USB EHCI Host Controller User Guide

Version 1.30

For use with USBH EHCI Host Controller versions 3.12 and above

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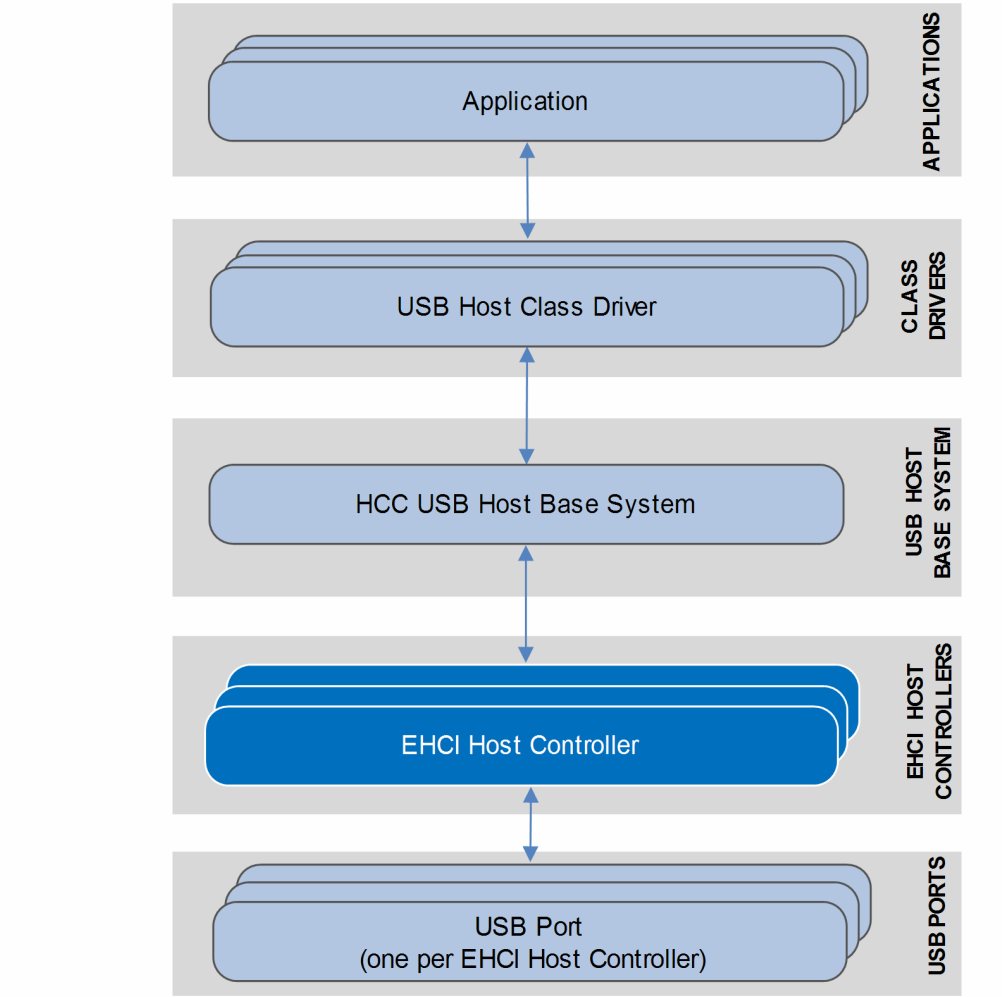
1 System Overview

1.1 Introduction

This guide is for those who want to configure and use HCC Embedded's Enhanced Host Controller Interface (EHCI) module with HCC's USB host stack. The EHCI module provides a high speed USB 2.0 host controller which provides both full speed and low speed USB functions. The controller can handle all USB transfer types and, in conjunction with the USB host stack, can be used with any USB class driver.

The EHCI Host Controller package provides a host controller for a USB stack, as shown below.



1.2 Feature Check

The main features of the host controller are the following:

- Conforms to the HCC Advanced Embedded Framework.
- Designed for integration with both RTOS and non-RTOS based systems.
- Integrated with HCC USB Host stack and all its class drivers.
- Can be used with any EHCI-compliant USB host controller.
- Supports multiple simultaneous EHCI controllers, each with multiple devices attached.
- Supports all USB transfer types: Control, Bulk, Interrupt and Isochronous.

1.3 Packages and Documents

Packages

The table below lists the packages that you need in order to use this module:

Package	Description
hcc_base_doc	This contains the two guides that will help you get started.
usbh_base	The USB host base package. This is the framework used by USB class drivers to communicate over USB using a specific USB host controller package.
usbh_drv_ehci	The USB EHCI host controller package described by this document.

Documents

For an overview of HCC's embedded USB stacks, see Product Information on the main HCC website.

Readers should note the points in the HCC Documentation Guidelines on the HCC documentation website.

HCC Firmware Quick Start Guide

This document describes how to install packages provided by HCC in the target development environment. Also follow the *Quick Start Guide* when HCC provides package updates.

HCC Source Tree Guide

This document describes the HCC source tree. It gives an overview of the system to make clear the logic behind its organization.

HCC USB Host Base System User Guide

This document defines the USB host base system upon which the complete USB stack is built.

HCC USB EHCI Host Controller User Guide

This is this document.

1.4 Change History

This section describes past changes to this manual.

- To view or download earlier manuals, see Archive: USB EHCI Host Controller User Guide.
- For the history of changes made to the package code itself, see History: usbh_drv_ehci.

The current version of this manual is 1.30. The full list of versions is as follows:

Manual version	Date	Software version	Reason for change
1.30	2017-06-19	3.12	New *Change History* format.
1.20	2015-03-27	3.09	Removed *Hardware-Specific Functions* section.
1.10	2015-03-09	3.09	Added *Change History*. Added *Hardware-Specific Functions* to *PSP Porting*.
1.00	2014-08-29	3.09	First release.

2 Source File List

This section describes all the source code files included in the system. These files follow the HCC Embedded standard source tree system, described in the *HCC Source Tree Guide*. All references to file pathnames refer to locations within this standard source tree, not within the package you initially receive.

> **Note:** Do not modify any of these files except the configuration file and PSP file.

2.1 API Header File

The file **src/api/api_usbh_ehci.h** is the only file that should be included by an application using this module. It declares the usbh_ehci_hc() function.

2.2 Configuration File

The file **src/config/config_usbh_ehci.h** contains all the configurable parameters. Configure these as required. For details of these options, see Configuration Options.

2.3 Source Code

These are the source code files. **These files should only be modified by HCC**.

File	Description
src/usb-host/usb-driver/ehci/ehci.c	Source file for EHCI code.
src/usb-host/usb-driver/ehci/ehci.h	Header file for EHCI public functions.
src/usb-host/usb-driver/ehci/ehci_hc.c	Source file for EHCI HC descriptor.
src/usb-host/usb-driver/ehci/ehci_hc.h	EHCI-specific header file.
src/usb-host/usb-driver/ehci/ehci_hub.c	Source file for the EHCI hub.
src/usb-host/usb-driver/ehci/ehci_hub.h	Header file for EHCI hub public functions.
src/usb-host/usb-driver/ehci/ehci_hw.h	Header file for EHCI hardware-specific functions.
src/usb-host/usb-driver/ehci/ehci_reg.h	EHCI register file.

2.4 Version File

The file **src/version/ver_usbh_ehci.h** contains the version number of this module. This version number is checked by all modules that use this module to ensure system consistency over upgrades.

2.5 Platform Support Package (PSP) File

The file **src/psp/target/usb-host-ehci/ehci_hw.c** provides functions and elements the core code may need to use, depending on the hardware.

Note: These are PSP implementations for the specific microcontroller and development board; you may need to modify these to work with a different microcontroller and/or board. See PSP Porting for details.

3 Configuration Options

Set the system configuration options in the file **src/config/config_usbh_ehci.h**. This section lists the available configuration options and their default values.

EHCI_TRANSFER_TASK_STACK_SIZE

The stack size of the EHCI transfer task(s). The default is 1024.

EHCI_MAX_DEVICE

The maximum number of devices supported. The default is 4. This should correspond to the maximum number of physical devices that will be attached; each externally attached hub counts as a device.

EHCI_MAX_EP

The maximum number of Bulk and Interrupt endpoints. The default is 16.

EHCI_MAX_TRANSFERS

The maximum number of simultaneous transfers. The default is 10.

EHCI_MAX_ISO_EP

The maximum number of isochronous (ISO) endpoints. The default is 4.

EHCI_MAX_SISO_LEVEL

The maximum number of split ISO levels. This defines how many parallel ISO transfers can be executed. The default is 2.

EHCI_PERIODIC_LIST_SIZE

The periodic list size. The default is 256.

Set this to 0 to disable ISO/INT transfers. Valid values are 0, 256, 512, and 1024. Some EHCI controllers only support 1024 so, unless you know that 256 and/or 512 is supported, using 0 or 1024 is recommended.

EHCI_MAX_SCHEDULE_IDLE_TIME

The time in milliseconds that the async/periodic schedule needs to be idle before it is disabled. The default is 1.

- If this is set to 0 the schedule is disabled immediately if there is no transfer. In this case Direct Memory Access (DMA) traffic is only generated if it is necessary, but performance might be poorer.
- If this is set, some needless DMA traffic is generated but the impact on the overall performance is minimal.

EHCI_HC_COUNT

The number of EHCI controllers supported. (Some microcontrollers have more than one EHCI controller.) The maximum is 4 and the default is 1.

EHCI_REG_RENDIAN

The reverse endianness between EHCI registers and the system. Set this to 1 if the EHCI controller is operating in reverse endianness relative to the processor. The default is 1.

EHCI_DATA_RENDIAN

The reverse endianness between EHCI structures and the system. The default is 1.

EHCI_64BIT_MODE

Set this to 1 if the EHCI controller operates in 64 bit mode. The default is 0.

EHCI_DYNAMIC_OFFSET

If you set this, the offset of the EHCI controller can be changed dynamically. The default is 0. See EHCI_OFFSET_n and OPERATIONAL_OFFSET_n below.

EHCI_READ_REG_32, EHCI_WRITE_REG_32

These specify the read/write routines to use when accessing an EHCI register. Currently these are mapped to **psp_rreg32()** and **psp_wreg32()**.

These macros are defined in **psp/include/psp_reg.h** and the parameters are (base, offset) for read and (base, offset, value) for write. *base* is always USB_BASE_n. *offset* is calculated using EHCI_OFFSET_n+ [OPERATIONAL_OFFSET_n]+EHCI_REGISTER_ADDRESS.

Note: For the following options, *n* is 0 to 3. Only set values for the host controllers which are used.

USB_BASE_n

The base address of the USB module that includes the EHCI register set, required if processor-specific registers are available for additional settings. The default is 0.

For microcontrollers which have non-EHCI registers belonging to the host controller, you can set USB_BASE_n to be able to access these registers using the **_ehci_[r|w|sb|cb|gb]32_reg** routines. The register read/write routines can be used relative to USB_BASE. This can be useful for addressing registers in **ehci_hw_*** functions.

Some platforms need the option of changing the way registers are accessed (see EHCI_READ_REG_32 and EHCI_WRITE_REG_32). In these cases this can represent a unique identifier that needs to be passed to the dedicated read/write function. For example, the parameters identifying the EHCI units can be stored in an array and this number is the index of the array.

EHCI_OFFSET_n

This can be either of the following:

- The offset of the EHCI register, relative to USB_BASE_n. If EHCI_DYNAMIC_OFFSET is set, then this is a pointer to a variable that stores the offset.
- A pointer to a uint32_t that stores the dynamic offset (if EHCI_DYNAMIC_OFFSET is set).

The default is ISP1561_EHCI_BASE. The type is uint32_t if EHCI_DYNAMIC_OFFSET is 0 and uint32_t * if EHCI_DYNAMIC_OFFSET is set to 1.

OPERATIONAL_OFFSET_n

The operational register offset relative to EHCI_OFFSET_n. The default is 0xC.

- If EHCI_DYNAMIC_OFFSET is set, this value is not used and the operational offset is always obtained from the CAPLENGTH register.
- If EHCI_DYNAMIC_OFFSET is disabled, the value of CAPLENGTH register needs to be set; this way a lot of unnecessary reads are avoided.

CC_EN_n

Set this option to 1 (the default) if the EHCI controller can only handle full and low speed devices via a companion controller (generally OHCI) and this is available.

EHCI_ISR_ID_n

The ISR identifier of the EHCI controller. The default is 5. This is always platform/RTOS-specific.

EHCI_ISR_PRIORITY_n

The ISR priority of the EHCI controller. The default is 0. This is always platform/RTOS-specific.

4 Starting the EHCI Controller

This section shows how to start the host controller and describes the task created. It includes a code example.

4.1 usbh_ehci_hc

This is the only external interface function. This is the host controller descriptor required by the **usbh_hc_init()** function.

Format

```
extern void * const  usbh_ehci_hc
```

4.2 Host Controller Task

The host controller task handles all completed transfers. Callback requested for the transfer is executed from this task.

The task has the following attributes:

Attribute	Description
Entry point	*ehci_transfer_task_n* (n = 0/1/2/3)
Priority	OAL_HIGHEST_PRIORITY (USBH_TRANSFER_TASK_PRIORITY)
Stack size	This depends on the RTOS. 1024 is the default.

4.3 Code Example

This example shows how to initialize the EHCI host controller. Note the following:

- There is only one external interface function, **usbh_ehci_hc()**. You call the **usbh_hc_init()** function with this function as a parameter to link this host controller to the system.
- The last parameter in the **usbh_hc_init()** call is the number of the host controller. In this example EHCI has two controller units so the first call uses 0 and the second call uses 1.

```
void start_usb_host_stack ( void )
{
    int  rc;
    rc = hcc_mem_init();

    if ( rc == 0 )
    {
        rc = usbh_init();   /* Initialize the USB host stack */
    }

    if ( rc == 0 )
    {
        /* Attach first EHCI host controller */
        rc = usbh_hc_init( 0, usbh_ehci_hc, 0 );
    }

    if ( rc == 0 )
    {
        /* Attach second EHCI host controller */
        rc = usbh_hc_init( 0, usbh_ehci_hc, 1 );
    }

    if ( rc == 0 )
    {
        rc = usbh_start();   /* Start the USB host stack */
    }

    if ( rc == 0 )
    {
        rc = usbh_hc_start( 0 );   /* Start first EHCI host controller */
    }

    if ( rc == 0 )
    {
        rc = usbh_hc_start( 1 );   /* Start second EHCI host controller */
    }

.....

}
```

5 Integration

This section specifies the elements of this package that need porting, depending on the target environment.

5.1 OS Abstraction Layer

All HCC modules use the OS Abstraction Layer (OAL) that allows the module to run seamlessly with a wide variety of RTOSes, or without an RTOS.

This module requires the following OAL elements:

OAL Resource	Number Required
Tasks	1
Mutexes	1
Events	1
ISRs	One for each supported EHCI host controller (EHCI_HC_COUNT).

5.2 PSP Porting

The Platform Support Package (PSP) is designed to hold all platform-specific functionality, either because it relies on specific features of a target system, or because this provides the most efficient or flexible solution for the developer.

The module makes use of the following standard PSP functions:

Function	Package	Element	Description
psp_membar()	psp_base	psp_membar	Executes a memory barrier. This is required for systems where the processor can optimize the memory access sequences and it is necessary to wait for all memory accesses to complete. For example, before starting a DMA transfer, all registers and data must be set as required.
psp_memcpy()	psp_base	psp_string	Copies a block of memory. The result is a binary copy of the data.
psp_memset()	psp_base	psp_string	Sets the specified area of memory to the defined value.
psp_rreg32()	psp_base	psp_reg	Read routine used to access an EHCI register.
psp_wreg32()	psp_base	psp_reg	Write routine used to access an EHCI register.

The host controller makes use of the following functions that must be provided by the PSP. These are designed for you to port them easily to work with your hardware solution. The package includes samples in the **src/psp/target/usb-host-ehci/ehci_hw.c** file.

Function	Description
ehci_hw_init()	Initializes the device.
ehci_hw_start()	Starts the device.
ehci_hw_stop()	Stops the device.
ehci_hw_delete()	Deletes the device, releasing the associated resources.
ehci_hw_suspend()	Suspends a device.
ehci_hw_resume()	Resumes a suspended device.
ehci_hw_state()	Gets the state of a device.
ehci_hw_connect()	Connects a device.
ehci_hw_disconnect()	Disconnects a device.

These functions are described in the following sections.

Note: HCC can provide samples for different configurations; contact support@hcc-embedded.com.

ehci_hw_init

This function must be provided by the PSP to initialize the device.

Format

```
int ehci_hw_init ( t_usbh_unit_id unit )
```

Arguments

Argument	Description	Type
unit	The unit ID.	t_usbh_unit_id

Return Values

Return value	Description
USBH_SUCCESS	Successful execution.
USBH_ERROR	Operation failed.

ehci_hw_start

This function must be provided by the PSP to start the device.

Format

```
int ehci_hw_start ( t_usbh_unit_id unit )
```

Arguments

Argument	Description	Type
unit	The unit ID.	t_usbh_unit_id

Return Values

Return value	Description
USBH_SUCCESS	Successful execution.
USBH_ERROR	Operation failed.

ehci_hw_stop

This function must be provided by the PSP to stop the device.

Format

```
int ehci_hw_stop ( t_usbh_unit_id unit )
```

Arguments

Argument	Description	Type
unit	The unit ID.	t_usbh_unit_id

Return Values

Return value	Description
USBH_SUCCESS	Successful execution.
USBH_ERROR	Operation failed.

ehci_hw_delete

This function must be provided by the PSP to delete the device, releasing associated resources.

Format

```
int ehci_hw_delete ( t_usbh_unit_id unit )
```

Arguments

Argument	Description	Type
unit	The unit ID.	t_usbh_unit_id

Return Values

Return value	Description
USBH_SUCCESS	Successful execution.
USBH_ERROR	Operation failed.

ehci_hw_suspend

This function must be provided by the PSP to suspend a device.

Format

```
int ehci_hw_suspend ( t_usbh_unit_id unit )
```

Arguments

Argument	Description	Type
unit	The unit ID.	t_usbh_unit_id

Return Values

Return value	Description
USBH_SUCCESS	Successful execution.
USBH_ERROR	Operation failed.

ehci_hw_resume

This function must be provided by the PSP to resume a suspended device.

Format

```
int ehci_hw_resume( t_usbh_unit_id unit )
```

Arguments

Argument	Description	Type
unit	The unit ID.	t_usbh_unit_id

Return Values

Return value	Description
USBH_SUCCESS	Successful execution.
USBH_ERROR	Operation failed.

ehci_hw_state

This function must be provided by the PSP to get the state of a device.

Format

```
int ehci_hw_state ( t_usbh_unit_id unit )
```

Arguments

Argument	Description	Type
unit	The unit ID.	t_usbh_unit_id

Return Values

Return value	Description
USBH_SUCCESS	Successful execution.
USBH_ERROR	Operation failed.

ehci_hw_connect

This function must be provided by the PSP to connect a device.

Format

```
void ehci_hw_connect ( t_usbh_unit_id unit, uint8_t port, uint8_t speed )
```

Arguments

Argument	Description	Type
unit	The unit ID.	t_usbh_unit_id
port	The port to connect to.	uint8_t
speed	The line speed.	uint8_t

Return Values

Return value	Description
USBH_SUCCESS	Successful execution.
USBH_ERROR	Operation failed.

ehci_hw_disconnect

This function must be provided by the PSP to disconnect a device.

Format

```
void ehci_hw_disconnect ( t_usbh_unit_id unit, uint8_t port )
```

Arguments

Argument	Description	Type
unit	The unit ID.	t_usbh_unit_id
port	The port to disconnect.	uint8_t

Return Values

Return value	Description
USBH_SUCCESS	Successful execution.
USBH_ERROR	Operation failed.