Renesas USB MCU

USB PMSC with Local File System and Flash Storage

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Introduction

This document is an extension of the PMSC application note R01AN0514EJ0400. for USB Peripheral Mass Storage class using Renesas. Added to this version is the ability of the RX platfrom to locally access (r/w) files on the board using its own file system library, and also the ability to use the RSK63N's serial flash chip.

It is an add-on for the RSK63N, but the implementation can be applied to any of the devices in the RX600.

Target Device

RX63N Group. This program can be used with other RX600 Series microcontrollers that have the same USB module as the above target devices. When using this code in an end product or other application, its operation must be tested and evaluated thoroughly.

This program has been evaluated usingthe Renesas Starter Kit board for RX63N.

The default storage for demo is RAM. See 9 for how to use the board SPI flash.

The storage media block size is set to 4 kB which only works with Win7 or later. This can be changed to standard 512 B bokcs in *ram_disk.h* and *ff_conf.h*.

Content

1. Overview

This document is a manual describing use of the USB Peripheral Mass Storage class driver for Renesas.

1.1 Functions and Features

The USB Peripheral Mass Storage Class driver comprises a USB Mass Storage class bulk-only transport (BOT) protocol. When combined with a USB peripheral control driver and storage device driver, it enables communication with a USB host as a BOT-compatible storage device.

1.2 Related Documents

1. USB Revision 2.0 Specification
2. USB Mass Storage Class Specification Overview Revision 1.1
3. USB Mass Storage Class Bulk-Only Transport Revision 1.0, “BOT” protocol
   [http://www.usb.org/developers/docs/]
4. RX62N Group, RX621 Group User's Manual: Hardware. (Document No. R01UH0033EJ.)
5. RX63N Group User's Manual: Hardware. (Document No. R01UH0041EJ.)
6. RX630 Group User's Manual: Hardware. (Document No. R01UH0040EJ.)
7. R8A66597 Data Sheet. (Document No.REJ03F0229RJJ03F.)
8. Renesas USB Basic Firmware Application Note. (Document No. R01AN0512EJ.)
9. RX600 Series USB PMSC with Local File System and Flash Storage installation guide.
   (Document No. R01AN0529EJ.)
10. Block Access Media Driver API. (Document No. R01AN1443EU.)
11. Block Storage Driver for Serial Flash via RSPI. (Document No. R01AN1466EU.)

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

USB Devices Page
[http://www.renesas.com/prod/usb/]

1.3 Terms and Abbreviations

ANSI	:	American National Standards Institute
APL	:	Application program
ASSP (asp)	:	Application Specific Standard Produce
BOT	:	USB mass storage class bulk only transport. See “Universal Serial Bus Mass Storage Class Bulk-Only Transport” at USB Implementers Forum.
cost	:	Prefix of Function and File for Host & Peripheral USB-Basic-F/W
DDI	:	Device driver interface, or PMSDD API.
HEW	:	High-performance Embedded Workshop
H/W	:	Renesas USB device
ITRON, uITRON	:	Industrial The Real-time Operating system Nucleus
non-OS	:	USB basic firmware for OS less system
PCD	:	Peripheral control driver of USB-Basic-F/W
PCDC	:	Communications Devices Class for peripheral
PCI	:	PCD interface
PMSCD	:	Peripheral mass storage USB class driver (PMSCF + PCI + DDI)
PMSCF	:	Peripheral mass storage class function
PMSDD	:	Peripheral mass storage device driver (sample ATAPI driver)
PP	:	Pre-processed definition
pstd	:	Prefix of Function and File for Peripheral USB-Basic-F/W
R8A66597	:	Renesas Hi-Speed USB2.0 ASSP R8A66597 board (Use in combination with RX62N-RSK.)
RTOS	:	USB basic firmware for uITRON system
RX62N-RSK	:	Renesas Starter Kits for RX62N
RX630-RSK	:	Renesas Starter Kits for RX630
RX63N-RSK	:	Renesas Starter Kits for RX63N
Scheduler	:	Used to schedule functions, like a simplified OS.
Scheduler Macro	:	Used to call a scheduler function (non-OS)
Task	:	Processing unit
USB	:	Universal Serial Bus
USB-Basic-F/W	:	USB basic firmware for Renesas USB device (non-OS& RTOS)

(Note 1) When RX62N-RSK is used in conjunction with the R8A66597, SW1 is allocated to a port used by an interrupt. Therefore, do not use SW1.

2. Using E2studio

2.1 Import the Project

With e^2 studio, a project should not be moved, but first exported then imported. Follow the directions below.

2.1.1 New Workspace

1. Create empty folder where you want workspace.
2. Start E2S, and point to that folder as E2S asks what workspace to open.
3. Click Workbench icon (bottom right in blue intro-screen).
4. Continue with next step below.

2.1.2 Existing Workspace

1. Select Import.
2. Select General => Existing Projects into workspace. ("Create new projects from an archive file or directory.")
3. Browse to

    Archive zip-file, *or*

    Root directory

For both, make sure checkbox "*Copy project to workspace*" is checked.

You have now imported this project into the workspace. You can go ahead and import other projects into the same workspace... Follow below for importing to existing workspace.

Build with *Cntrl+B*.

3. Software Configuration

3.1 Module Configuration

As shown in Figure 3-1, PDCD comprises two layers: PMSCD and PMSDD.

PMSCD comprises three layers: PCD API (PCI), PMSDD API (DDI), and BOT protocol control and data sends and receives (PMSCF).

In the case of RTOS, PMSCD and PMSDD run on top of uITRON as tasks.

PMSCD uses the BOT protocol to communicate with the host via PCD.

PMSDD analyzes and executes storage commands received from PMSCD. PMSDD accesses media data via the media driver.

Figure 3-1 shows the configuration of the modules.

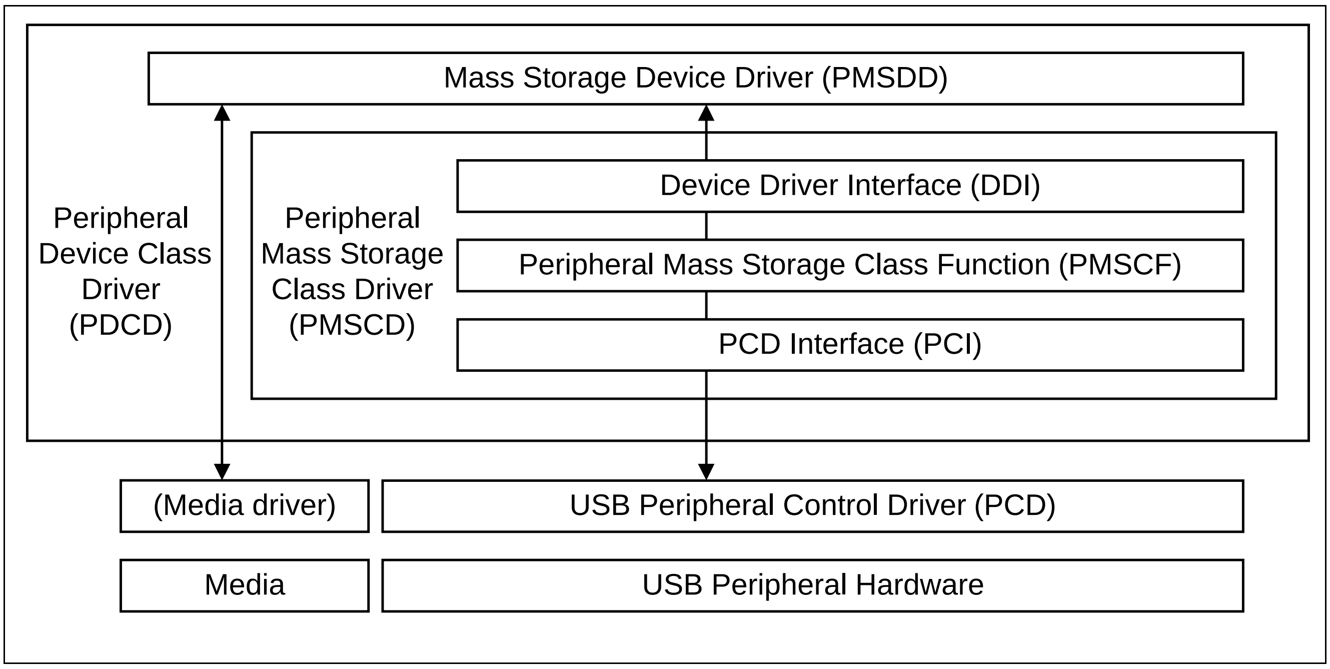

Mass Storage Device Driver (PMSDD)
Peripheral Device Class Driver (PDCD)
Peripheral Mass Storage Class Driver (PMSCD)
Device Driver Interface (DDI)
Peripheral Mass Storage Class Function (PMSCF)
PCD Interface (PCI)
(Media driver)
USB Peripheral Control Driver (PCD)
Media
USB Peripheral Hardware

Figure 3-1 Software Configuration Diagram

3.1.1 PDCD

As shown in Figure 3-1, PDCD incorporates PMSDD and PMSCD. PDCD takes care of class requests from the USB host, and responds to USB host storage commands.

Table 3-1 provides an overview of the parts of PDCD, aswell as PCD and the media driver. The media driver is implemented as an interchangeable block media type storage driver.

3.1.2 PMSCD

PMSCD comprises three layers: PMSCF, which performs BOT protocol control and data transmission/reception; DDI for interfacing with PMSDD; and a group of functions (PCI) for interfacing with PCD. The main functions of these layers are as follows.

1. PMSCF:

USB mass storage class BOT protocol control

CBW analysis, data transmission/reception, and CSW creation in coordination with PMSDD/PCD

Responding to class requests (MassStorageReset, GetMaxLUN)

2. PCI :

Processing of tasks, message boxes, and memory pools during configuration and detach

Receiving class requests

Clearing STALL states and setting related callback functions

Setting structures and callback functions for PCD transmit/receive data

3. DDI:

Driver registration.

Transferring data information and execution results during PMSDD execution - the ATAPI command result callback is executed.

Table 3-1 Overview of Modules

Chapter this doc	Module	Description	Reference folder/file	Note
USB Basic FW	PCD	USB peripheral hardware control driver.	\USBSTDFW	See “Renesas USB Device USB Basic Firmware Application note” Document no. R01AN0512.
Ch. 0	PCI	PMSCF-PCD interface functions.	\MSCFW\PMSC\ r_usb_pmsc_pci.c	
Ch. 0	PMSCF	Core component of PMSCD. Controls BOT protocol data and responds to USB class requests. Also transfers storage commands and data to and from storage (PMSDD).	\MSCFW\PMSC\ r_usb_pmsc_request.c r_usb_pmsc_driver.c	
	DDI	PMSDD-PMSCF interface: Driver registration and ATAPI result callback.	\MSCFW\PMSC\ r_usb_pmsc_ddi.c	
Ch. 0	PMSDD	Peripheral mass storage media driver. It processes storage commands from PMSCD and accesses the media via the block media driver below. (To be modified to match the memory device.)	\MSCFW\MEDIA \r_usb_atapi_driver.c	
Ch. 0	Block Media Driver	Block media storage driver. For either RAM or SPI flash data storage.	\MSCFW\MEDIA r_usb_atapi_memory.c	

3.2 File Structure

The following shows the folder structure for the files provided in this device class.

This source code does not use the ANSI-C type IO interface.

+---WorkSpace

(USB-BASIC-FW) [Common USB code that is used by all USB firmware]	
+---USBSTDFW	USB Basic FW
+---include	USB Basic FW Common header file
+---nonOS / RTOS	
((ANSI-C File I/O System Calls)	
+---ANSI [*open(), close(), read(), write(), etc of the USB class driver*]	
(Class F/W)	
+---MSCFW	
| +---include	Peripheral MSC header file
| +---PMSC	Peripheral MSC driver
(Sample Code) [*user application*]	
+---SmplMain	
| +---APL	Sample Application
(HW Setting) [Hardware access layer; to manipulate the MCU's USB register]	
+---HwResourceForUSB	Hardware resource for RX63N/RX631 Group
(media_driver)	File system and storage media
+---elm	ELM FAT32 file system (long filenames and 4 kB storage media possible)
+---r_bsp	FIT BSP
+---ram_disk	Driver when using RAM instaed of serial flash (default)
+---r_rspi_rx	FIT RSPI
+---r_spi_flash	FIT Flash
+---r_switches	FIT Switches package
+--- spi_flash_block_if	Block storage interface
(uITRON) [uItron OS code]	
+---RI600_4	ITRON Folder (not included in non-OS version)

3.3 Setting Up the Code For Your Board

In this chapter we will set up the code for the MCU and board you want to use.

3.3.1 Endian

Set target for Little Endian as this is the default setup of the SW.

3.3.2 Add the Right "HW Resource" Code

Replace the existing code in folder *HwResourceForUSB* with the content of the relevant folder *HwResourceForUSB_**devicename***, as mentioned in 3.2.

3.3.3 Selecting Platform

Open file platform.h and uncomment one include file corresponding to your board

```
/* RSKRX63N */
#include "./board/rskrx63n/r_bsp.h"
```

3.3.4 Selecting Build Configuration

This version only supports RSK63N.

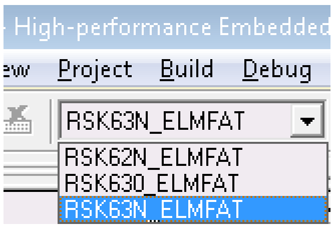


Figure 2. In HEW, Select the Build Configuration for the board you are going to use. Selecting configuration determines which files are included in the project, include file directory paths, build options, etc.

Table 3-2 shows the file structure supplied with PDCD.

Table 3-2 File Structure

File Name	Description	Note
MEDIA/r_usb_atapi_memory.c	FAT (16) /FAT(12) data	Sample
MEDIA/r_usb_atapi_driver.c	Device driver (PMSDD/media driver)	Sample
include/r_usb_catapi_define.h	Device driver header file	Sample
PMSC/r_usb_pmsc_ddi.c	PMSDD interface functions (DDI) Driver registration, storage command callback.	
PMSC/r_usb_pmsc_driver.c	USB class driver (PMSCF)	
PMSC/r_usb_pmsc_pci.c	PCD interface functions (PCI)	
PMSC/r_usb_pmsc_request.c	PCD interface functions (class requests)	
include/r_usb_pmsc_define.h	PMSCD header file	
APL/r_usb_pmsc_descriptor.c	Mass storage class descriptor	Sample
include/r_usb_cmsc_define.h	PDCD(PMSCD+PMSDD) common header file	
include/r_usb_pmsc_extern.h	External reference header file	

3.4 System Resources

3.4.1 RTOS version

Table 3-3 shows the μITRON resources used by PDCD on the μITRON version.

These resources are defined in the r_usb_peri.cfg file.

For details on how to define, refer to the Renesas USB Device USB Basic Firmware Application note.

Table 3-3 uITRON Resources

Object Type	Name/Task ID	Task Description
Task Stack size: USB_TSK_STK (512)	USB_PMSC_TSK	PMSCD or **usb_pmsc_Task** **(File : r_usb_pmsc_driver.c)** Priority=3
	USB_PFLSH_TSK	PMSDD or **usb_pmsc_SmpAtapiTask** **(File : r_usb_atapi_driver.c)** Priority: 4
Mailboxes Priority: 1 Waiting task queue: FIFO order Message queue: FIFO order	USB_PMSC_MBX	PDCD -> PMSCD / PMSDD -> PMSCD mailbox ID
	USB_PFLSH_MBX	PMSCD -> PMSDD mailbox ID
Memory pool Block count: USB_BLK_CNT (10) Block size: USB_BLK_SIZ (64) Waiting task queue: FIFO order	USB_PMSC_MPL	PMSCD memory pool ID
	USB_PFLSH_MPL	PMSDD memory pool ID
OS base timer	Hardware timer	1 ms

3.4.2 Non-OS Version

In the Non-OS version of PMSC, there is a scheduler that invokes a “task” when it has message(s) pending in the task’s mailbox, and according to the task’s priority. Table 3-4 lists the ID and priority definitions used to register PMSC in the scheduler.

These are defined in the **r_usb_cKernelId.h** header file.

For details on how to define, refer to the Renesas USB Device USB Basic Firmware Application note.

Table 3-4 ‘Tasks’ (Mailboxes)

Object	**Task Name / ID / Mailbox**	**Module**
Task	USB_PMSC_TSK / USB_TID_3	PMSCD, or **usb_pmsc_Task** *(r_usb_pmsc_driver.c)* Priority: USB_PMSC_PRI (default=1)
	USB_PFLSH_TSK / USB_TID_4	PMSDD, or **usb_pmsc_SmpAtapiTask** *(r_usb_atapi_driver.c)* Priority: USB_PFLSH_PRI (default=2)
Mailbox ID	USB_PMSC_MBX / USB_PMSC_TSK	PDCD => PMSCD / PMSDD => PMSCD *(r_usb_pmsc_pci.c,* *r_usb_pmsc_driver.c,* *r_usb_pmsc_ddi.c)*
	USB_PFLSH_MBX / USB_PFLSH_TSK	PMSCD => PMSDD mailbox ID *(r_usb_atapi_driver.c)*
Memory pool ID	USB_PMSC_MPL / USB_PMSC_TSK	PMSCD memory pool ID
	USB_PFLSH_MPL / USB_PFLSH_TSK	PMSDD memory pool ID

4. Peripheral MSC Firmware Application Functionality (APL)

Both the USB host and the MCU's firmware application can read and write to the storage media. This is possible since both have FAT file system software. To avoid "collisions" due to writes from both sides to the FAT table and media, the local file system should not be able to write data when attached to a USB host,

4.1 Media R/W functionality as seen from USB Host

PMSC's main function is to enable file read/write operations on the connected USB mass storage device. The USB peripheral is to be recognized by the host as a removable disk, so the host (e.g. PC) can performs operations such as read and write files. Mass Storage Class specification defines the transport protocol (BOT), however, various command sets could be used to control a storage device. The following are the command sets which can be used over USB:

SFF-8070i, (ATAPI) * – *Command set used in this sample code.*
SFF-8020i, MMC-2 (ATAPI)
QIC-157
UFI
SCSI transparent command set

This sample mass storage device driver supports the storage command set **SFF-8070i (ATAPI)** *.

* As listed in "Mass Storage Specification Overview v1.2", command block specification SFF-8070i is used (bInterfaceSubClass = 05h) together with protocol code "USB Mass Storage Class Bulk-Only" (BBB; bInterfaceProtocol = 050h).

4.1.1 Operating Environment

The following diagram illustrates data transfer.

Figure 4.1 shows the operating environment example and Figure 4.2 shows the application operations example.

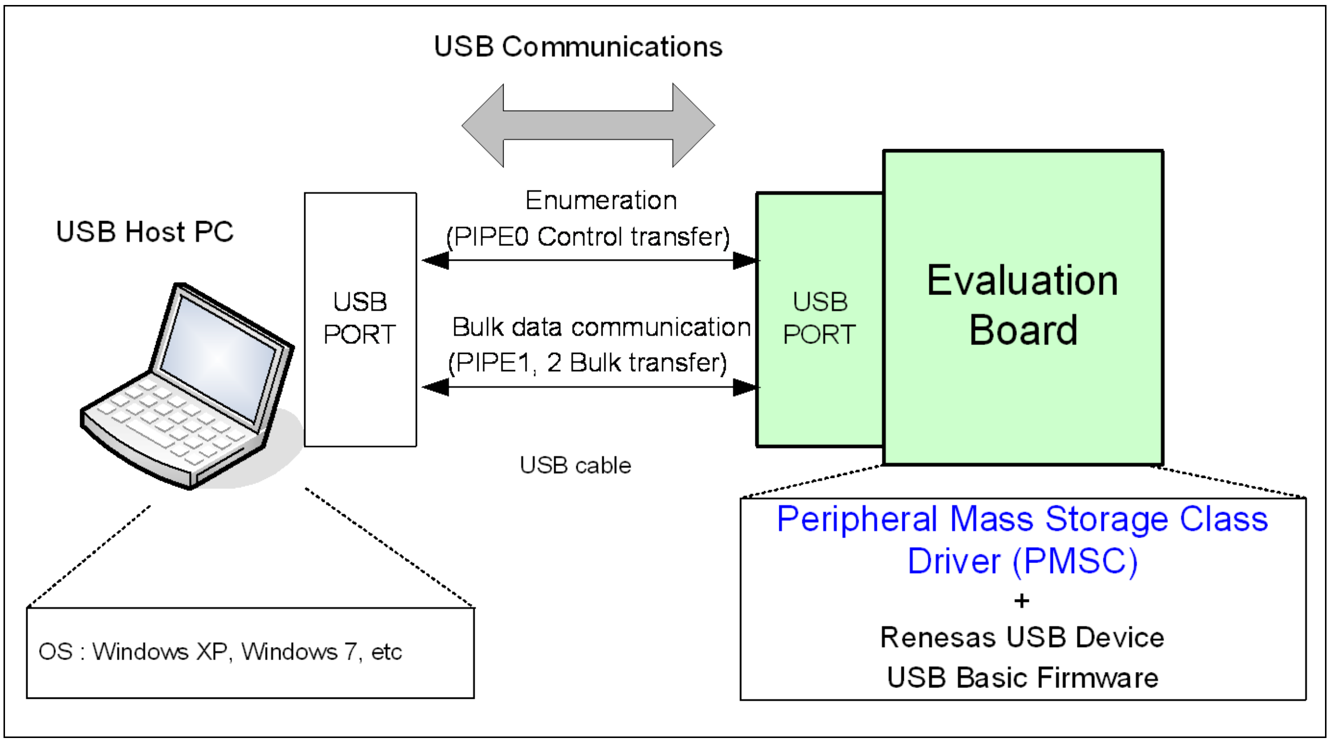
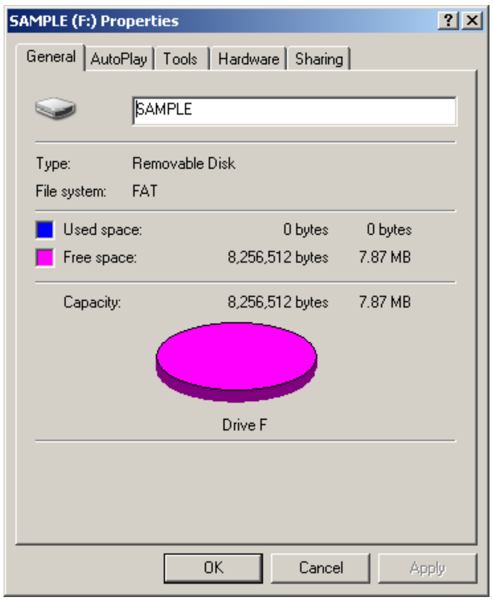


Figure 4.1 Operating Environment Example


SAMPLE (F:) Properties

General | AutoPlay | Tools | Hardware | Sharing

SAMPLE

Type:	Removable Disk	
File system:	FAT	
🟦 Used space:	0 bytes	0 bytes
🟪 Free space:	8,256,512 bytes	7.87 MB
Capacity:	8,256,512 bytes	7.87 MB

Drive F

Figure 4.2 Application Operations Example

4.1.2 Application Program Flow

In a sense, there is no "user application" The mass storage class driver and mass storage device driver solely executes requests from the host.

Figure 4.3 shows the application processing flow overview.

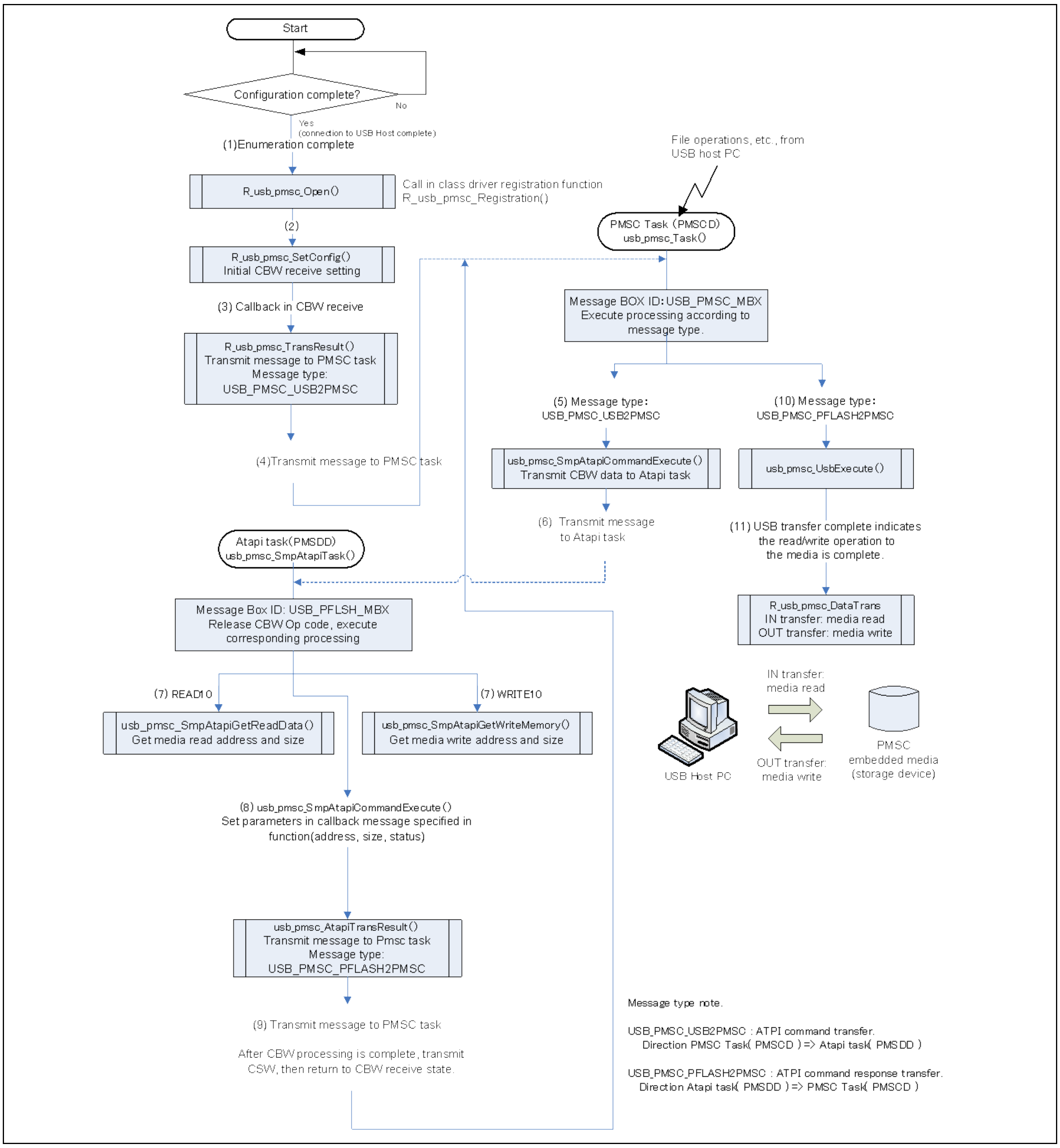

Start
Configuration complete?
No
Yes
(connection to USB Host complete)
(1)Enumeration complete
R_usb_pmsc_Open()
Call in class driver registration function
R_usb_pmsc_Registration()
(2)
R_usb_pmsc_SetConfig()
Initial CBW receive setting
(3) Callback in CBW receive
R_usb_pmsc_TransResult()
Transmit message to PMSC task
Message type:
USB_PMSC_USB2PMSC
(4)Transmit message to PMSC task
File operations, etc., from
USB host PC
PMSC Task (PMSCD)
usb_pmsc_Task()
Message BOX ID: USB_PMSC_MBX
Execute processing according to message type.
(5) Message type:
USB_PMSC_USB2PMSC
(10) Message type:
USB_PMSC_PFLASH2PMSC
usb_pmsc_SmpAtapiCommandExecute()
Transmit CBW data to Atapi task
usb_pmsc_UsbExecute()
(6) Transmit message
to Atapi task
(11) USB transfer complete indicates
the read/write operation to
the media is complete.
R_usb_pmsc_DataTrans
IN transfer: media read
OUT transfer: media write
Atapi task(PMSDD)
usb_pmsc_SmpAtapiTask()
Message Box ID: USB_PFLSH_MBX
Release CBW Op code, execute
corresponding processing
(7) READ10
(7) WRITE10
usb_pmsc_SmpAtapiGetReadData()
Get media read address and size
usb_pmsc_SmpAtapiGetWriteMemory()
Get media write address and size
(8) usb_pmsc_SmpAtapiCommandExecute()
Set parameters in callback message specified in
function(address, size, status)
usb_pmsc_AtapiTransResult()
Transmit message to Pmsc task
Message type:
USB_PMSC_PFLASH2PMSC
(9) Transmit message to PMSC task
After CBW processing is complete, transmit
CSW, then return to CBW receive state.
IN transfer:
media read
OUT transfer:
media write
USB Host PC
PMSC
embedded media
(storage device)
Message type note.
USB_PMSC_USB2PMSC : ATPI command transfer.
Direction PMSC Task(PMSCD) => Atapi task(PMSDD)
USB_PMSC_PFLASH2PMSC : ATPI command response transfer.
Direction Atapi task(PMSDD) => PMSC Task(PMSCD)

Figure 4.3 Application Processing Sequence

4.1.3 API tasks

Table 4-1 shows lists the APL tasks.

Table 4-1 Lists of APL tasks

Function name	Description
usb_cstd_task_start	Starts Task
usb_pmsc_task_start	A variety of Stars Task for peripheral USB
usb_papl_task_start	Start Application task
usb_apl_task_switch	Switches Task (non-OS version only)

4.2 Media R/W functionality as seen from MCU application layer

See chapter 9.1 “Overview of Media Driver API Functions”.

5. Peripheral Device Class Driver (PDCD)

5.1 Basic Functions

The functions of PDCD are to:

1. Respond to mass storage class requests from USB host.
2 Respond to USB host storage commands which are encapsulated in the BOT protocol (Bulk Only Transport), see below)

5.2 BOT Protocol Overview

BOT (USB MSC Bulk-Only Transport) is a transfer protocol that, encapsulates command, data, and status (results of commands) using only two endpoints (one bulk in and one bulk out).

The ATAPI storage commands and the response status are embedded in a “Command Block Wrapper” (CBW) and a “Command Status Wrapper” (CSW).

Figure 5-1 shows an overview of how the BOT protocol progresses with command and status data flowing between USB host and peripheral.

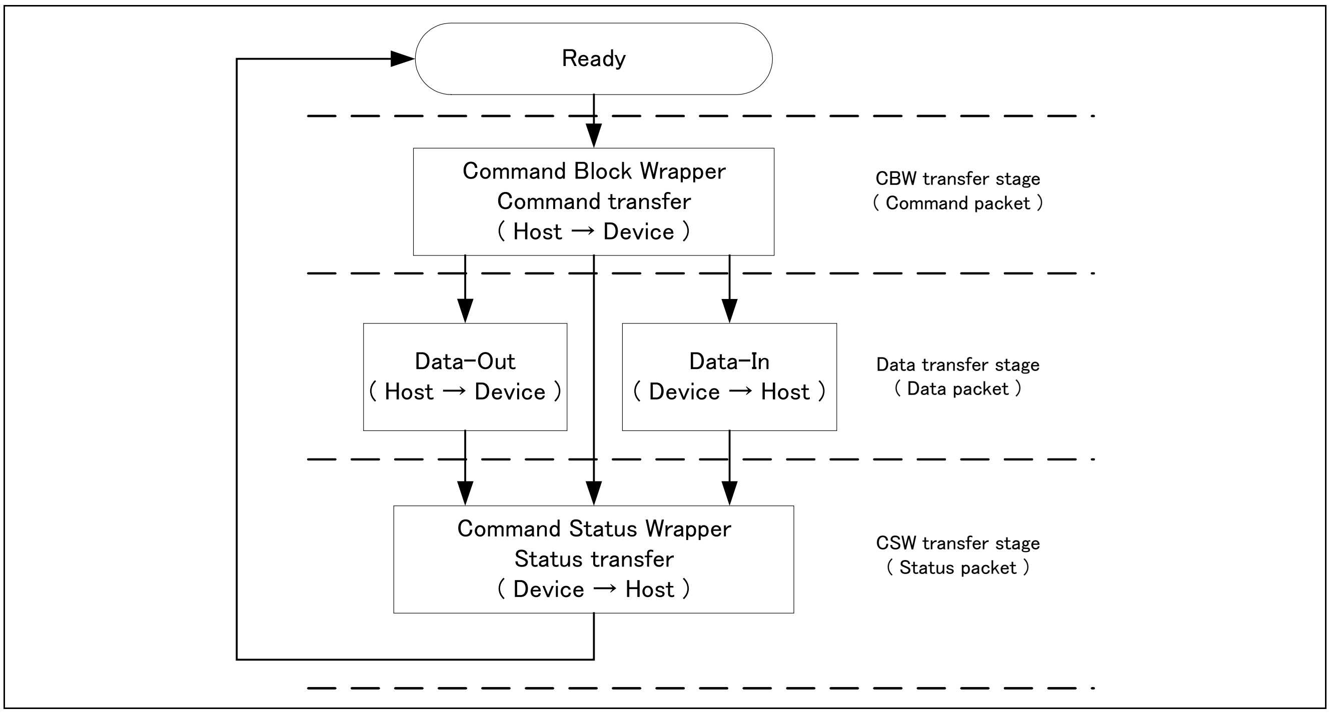


Figure 5-1 BOT protocol Overview.
Command and status flow between USB host and peripheral.

5.2.1 CBW processing

When PMSCD receives a command block wrapper (CBW) from the host, it first verifies the validity of the CBW. If the CBW is valid, PMSCD notifies PMSDD of the storage command contained in the CBW and requests analysis of the command. PMSCD finally performs processing based on the analysis by PMSDD (command validity, data transfer direction and size) and the information contained in the wrapper (data communication direction and size).

5.2.2 Sequence for storage command with no data transmit/receive

Figure 5-2 shows the sequence of storage commands without data transfer.

(1) CBW transfer stage

PMSCD issues a CBW receive request to PCD and registers a callback function. When PCD receives the CBW, it executes a callback function which starts the CBW transfer stage. PMSCD verifies the validity of the CBW and transfers the storage command (CBWCB) to PMSDD. PMSCD requests PMSDD to execute storage commands. PMSDD executes the storage command and returns the result to PMSCD.

(2) CSW transfer stage

Based on the execution result at the time of callback, PMSCD creates a command status wrapper (CSW) and transmits it to the host via PCD.

For details on PCD operation refer to the USB basic firmware Application note.

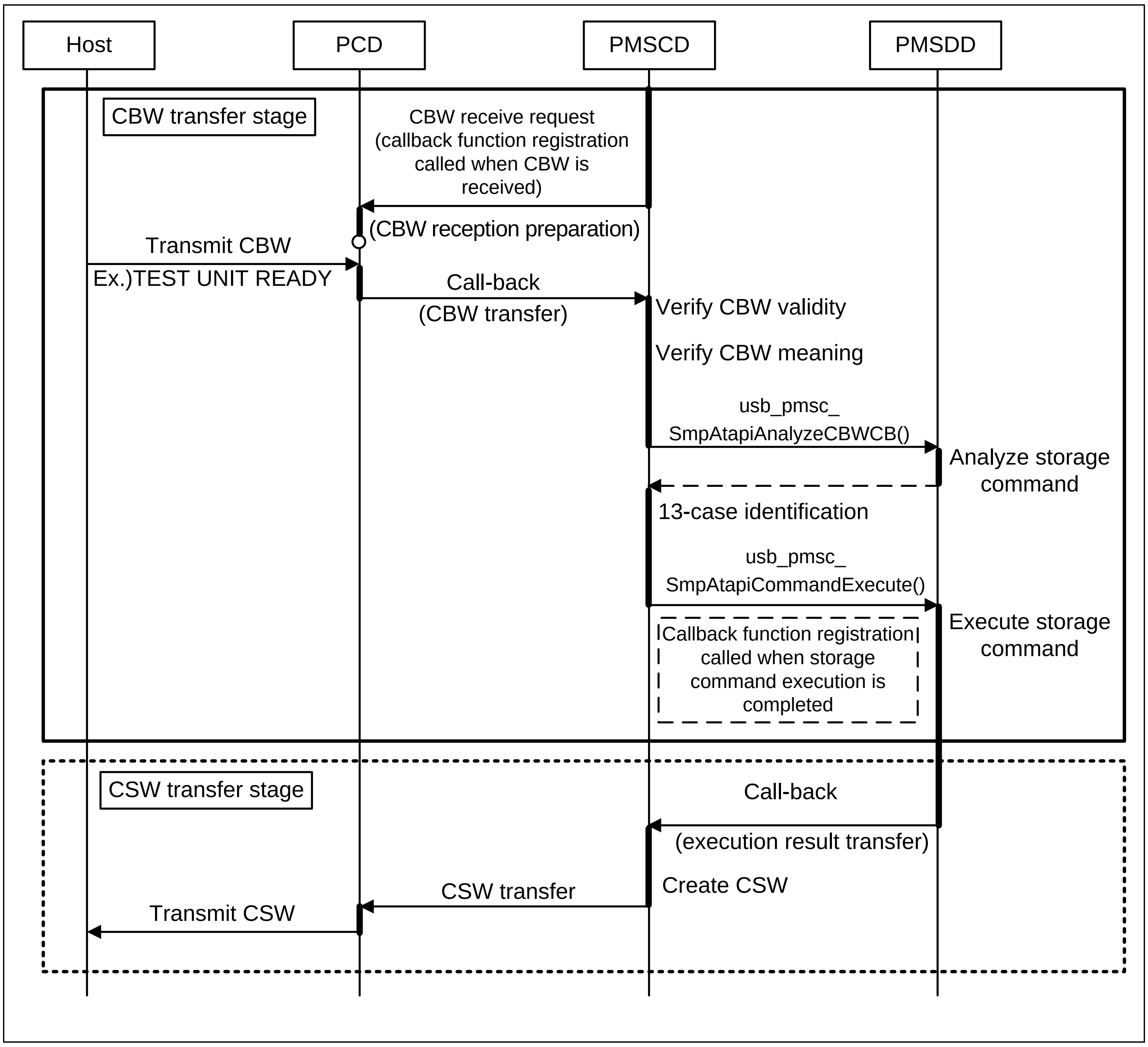

Host
PCD
PMSCD
PMSDD
CBW transfer stage
CBW receive request (callback function registration called when CBW is received)
(CBW reception preparation)
Transmit CBW
Ex.)TEST UNIT READY
Call-back
(CBW transfer)
Verify CBW validity
Verify CBW meaning
usb_pmsc_ SmpAtapiAnalyzeCBWCB()
Analyze storage command
13-case identification
usb_pmsc_ SmpAtapiCommandExecute()
Execute storage command
Callback function registration called when storage command execution is completed
CSW transfer stage
Call-back
(execution result transfer)
Create CSW
CSW transfer
Transmit CSW

Figure 5-2 Sequence of Storage Command for No Transmit/Receive Data

5.2.3 Sequence with storage command for transmit (IN) data

Figure 5-3 shows the sequence of storage command when there is transmit (IN) data from the peripheral side.

(1) CBW transfer stage

PMSCD executes a CBW receive request to PCD, and sets up a callback. When PCD receives the CBW it executes the callback. PMSCD verifies the validity of the CBW and transfers the storage command (CBWCB) to PMSDD. PMSDD analyzes the data transmit command and returns the result to PMSCD. PMSCD then reads the CBW and sends an ATAPI storage command execution request to PMSDD together with a callback registration.

(2) Data IN transfer stage

Based on the execution result at the time of callback, PMSCD notifies PCD of the data storage area and data size, and data communication with the USB host takes place. When the peripheral PCD issues a transmit end notification (status), PMSCD once again sends a continuation request to PMSDD, and data transmission is repeated.

(3) CSW transfer stage

When PMSCD receives a command processing end result from PMSDD, PMSCD creates a command status wrapper (CSW) and transmits it to the host via PCD.

For PCD operation details refer the USB Basic Firmware Application note.

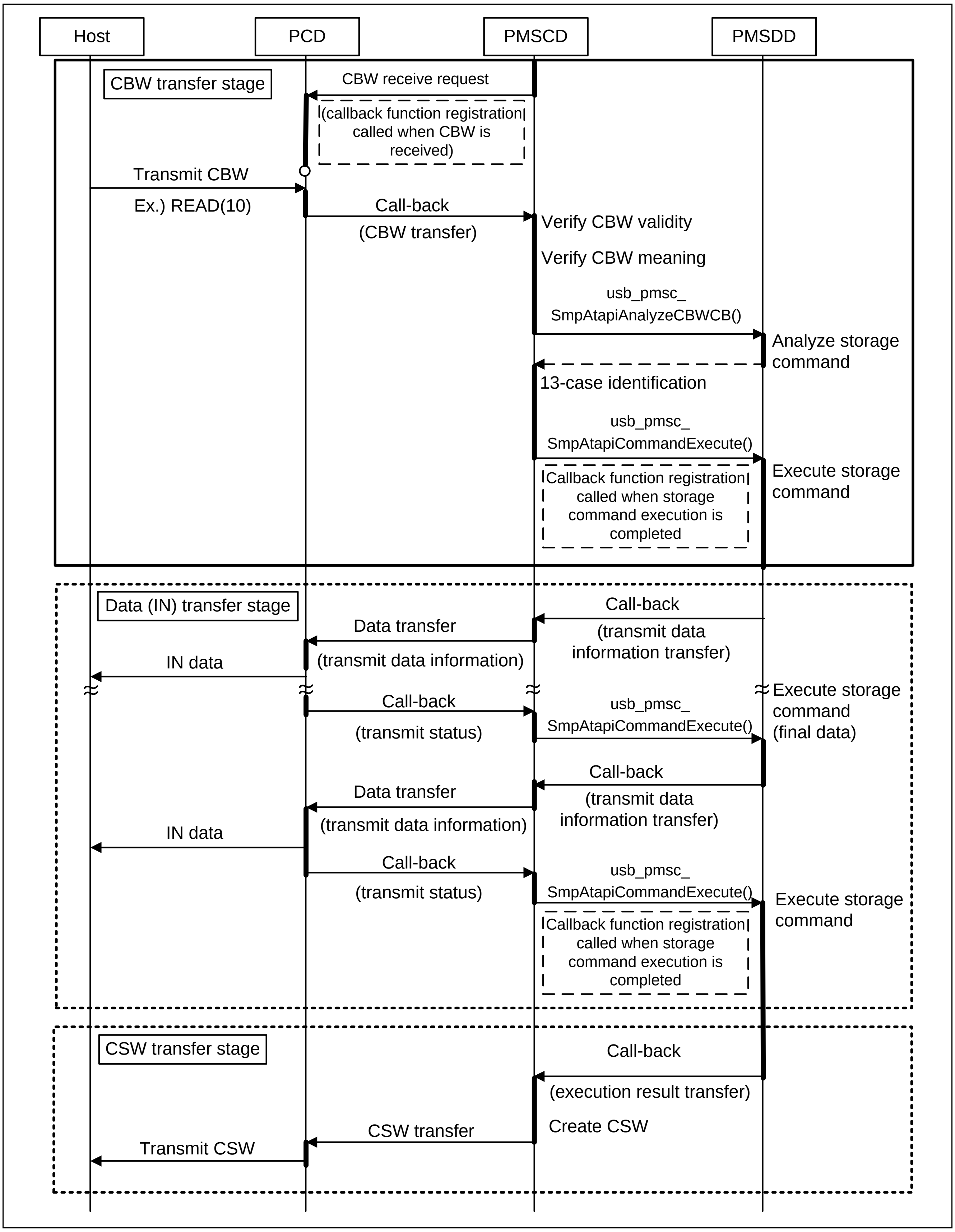

Host
PCD
PMSCD
PMSDD
CBW transfer stage
CBW receive request
(callback function registration called when CBW is received)
Transmit CBW
Ex.) READ(10)
Call-back
(CBW transfer)
Verify CBW validity
Verify CBW meaning
usb_pmsc_SmpAtapiAnalyzeCBWCB()
Analyze storage command
13-case identification
usb_pmsc_SmpAtapiCommandExecute()
Execute storage command
Callback function registration called when storage command execution is completed
Data (IN) transfer stage
Call-back
(transmit data information transfer)
Data transfer
(transmit data information)
IN data
Call-back
(transmit status)
usb_pmsc_SmpAtapiCommandExecute()
Execute storage command (final data)
Call-back
(transmit data information transfer)
Data transfer
(transmit data information)
IN data
Call-back
(transmit status)
usb_pmsc_SmpAtapiCommandExecute()
Execute storage command
Callback function registration called when storage command execution is completed
CSW transfer stage
Call-back
(execution result transfer)
Create CSW
CSW transfer
Transmit CSW

Figure 5-3 Sequence of Storage Command for Transmit (IN) Data

5.2.4 Sequence for storage command with receive (OUT) data

Figure 5-4 shows the sequence of storage command when there is transmit (OUT) data from the peripheral.

(1) CBW transfer stage

In the CBW transfer stage, PMSCD issues a CBW receive request to PCD and sets up a callback.. When PCD receives the CBW it executes the callback. PMSCD verifies the validity of the CBW and transfers the storage command (CBWCB) to PMSDD. PMSDD analyzes the data transmit command, and returns the result to PMSCD. PMSCD then compares the analysis result from PMSDD with the information contained in the CBW and sends an ATAPI storage command execution request to PMSDD together with a callback registration.

(2) Data OUT transfer stage

Based on the callback execution result, PMSCD notifies PCD of the data storage area and data size, and data communication with the host takes place. When it receives transmit end notification from PCD, PMSCD once again sends a common continuation request to PMSDD, and data transmission is repeated.

(3) CSW transfer stage

When it receives a command processing end result from PMSDD, PMSCD creates a command status wrapper (CSW) and transmits it to the host via PCD.

For PCD operation details refer to the USB Basic Firmware Application note.

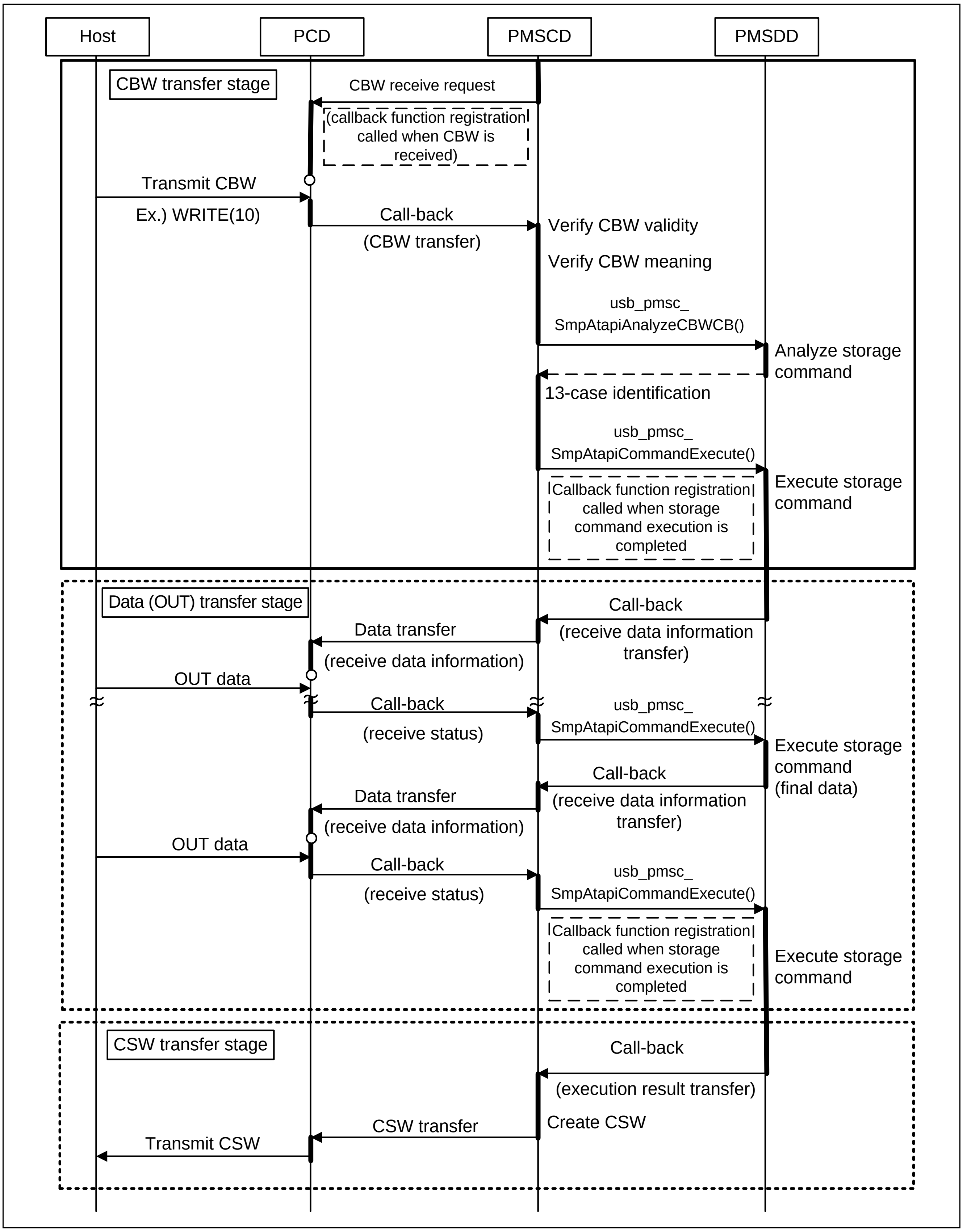

Host
PCD
PMSCD
PMSDD
CBW transfer stage
CBW receive request
(callback function registration called when CBW is received)
Transmit CBW
Ex.) WRITE(10)
Call-back
(CBW transfer)
Verify CBW validity
Verify CBW meaning
usb_pmsc_ SmpAtapiAnalyzeCBWCB()
Analyze storage command
13-case identification
usb_pmsc_ SmpAtapiCommandExecute()
Execute storage command
Callback function registration called when storage command execution is completed
Data (OUT) transfer stage
Call-back
(receive data information transfer)
Data transfer
(receive data information)
OUT data
Call-back
(receive status)
usb_pmsc_ SmpAtapiCommandExecute()
Execute storage command (final data)
Call-back
(receive data information transfer)
Data transfer
(receive data information)
OUT data
Call-back
(receive status)
usb_pmsc_ SmpAtapiCommandExecute()
Callback function registration called when storage command execution is completed
Execute storage command
CSW transfer stage
Call-back
(execution result transfer)
Create CSW
CSW transfer
Transmit CSW

Figure 5-4 Sequence of Storage Command for Receive (OUT) Data

5.2.5 Access sequence for class request

Figure 5-5 shows the sequence when a mass storage class request is received.

(1) Setup Stage

When PCD receives a class request in the control transfer setup stage, it sends a request received notification to PMSCD.

(2) Data Stage

PMSCD executes the control transfer data stage and notifies PCD of data stage end by means of a callback function.

(3) Status Stage

PCD executes the status stage and ends the control transfer.

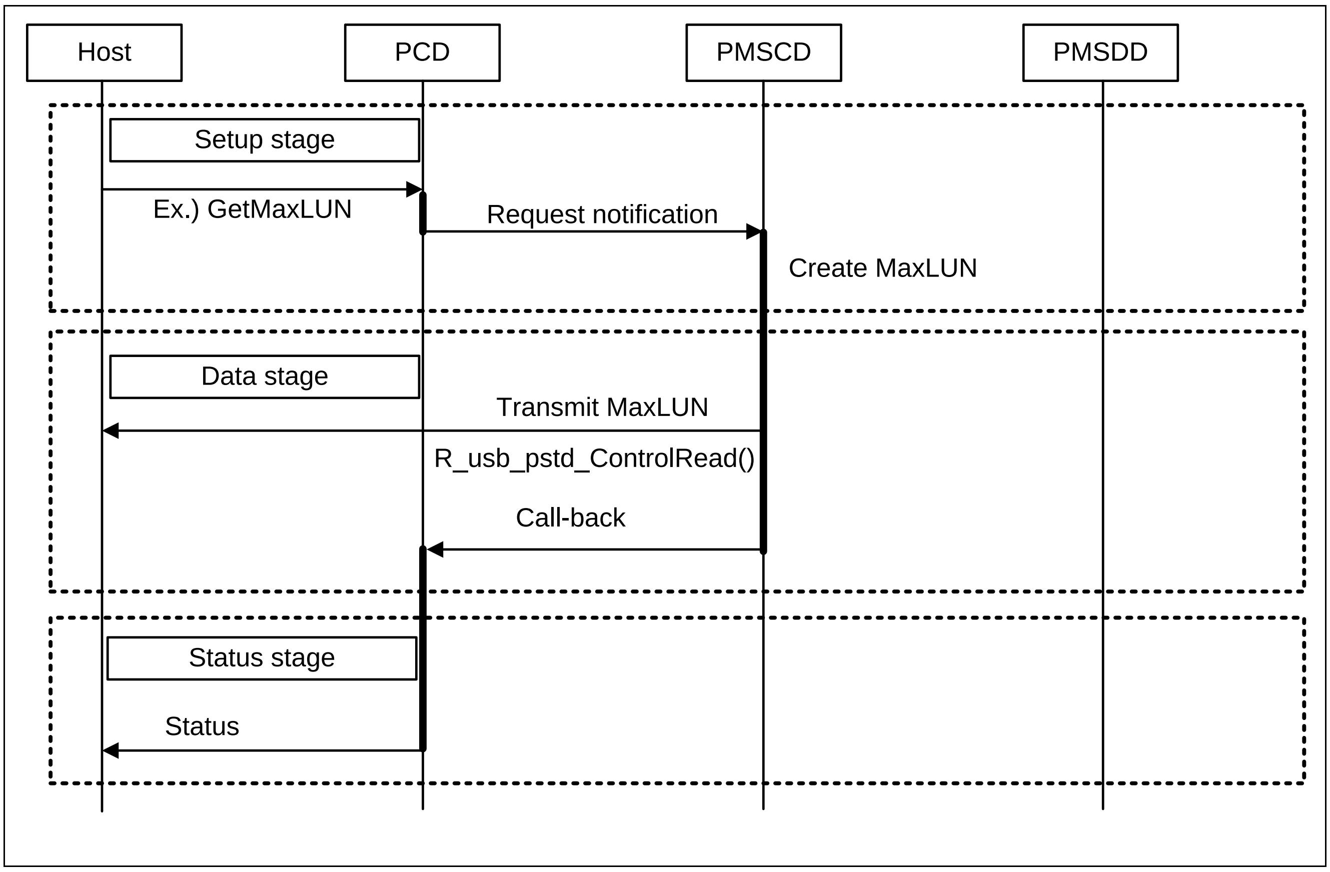


Figure 5-5 Sequence for Class Request

6. USB Peripheral Mass Storage Class Driver (PMSCD)

6.1 Basic Functions

The basic interface functions of PMSCD are to register, open, and close the Peripheral Mass Storage Class Driver.

The rest of the functionality inside PMSCD was already described in the sequence charts in chapter 0

Peripheral Device Class Driver (PDCD).

6.2 List of API Functions

Table 4.10 List of API Functions

Function Name	Description
R_usb_pmsc_Registration	Registers PMSC driver
R_usb_pmsc_Open	Open PMSC driver
R_usb_pmsc_Close	Close PMSC driver

R_usb_pmsc_Registration

Registers PMSC driver

Format

void R_usb_pmsc_Registration(USB_UTR_t *ptr)

Arguments

USB_UTR_t	*ptr	: Pointer to USB Transfer Structure

Return Values

—

Description

Register for the USB Peripheral Mass Storage Class .

Make your changes to the registration function according to the application program.

Use the USB_PCDREG_t type structure to register the driver to PCD.

For details, refer to "USB basic firmware Application note".

The information registered with the USB_PCDREG_t type structure members are as follows.

pipetbl	Pipe information table address
devicetbl	Device descriptor address
qualitbl	Device qualifier descriptor address
configtbl	Configuration descriptor address
othertbl	Other speed descriptor address
stringtbl	String descriptor address table
classinit	callback function to start at registration PDCD
devdefault	Callback function to start at transition to the default state
devconfig	Callback function to start at transition to the configuration state
devdetach	Callback function to start at transition to the detach starte
devsuspend	Callback function to start at transition to the suspend state
devresume	Callback function to start at transition to the resume state
interface	Callback function to start at change of interface
ctrltrans	Callback function to start at control transfer for the user

Notes

1. Please set the following member of USB_UTR_t structure.

```
USB_REGADR_t  ipp: USB register base address
uint16_t      ip : USB IP Number
```

If the callback process is not necessary, register to prepare a dummy function.

For USB device state detail, refer to " Universal Serial Bus Specification Revision 2.0 " Figure 9-1 Device State Diagram

String descriptor address table is the more string descriptor address table. Reference case is as follows

```
uint8_t  *usb_gpmsc_StrPtr[USB_STRINGNUM] =
{
  usb_gpmsc_StringDescriptor0, /* Language ID String Descriptor Address */
  usb_gpmsc_StringDescriptor1, /* iManufacturer String Descriptor Address */
  usb_gpmsc_StringDescriptor2, /* iProduct String Descriptor Address */
  usb_gpmsc_StringDescriptor3, /* iInterface String Descriptor Address */
  usb_gpmsc_StringDescriptor4, /* iConfiguration String Descriptor Address */
  usb_gpmsc_StringDescriptor5, /* iConfiguration String Descriptor Address */
  usb_gpmsc_StringDescriptor6  /* iSerialNumber String Descriptor Address */
};
```

Example

```
void usb_pmsc_task_start( void )
{
  USB_UTR_t  utr;
  USB_UTR_t  *ptr;

  ptr = &utr;
  ptr->ip = USB_PERI_USBIP_NUM;
  if( USB_NOUSE_PP != ptr->ip )
  {
    ptr->ipp = R_usb_cstd_GetUsbIpAdr( ptr->ip );

    R_usb_pmsc_Registration( ptr );   /* Peripheral Application Registration */
    R_usb_pmsc_driver_start( ptr );   /* Peripheral Class Driver Task Start
                                         setting */
    usb_pstd_usbdriver_start( ptr );  /* Peripheral USB Driver Start Setting */
    usb_papl_task_start( ptr );       /* Peripheral Application Task Start
                                         setting */
  }
}
```

R_usb_pmsc_Open

Open PMSC driver

Format

USB_ER_t R_usb_pmsc_Open(USB_UTR_t *ptr, uint16_t data1, uint16_t data2)

Argument

USB_UTR_t	*ptr	: Pointer to USB Transfer Structure
uint16_t	data1	: Not used
uint16_t	data2	: Not used

Return Value

uint16_t	—	Processing result 0:USB_E_OK

Description

This function is called when the USB device is connected to the USB host device and the USB communication has enabled, and sets the CBW reception setting.

Note

This function is registered as a callback function to the member(devconfig) of USB_PCDREG_t structure.

Example

```
void R_usb_pmsc_Registration(USB_UTR_t *ptr)
{
  USB_PCDREG_t  driver;

  /* Driver registration */
  /* Pipe Define Table address */
  driver.pipetbl      = &usb_gpmsc_EpPtr[0];
  /* Device descriptor Table address */
  driver.devicetbl = (uint8_t*)&usb_gpmsc_DeviceDescriptor;
  /* Qualifier descriptor Table address */
  driver.qualitbl     = (uint8_t*)&usb_gpmsc_QualifierDescriptor;
  /* Configuration descriptor Table address */
  driver.configtbl = (uint8_t**)&usb_gpmsc_ConPtr;
  /* Other configuration descriptor Table address */
  driver.othertbl     = (uint8_t**)&usb_gpmsc_ConPtrOther;
  /* String descriptor Table address */
  driver.stringtbl = (uint8_t**)&usb_gpmsc_StrPtr;
  /* Driver init */
  driver.classinit = &usb_cstd_DummyFunction;
  /* Device default */
  driver.devdefault   = &R_usb_pmsc_DescriptorChange;
  /* Device configuered */
  driver.devconfig = (USB_CB_INFO_t)&R_usb_pmsc_Open;
  /* Device detach */
  driver.devdetach = (USB_CB_INFO_t)&R_usb_pmsc_Close;
  /* Device suspend */
  driver.devsuspend   = &usb_cstd_DummyFunction;
  /* Device resume */
  driver.devresume = &usb_cstd_DummyFunction;
  /* Interfaced change */
```

```
   driver.interface = &R_usb_pmsc_SetInterface;
   /* Control Transfer */
   driver.ctrltrans = &usb_pmsc_UsrCtrlTransFunction;
   R_usb_pstd_DriverRegistration(ptr, &driver);
 }
```

R_usb_pmsc_Close

Close PMSC driver

Format

USB_ER_t R_usb_pmsc_Close(USB_UTR_t *ptr, uint16_t data1, uint16_t data2)

Argument

USB_UTR_t	*ptr	: Pointer to a USB Transfer Structure
uint16_t	data1	: Not used
uint16_t	data2	: Not used

Return Value

uint16_t	—	USB_E_OK

Description

This function is called at transition to the detached state. There are no operations. Add if necessary.

Note

This function is registered as a callback function to the members (devdetach) of USB_PCDREG_t structure

.

Example

```
void R_usb_pmsc_Registration(USB_UTR_t *ptr)
{
  USB_PCDREG_t  driver;

  /* Driver registration */
  /* Pipe Define Table address */
  driver.pipetbl     = &usb_gpmsc_EpPtr[0];
  /* Device descriptor Table address */
  driver.devicetbl= (uint8_t*)&usb_gpmsc_DeviceDescriptor;
  /* Qualifier descriptor Table address */
  driver.qualitbl    = (uint8_t*)&usb_gpmsc_QualifierDescriptor;
  /* Configuration descriptor Table address */
  driver.configtbl= (uint8_t**)&usb_gpmsc_ConPtr;
  /* Other configuration descriptor Table address */
  driver.othertbl    = (uint8_t**)&usb_gpmsc_ConPtrOther;
  /* String descriptor Table address */
  driver.stringtbl= (uint8_t**)&usb_gpmsc_StrPtr;
  /* Driver init */
  driver.classinit= &usb_cstd_DummyFunction;
  /* Device default */
  driver.devdefault  = &R_usb_pmsc_DescriptorChange;
  /* Device configuered */
  driver.devconfig= (USB_CB_INFO_t)&R_usb_pmsc_Open;

  /* Device detach */
  driver.devdetach= (USB_CB_INFO_t)&R_usb_pmsc_Close; //←

  /* Device suspend */
  driver.devsuspend  = &usb_cstd_DummyFunction;
  /* Device resume */
  driver.devresume= &usb_cstd_DummyFunction;
  /* Interfaced change */
  driver.interface= &R_usb_pmsc_SetInterface;
  /* Control Transfer */
  driver.ctrltrans= &usb_pmsc_UsrCtrlTransFunction;
  R_usb_pstd_DriverRegistration(ptr, &driver);
}
```

6.3 Class Driver Registration

The device class driver PMSCD must be registered with PCD to function. Use the PeripheralRegistration() function to register PMSCD, using the sample code as reference. For details, refer to the Renesas USB Device USB Basic Firmware Application note.

6.4 User Definition Tables

It is necessary to create a descriptor table and pipe information table for use by PCD. Refer to the sample files *r_usb_PMSCdescriptor.c* and *r_usb_PMSCdefEp.h* when creating these tables. For details, refer to the Renesas USB Device USB Basic Firmware Application note.

7. Peripheral Mass Storage Device Driver (PMSDD)

The main function of PMSDD is to analyze and call for execution of storage commands received from the host via PMSCD. Enumeration is set up with *InterfaceSubClass* in the code as SFF-8070i (ATAPI). This command set is therefore used by the host to control the storage media. These are the storage commands:

READ10
INQUIRY
REQUEST_SENSE
MODE_SENSE6
MODE_SENSE10
READ_FORMAT_CAPACITY
READ_CAPACITY
WRITE10
WRITE_AND_VERIFY
MODE_SELECT6
MODE_SELECT10
FORMAT_UNIT
TEST_UNIT_READY
START_STOP_UNIT
SEEK
VERIFY10
PREVENT_ALLOW

PMSDD notifies PMSCD of communication data and execution results related to storage command execution.

PMSDD divides the data transfer intp0 pieces when the transfer data length exceeds the user-specified block count.

A master boot record (FAT16) sample table is provided.

7.1 PMSDD Storage Command Structure

The “storage command structure” is USB_PMSC_CDB_t. The format of a storage command (SFF-8070i) differs depending on the command category, so a union is used. Four patterns sort out from ten kinds of command type details as shown in Table 7-1.

Table 7-1 USB_PMSC_CDB_t Structure

Union Member	Type	Structure Member	Bit Count	Command Category
s_usb_ptn0	uint8_t	uc_OpCode		Command determination (common)
	uint8_t s_LUN	b_LUN	3	
		b_reserved	5	
	uint8_t	uc_data		
s_usb_ptn12	uint8_t	uc_OpCode		INQUIRY / REQUEST_SENSE
	uint8_t s_LUN	b_LUN	3	
		b_reserved4	4	
		b_immed	1	
	uint8_t	uc_rsv2[2]		
	uint8_t	uc_Allocation		
	uint8_t	uc_rsv1[1]		
	uint8_t	uc_rsv6[6]		
s_usb_ptn378	uint8_t	uc_OpCode		Not used (FORMAT UNIT)
	uint8_t s_LUN	b_LUN	3	
		b_FmtData	1	
		b_CmpList	1	
		b_Defect	3	
	uint8_t	ul_LBA0		
	uint8_t	ul_LBA1		
	uint8_t	ul_LBA2		
	uint8_t	ul_LBA3		
	uint8_t	uc_rsv6[6]		
s_usb_ptn4569	uint8_t	uc_OpCode		READ10 / WRITE10 / WRITE _AND_VERIFY / MODE_SENSE / FORMAT CAPACITY / MODE SELECT
	uint8_t s_LUN	b_LUN	3	
		b_1	1	
		b_reserved2	2	
		b_ByteChk	1	
		b_SP	1	
	uint8_t	ul_LogicalBlock0		
	uint8_t	ul_LogicalBlock1		
	uint8_t	ul_LogicalBlock2		
	uint8_t	ul_LogicalBlock3		
	uint8_t	uc_rsv1[1]		
	uint8_t	us_Length_Hi		
	uint8_t	us_Length_Lo		
	uint8_t	uc_rsv3[3]		

Table 7-2 shows storage commands analysis result .

Table 7-2 The USB_PMSC_CBM_t Structure
- Contains “analysis” result of usb_pmsc_SmpAtapi AnalyzeCbwCb.

	Member	PMSDD storage command analysis RESULT	Remarks
uint32_t	ar_rst	Data direction.	Direction of data transported in last ATAPI command.
uint32_t	ul_size	Data size	Size of data in last ATAPI command.

7.2 List of PMSDD Functions

Table 7-3 lists the functions of PMSDD.

Table 7-3 List of PMSDD Functions

Function Name	Description
usb_pmsc_SmpAtapiAnalyzeCbwCb	Analyzes storage command.
usb_pmsc_SmpAtapiTask	Main task of PMSDD
usb_pmsc_SmpAtapiGetReadData	Returns transmit data storage address and data size.
usb_pmsc_SmpAtapiGetReadMemory	Read data address and data size
usb_pmsc_SmpAtapiGetWriteMemory	Write data address and data size
usb_pmsc_SmpAtapiInitMedia	Initialization at PMSDD start
usb_pmsc_SmpAtapiCloseMedia	Processing at PMSDD end
usb_pmsc_SmpAtapiCommandExecute	Transmits message from PMSCD to PMSDD main task.

7.3 PMSDD Task Description

PMSDD receives storage commands from PMSCD and executes the storage command. PMSDD also receives host data transfer results from PMSCD. Table 7-4 lists PMSDD command processing. When the transfer data size exceeds USB_ATAPI_TRANSFER_UNIT, the data is divided into smaller units and transferred.

For commands that do not involve memory access, the transmitted data is created from the response data tables
usb_gpmsc_AtapiDataSize[],
usb_gpmsc_AtapiDataIndx[],
usb_gpmsc_AtapiReqIndx[], and
usb_gpmsc_AtapiRdDataTbl[]. (*1)

(*1) The response data table follows storage command set SFF-8070i, and the index into the table is determined by the command. Refer to uc_OpCode in Table 7-1 USB_PMSC_CDB_t Structure) provided in the subclass.

Table 7-4 Corresponding Function for Each Storage Command

Storage command	Corresponding Function	Description
READ10	usb_pmsc_SmpAtapiGetReadMemory()	Gets start address and size.
INQUIRY	usb_pmsc_SmpAtapiGetReadData()	Selects response data from array usb_gpmsc_AtapiRdDataTbl.
REQUEST_SENSE	usb_pmsc_SmpAtapiGetReadData()	Selects response data from array usb_gpmsc_AtapiRdDataTbl.
MODE_SENSE10	usb_pmsc_SmpAtapiGetReadData()	Selects response data from array usb_gpmsc_AtapiRdDataTbl.
READ_FORMAT_CAPACITY	usb_pmsc_SmpAtapiGetReadData()	Selects response data from array usb_gpmsc_AtapiRdDataTbl.
READ_CAPACITY	usb_pmsc_SmpAtapiGetReadData()	Selects response data from array usb_gpmsc_AtapiRdDataTbl.
WRITE10	usb_pmsc_SmpAtapiGetWriteMemory()	Gets start address and size.
WRITE_AND_VERIFY	usb_pmsc_SmpAtapiGetWriteMemory()	Gets start address and size.
MODE_SELECT10	usb_pmsc_SmpAtapiGetWriteMemory()	Gets start address and size.
FORMAT_UNIT	usb_pmsc_SmpAtapiGetWriteMemory()	Gets start address and size.
TEST_UNIT_READY	usb_pmsc_SmpAtapiTask()	Status = USB_PMSC_CMD_COMPLETE
START_STOP_UNIT	usb_pmsc_SmpAtapiTask()	Status = USB_PMSC_CMD_COMPLETE
SEEK	usb_pmsc_SmpAtapiTask()	Status = USB_PMSC_CMD_COMPLETE
VERIFY10	usb_pmsc_SmpAtapiTask()	Status = USB_PMSC_CMD_COMPLETE
PREVENT_ALLOW	usb_pmsc_SmpAtapiTask()	Status = USB_PMSC_CMD_FAILED
Else	usb_pmsc_SmpAtapiTask()	Status = USB_PMSC_CMD_ERROR

8. Target File System

A FAT32 file system is incorporated with PMSC. This was added so that the target application can locally read and write files to the media, separately from the USB host.

Before using this file system acknowledge the license conditions at *http://creativecommons.org/licenses/by/3.0*

This file system has many features, yet it is rather small in object size. Among them:

- It is a Windows compatible FAT32 file system.
- Long file name support is added. To test this in the demo, set USE_LONG_FILENAMES to 1 in *browse_files_from_rsk.c*. The preprocessor output will then direct you to adjust a few more things to use this.
- Multiple storage sector size support is abvailable. That is, larger than 512 byte memory blocks. This is needed for many storage flash chips, for example the RSK63N has sector (block) storage size 4096 Bytes.

See *http://elm-chan.org/fsw/ff/00index_e.html* for details on the file system and its API.

8.1 User Interactive Board Demo

A local file browsing demo is also added.

SW1: List next file in current directory.

SW2: View file. Since the board only has a 2*8 character display, the content is only visible in the Debug Console window.

SW3. Add a test file.

In the demo, files are only written when PMSC is in the non-configured USB state. That is, the USB cable is disconnected. This was put in place to avoid duplicate - different - cached copies of FAT tables; the USB host's and the local one in PMSC. Non-identical copies of FAT tables could arise if both USB host and the PMSC APL both add files while the media is mounted,

The source code for this demo is mainlyh in the file *browse_files_from_rsk.c*.By manuevering switches SW1-3 the user browses the media and add test files.

The file system and demo can be removed if desired, e.g. to save space. In that case exclude files of the HEW project window pane "Board_app_file_access", and any calls to these modules or demo switches etc.

8.2 Long Filenames

Please be aware of any license restrictions on using long filenames in your product.

To use long file names, set USE_LONG_FILENAMES to 1 in *browse_files_from_rsk.c* and follow the text from the preprocessor output to enable this. When enabled, The demo then write files with long names when SW3 is pressed.

9. Media Driver Interface

This chapter is an introduction to the block **USB PMSC with Local File System and Flash Storage**, and how it is used for PMSC. For complete details on this API and how to create new media drivers that interface through it, see application note no. r01an1443eu_rx.

PMSC is able to operate with a variety of devices as data storage media. It uses a block storage type driver API described in the application note **USB PMSC with Local File System and Flash Storage** (Document No. r01an1443eu_rx). The storage media interface is an abstract set of functions (*R_MEDIA_Read*, *R_MEDIA_Write*, etc) which are the same regardless of the underlying driver that will be called behind the interface. PMSC can interface any media driver that supports this API.

By default, this application uses a RAM-disk media driver that is supplied preconfigured to use a specific RAM memory area as example storage media. For the RSK63N there is the option to use the board's SPI-flash as storage. See 9.3.2.

9.1 Overview of Media Driver API Functions

The Block Access Media Driver API serves to interface the PMSC application to a specific media device driver. The selection of media is made through configuration files that the user must customize. There is one configuration file for the Block Access Media Driver API, *r_media_driver_api_config.h*, which has a list of media devices, and another configuration file for PMSC, *r_usb_atapi_driver_config.h*, which assigns the selected media driver to be used for PMSC.

The transport layer subtype in this application is SFF-8070i (ATAPI). This layer processes the storage commands that are contained in the Command Blocks that are tunneled through the BOT transport layer. Most of the work done to process the command set is accomplished by routines in the file *r_usb_atapi_driver.c*. This is where the ATAPI data storage commands that write or read the storage media, that is, the block API calls, originate. Storage commands pass through the Block Access Media Driver API layer where they are directed to drivers for the assigned storage device.

Table 9-1 The Block Access Media Driver API functions

Function Name	Description
R_MEDIA_Initialize	Registers the media driver
R_MEDIA_Open	Open media driver
R_MEDIA_Close	Close media driver
R_MEDIA_Read	Read from a media device
R_MEDIA_Write	Write to a media device
R_MEDIA_Ioctl	Perform control and query operations on a media device

9.2 Selecting Media Driver

A media driver has a structure that contains the pointers to its implementation of the API's abstract functions shown in Table 9-1 above. The name of this driver implementation structure must be assigned to a macro used by the ATAPI task: ATAPI_MEDIA_DEVICE_DRIVER in *r_media_driver_api_config.h.*

The media driver has a logical unit number, LUN, assigned to it. The LUN used by the ATAPI task must be defined by the macro ATAPI_MEDIA_LUN. The storage media used will be determined by how ATAPI_MEDIA_LUN is defined.

Example:

```
/* r_usb_atapi_driver_config.h */
#define ATAPI_MEDIA_DEVICE_DRIVER   g_RamMediaDriver
#define ATAPI_MEDIA_LUN             RAM_DISK_LUN
#define USB_ATAPI_BLOCK_UNIT        RAMDISK_SECTSIZE
```

There are a few examples where this is done. To change (only RSK63N can be changed for now) uncomment one of the macros under

```
/* UNCOMMENT ONE STORAGE MEDIA */
```

In the default example code for PSC, and as can be seen above, *g_RamMediaDriver* is a RAM-disk driver media structure instantiated in the *r_ram_disk.c* source module. RAM_DISK_LUN is from the enumerated list of media drivers in *r_media_driver_api_config.h*. The section, or block, size must match both what the host can handle (e.g. Windows FAT and what the bottom layer driver can handle, e.g. 512 or 4096 bytes.

9.2.1 Initializing the Media Driver Function Set

Once the block media driver functions listed in the g_RamMediaDriver structure actually exist, all that is needed is to call the abstract function

```
R_MEDIA_Initialize(ATAPI_MEDIA_LUN, &ATAPI_MEDIA_DEVICE_DRIVER);
```

which will write the actual driver member functions to g_MediaDriverList[] at runtime. Once the member functions have populated MediaDriverList, calls to the other abstract block media functions; R_MEDIA_Open, R_MEDIA_Read, R_MEDIA_Write,… will redirect to call the user's particular driver functions. In other words, it all happens behind the scene without the user having to replace the abstract call with the actual driver calls.

This runtime registration of the drivers can be omitted and the member functions be called directly. In that case the member functions cannot be declared static in the driver source code.

This initialization call is already done in PMSC in file *r_media_driver_api.c*.

9.3 Changing (adding) Storage Media

Suppose you would like to change what media the data is stored on. Default is RAM, which being volatile memory will not survive a power cycling. To use a different storage media, the read, write, etc functions must first be made to conform to the block media driver API described above**.**

9.3.1 Steps to conform a driver to the block media API

1. In *r_media_driver_api_config.h* add the new media logical unit number to the enumeration.
2. Add the media driver interface function source code, using return types and arguments as specified in *r_media_driver_api.h*. Add a *media_driver_s* structure containing pointers to these members at the top.
3. In *r_usb_atapi_driver_config.h*, add the definitions as described in 9.2.
4. Make sure to call the abstract initialize function.

9.3.2 Example - Serial Flash as Storage Media

As an example of a different permanent block storage media (as opposed to volatile RAM) a SPI-flash driver for a serial SPI flash (U4 on the RSK63N) is added to the source tree. The serial flash chip is connected to the MCU over the Renesas SPI interface; "RSPI".

The member functions of this SPI flash driver, and all other files needed to use the SPI flash are in the folder *spi_flash_block_if*. This folder contains the files shown in the *SPI* folder in HEW's project pane. The file *spi_flash_block_if.c* holds the API function definitions to interface the storage chip.

Setup To Use Serial Flash

The serial flash is available for the RSK63N only (PMSC v4.00), and is activated by following these steps.

1. Change *r_usb_atapi_driver_config.h* as shown below. This will change the build so that the code will use the serial flash instead of RAM.

```
/* UNCOMMENT ONE STORAGE MEDIA */
//#define USE_RAM        1
#define USE_SPI_FLASH    1
```

2. Include the files grouped under the *SPI* folder in the project / build configuration. That is, the files *spi_flash_block_if.c*, (*spi_flash_test.c*), *r_rspi_rx.c*, and *r_spi_flash.c* with associated include files.
3. Switch to 4 kB block size: Change *MAX_SS* in *ffconf.h* to be *0x1000* (4096 bytes). Also make sure that *SPIFLASH_DISK_SECTSIZE* in *spi_flash_block_if.h* is the same size. See Restrictions below for more information regarding block size change.

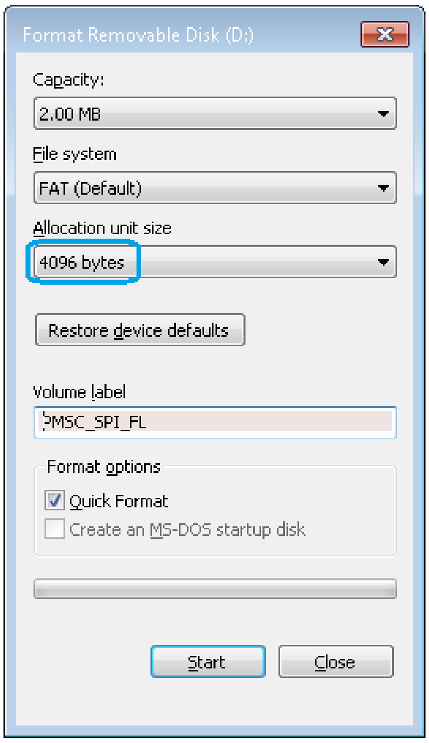
Restrictions

The default demo, using RAM, with 512 byte sector size, will run fine on any Windows USB host.

To use the serial flash on the RSK63N with Windows as the USB host , Windows 7 or later must be used. This is because the SPI flash needs a 4 kB file system allocation block size since that is the erase size of the U4 chip on the RSK63N. Windows7 supports 4 kB physical blocks as opposed to previous versions of Windows.

The industry is rapidly moving towards 4 kB size for storage media. Using 512 bytes as sector size for the SPI flash driver, being non-native for this particular SPI-flash would cause the code to be much complex, wear out the flash chip up to 8 times as fast, and make writing some 8 times as slow. More on 4 kB sector (block) size for media storage can be found at

http://www.support.microsoft.com/kb/2510009
http://www.seagate.com/tech-insights/advanced-format-4k-sector-hard-drives-master-ti


Format Removable Disk (D:)

Capacity: 2.00 MB

File system: FAT (Default)

Allocation unit size: 4096 bytes

Volume label: PMSC_SPI_FL

Format options:
- [✓] Quick Format
- [ ] Create an MS-DOS startup disk

Figure 6. When using the SPI-flash for RSK63N, the drive must be formatted using 4 kB sectors with Windows7 (standard block size going forward) as that is the erase size of the serial flash chip used.

10. The RAM Media Driver

The RAM-disk media driver that is supplied preconfigured to use RAM memory area as a virtual storage media device. While this is provided primarily as a simplified example of a media driver to demonstrate the functionality of USB-PMSC, it can still be useful as a means to transfer data to or from the MCU to the USB host. The RAM-disk uses either on-chip RAM or external SDRAM if available.

1. The RX62N and RX63N sample code operates as media with 8 MB SDRAM
2. The RX630 operates as media with internal 32-kByte RAM.
3. Media is preformatted to appear as removable FAT file storage device.
4. Media driver supports connection to Windows OS (2000, XP, 7, etc) host.
5. Default format may be overwritten by format command from the host.
6. Host can read files from RAM-disk or write files to it, and can update the FAT format information as needed.
7. Size of the RAM-disk can be configured at build time by settings in a configuration file.

10.1 RAM-disk Media Driver Default FAT Format

The RAM-disk virtual media device is preformatted to appear as removable FAT file storage device. This permits files to be placed in RAM and read back by the USB host. This format is implemented as a pre-initialized data section in RAM with boot sector, FAT tables, and directory areas defined by hard-coded values. The file *r_ram_disk_format_data.c* contains the section declarations and the pre-initialized data that will get copied to RAM at system startup.

The beginning of the RAM-disk area (lowest memory address) is considered to be the boot sector (sector 0), as block zero is the default boot sector area in a FAT formatted storage device. Therefore, all storage blocks are addressed relative to this location. When a host device accesses the media device it will always communicate in terms of starting logical block number (LBN) and block count (how many blocks to transfer.) Since the host knows how to navigate a FAT formatted storage device, it will read the first sector to gain additional information about the specific format on the RAM-disk, and from there it will discover where to look for additional file information. From that the host will know which block number to access.

Alternatively, the host can re-format the RAM-disk, replacing the default boot sector, FAT tables, etc, with its own format. In this case the host still knows where in the RAM image a specific block of data resides.

Note: It is not strictly necessary for a USB-PMSC device to have a FAT file system format, however most host systems will expect to use the PMSC device for file storage with FAT as the file system type.

10.2 RAM-disk Global Area Variables

The entire RAM-disk RAM section is of global scope with a number of named variables. Table 10-1 lists the global area variables of the media driver.

Table 10-1 Media Driver Global Areas

Type	Variable Name	Description
uint8_t	g_ram_disk_boot_sector	Primary Boot Record area (sector 0)
uint8_t	g_ram_disk_table1	Dummy area (sector 1) *
uint8_t	g_ram_disk_table_fat1	FAT table (sector 2) *
uint8_t	g_ram_disk_table_fat2	FAT table (sector 3/66) *
uint8_t	g_ram_disk_root_dir	Directory entry area (sector 4/130) *

*Note: This RAM-disk media driver implementation only references the `g_ram_disk_boot_sector` variable, which corresponds to the beginning of the RAM-disk memory section.

10.3 Constant Definitions

Table 10-2 shows the constant definitions used for the RAM-disk media driver.

Table 10-2 PMSDD Constant Definitions

Description	Definition name	Value	Remark
Media type	RAMDISK_MEDIATYPE	0xF8u	Modifiable
Signature	RAMDISK_SIGNATURE	0xAA55u	Not modifiable
Sector size	RAMDISK_SECTSIZE	512ul	Modifiable
Cluster size	RAMDISK_CLSTSIZE	0x01u	Modifiable
FAT number	RAMDISK_FATNUM	0x02u	Modifiable
Media size *1	RAMDISK_MEDIASIZE	RX62N, 6X63N: 8*1024*1024（=8 MB） RX630: 32*1024（=32 kB）	Modifiable
Total number of sectors*2	RAMDISK_TOTALSECT	USB_MEDIA_SIZE / RAMDISK_SECTSIZE	Not modifiable
FAT Table Length*2	RAMDISK_FATLENGTH	341ul（FAT12, 256ul（FAT16）	Not modifiable
FAT table length*2	RAMDISK_FATSIZE	(((RAMDISK_TOTALSECT-8) / RAMDISK_FATLENGTH)+1)	Not modifiable
Root directory	RAMDISK_ROOTTOP	(((RAMDISK_FATSIZE * RAMDISK_FATNUM+1)/8+1)*8)	Not modifiable (Not used)
FAT start	RAMDISK_FATTOP	(RAMDISK_ROOTTOP - (RAMDISK_FATSIZE * RAMDISK_FATNUM))	Not modifiable (Not used)
Root Directory size	RAMDISK_ROOTSIZE	1ul	Not modifiable (Not used)

*1 A minimum 20K byte capacity is required when connecting the device to a PC running WindowsXP.

FAT12 is selected when the media size is set to under 2M bytes.

FAT16 is selected when the media size is set to under 32M bytes.

“RAMDISK_MEDIASIZE” is defined in r_ram_disk.h and is 8M bytes for RX62N and RX63N SDRAMs and 32K bytes for RX630 built-in RAM.

*2 Total number of sectors, FAT data length, and FAT table length are automatically calculated based on the media size.

10.4 Operation Overview

Table 10-3 lists the RAM media variables and Figure 10.1 shows the RAM media block diagram.

Table 10-3 Media Variables

Sector No.	Physical Address	Accesible Size
Sector 0	g_ram_disk_boot_sector[ ]	512Byte
Sector 1	g_ram_disk_table1[ ]	512Byte
Sector 2	g_ram_disk_table_fat1[ ]	512Byte× RAMDISK_FATSIZE
Sector 3/66	g_ram_disk_table_fat2[ ]	512Byte× RAMDISK_FATSIZE
Sector 4/130	g_ram_disk_root_dir[ ]	512Byte×16

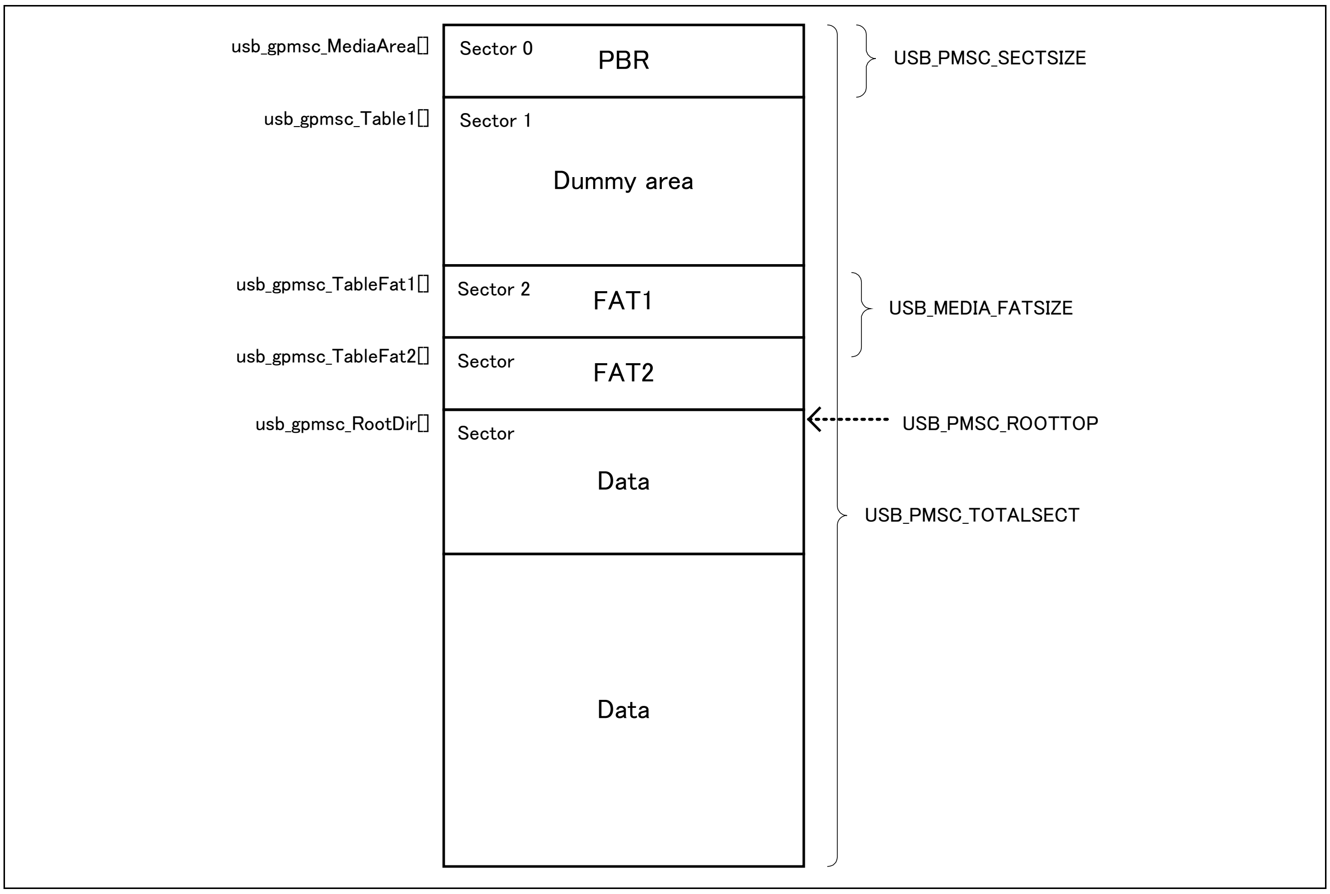


Figure 10.1 Media Block

11. OS and Non-OS Resources

The methods of including resources when using the RTOS and non-OS versions are described below.

Please refer to USB Basic Firmware Application note for detail of how to register.

11.1 Including Resources in RTOS

When using the RTOS version (RI600), it is necessary to register tasks, mailboxes, memory pools, and interrupt vectors in the ITRON configuration file (r_usb_peri.cfg).

11.1.1 PMSC Registration

In the sample program, the PMSC task is registered as follows.

```
task[]{
      entry_address  = usb_pmsc_Task();
      name           = USB_PMSC_TSK;
      stack_size     = 512;
      stack_section  = SURI_STACK;
      priority       = 5;
      initial_start  = OFF;
      exinf          = 0x0;
};
```

11.1.2 APL Registration

In the sample program, the APL task is registered as follows. The priority is defined as the lowest level, except for idle tasks.

```
task[]{
      entry_address  = usb_pmsc_SmpAtapiTask();
      name           = USB_PFLSH_TSK;
      stack_size     = 512;
      stack_section  = SURI_STACK;
      priority       = 5;
      initial_start  = OFF;
      exinf       =   0x0;
};
```

11.1.3 PMSC Mailbox Registration

In the sample program, the PMSC mailbox is registered as follows.

```
   mailbox[]{
         name           = USB_CLS_MBX;
         wait_queue     = TA_TFIFO;
         message_queue  = TA_MFIFO;
         max_pri        = 1;
};
```

11.1.4 APL Mailbox Registration

In the sample program, the APL mailbox is registered as follows.

```
mailbox[]{
      name           = USB_PMSC_MBX;
      wait_queue     = TA_TFIFO;
      message_queue  = TA_MFIFO;
      max_pri        = 1;
};
```

11.1.5 PMSC Memory Pool Registration

In the sample program, the PMSC memory pool is defined as ten 64-byte blocks.

```
memorypool[]{
            name        = USB_PCD_MPL;
            wait_queue  = TA_TFIFO;
            section     = BRI_HEAP;
            siz_block   = 64;
            num_block   = 10;
};
```

11.1.6 APL Memory Pool Registration

In the sample program, the APL memory pool is defined as ten 64-byte blocks.

memorypool[]{

```
            name        = SB_PMSC_MPL;
            wait_queue  = TA_TFIFO;
            section     = BRI_HEAP;
            siz_block   = 64;
            num_block   = 10;
};
```

11.2 Resource Registration in Non-OS Scheduler

When using the non-OS scheduler, it is necessary to register resources such as task IDs, mailbox IDs, and memory pool IDs in the file"r_usb_cKernelId.h".

In the sample file, the registrations are as follows.

```
/* Peripheral MSC Driver Task */
#define  USB_PMSC_TSK   USB_TID_3          /* Task ID */
#define  USB_PMSC_MBX   USB_PMSC_TSK       /* Mailbox ID */
#define  USB_PMSC_MPL   USB_PMSC_TSK       /* Memorypool ID */

/* Peripheral MSC Sample Task */
#define  USB_PFLSH_TSK     USB_TID_4       /* Task ID */
#define  USB_PFLSH_MBX     USB_PFLSH_TSK   /* Mailbox ID */
#define  USB_PFLSH_MPL     USB_PFLSH_TSK   /* Memorypool ID */
```

12. Limitations

The following limitations apply to PMSC.

1. Structures are composed of members of different types.

13. Using the Renesas Debug Console

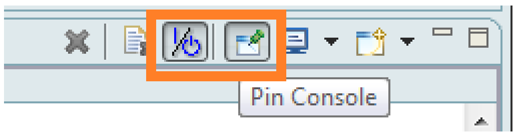
The Renesas Debug Console means you have the ability to use *printf()* statements in C to send trace strings to the standard output. Standard output will in this case be the E1/E20 debug register. To use this feature, the following must be true.

1. *INIT_IOLIB()* must be called. This is sometimes commented out in *resetprog.c* to save object code space.
2. In ..\media_driver\r_bsp\board\rskrx63nr_bsp_config.h, set
   #define BSP_CFG_IO_LIB_ENABLE (1)
3. The code in 13.1 constitutes the *putchar* and *getchar* functions to reside in *lowlvl.src* so that the E1/E20 debug ports are used for I/O processing. Replace the existing code with this if is not already in *lowlvl.src*.
4. Include <*stdio.h*> in any files where you wish to use printf-statements.
5. In e^2 studio, add the Debug Console window by switching on both icons

   "**1/0**" and

   "**Pin Console**" as shown below.

   Both must be on so that the print buffer in E1/E20 can be emptied, and not block.



13.1 STDIO Low Level Source Code

Use the following code in *lowlvl.src* to get printf statements to the E1/E20 Debug Console.

```
;------------------------------------------------------------------------
; FILE :lowlvl.src
; DATE :Wed, Jul 01, 2009
; DESCRIPTION :Program of Low level
; CPU TYPE :RX
;------------------------------------------------------------------------
                .GLB    _charput
                .GLB    _charget

FC2E0           .EQU    00084080h
FE2C0           .EQU    00084090h
DBGSTAT         .EQU    000840C0h
RXFL0EN         .EQU    00001000h
TXFL0EN         .EQU    00000100h

                .SECTION P,CODE
;------------------------------------------------------------------------
; _charput:
;------------------------------------------------------------------------
_charput:
                .STACK  _charput = 00000000h
__C2ESTART:     MOV.L   #TXFL0EN,R3
                MOV.L   #DBGSTAT,R4
__TXLOOP:       MOV.L   [R4],R5
                AND     R3,R5
                BNZ     __TXLOOP
__WRITEFC2E0:   MOV.L   #FC2E0,R2
                MOV.L   R1,[R2]
__CHARPUTEXIT:  RTS
;------------------------------------------------------------------------
; _charget:
;------------------------------------------------------------------------
_charget:
                .STACK  _charget = 00000000h
__E2CSTART:     MOV.L   #RXFL0EN,R3
                MOV.L   #DBGSTAT,R4
__RXLOOP:       MOV.L   [R4],R5
                AND     R3,R5
                BZ      __RXLOOP
__READFE2C0:    MOV.L   #FE2C0,R2
                MOV.L   [R2],R1
__CHARGETEXIT:  RTS
-----------------------------------------------------------------------
; End of conditional code (section)
                .END
```

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Revision Record

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	May 26, 2014	All	Adapted from r01an0514ej_usb_pmsc, v.210. **Document:** Added chapter “Target File System”, and refined the chapter “Media Driver Interface”. Added chapter “Using the Renesas Debug Console”. Added chapter “Using E2studio”. **Source code:** Major feature upgrades. - Added target file system (Elm FAT32) to code. A local application on board can now read and write files to the media, aside from the USB host. - A local file browsing demo is added. User uses switches SW1-3 to browse, add test files etc. - Long filenames are fully incorporated (R/W), and multiple drives are supported (TFAT only one drive). - SPI flash on RSK63N can be used as storage. For Win7 and later only.

General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Handling of Unused Pins

   Handle unused pins in accordance 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 a product with a different part number, confirm that the change will not lead to problems.

   — The characteristics of an MPU or MCU in the same group but having a different part number may differ in terms of the internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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

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