)
         {
            snd_ret = usbf850_send_buf(&UserBuf[0], rcv_ret);
         }
      }
      else
      {
         snd_ret = 0;
         rcv_ret = 0;
      }

      if (usbf850_rsuspd_flg == SUSPEND)
      {

         __DI();

         __halt();

         usbf850_rsuspd_flg = RESUME;

         __EI();
      }
   }
}
```

Figure 7.1 Sample Application Code

7.2.2 Register Settings

The registers that the sample driver uses (writes to) and their settings are defined in the file “usbf850.h.” By rewriting these values in the file according to the actual application, you can configure the operation of the target device through the sample driver.

(1) File “usbf850.h”

Defines the settings of the USB function controller registers.

7.2.3 Contents of the Descriptors

The file “usbf850_desc.h” defines the data (see section 4.1.3, Descriptor Settings) that the sample driver registers in the USB function controller during initialization processing. By rewriting these values in the file according to the actual application, you can set up the attributes and other information of the target device through the sample driver.

Note that if the device descriptor vendor ID and product ID are modified, it will be necessary to also modify the host driver (.inf file) used when connecting the target device in the same way. (See section 7.2.4 (3) Changing the Vendor ID and Product ID.)

Also, arbitrary information can be registered in the string descriptor. Since manufacturer and product information are defined in the sample driver, the user should declare and modify this information.

7.2.4 Virtual COM Port Host Driver Settings

The following sort of customization is also possible in relation to the driver installed in section 6.2.2 Setting up the Target Environment.

(1) Changing the COM Port Number

When a USB device connection is recognized, the host automatically allocates a COM port number for that device. However, this can be changed to be an arbitrary number. The procedure for changing the COM port number on the host machine is shown below.

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

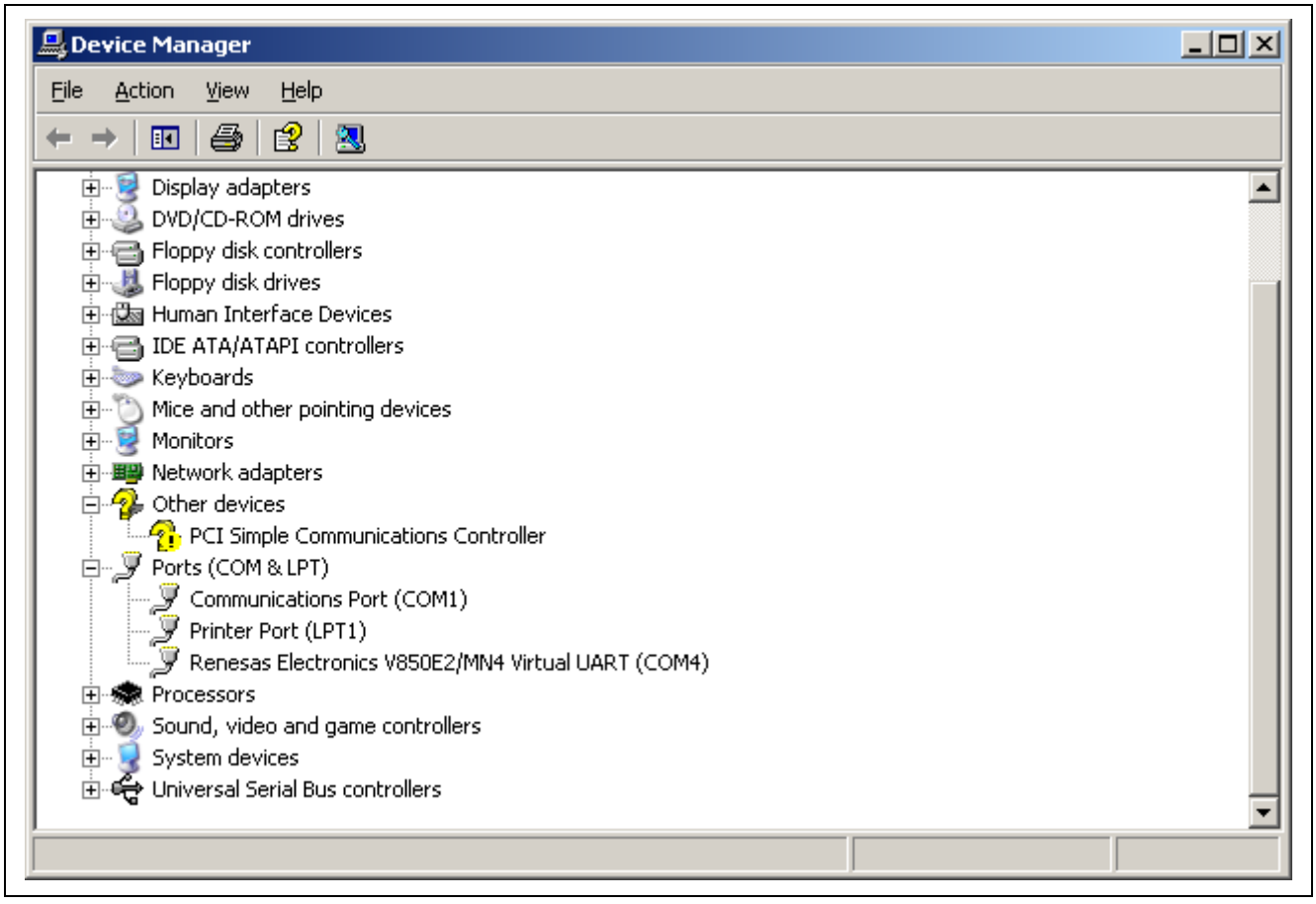


Figure 7.2 Device Manager Display

<2> Select “Renesas Electronics V850E2/MN4 Virtual UART (COMn)” (where n is the number allocated by the host) and display its properties.

<3> On the “Port Settings” tab, click “Advanced”.

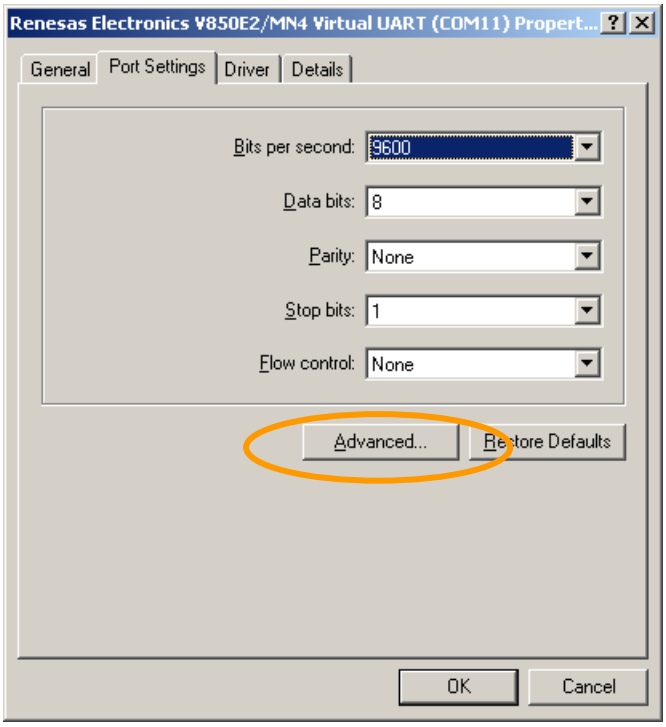


Figure 7.3 Port Settings Tab Display

<4> The “Advanced Settings for COMn” dialog (where n is the number allocated by the host) will open. Select an arbitrary port number from the drop down list for the “COM Port Number” field.

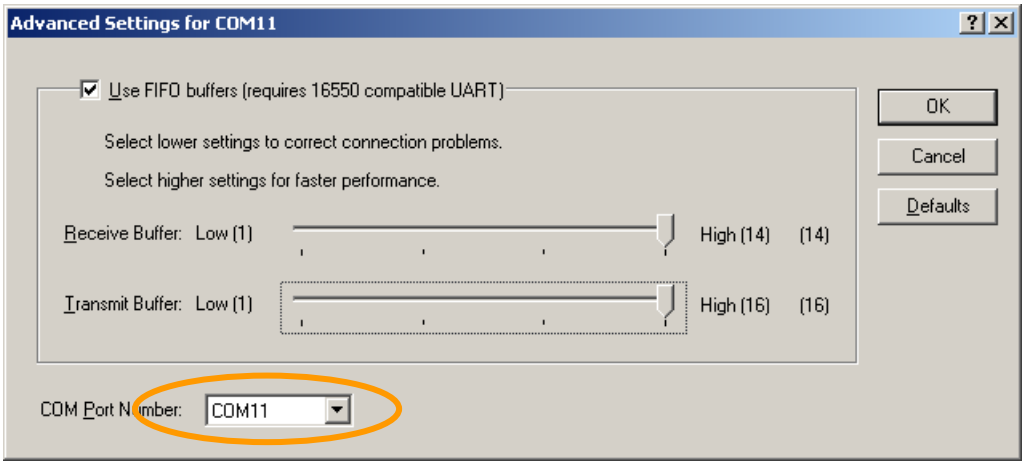


Figure 7.4 COM Port Number Specification

Notes: 1. Do not select a port number that conflicts, i.e. that is being used by another device.
2. Although the new port number becomes effective immediately after the change, it may not be immediately reflected in the Device Manager list.

(2) Changing the Properties

Certain of the device properties and other information used by the Windows “Device Manager” can be changed to arbitrary values. The following items can be changed.

<1> Device name (device list)

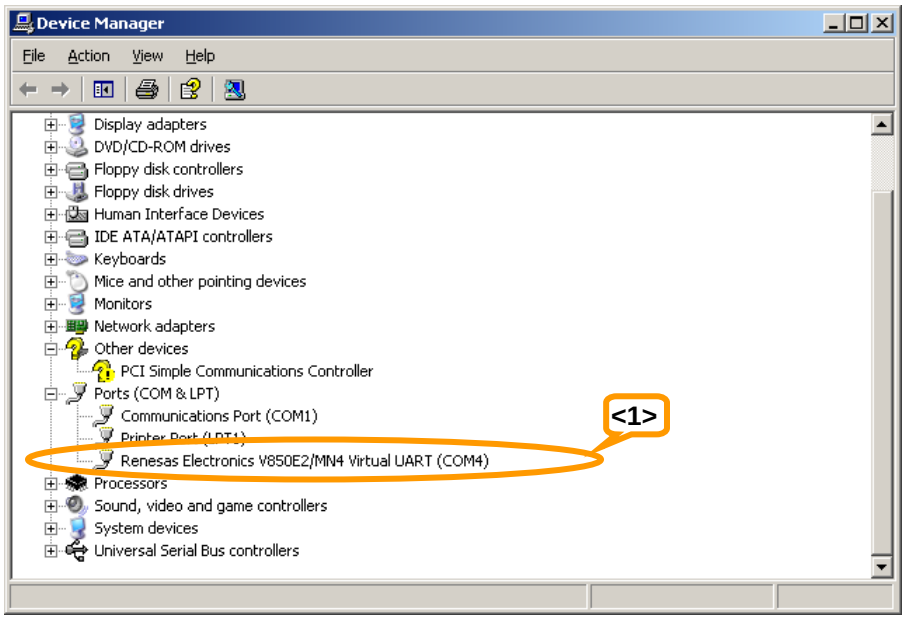


Figure 7.5 Device Name in the Device Manager

<2> Device name, manufacturer name, and version (device properties)

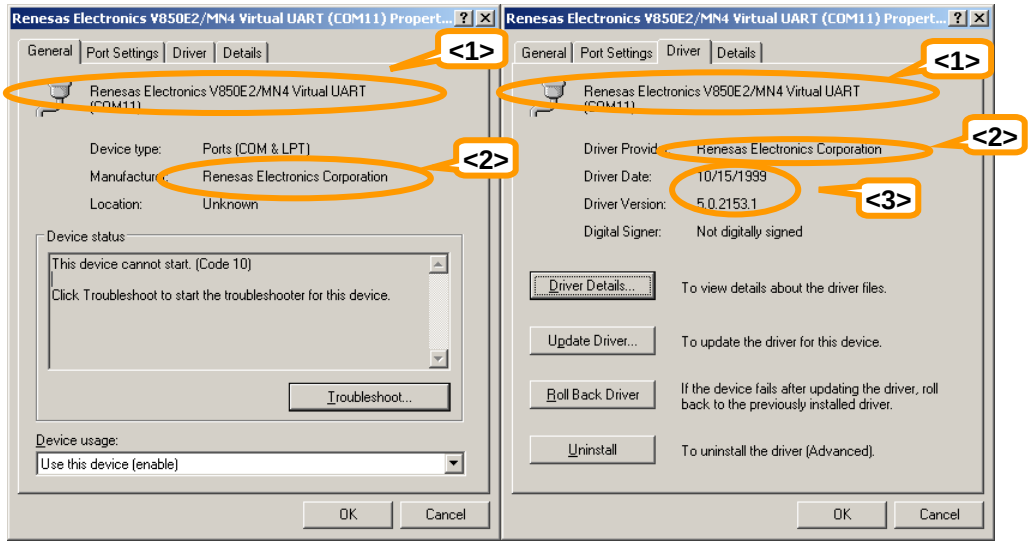


Figure 7.6 Device Properties

Since these items are displayed based on information coded in the host driver (in the .inf file), they can be changed by modifying the .inf file. The figure shows the parts in the .inf file that corresponds to the numbered items above.

```
1  ; .inf file (Win2000,XP):
2  [Version]
3  Signature="$Windows NT$"
4  Class=Ports
5  ClassGuid={4D36E978-E325-11CE-BFC1-08002BE10318}
6
7  Provider=%RENESAS%
8  LayoutFile=layout.inf
9  DriverVer=10/15/1999,5.0.2153.1                                    <3>
10
11 [Manufacturer]
12 %RENESAS%=RENESAS
13
14 [RENESAS]
15 %RENESASV850E2MN4%=Reader, USB\VID_045B&PID_0200
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 RENESAS = "Renesas Electronics Corporation"                        <2>
49 RENESASV850E2MN4 = "Renesas Electronics V850E2/MN4 Virtual UART"   <1>
50 Serial.SvcDesc = "USB Serial emulation driver"
```

Figure 7.7 Notation in the MN4_CDC_XP.inf File

(3) Changing the Vendor ID and Product ID

When changing the vendor ID and product ID in the device descriptor, the same content must also be specified in the host driver (.inf file).

In the .inf file, the vendor ID and product ID must be notated with the following format at the 15th line in listing 6-2.

Vendor ID: A 4-digit hexadecimal number prefixed with “VID_”.

Product ID: A 4-digit hexadecimal number prefixed with “PID_”.

7.3 Function Usage

Processing that is frequently used or is of high generality is provided as functions that can simplify application coding and lead to reduced code size. See section 4.3, Function Specifications, for details on each of these functions.

The following sections of the sample application shown in the listing can be reused as an example of the application of these predefined processing units.

(1) User Data FIFO State Verification

The user data FIFO state reporting function (usbf850_get_bufinit_flg()) is called on line 24 in figure 7.1 to monitor the usbf850_bufinit_flg user data FIFO initialization flag. This flag is defined independently by the sample driver and is set to 1 when FIFO initialization is executed either in bus reset processing, which is notified by the sample driver INTUSFA0I1 interrupt or in the class request SetLineCoding request processing. In the sample application, the user send/receive processing error state is cleared to 0 on this FIFO initialization.

(2) User Data Reception Processing

In the sample driver, receive data acquisition is divided into two stages, data size acquisition and data copying, and functions for each of these operations are defined. When reception processing is performed based on the actually received size, the size of the received data can be verified. However, note that the maximum data size that can be processed in one reception operation is limited to being no larger than the size of the data that can be received in a single packet. The sample application is a usage example for the case where the buffer size is determined in advance and in the user data reception processing function (usbf850_recv_buf()), if there is receive data, that data is read from the used endpoint.

(3) User Data Transmission Processing

In the user data transmission processing function (usbf850_send_buf()) on line 29 of figure 7.1, if there is data to transmit, it checks the state of the FIFO for the used endpoint and if the FIFO is empty, it writes the data. If the FIFO is full, it terminates with an error. Also, if there is no transmit data, if the data size for the previously transmitted packet was equal to MaxPacketSize, it performs a null packet transmission operation. This is because in the communication device class specifications, if the data in the last packet is equal to MaxPacketSize, a null packet must be transmitted to notify the host that it was the last data.

7.4 Notice

Since terminal connection cannot be recovered when the USB cable is disconnected in connection by terminal emulator and it is connected again after that, it may be unable to reconnect or the COM port of sample driver is not displayed.

<Example of measures>
- When the USB cable is disconnected, the COM port currently used for CDC connection by application program is closed, and connection processing is terminated.
- When developing an application program, the COM port is opened only when performing communication, and when the communication is completed or terminates with an error, it is closed.

8. Outline of the Starter Kit

This section gives a brief description of the RTE-V850E2/MN4-EB-S starter kit for the V850E2/MN4, manufactured by Midas lab Inc.

8.1 Outline

The RTE-V850E2/MN4-EB-S is a starter kit that allows you to experience the development of an application system using the V850E2/MN4. You can follow a sequence of development processes from program preparation, building, debugging, to operation check simply by installing required development tools and a USB driver on the host machine and connecting this kit via MINICUBE.

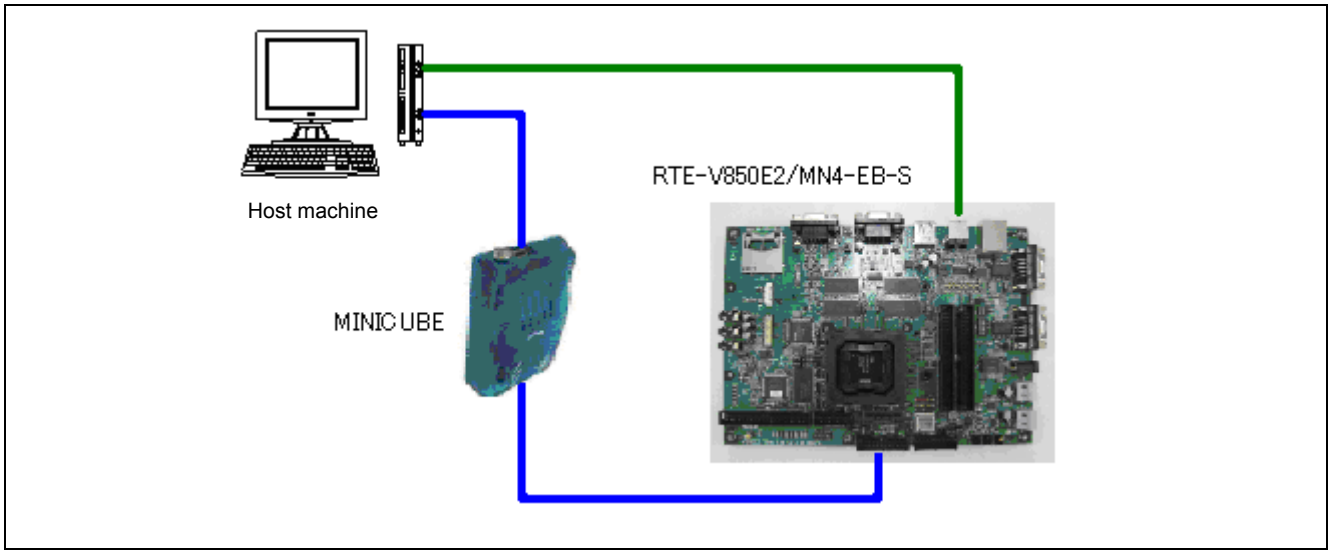


Figure 8.1 Outline of RTE-V850E2/MN4-EB-S Connection

8.2 Features of the Starter Kit

The RTE-V850E2/MN4-EB-S has the following features:

- 2 systems of memory controllers, DMA, timer array, UART, CSI , CAN, A/D converter, USB function controller, USB host controller, Ethernet controller, and other peripheral functions
- I/O ports for 7 input lines and 181 I/O lines
- Permits efficient development when combined with an integrated development environment (CubeSuite/Multi/IAR Embedded Workbench).

8.3 Major Specifications

The major specifications of the RTE-V850E2/MN4-EB-S are given below.

- CPU: μPD70F3512 (V850E2/MN4)
- Operating frequency: 200 MHz (PLL-driven x20 multiplier function)
- Interface: Two USB receptacles (USB host type A × 1, USB function type B × 1)
  N-Wire connector
  Two channels of UART
  Two channels of CAN
  Ethernet connector
- Supported models: Host machine: PC/AT compatible with a USB interface
  OS: Windows 2000 or Windows XP
- Operating voltage: 5.0 V
- Dimensions: W200 × D150 (mm)

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Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	Jun 30, 2010	—	First edition issued
1.01	Feb 01, 2012	All pages	Format revisions associated with the merger into Renesas Electronics Corporation Content concerning the GHS and IAR Embedded Workbench version added to section 6

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

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

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