USB SAF1761 Host Controller User Guide

Version 1.10

For use with USBH SAF1761 Host Controller versions 2.11 and above

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Table of Contents

1 System Overview

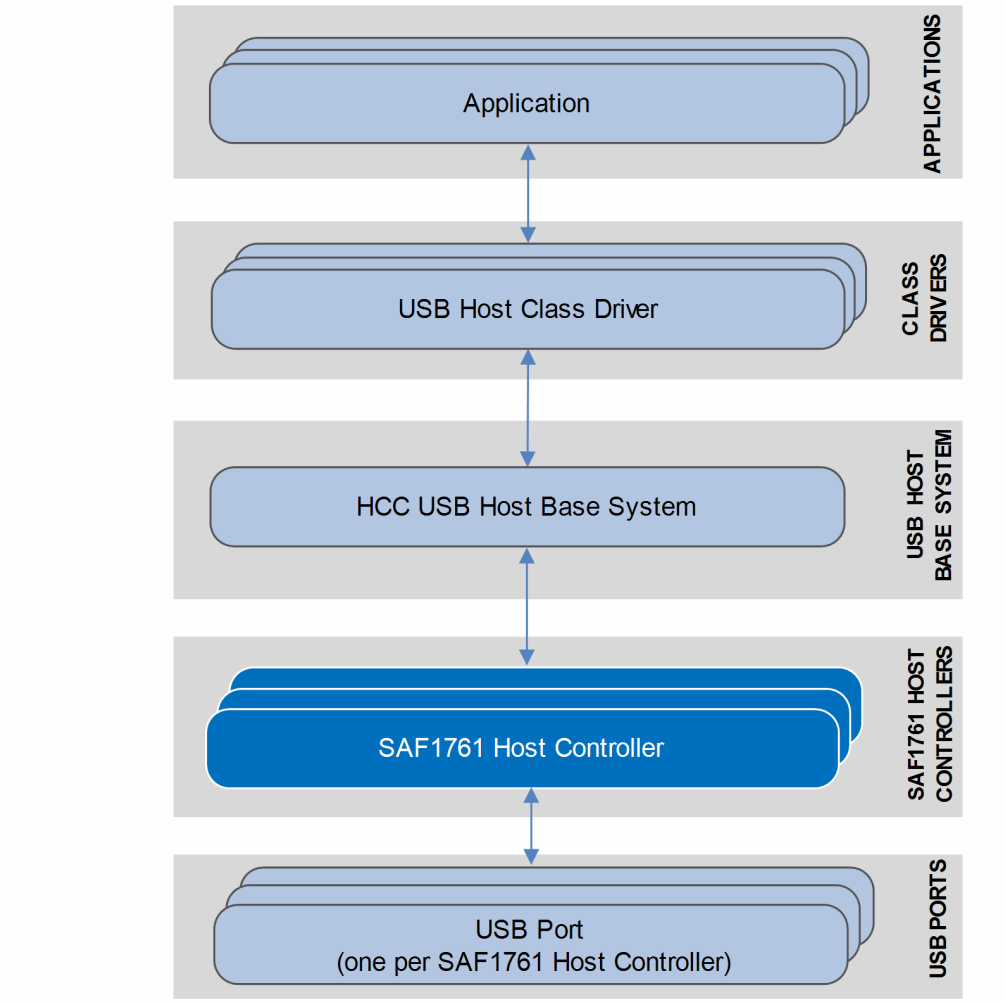
1.1 Introduction

This guide is for those who want to implement HCC Embedded's USB host stack with NXP Semiconductors' SAF1761 USB host controllers. The NXP devices supported are the SAF1761 and also the legacy products ISP1760, ISP1761, and ISP1763.

The SAF1761 includes a USB host controller and a USB device controller. The USB device controller is actually an ISP1582, for which we provide a separate driver. These two drivers can be used together as required. This manual only covers the USB host functionality of the SAF1761. The ISP1582 is covered in the *USB Device Low Level Driver for ISP1582 User Guide*.

The SAF1761 module provides a high speed USB 2.0 host controller which provides both full 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 position of the host controller within the USB stack is 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 the HCC USB Host stack and all its class drivers.
- Supports NXP Semiconductors' SAF1761 host controllers and also the legacy ISP1760, ISP1761, and ISP1763 host controllers.
- Supports multiple simultaneous SAF1761 controllers, each with multiple devices attached.
- Can work together with HCC's USB device controller for the ISP1582.
- Supports all USB transfer types: control, bulk, interrupt, and isochronous.

1.3 Compatible Devices

The module supports the following devices:

Device	Notes
NXP ISP1760	This is no longer marketed by NXP.
NXP ISP1761	This is no longer marketed by NXP.
ST ISP1763	This is now produced by ST Microelectronics.
NXP SAF1761	This is automotive grade, compliant with AEC-Q100.

1.4 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_isp176x	The USB host controller package described by this document.
usbc_drv_isp1582_isp176x	Common code used by both the SAF1761 module and the ISP1582 device low level driver module.

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 SAF1761 Host Controller User Guide

This is this document.

1.5 Change History

This section describes past changes to this manual.

- To view or download earlier manuals, see Archive: USB SAF1761 Host Controller User Guide.
- For the history of changes made to the package code itself, see History: usbh_drv_isp176x and History: usbc_drv_isp1582_isp176x.

The current version of this manual is 1.10. The full list of versions is as follows:

Manual version	Date	Software version	Reason for change
1.10	2017-06-19	2.11 and 1.02	New *Change History* format.
1.00	2015-12-22	2.11 and 1.02	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.

2.1 API Header File

The file **src/api/api_usbh_isp176x.h** is the only file that should be included by an application using this module. It declares the **usbh_isp_hc()** function. For details, see Starting the Host Controller.

2.2 Configuration File

The file **src/config/config_usbh_isp176x.h** contains all the configurable parameters. Configure these as required. For details of these options, see Configuration Options.

2.3 Source Code

The source code files are in the directory **src/usb-host/usb-driver/isp176x**. **These files should only be modified by HCC**.

File	Description
isp176x.c	Source file for SAF1761 code.
isp176x.h	Header file for SAF1761 public functions.
isp176x_hc.c	Source file for the SAF1761 HC descriptor.
isp176x_hc.h	HC descriptor header file.
isp176x_hub.c	Source file for SAF1761 hub.
isp176x_hub.h	Header file for SAF1761 hub public functions.
isp176x_reg.h	Header file for SAF1761 registers.

2.4 Version File

The file **src/version/ver_usbh_isp176x.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.

3 Source Files in the Common Package

This section describes the source code files included in the common package used by both the SAF1761 module and the ISP1582 device low level driver. 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.

3.1 Configuration File

The file **src/config/config_usbc_isp1582_isp176x.h** contains the common configurable parameters. Configure these as required. For details of these options, see Configuration Options.

3.2 Source Code

The source code files are in the directory **src/usb-common/usb-drivers/isp_1582_isp176x**. **These files should only be modified by HCC**.

File	Description
usbc_isp1582_isp176x.c	Source file for common code.
usbc_isp1582_isp176x.h	Header file for common public functions.

3.3 Version File

The file **src/version/ver_usbh_isp1582_isp176x.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.

3.4 Platform Support Package (PSP) Files

These files are in the directory **src/psp/target/usbh_usbd_isp**. They provide 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.

File	Description
psp_isp1582_isp176x.c	Functions source code.
psp_isp1582_isp176x.h	Functions header file.

4 Configuration Options

This section lists the available configuration options and their default values.

4.1 SAF1761 Configuration File

Set the following system configuration options in the file **src/config/config_usbh_isp176x.h**.

MAX_DEVICE

The maximum number of devices supported. The default is 2.

MAX_EP

The maximum number of endpoints (bulk, isochronous, and interrupt). The default is 4.

USBH_ISP_TRANSFER_STACK_SIZE

The stack size of the transfer task(s). The default is 4096.

4.2 SAF1761/ISP1582 Common Package Configuration File

Set the following system configuration options in the common package's file **src/config /config_usbc_isp1582_isp176x.h**.

> **Note:** For full details of these options, refer to the manufacturer's manual for the device.

ISP_USE_HOST

Keep the default of 1 to enable the host (if one is available).

ISP_USE_DEVICE

Set this to 0.

ISP_CHIP_VERSION

This specifies the ISP device used:

- 0 = ISP1760.
- 1 = ISP1761.
- 3 = ISP1763 (the default).

ISP_CHIP_VER_SAF

Specify the device type; see Compatible Devices:

- 0 = ISP176x (the default).
- 1 = SAF176x

ISP_32BIT_IF

This specifies how ISP is interfaced:

- 0 = 16bit mode (the default).
- 1 = in 32 bit mode.

ISP_INT_LEVEL

The interrupt trigger type:

- 0 - level triggered.
- 1 - edge triggered (the default).

ISP_INT_POL

The interrupt polarity:

- 0 - active low (the default).
- 1 - active high.

ISP_ISR_ID

The ISR ID. The default is (ISR_ID_XINT1).

ISP_INT_PRIO

The interrupt priority. This is local to the ISP Controller. The default is 0.

5 Starting the Host Controller

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

5.1 usbh_isp_hc

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

Format

```
extern void * const  usbh_isp_hc
```

5.2 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	*usbh_isp_transfer_task*
Priority	USBH_TRANSFER_TASK_PRIORITY
Stack size	USBH_ISP_TRANSFER_STACK_SIZE. The default is 4096.

5.3 Code Example

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

- There is only one external interface function, **usbh_isp_hc()**. To link this host controller to the system, you call the **usbh_hc_init()** function with this function as a parameter.
- The last parameter in the **usbh_hc_init()** call is the number of the host controller.

```
void start_usb_host_stack ( void )

{
int  rc;
rc = hcc_mem_init();


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

    if ( rc == 0 )
    {
        /* Attach SAF1761 host controller */
        rc = usbh_hc_init( 0, usbh_isp_hc, 0 );
    }

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


    if ( rc == 0 )
    {
        rc = usbh_hc_start( 0 );  /* Start SAF1761 Host controller */
    }

.....

}
```

6 Integration

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

6.1 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	1

6.2 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 host controller makes use of the following functions provided by the common ISP device package **usbc_isp1582_isp176x.h** file.

Function	Description
usbc_isp_init()	Initializes the device.
usbc_isp_delete()	Deletes the device.
usbc_isp_isr_install()	Installs the ISR.
usbc_isp_isr_enable()	Enables the ISR.
usbc_isp_isr_disable()	Disables the ISR.
usbc_isp_isr_delete()	Deletes the ISR.
usbc_isp_lock()	Locks the device.
usbc_isp_unlock()	Unlocks the device.

The host controller makes use of the following functions provided by the common PSP template file **psp_isp1582_isp176x.h** file. These are target-specific.

Function	Description
psp_isp_init()	Initializes the device.
psp_isp_r16()	Reads a 16 bit ISP address.
psp_isp_r32()	Reads a 32 bit ISP address.
psp_isp_w16()	Writes a 16 bit ISP address.
psp_isp_w32()	Writes a 32 bit ISP address.
psp_isph_read_mem()	Reads from the host memory area.
psp_isph_write_mem()	Writes to the host memory area.
psp_isph_read_ptd()	Reads from the PTD.
psp_isph_write_ptd()	Writes to the PTD.

These functions are described in the following sections.

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

psp_isp_init

This function is provided by the PSP to initialize the device.

This enables the clocks, GPIO pin, external memory interface, and so on.

Format

```
int psp_isp_init ( void )
```

Arguments

None.

Return Values

Return value	Description
0	Successful execution.
Else	Operation failed.

psp_isp_r16

This function is provided by the PSP to read a 16 bit value from the specified address.

This macro is configurable for 16 and 32 bit addressing, based on the setting of ISP_32BIT_IF.

Format

```
psp_isp_r16 ( d, a )
```

Arguments

Parameter	Description	Type
d	The destination; where to put the data read.	uint16_t
a	The address; where to read the data from.	uint16_t

psp_isp_r32

This function is provided by the PSP to read a 32 bit value from the specified address.

This macro is configurable for 16 and 32 bit addressing, based on the setting of ISP_32BIT_IF.

Format

```
psp_isp_r32 ( d, a )
```

Arguments

Parameter	Description	Type
d	The destination; where to put the data read.	uint32_t
a	The address; where to read the data from.	uint32_t

psp_isp_w16

This function is provided by the PSP to write a 16 bit value.

Format

```
psp_isp_w16 ( a, v )
```

Arguments

Parameter	Description	Type
a	Where to write the value.	uint16_t
v	The value to write.	uint16_t

psp_isp_w32

This function is provided by the PSP to write a 32 bit value.

Format

```
psp_isp_w32 ( a, v )
```

Arguments

Parameter	Description	Type
a	Where to write the value.	uint32_t
v	The value to write.	uint32_t

psp_isph_read_mem

This function is provided by the PSP to read from the Host memory area.

Format

```
void psp_isph_read_mem (
    uint8_t *   p_dst,
    uint32_t    addr,
    uint32_t    size )
```

Arguments

Parameter	Description	Type
p_dst	Where to put the data read.	uint8_t *
addr	The address to read from.	uint32_t
size	The number of bytes to read.	uint32_t

Return Values

None.

psp_isph_read_ptd

This function is provided by the PSP to read from the PTD.

Format

```
void psp_isph_read_ptd (
    uint32_t *   p_ptd,
    uint32_t     addr,
    uint16_t     size )
```

Arguments

Parameter	Description	Type
p_ptd	Where to put the data read.	uint32_t *
addr	The address to read from.	uint32_t
size	The number of bytes to read.	uint16_t

Return Values

None.

psp_isph_write_mem

This function is provided by the PSP to write to the Host memory area.

Format

```
void psp_isph_write_mem (
    uint32_t    addr,
    uint8_t *   p_src,
    uint32_t    size )
```

Arguments

Parameter	Description	Type
addr	Where to write to.	uint32_t
p_src	A pointer to the data to write.	uint8_t *
size	The number of bytes to write.	uint32_t

Return Values

None.

psp_isph_write_ptd

This function is provided by the PSP to write to the PTD.

Format

```
void psp_isph_write_ptd (
    uint32_t     addr,
    uint32_t *   p_ptd,
    uint16_t     size )
```

Arguments

Parameter	Description	Type
addr	The address in the PTD to write to.	uint32_t
p_ptd	A pointer to the data to write.	uint32_t *
size	The number of bytes to write.	uint16_t

Return Values

None.