Vendor Defined Bulk IN/Bulk OUT Library for Analog Devices ADSP-BF70x User's Guide Revision 2.00

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Introduction

The Closed Loop Design (CLD) Bulk library creates a simplified interface for developing a Bulk IN/Bulk OUT USB 2.0 device using the Analog Devices ADSP-BF707 EZ-Board. The CLD BF70x Bulk library also includes support for a serial console and timer functions that facilitate creating timed events quickly and easily. The library's BF707 application interface is comprised of parameters used to customize the library's functionality as well as callback functions used to notify the User application of events. These parameters and functions are described in greater detail in the CLD BF70x Bulk Library API section of this document.

USB Background

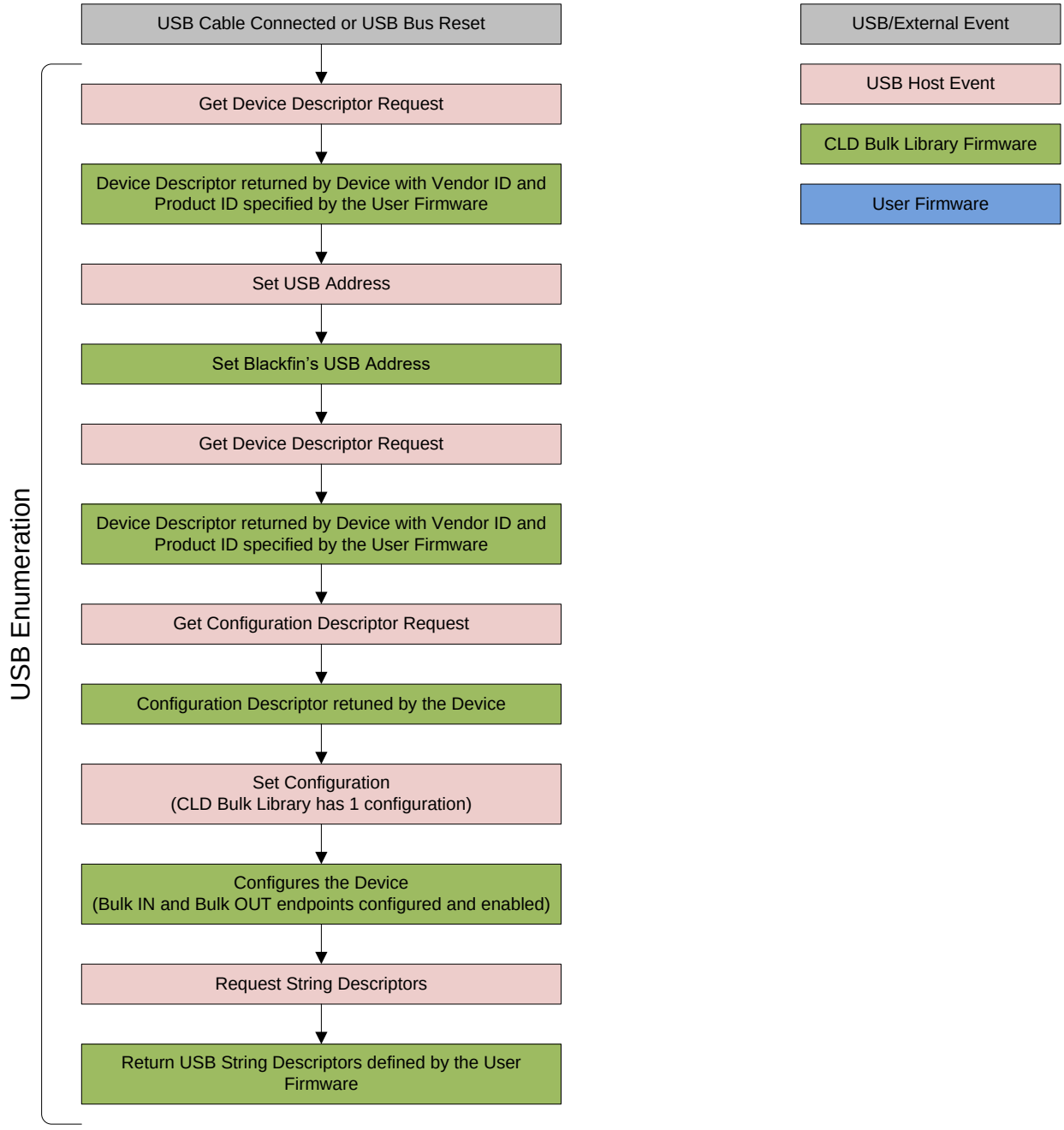
The following is a very basic overview of some of the USB concepts that are necessary to use the CLD BF70x Bulk Library. However, it is still recommended that developers have at least a basic understanding of the USB 2.0 protocol. The following are some resources to refer to when working with USB:

- The USB 2.0 Specification: http://www.usb.org/developers/docs/usb20_docs/
- USB in a Nutshell: A free online wiki that explains USB concepts. http://www.beyondlogic.org/usbnutshell/usb1.shtml
- "USB Complete" by Jan Axelson ISBN: 1931448086

USB is a polling based protocol where the Host initiates all transfers, so all USB terminology is from the Host's perspective. For example, an 'IN' transfer is when data is sent from a Device to the Host, and an 'OUT' transfer is when the Host sends data to a Device.

The USB 2.0 protocol defines a basic framework that devices must implement in order to work correctly. This framework is defined in the Chapter 9 of the USB 2.0 protocol, and is often referred to as the USB 'Chapter 9' functionality. Part of the Chapter 9 framework is standard USB requests that a USB Host uses to control the Device. Another part of the Chapter 9 framework is the USB Descriptors. These USB Descriptors are used to notify the Host of the Device's capabilities when the Device is attached. The USB Host uses the descriptors and the Chapter 9 standard requests to configure the Device. This process is called the USB Enumeration. The CLD BF70x Bulk Library includes support for the USB standard requests and USB Enumeration using some of the parameters specified by the User application when initializing the library. These parameters are discussed in the cld_bf70x_bulk_lib_init section of this document. The CLD BF70x Bulk Library facilitates USB enumeration and is Chapter 9 compliant without User Application intervention as shown in the flow chart below. If you'd like additional information on USB Chapter 9 functionality or USB Enumeration please refer to one of the USB resources listed above.

CLD BF70x Bulk Library USB Enumeration Flow Chart



All USB data is transferred using Endpoints that act as a source or sink for data based on the endpoint's direction (IN or OUT). The USB protocol defines four types of Endpoints, each of which has unique characteristics that dictate how they are used. The four Endpoint types are: Control, Interrupt, Bulk and Isochronous. Data that is transmitted over USB is broken up into blocks of data called packets. For each endpoint type there are restrictions on the allowed max packet size. The allowed max packet sizes also vary based on the USB connection speed. Please refer to the USB 2.0 protocol for more information about the max packet size supported by the four endpoint types.

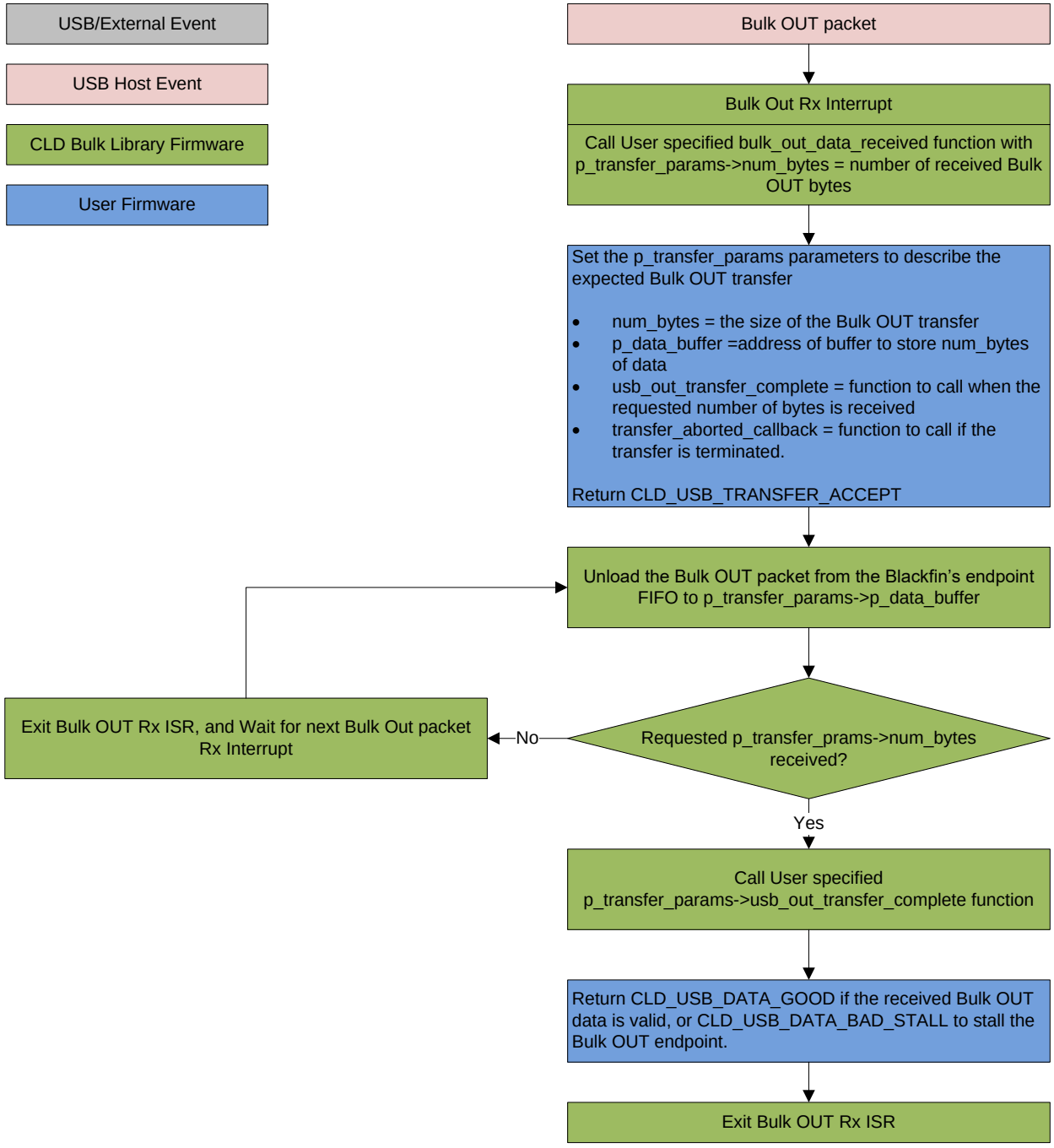
The CLD BF70x Bulk Library uses Control and Bulk endpoints, these endpoint types will be discussed in more detail below.

A Control Endpoint is the only bi-directional endpoint type, and is typically used for command and status transfers. A Control Endpoint transfer is made up of three stages (Setup Stage, Data Stage and Status Stage). The Setup Stage sets the direction and size of the optional Data Stage. The Data Stage is where any data is transferred between the Host and Device. The Status Stage gives the Device the opportunity to report if an error was detected during the transfer. All USB Devices are required to include a default Control Endpoint at endpoint number 0, referred to as Endpoint 0. Endpoint 0 is used to implement all the USB Protocol defined Chapter 9 framework and USB Enumeration. In the CLD BF70x Bulk Library Endpoint 0 is only used for USB Chapter 9 requests, which are handled by the CLD BF70x Bulk library, thus Endpoint 0 is not accessible by the User application.

Bulk Endpoints are used to transfer large amounts of data where data integrity is critical, but does not require deterministic timing. A characteristic of Bulk Endpoints is that they can fill USB bandwidth that isn't used by the other endpoint types. This makes Bulk the lowest priority endpoint type, but it can also be the fastest as long as the other endpoints don't saturate the USB Bus. An example of a devices that uses Bulk endpoints is a Mass Storage Device (thumb drives). The CLD BF70x Bulk Library includes a Bulk IN and Bulk OUT endpoint, which are used to send and receive data with the USB Host, respectively.

The flow charts below give an overview of how the CLD BF70x Bulk Library and the User firmware interact to process Bulk OUT and Bulk IN transfers. Additionally, the User firmware code snippets included at the end of this document provide a basic framework for implementing a Bulk IN/Bulk Out device using the CLD BF70x Bulk Library.

CLD BF70x Bulk Library Bulk OUT Flow Chart



CLD BF70x Bulk Library Bulk IN Flow Chart

Dependencies

In order to function properly the CLD BF70x Bulk Library requires the following Blackfin resources:

- 24Mhz clock input connected to the Blackfin USB0_CLKIN pin.
- Optionally the CLD BF70x Bulk Library can use one of the Blackfin UARTs to implement a serial console interface.
- The User firmware is responsible for setting up the Blackfin clocks, as well as enabling the Blackfin's System Event Controller (SEC) and configuring SEC Core Interface (SCI) interrupts to be sent to the Blackfin core.

Memory Footprint

The CLD BF70x Bulk Library approximate memory footprint is as follows:

Code memory:	23708 bytes
Data memory:	5060 bytes
Total:	28768 bytes or 28.09k
Heap memory:	1152 bytes (only malloc'ed if optional cld_console is enabled)

Note: The CLD BF70x Bulk Library is currently optimized for speed (not space).

CLD BF70x Bulk Library Scope and Intended Use

The CLD BF70x Bulk Library implements a Vendor Specific Bulk IN/Bulk OUT USB device, as well as providing time measurements and optional bi-directional UART console functionality. The CLD BF70x Bulk Library is designed to be added to an existing User project, and as such only includes the functionality needed to implement the above mentioned USB, and UART console features. All other aspects of Blackfin processor configuration must be implemented by the User code.

CLD Bulk Loopback Example v2.0 Description

The CLD_Bulk_loopback_example_v2_0 project provided with the CLD BF70x Bulk Library implements the Analog Devices (ADI) vendor specific Bulk IN/Bulk OUT protocol used by the ADI hostapp.exe program included with CrossCore Embedded Studio. This example is not indented to be a used as a complete standalone project. Instead, this project only includes the User functionality required to interface with hostapp.exe, and it is up to the User to include their own custom system initialization and any extra functionality they require.

For information about running the ADI hostapp program please refer to the "Using ADI hostapp.exe" section of this Users Guide.

CLD BF70x Bulk Library API

The following CLD library API descriptions include callback functions that are called by the library based on USB events. The following color code is used to identify if the callback function is called from the USB interrupt service routine, or from mainline. The callback functions called from the USB interrupt service routine are also italicized so they can be identified when printed in black and white.

Callback called from the mainline context
Callback called from the USB interrupt service routine

cld_bf70x_bulk_lib_init

```
CLD_RV cld_bf70x_bulk_lib_init (CLD_BF70x_Bulk_Lib_Init_Params *
cld_bulk_lib_params)
```

Initialize the CLD BF70x Bulk Library.

Arguments

cld_bulk_lib_params	Pointer to a CLD_BF70x_Bulk_Lib_Init_Params structure that has been initialized with the User Application specific data.

Return Value

This function returns the CLD_RV type which represents the status of the CLD BF70x Bulk initialization process. The CLD_RV type has the following values:

CLD_SUCCESS	The library was initialized successfully
CLD_FAIL	There was a problem initializing the library
CLD_ONGOING	The library initialization is being processed

Details

The cld_bf70x_bulk_lib_init function is called as part of the device initialization and must be repeatedly called until the function returns CLD_SUCCESS or CLD_FAIL. If CLD_FAIL is returned the library will output an error message identifying the cause of the failure using the cld_console UART if enabled by the User application. Once the library has been initialized successfully the main program loop can start.

The CLD_BF70x_Bulk_Lib_Init_Params structure is described below:

```
typedef struct
{
    CLD_Uart_Num uart_num;
    unsigned long uart_baud;
    unsigned long sclk0;

    void (*fp_console_rx_byte) (unsigned char byte);

    unsigned short vendor_id;
```

```
    unsigned short product_id;

    CLD_Bulk_Endpoint_Params * p_bulk_in_endpoint_params;

    CLD_Bulk_Endpoint_Params * p_bulk_out_endpoint_params;

    CLD_USB_Transfer_Request_Return_Type (*fp_bulk_out_data_received)
                              (CLD_USB_Transfer_Params * p_transfer_data);

    unsigned char usb_bus_max_power;

    unsigned short device_descriptor_bcdDevice;

    const char * p_usb_string_manufacturer;
    const char * p_usb_string_product;
    const char * p_usb_string_serial_number;
    const char * p_usb_string_configuration;
    const char * p_usb_string_interface;

    unsigned short usb_string_language_id;

    void (*fp_cld_usb_event_callback) (CLD_USB_Event event);
    void (*fp_cld_lib_status) (unsigned short status_code,
                               void * p_additional_data,
                               unsigned short additional_data_size);
} CLD_BF70x_Bulk_Lib_Init_Params;
```

A description of the CLD_BF70x_Bulk_Lib_Init_Params structure elements is included below:

Structure Element	Description
uart_num	Identifies which of the ADSP-BF707 UARTs should be used by the CLD BF70x Bulk Library to implement the cld_console (refer to the cld_console API description for additional information). The valid uart_num values are listed below: CLD_UART_0 CLD_UART_1 CLD_UART_DISABLE If uart_num is set to CLD_UART_ DISABLE the CLD BF70x Bulk Library will not use a UART, and the cld_console functionality is disabled.
uart_baud	Sets the desired UART baud rate used for the cld_console. The remaining cld_console UART parameters are as follows: Number of data bits: 8 Number of stop bits: 1 No Parity No Hardware Flow Control
sclk0	Used to tell the CLD BF70x Bulk Library the frequency of the ADSP_BF707 SCLK0 clock.
fp_console_rx_byte	Pointer to the function that is called when a byte is received by the cld_console UART. This function has a single parameter ('byte') which is the value received by the UART.

<table>
<tr><td></td><td>Note: Set to NULL if not required by application</td></tr>
<tr><td>vendor_id</td><td>The 16-bit USB vendor ID that is returned to the USB Host in the USB Device Descriptor.
USB Vendor ID's are assigned by the USB-IF and can be purchased through their website (www.usb.org).</td></tr>
<tr><td>product_id</td><td>The 16-bit product ID that is returned to the USB Host in the USB Device Descriptor.</td></tr>
<tr><td>p_bulk_in_endpoint_params</td><td>Pointer to a CLD_Bulk_Endpoint_Params structure that describes how the Bulk IN endpoint should be configured. The CLD_Bulk_Endpoint_Params structure contains the following elements:

<table>
<tr><td>Structure Element</td><td>Description</td></tr>
<tr><td>endpoint_num</td><td>Sets the USB endpoint number of the Bulk endpoint. The endpoint number must be within the following range:
1 ≤ endpoint_num ≤ 12. Any other endpoint number will result in the cld_bf70x_bulk_lib_init function returning CLD_FAIL</td></tr>
<tr><td>max_packet_size_full_speed</td><td>Sets the Bulk endpoint's max packet size when operating at Full Speed. The valid Bulk endpoint max packet sizes are as follows:
8, 16, 32, and 64 bytes.</td></tr>
<tr><td>max_packet_size_high_speed</td><td>Sets the Bulk endpoint's max packet size when operating at High Speed. The valid Bulk endpoint max packet sizes are as follows:
8, 16, 32, 64 and 512 bytes.</td></tr>
</table></td></tr>
<tr><td>p_bulk_out_endpoint_params</td><td>Pointer to a CLD_Bulk_Endpoint_Params structure that describes how the Bulk Out endpoint should be configured. Refer to the p_bulk_in_endpoint_params description for information about the CLD_Bulk_Endpoint_Params structure.</td></tr>
<tr><td>fp_bulk_out_data_received</td><td>Pointer to the function that is called when the Bulk OUT endpoint receives data. This function takes a pointer to the CLD_USB_Transfer_Params structure ('p_transfer_data') as a parameter.

The following CLD_USB_Transfer_Params structure elements are used to processed a Bulk OUT transfer:

<table>
<tr><td>Structure Element</td><td>Description</td></tr>
<tr><td>num_bytes</td><td>The number of bytes to transfer to the p_data_buffer before calling the</td></tr>
</table></td></tr>
</table>

	usb_out_transfer_complete callback function. When the bulk_out_data_received function is called num_bytes is set the number of bytes in the current Bulk OUT packet. If the Bulk OUT total transfer size is known num_bytes can be set to the transfer size, and the CLD BF70x Bulk Library will complete the entire bulk transfer without calling bulk_out_data_received again. If num_bytes isn't modified the bulk_out_data_received function will be called for each Bulk OUT packet.
p_data_buffer	Pointer to the data buffer to store the received Bulk OUT data. The size of the buffer should be greater than or equal to the value in num_bytes.
fp_usb_out_transfer_compelete	Function called when num_bytes of data has been transferred to the p_data_buffer memory.
fp_transfer_aborted_callback	Function called if there is a problem transferring the requested Bulk OUT data.
transfer_timeout_ms	Bulk OUT transfer timeout in milliseconds. If the Bulk out transfer takes longer then this timeout the transfer is aborted and the transfer_aborted_callback is called. Setting the timeout to 0 disables the timeout

The fp_bulk_out_data_received function returns the CLD_USB_Transfer_Request_Return_Type, which has the following values:

Return Value	Description
CLD_USB_TRANSFER_ACCEPT	Notifies the CLD BF70x Bulk Library that the Bulk OUT data should be accepted using the p_transfer_data values.

	CLD_USB_TRANSFER_PAUSE	Requests that the CLD BF70x Bulk Library pause the current transfer. This causes the Bulk OUT endpoint to be nak'ed until the transfer is resumed by calling cld_bf70x_bulk_lib_resume_ paused_bulk_out_transfer.
	CLD_USB_TRANSFER_DISCARD	Requests that the CLD BF70x Bulk Library discard the number f bytes specified in p_transfer_params-> num_bytes. In this case the library accepts the Bulk OUT data from the USB Host but discards the data. This is similar to the concepts of frame dropping in audio/video applications.
	CLD_USB_TRANSFER_STALL	This notifies the CLD BF70x Bulk Library that there is an error and the Bulk OUT endpoint should be stalled.
usb_bus_max_power	USB Configuration Descriptor bMaxPower value (0 = self-powered). Refer to the USB 2.0 protocol section 9.6.3.	
device_descriptor_bcd_device	USB Device Descriptor bcdDevice value. Refer to the USB 2.0 protocol section 9.6.1.	
p_usb_string_manufacturer	Pointer to the null-terminated string. This string is used by the CLD BF70x Bulk Library to generate the Manufacturer USB String Descriptor. If the Manufacturer String Descriptor is not used set p_usb_string_manufacturer to NULL.	
p_usb_string_product	Pointer to the null-terminated string. This string is used by the CLD BF70x Bulk Library to generate the Product USB String Descriptor. If the Product String Descriptor is not used set p_usb_string_product to NULL.	
p_usb_string_serial_number	Pointer to the null-terminated string. This string is used by the CLD BF70x Bulk Library to generate the Serial Number USB String Descriptor. If the Serial Number String Descriptor is not used set p_usb_string_serial_number to NULL.	
p_usb_string_configuration	Pointer to the null-terminated string. This string is used by the CLD BF70x Bulk Library to generate the Configuration USB String Descriptor. If the Configuration String Descriptor is not used set p_usb_string_configuration to NULL.	
p_usb_string_interface	Pointer to the null-terminated string. This string is used by the CLD BF70x Bulk Library to generate the Interface 0 USB String Descriptor. If the Product String Descriptor is not used set p_usb_string_interface to NULL.	
usb_string_language_id	16-bit USB String Descriptor Language ID Code as defined in the USB Language Identifiers (LANGIDs) document (www.usb.org/developers/docs/USB_LANGIDs.pdf).	

<table>
<tr><td></td><td>0x0409 = English (United States)</td></tr>
<tr><td>fp_cld_usb_event_callback</td><td>Function that is called when one of the following USB events occurs. This function has a single CLD_USB_Event parameter.

Note: This callback can be called from the USB interrupt or mainline context depending on which USB event was detected. The CLD_USB_Event values in the table below are highlighted to show the context the callback is called for each event.

The CLD_USB_Event has the following values:
<table>
<tr><th>Return Value</th><th>Description</th></tr>
<tr><td>CLD_USB_CABLE_CONNECTED</td><td>USB Cable Connected.</td></tr>
<tr><td>CLD_USB_CABLE_DISCONNECTED</td><td>USB Cable Disconnected</td></tr>
<tr><td>CLD_USB_ENUMERATED_CONFIGURED_HS</td><td>USB device enumerated at High-Speed (USB Configuration set to a non-zero value)</td></tr>
<tr><td>CLD_USB_ENUMERATED_CONFIGURED_FS</td><td>USB device enumerated at Full-Speed (USB Configuration set to a non-zero value)</td></tr>
<tr><td>CLD_USB_UN_CONFIGURED</td><td>USB Configuration set to 0</td></tr>
<tr><td>CLD_USB_BUS_RESET</td><td>USB Bus reset received</td></tr>
<tr><td>CLD_USB_BUS_SUSPEND</td><td>USB Suspend detected</td></tr>
<tr><td>CLD_USB_BUS_RESUME</td><td>USB Resume detected</td></tr>
</table>

Note: Set to CLD_NULL if not required by application</td></tr>
<tr><td>fp_cld_lib_status</td><td>Pointer to the function that is called when the CLD library has a status to report. This function has the following parameters:

<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td>status_code</td><td>16-bit status code. If the most significant bit is a '1' the status being reported is an Error.</td></tr>
<tr><td>p_additional_data</td><td>Pointer to additional data included with the status.</td></tr>
<tr><td>additional_data_size</td><td>The number of bytes in the specified additional data.</td></tr>
</table>

If the User plans on processing outside of the fp_cld_lib_status function they will need to copy the additional data to a User buffer.</td></tr>
</table>

cld_bf70x_bulk_lib_main

```
void cld_bf70x_bulk_lib_main (void)
```

CLD BF70x Bulk Library mainline function

Arguments

None

Return Value

None.

Details

The cld_bf70x_bulk_lib_main function is the CLD BF70x Bulk Library mainline function that must be called in every iteration of the main program loop in order for the library to function properly.

cld_bf70x_bulk_lib_transmit_bulk_in_data

```
CLD_USB_Data_Transmit_Return_Type cld_bf70x_bulk_lib_transmit_bulk_in_data
      (CLD_USB_Transfer_Params * p_transfer_data)
```

CLD BF70x Bulk Library function used to send data over the Bulk IN endpoint.

Arguments

p_transfer_data	Pointer to a CLD_USB_Transfer_Params structure used to describe the data being transmitted.

Return Value

This function returns the CLD_USB_Data_Transmit_Return_Type type which reports if the Bulk IN transmission request was started. The CLD_USB_Data_Transmit_Return_Type type has the following values:

CLD_USB_TRANSMIT_SUCCESSFUL	The library has started the requested Bulk IN transfer.
CLD_USB_TRANSMIT_FAILED	The library failed to start the requested Bulk IN transfer. This will happen if the Bulk IN endpoint is busy, or if the p_transfer_data-> data_buffer is set to NULL

Details

The cld_bf70x_bulk_lib_transmit_bulk_in_data function transmits the data specified by the p_transfer_data parameter to the USB Host using the Device's Bulk IN endpoint.

The CLD_USB_Transfer_Params structure is described below.

```
typedef struct
{
    unsigned long num_bytes;
    unsigned char * p_data_buffer;
    union
    {
        CLD_USB_Data_Received_Return_Type (*fp_usb_out_transfer_complete)(void);
        void (*fp_usb_in_transfer_complete) (void);
```

```
    }callback;
    void (*fp_transfer_aborted_callback) (void);
    CLD_Time transfer_timeout_ms;
} CLD_USB_Transfer_Params;
```

A description of the CLD_USB_Transfer_Params structure elements is included below:

Structure Element	Description
num_bytes	The number of bytes to transfer to the USB Host. Once the specified number of bytes have been transmitted the usb_in_transfer_complete callback function will be called.
p_data_buffer	Pointer to the data to be sent to the USB Host. This buffer must include the number of bytes specified by num_bytes.
fp_usb_out_transfer_complete	Not Used for Bulk IN transfers
fp_usb_in_transfer_complete	Function called when the specified data has been transmitted to the USB host. This function pointer can be set to NULL if the User application doesn't want to be notified when the data has been transferred.
fp_transfer_aborted_callback	Function called if there is a problem transmitting the data to the USB Host. This function can be set to NULL if the User application doesn't want to be notified if a problem occurs.
transfer_timeout_ms	Bulk OUT transfer timeout in milliseconds. If the Bulk out transfer takes longer then this timeout the transfer is aborted and the fp_transfer_aborted_callback is called. Setting the timeout to 0 disables the timeout

cld_bf70x_bulk_lib_resume_paused_bulk_out_transfer

```
void cld_bf70x_bulk_lib_resume_paused_bulk_out_transfer (void)
```

CLD BF70x Bulk Library function used to resume a paused Bulk OUT transfer.

Arguments

None

Return Value

None.

Details

The cld_bf70x_bulk_lib_resume_paused_bulk_out_transfer function is used to resume a Bulk OUT transfer that was paused by the `fp_bulk_out_data_received` function returning CLD_USB_TRANSFER_PAUSE. When called the cld_bf70x_bulk_lib_resume_paused_bulk_out_transfer function will call the User application's `fp_bulk_out_data_received` function passing the CLD_USB_Transfer_Params of the original paused transfer. The `fp_bulk_out_data_received` function can then chose to accept, discard, or stall the bulk out request.

cld_ lib_usb_connect

```
void cld_lib_usb_connect (void)
```

CLD BF70x Bulk Library function used to connect to the USB Host.

Arguments
None

Return Value
None.

Details
The cld_lib_usb_connect function is called after the CLD BF70x Bulk Library has been initialized to connect the USB device to the Host.

cld_ lib_usb_disconnect

```
void cld_lib_usb_disconnect (void)
```

CLD BF70x Bulk Library function used to disconnect from the USB Host.

Arguments
None

Return Value
None.

Details
The cld_lib_usb_disconnect function is called after the CLD BF70x Bulk Library has been initialized to disconnect the USB device to the Host.

cld_time_125us_tick

```
void cld_time_125us_tick (void)
```

CLD library timer function that should be called once per 125 microseconds.

Arguments
None

Return Value
None.

Details
This function should be called once every 125 microseconds in order to the CLD to processed periodic events.

cld_usb_isr_callback

```
void cld_usb_isr_callback (void)
```

CLD library USB interrupt service routines

Arguments
None

Return Value
None.

Details
These USB ISR functions should be called from the corresponding USB Port Interrupt Service Routine as shown in the CLD provided example projects.

cld_console_tx_isr_callback

```
void cld_console_tx_isr_callback (void)
```

CLD library console UART transmit interrupt service routines

Arguments
None

Return Value
None.

Details
These transmit ISR functions should be called from the corresponding UART transmit Interrupt Service Routine as shown in the CLD provided example projects.

cld_console_rx_isr_callback

```
void cld_console_rx_isr_callback (void)
```

CLD library console UART receive interrupt service routines

Arguments
None

Return Value
None.

Details
These receive ISR functions should be called from the corresponding UART receive Interrupt Service Routine as shown in the CLD provided example projects

cld_time_get

```
CLD_Time cld_time_get(void)
```

CLD BF70x Bulk Library function used to get the current CLD time.

Arguments
None

Return Value
The current CLD library time.

Details
The cld_time_get function is used in conjunction with the cld_time_passed_ms function to measure how much time has passed between the cld_time_get and the cld_time_passed_ms function calls.

cld_time_passed_ms

```
CLD_Time cld_time_passed_ms(CLD_Time time)
```

CLD BF70x Bulk Library function used to measure the amount of time that has passed.

Arguments

`time`	A CLD_Time value returned by a cld_time_get function call.

Return Value
The number of milliseconds that have passed since the cld_time_get function call that returned the CLD_Time value passed to the cld_time_passed_ms function.

Details
The cld_time_passed_ms function is used in conjunction with the cld_time_get function to measure how much time has passed between the cld_time_get and the cld_time_passed_ms function calls.

cld_time_get_125us

```
CLD_Time cld_time_get_125us(void)
```

CLD library function used to get the current CLD time in 125 microsecond increments.

Arguments
None

Return Value
The current CLD library time.

Details
The cld_time_get_125us function is used in conjunction with the cld_time_passed_125us function to measure how much time has passed between the cld_time_get_125us and the cld_time_passed_125us function calls in 125 microsecond increments.

cld_time_passed_125us

```
CLD_Time cld_time_passed_125us(CLD_Time time)
```

CLD library function used to measure the amount of time that has passed in 125 microsecond increments.

Arguments

`time`	A CLD_Time value returned by a cld_time_get_125us function call.

Return Value
The number of 125microsecond increments that have passed since the cld_time_get_125us function call that returned the CLD_Time value passed to the cld_time_passed_125us function.

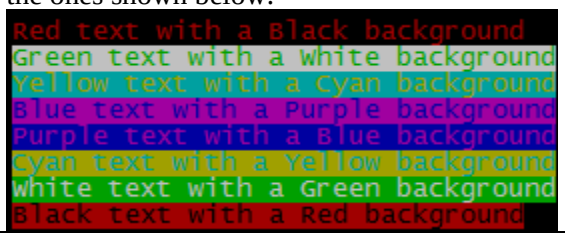
Details
The cld_time_passed_125us function is used in conjunction with the cld_time_get_125us function to measure how much time has passed between the cld_time_get_125us and the cld_time_passed_125us function calls in 125 microsecond increments.

cld_console

```
CLD_RV cld_console(CLD_CONSOLE_COLOR foreground_color, CLD_CONSOLE_COLOR
      background_color, const char *fmt, ...)
```

CLD Library function that outputs a User defined message using the UART specified in the CLD_BF70x_Bulk_Lib_Init_Params structure.

Arguments

foreground_color	The CLD_CONSOLE_COLOR used for the console text. CLD_CONSOLE_BLACK CLD_CONSOLE_RED CLD_CONSOLE_GREEN CLD_CONSOLE_YELLOW CLD_CONSOLE_BLUE CLD_CONSOLE_PURPLE CLD_CONSOLE_CYAN CLD_CONSOLE_WHITE
background_color	The CLD_CONSOLE_COLOR used for the console background. CLD_CONSOLE_BLACK CLD_CONSOLE_RED CLD_CONSOLE_GREEN CLD_CONSOLE_YELLOW CLD_CONSOLE_BLUE CLD_CONSOLE_PURPLE CLD_CONSOLE_CYAN CLD_CONSOLE_WHITE The foreground and background colors allow the User to generate various color combinations like the ones shown below: 
fmt	The User defined ASCII message that uses the same format specifies as the printf function.
...	Optional list of additional arguments

Return Value

This function returns whether or not the specified message has been added to the cld_console transmit buffer.

CLD_SUCCESS	The message was added successfully.
CLD_FAIL	The message was not added, so the message will not be transmitted. This will occur if the CLD Console is disabled, or if the message will not fit into the transmit buffer.

Details

cld_console is similar in format to printf, and also natively supports setting a foreground and background color.
The following will output 'The quick brown fox' on a black background with green text:

```
cld_console(CLD_CONSOLE_GREEN, CLD_CONSOLE_BLACK, "The quick brown %s\n\r", "fox");
```

cld_lib_status_decode

```
char * cld_lib_status_decode (unsigned short status_cod,
                              void * p_additional_data,
                              unsigned short additional_data_size)
```

CLD Library function that returns a NULL terminated string describing the status passed to the function.

Arguments

status_code	16-bit status code returned by the CLD library. Note: If the most significant bit is a '1' the status is an error.
p_additional_data	Pointer to the additional data returned by the CLD library (if any).
additional_data_size	Size of the additional data returned by the CLD library.

Return Value

This function returns a decoded Null terminated ASCII string.

Details

The cld_lib_status_decode function can be used to generate an ASCII string which describes the CLD library status passed to the function. The resulting string can be used by the User to determine the meaning of the status codes returned by the CLD library.

Using the ADSP-BF707 Ez-Board

Connections:

Note about using UART0 and the FTDI USB to Serial Converter

On the ADSP-BF707 Ez-Board the Blackfin's UART0 serial port is connected to a FTDI FT232RQ USB-to-Serial converter. By default the UART 0 signals are connected to the FTDI chip. However, the demo program shipped on the Ez-Board disables the UART0 to FTDI connection. If the FTDI converter is used for the CLD BF70x Bulk Library console change the boot selection switch (located next to the power connector) so the demo program doesn't boot. Once this is done the FTDI USB-to-Serial converter can be used with the CLD BF70x Bulk Library console connected to UART0.

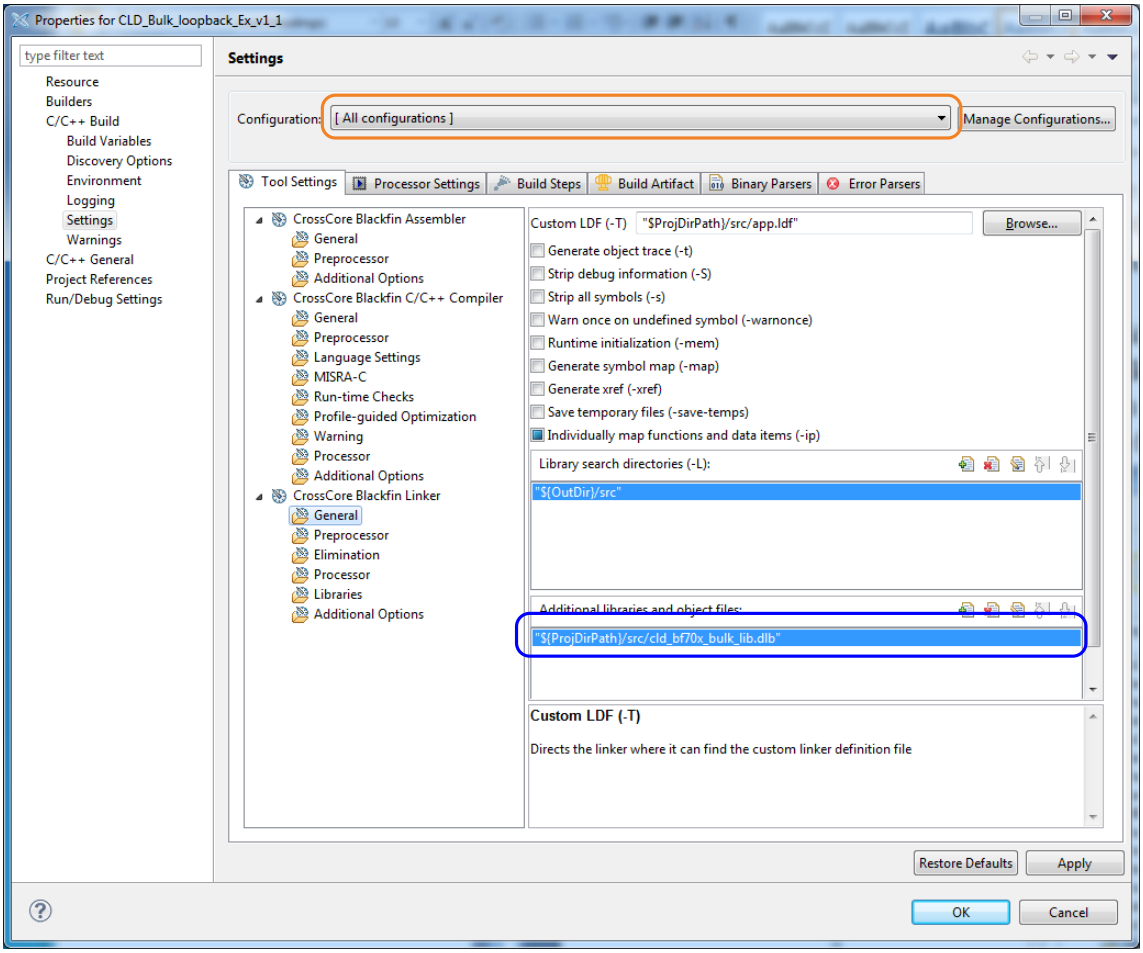
Adding the CLD BF70x Bulk Library to an Existing CrossCore Embedded Studio Project

In order to include the CLD BF70x Bulk Library in a CrossCore Embedded Studio (CCES) project you must configure the project linker settings so it can locate the library. The following steps outline how this is done.

1. Copy the cld_bf70x_bulk_lib.h and cld_bf70x_bulk_lib.dlb files to the project's src directory.
2. Open the project in CrossCore Embedded Studio.
3. Right click the project in the 'C/C++ Projects' window and select Properties.

   If you cannot find the 'C/C++ Projects" window make sure C/C++ Perspective is active. If the C/C++ Perspective is active and you still cannot locate the 'C/C++ Projects' window select Window → Show View → C/C++ Projects.
4. You should now see a project properties window similar to the one shown below.

   Navigate to the C/C++ Build → Settings page and select the CrossCore Blackfin Linker General page. The CLD BF70x Bulk Library needs to be included in the project's 'Additional libraries and object files' as shown in the diagram below (circled in blue). This lets the linker know where the cld_bf70x_bulk_lib.dlb file is located.



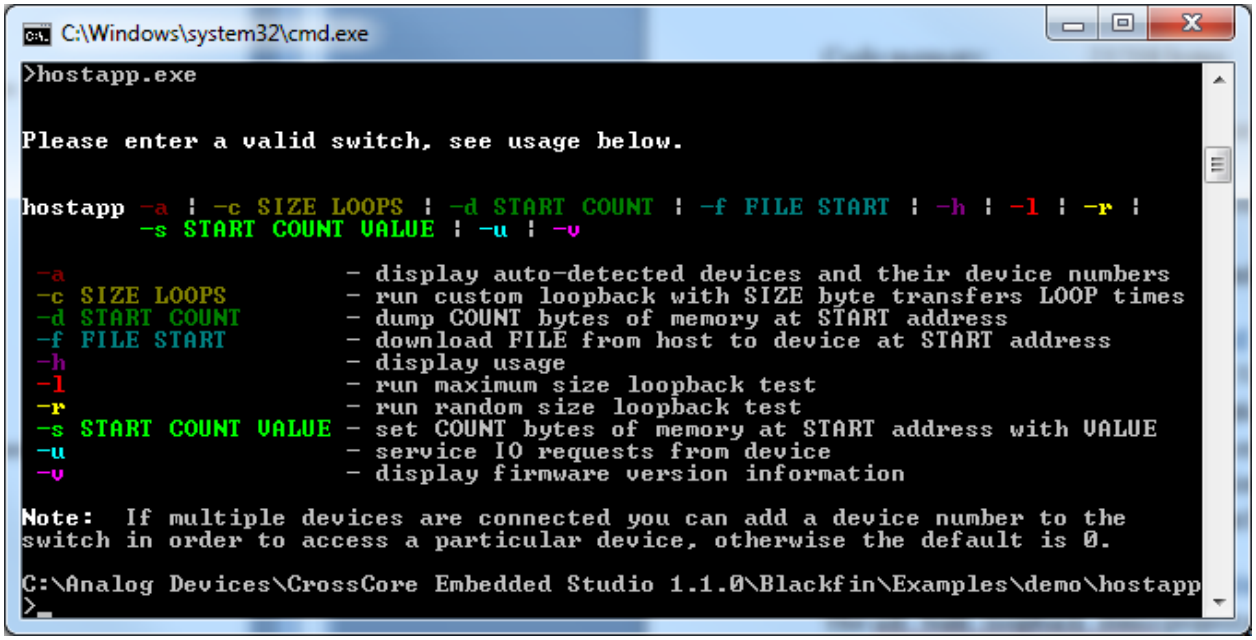
5. The 'Additional libraries and object files' setting needs to be set for all configurations (Debug, Release, etc). This can be done individually for each configuration, or all at once by selecting the [All Configurations] option as shown in the previous figure (circled in orange).

Using ADI hostapp.exe

Analog Devices includes the hostapp application as part of the CrossCore Embedded Studio (CCES), and is located in the following directory (assuming the CCES default installation directory was used):

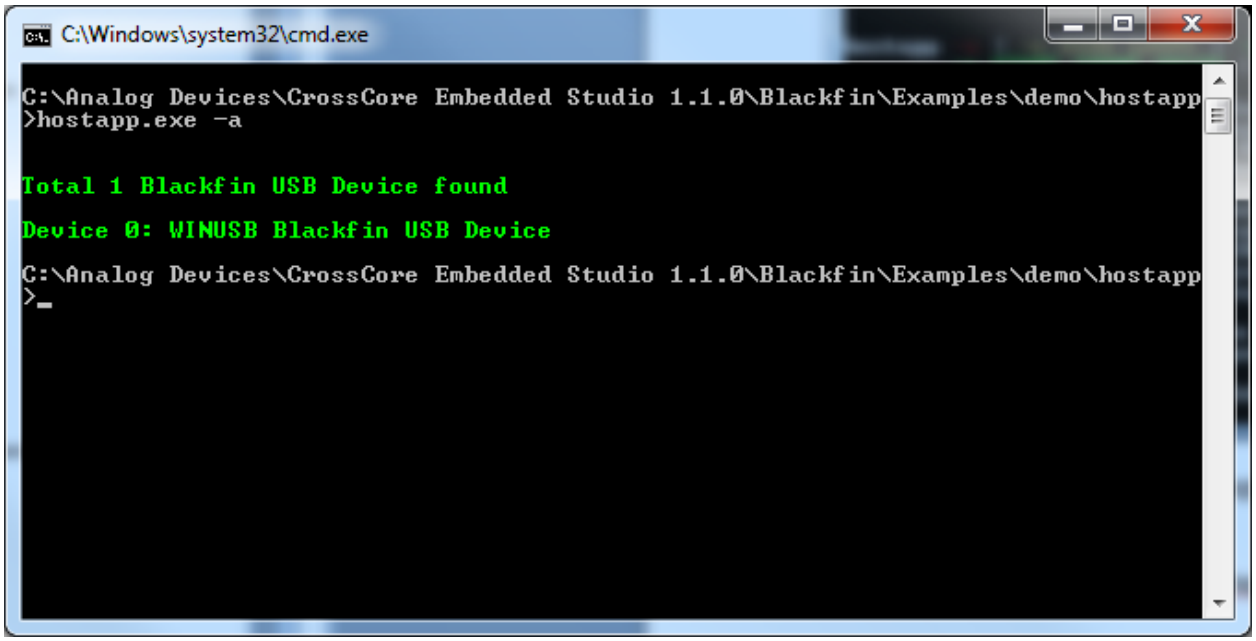
C:\Analog Devices\CrossCore Embedded Studio x.x.x\Blackfin\Examples\demo\hostapp

To launch hostapp navigate to the above directory using the Windows DOS console (type cmd.exe in the Windows Run dialog box). Once there, type hostapp.exe and press Enter to see a list of supported command switches as shown in the screen show below.



Note: The CLD Bulk Loopback Example supports all of the above command switches except for the '-u' switch.

Before going further connect the ADSP-BF707 EZ-Board running the CLD Bulk Loopback Example and try running 'hostapp -a' to display the detected USB devices that support hostapp. If everything is working correctly you should see the following:

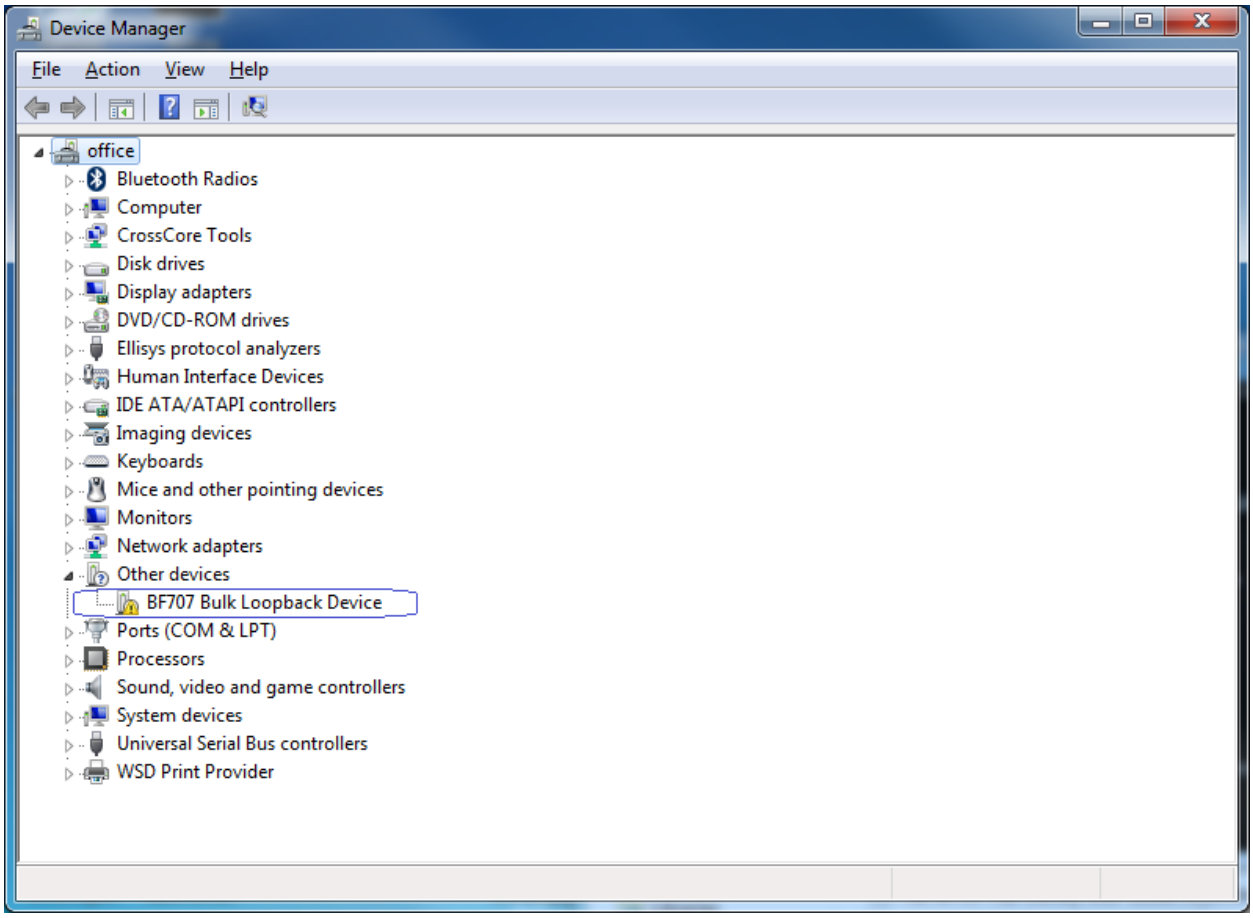


However, if hostapp.exe outputs "Total 0 Blackfin USB Device found" it means that hostapp was not able to detect a hostapp compatible device. If this occurs first check to make sure the CLD Bulk Loop Back Example is running on the ADSP-BF707 EZ-Board, and that you have a USB connected between the USB0 port and one of you PC USB ports. If this doesn't correct the problem the next step is to install the ADI hostapp USB driver as shown in the 'ADI hostapp USB Windows Driver Installation' section of this document.

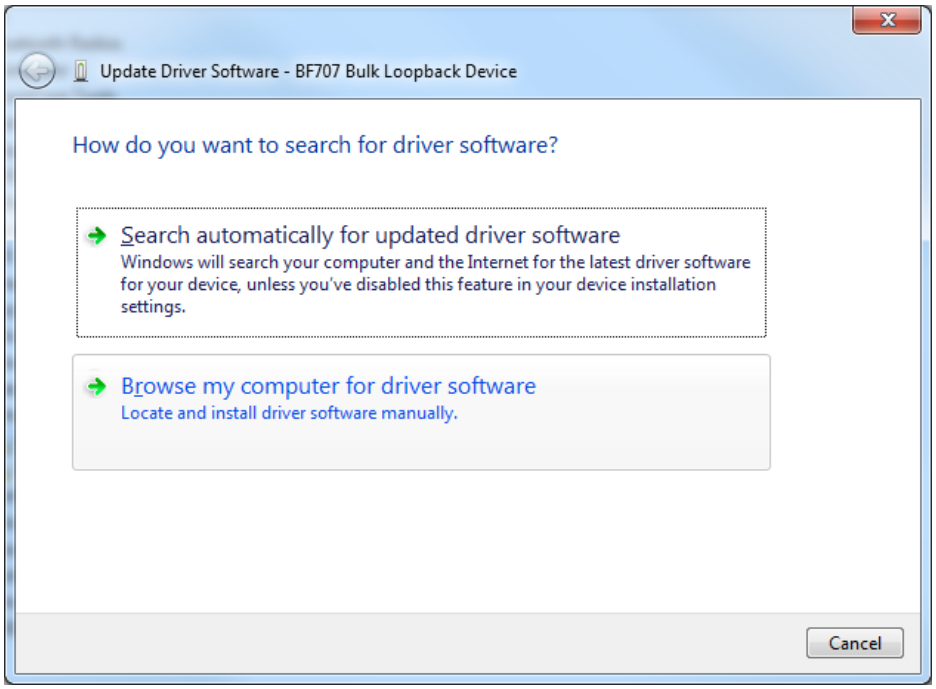
Once the USB driver has been installed you should be ready to run the remaining hostapp command switches (type hostapp.exe or hostapp -h to see the list of supported command switches).

ADI hostapp Windows USB Driver Installation

To install the ADI hostapp Windows USB driver open the Windows Device Manager by running "devmgmt.msc" from the Windows run dialog box. You should see a Device Manager windows similar to the one below.

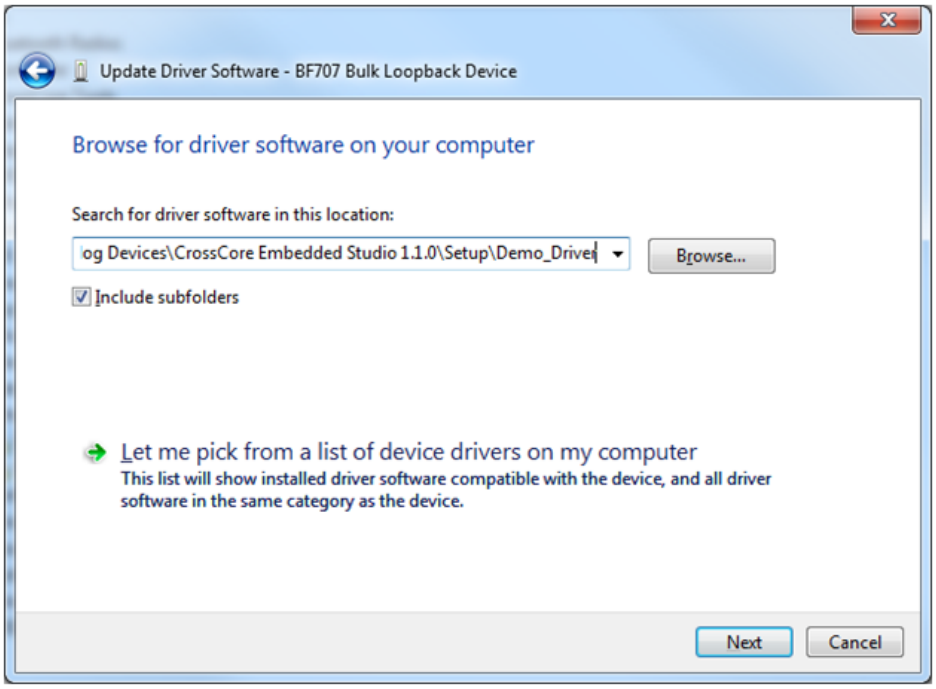


Notice the 'BF707 Bulk Loopback Device' circled in blue. This is the BF707 running the CLD Bulk Loopback Example that is missing the ADI hostapp USB driver. To install the USB driver right click the 'BF707 Bulk Loopback Device' device and select Update Driver Software. You should now see the Update Driver Software dialog box shown below.



Click 'Browse my computer for driver software'

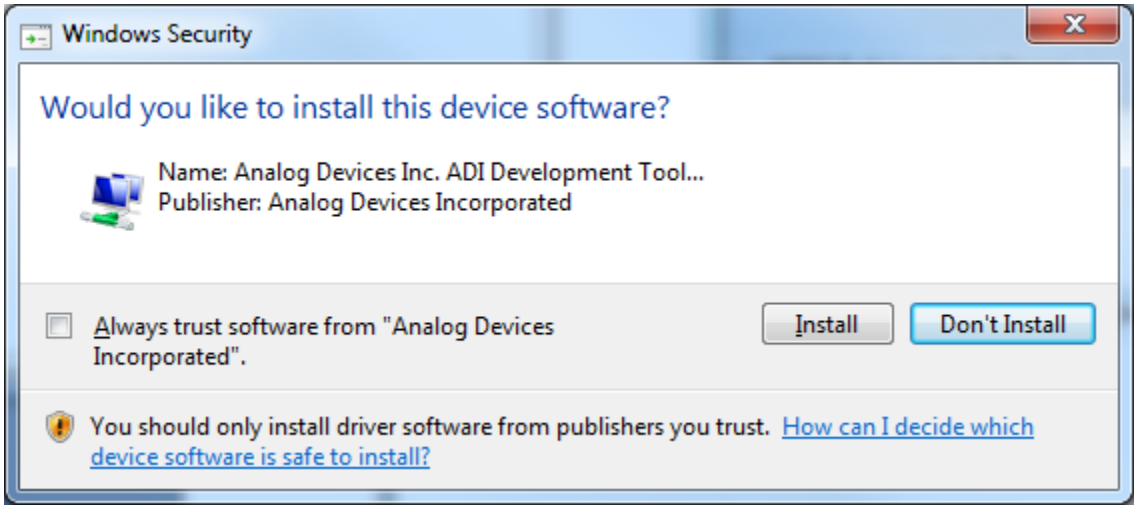
You should now see the following dialog box:



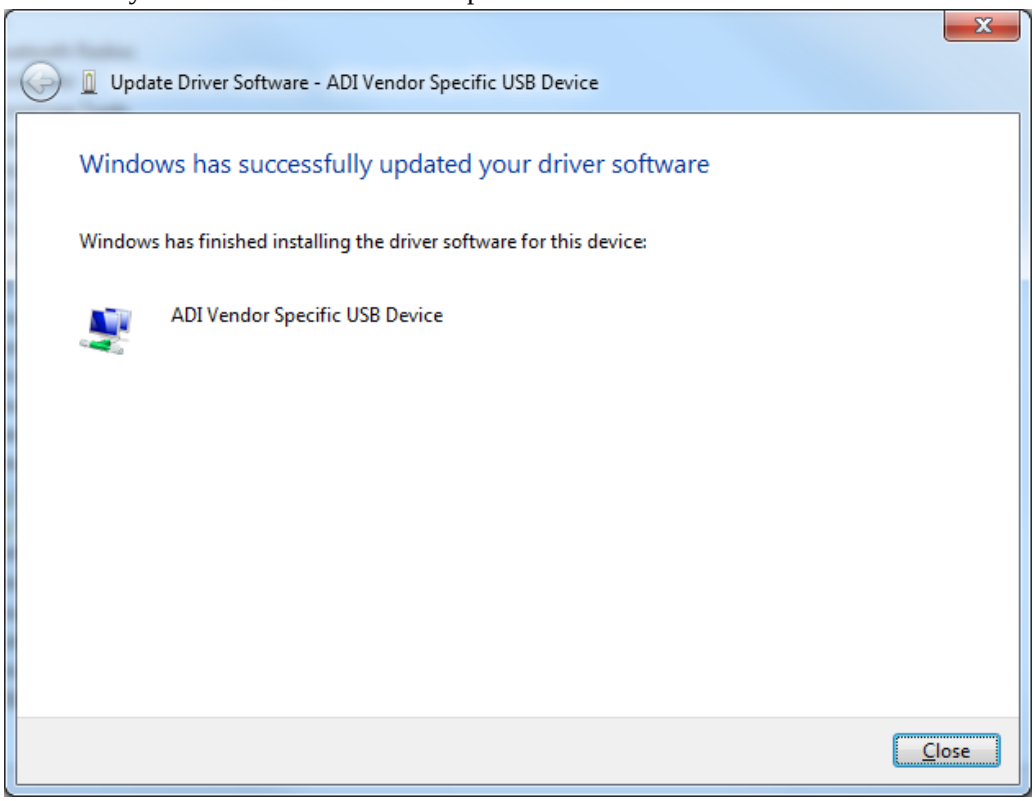
Click 'Browse...' and navigate to the directory containing the ADI hostapp USB driver shown below and click ok.
C:\Analog Devices\CrossCore Embedded Studio x.x.x\Setup\Demo_Driver

Click 'Next'

After clicking next you might see a Windows Security dialog box like the one shown below. If you do, click 'Install' to continue the driver installation.



You should now see the following dialog box showing that the ADI USB driver was installed successfully. Click 'Close' to exit the Update Driver Software wizard.



You should now be able to run hostapp-a and see that hostapp is now successfully detecting the BF707 running the CLD Bulk Loopback Example project.

User Firmware Code Snippets

The following code snippets are not complete, and are meant to be a starting point for the User firmware. For a functional User firmware example that uses the CLD BF70x Bulk Library please refer to the CLD_Bulk_loopback_Ex_v2_0 project included with the CLD BF70x Bulk Library. The CLD_Bulk_loopback_Ex_v2_0 project implements a Bulk IN/Bulk OUT device used by the Analog Devices hostapp.exe included with the Analog Devices CrossCore Embedded Studio.

main.c

```
void main(void)
{
    Main_States main_state = MAIN_STATE_SYSTEM_INIT;

    while (1)
    {
        switch (main_state)
        {
            case MAIN_STATE_SYSTEM_INIT:
                /* Enable and Configure the SEC. */

                /* sec_gctl - unlock the global lock  */
                pADI_SEC0->GCTL &= ~BITM_SEC_GCTL_LOCK;
                /* sec_gctl - enable the SEC in */
                pADI_SEC0->GCTL |= BITM_SEC_GCTL_EN;
                /* sec_cctl[n] - unlock */
                pADI_SEC0->CB.CCTL &= ~BITM_SEC_CCTL_LOCK;
                /* sec_cctl[n] - reset sci to default */
                pADI_SEC0->CB.CCTL |= BITM_SEC_CCTL_RESET;
                /* sec_cctl[n] - enable interrupt to be sent to core */
                pADI_SEC0->CB.CCTL = BITM_SEC_CCTL_EN;
                pADI_PORTA->DIR_SET = (3 << 0);
                pADI_PORTB->DIR_SET = (1 << 1);

                main_state = MAIN_STATE_USER_INIT;
            break;
            case MAIN_STATE_USER_INIT:
                rv = user_bulk_init();
                if (rv == USER_BULK_INIT_SUCCESS)
                {
                    main_state = MAIN_STATE_RUN;
                }
                else if (rv == USER_BULK_INIT_FAILED)
                {
                    main_state = MAIN_STATE_ERROR;
                }
            break;

            case MAIN_STATE_RUN:
                 user_bulk_main();
            break;

            case MAIN_STATE_ERROR:

            break;
        }
    }
}
```

user_bulk.c

```
/* Bulk IN endpoint parameters */
static CLD_Bulk_Endpoint_Params user_bulk_in_endpoint_params =
{
    .endpoint_number            = 1,
    .max_packet_size_full_speed = 64,
    .max_packet_size_high_speed = 512,
};

/* Bulk OUT endpoint parameters */
static CLD_Bulk_Endpoint_Params user_bulk_out_endpoint_params =
{
    .endpoint_number            = 1,
    .max_packet_size_full_speed = 64,
    .max_packet_size_high_speed = 512,
};

/* cld_bf70x_bulk_lib library initialization data. */
static CLD_BF70x_Bulk_Lib_Init_Params user_bulk_init_params =
{
    .uart_num        = CLD_UART_0,
    .uart_baud       = 115200,
    .sclk0           = 100000000u,
    .fp_console_rx_byte = user_bulk_console_rx_byte,
    .vendor_id       = 0x064b,
    .product_id      = 0x7823

    .p_bulk_in_endpoint_params = &user_bulk_in_endpoint_params,

    .p_bulk_out_endpoint_params = &user_bulk_out_endpoint_params,

    .fp_bulk_out_data_received = user_bulk_bulk_out_data_received,

    .usb_bus_max_power = 0,

    .device_descriptor_bcdDevice = 0x0100

    /* USB string descriptors - Set to CLD_NULL if not required */
    .p_usb_string_manufacturer  = "Analog Devices Inc",
    .p_usb_string_product       = "BF707 Bulk Loopback Device",
    .p_usb_string_serial_number = CLD_NULL,
    .p_usb_string_configuration = CLD_NULL,
    .p_usb_string_interface     = "BF707 Bulk Loopback Demo",

    .usb_string_language_id     = 0x0409,               /* English (US) language ID */

    .fp_cld_usb_event_callback  = user_bulk_usb_event,
    .fp_cld_lib_status          = user_audio_status,
};


User_Bulk_Init_Return_Code user_bulk_init (void)
{
    static unsigned char user_init_state = 0;
    CLD_RV cld_rv = CLD_ONGOING;
    User_Bulk_Init_Return_Code init_return_code = USER_BULK_INIT_ONGOING;

    switch (user_init_state)
    {
        case 0:

            /* TODO: add any custom User firmware initialization */
```

```
            user_init_state++;
        break;
        case 1:
            /* Initalize the CLD BF70x Bulk Library */
            cld_rv = cld_bf70x_bulk_lib_init(&user_bulk_init_params);

            if (cld_rv == CLD_SUCCESS)
            {
                /* TODO: Configure a timer to generate an interrupt every 125
                         microseconds, and call cld_time_125us_tick from interrupt. */
                /* TODO: Install USB and optionally the Console UART ISRs. */
                /* Connect to the USB Host */
                cld_lib_usb_connect();

                init_return_code = USER_BULK_INIT_SUCCESS;
            }
            else if (cld_rv == CLD_FAIL)
            {
                init_return_code = USER_BULK_INIT_FAILED;
            }
            else
            {
                init_return_code = USER_BULK_INIT_ONGOING;
            }
    }
    return init_return_code;
}

void user_bulk_main (void)
{
    cld_bf70x_bulk_lib_main();

}

/* Function called when a bulk out packet is received */
static CLD_USB_Transfer_Request_Return_Type
      user_bulk_bulk_out_data_received(CLD_USB_Transfer_Params * p_transfer_data)
{
    p_transfer_data->num_bytes = /* TODO: Set number of Bulk OUT bytes to transfer */
    p_transfer_data->p_data_buffer = /* TODO: address to store Bulk OUT data */

    /* User Bulk transfer complete callback function. */
    p_transfer_data->fp_callback.usb_out_transfer_complete = user_bulk_out_transfer_done;
    p_transfer_params->fp_transfer_aborted_callback = /* TODO: Set to User callback
                                                         function or CLD_NULL */;
    p_transfer_params->transfer_timeout_ms = /* TODO: Set to desired timeout */;

    /* TODO: Return how the Bulk OUT transfer should be handled (Accept, Pause,
             Discard, or Stall */
}

/* The function below is an example if the bulk out transfer done callback specified
   in the CLD_USB_Transfer_Params structure. */
static CLD_USB_Data_Received_Return_Type user_bulk_out_transfer_done (void)
{
    /* TODO: Process the received Bulk OUT transfer and return if the received data is
             good(CLD_USB_DATA_GOOD) or if there is an error(CLD_USB_DATA_BAD_STALL)*/

}

static void user_bulk_console_rx_byte (unsigned char byte)
{
```

```
    /* TODO: Add any User firmware to process data received by the CLD Console UART.*/
}

static void user_bulk_usb_event (CLD_USB_Event event)
{
    switch (event)
    {
        case CLD_USB_CABLE_CONNECTED:
            /* TODO: Add any User firmware processed when a USB cable is connected. */
        break;
        case CLD_USB_CABLE_DISCONNECTED:
            /* TODO: Add any User firmware processed when a USB cable is
               disconnected.*/
        break;
        case CLD_USB_ENUMERATED_CONFIGURED_HS:
        case CLD_USB_ENUMERATED_CONFIGURED_FS:
            /* TODO: Add any User firmware processed when a Device has been
               enumerated.*/
        break;
        case CLD_USB_UN_CONFIGURED:
            /* TODO: Add any User firmware processed when a Device USB Configuration
               is set to 0.*/
        break;
        case CLD_USB_BUS_RESET:
            /* TODO: Add any User firmware processed when a USB Bus Reset occurs. */
        break;
    }
}

/* The following function will transmit the specified memory using
   the Bulk IN endpoint. */
static user_bulk_transmit_bulk_in_data (void)
{
    static CLD_USB_Transfer_Params transfer_params;

    transfer_params.num_bytes = /* TODO: Set number of Bulk IN bytes */
    transfer_params.p_data_buffer = /* TODO: address Bulk IN data */
    transfer_params.callback.fp_usb_in_transfer_complete = /* TODO: Set to User
                                                              callback function or
                                                              CLD_NULL */;
    transfer_params.callback.fp_transfer_aborted_callback = /* TODO: Set to User
                                                             callback function or
                                                             CLD_NULL */;
    p_transfer_params->transfer_timeout_ms = /* TODO: Set to desired timeout */;

    if (cld_bf70x_bulk_lib_transmit_bulk_in_data(&transfer_params) ==
              CLD_USB_TRANSMIT_SUCCESSFUL)
    {
        /* Bulk IN transfer initiated successfully */
    }
    else /* Bulk IN transfer was unsuccessful */
    {
    }
}


static void user_cld_lib_status (unsigned short status_code, void * p_additional_data,
                                 unsigned short additional_data_size)
{
    /* TODO: Process the library status if needed.  The status can also be decoded to
             a USB readable string using cld_lib_status_decode as shown below: */
```

```
    char * p_str = cld_lib_status_decode(status_code, p_additional_data,
                                         additional_data_size);
}
```